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Biodiversity of Cladocera (Crustacea: Branchiopoda) in a Natural Freshwater Mountain Lake in Arunachal Pradesh, India

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ABSTRACT
Seventeen species of Cladocera belonging to 13 genera under seven families are reported from Ganga Lake, a natural mountain lake located within the Itanagar Wildlife Sanctuary near the capital city of Itanagar. This is the first species-level report of Cladocera from the lake which is characterised by mainly cosmopolitan and circumtropical elements including one Oriental endemics, *Flavalona cheni*. The necessity of documenting Cladocera fauna of the lake in view of its usage for fish farming and the anthropogenic pressure exerted by virtue of its location near a capital city is highlighted.

KEYWORDS: Eastern Himalaya, Papumpare, Itanagar Wildlife Sanctuary, biotope, endemic

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INTRODUCTION

Cladocera are minute branchiopods and are amongst the smallest crustaceans known to exist. They are omnipresent in all aquatic ecosystems including the continental shelf and the Antarctic, but predominant in the freshwaters. Though cladocera are ubiquitous in all forms of freshwaters, their typical habitat is, however, large perennial lakes, and beels (Greaves, 2012) where all the different zones of the water body are exploited by the group. Cladocera constitute an important component of lake plankton and contribute significantly to the functioning of lakes including its food chain and energy flow. These are also used as indicators of lake health.

Arunachal Pradesh, often synonymous with the "Eastern Himalaya" biodiversity hotspot lies in the easternmost part of India, bordering China and Myanmar. The state is very rich in water resources and has a total wetland area of about 1557 sq. km. which accounts for around 1.91 per cent of the total geographic area of the state (SAC, 2009). Lakes, both natural and man-made, present along the altitudinal gradient are one of the major types of wetlands in the state. There are about 1406 lakes/reservoirs/barrages with a cumulative area of about 203.65 sq. km. in the state and that's around 13 per cent of the state's total wetland area. These wetlands are of immense significance in maintaining ecological, hydrological, biological as well as cultural features of the landscape.

Gyakar Sinyik which is popularly known as Ganga Lake or Itanagar Lake in the Papumpare district in central Arunachal Pradesh is one among the thousands of lakes in the state. It is a somewhat ovuculate-triangular lake of about 4 sq. km. located at approximately 93.5679 E

longitude and 27.07456 N latitude near the capital city of Itanagar (Figure 1) and falls within the boundary of Itanagar Wildlife Sanctuary. For details about the origin, morphology, hydrological features and importance of the lake please refer to Sinha & Tamang (2012), Sinha (2023).

Out of about 700 species of Cladocera known globally (Kotov et al, 2013), around 139 species belonging to 55 genera and 12 families in four orders are recorded from India (Chatterjee et al, 2013; Sinha, 2024a). The state of Cladoceran study in the Himalayan state of Arunachal Pradesh is not encouraging; it took off very late, may be because of the inaccessible nature of the terrain. The first comprehensive review of the studies on the Cladocera of Arunachal Pradesh reported the occurrence of 20 species (Sinha, 2018). Subsequently, Saikia et al (2023) added another 14 species taking the tally to 34 species of Cladocera in the state. Recently, Sinha (2024b) reported 17 species of Cladocera under 12 genera and 7 families from the Tale Wildlife Sanctuary of the state including one new India record and four new additions to the state. As of now, 52 species of Cladocera are known from the state (Sinha 2025a, *in press*).

However, there are no biotope specific Cladoceran studies from the state like that of Ganga Lake though the state is well known for its unique ecosystems like high-altitude lakes, hot springs, cold springs and similar others. It is apparent from a thorough perusal of available literature that virtually nothing is known about the Cladoceran diversity of Ganga Lake except for some generic level reports. During a limnological study of the lake, Nath (1987) recorded three genera of Cladocera namely *Bosminopsis* sp., *Alona* sp. and *Diaphanosoma* sp. (misspelled as *Diapnosoma*). An article on ecological features of upland wetlands in Arunachal Pradesh by Sarma et al (2017) mentions the occurrence of six genera of Cladocera in the Ganga Lake. However, in the text, only three genera are mentioned which are *Daphnia* sp., *Moina* sp. and *Bosmina* sp. Nanda et al, (2020) reported *Bosmina* sp., *Sida* sp., and *Ceriodaphnia* sp., from the Ganga Lake. The present study is the first species level report of the Cladoceran diversity of Ganga Lake.

Figure 1: Birds's eye view of Ganga Lake, Itanagar, Arunachal Pradesh, India (Source: Google Earth)

MATERIALS AND METHODS

Water samples for qualitative study of Cladocera were collected from the lake quarterly during 2018-19 to include all the four climatic seasons. Four samples, one each from the east, west, north and south sides of the lake were collected during each sampling season. Water samples were collected from both the littoral and limnetic zones of the lake in the morning hours using a 50 µm mesh size Nylobolt plankton net. In the littoral zone, aquatic vegetation was disturbed prior to plankton sampling to dislodge the associated plankter. 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. Screening of plankton samples was done under a stereoscopic binocular microscope of Leica make and individual Cladocera specimens were segregated with the help of a fine camel hair brush. The specimens were stained with freshly prepared Rose Bengal stain for ease of identification. Individual taxa were identified using a Nikon Eclipse compound microscope equipped with NIS Elements-D software with the help of (Goulden, 1968; Smirnov and Timms, 1983; Smirnov, 1971, 1976, 1992, 1996; Michael and Sharma, 1988; Korinek, 2002; Korovchinsky, 1992; Bledzki and Rybak, 2016; Sinev, 2016; Sinev and Dumont, 2016; Sharma and Sharma, 1999). Generalised literatures like Michael (1973), Fernando (2002) were consulted for overall collection, identification and preservation processes. Glass slides were used for storing all the identified specimens and were deposited in the National Zoological Collection in Arunachal Pradesh Regional Centre, Zoological Survey of India, Itanagar. All measurements are in mm. Classification of Cladocera is as per Bledzki and Rybak (2016) and species under a genus are arranged alphabetically. Indian and global distribution of taxa is after Chatterjee et al. (2013) and Kotov et al. (2013) respectively, if otherwise mentioned.

RESULTS

Systematic Account of Species

Class Branchiopoda
Subclass **Phyllopoda**
Order **Diplostraca**
Suborder **Cladocera**
Infraorder **Ctenopoda**
Family **Sididae**
Subfamily **Sidinae**
Genus ***Diaphanosoma*** Fischer, 1850

1. *Diaphanosoma excisum* Sars, 1885
Material examined: 5 exs., 0.65-0.93 mm, 25.vi.2019, Coll. B. Sinha, APRC-CL-0114.
Distribution: INDIA: Arunachal Pradesh-L. Dibang Valley (Sinha, 2025b, *in press*), Papumpare (Sinha, 2025a, *in press*); throughout India.
Elsewhere: Afrotropical, Australasian, Oriental and Palaearctic.

2. *Diaphanosoma sarsi* Richard, 1895
Material examined: 7 exs., 0.87-1.13 mm, 27.x.2018, Coll. B. Sinha, APRC-CL-0110.
Distribution: INDIA: Arunachal Pradesh-E. Kameng (Sinha et al., 2002), L. Dibang Valley (Sinha, 2025b, *in press*), Papumpare (Sinha, 2025a, *in press*); throughout India.
Elsewhere:
Afrotropical, Australasian, Palaearctic, Pacific and Oriental.

Infraorder **Anomopoda**
Family **Bosminidae**
Genus ***Bosmina*** Baird, 1845
Subgenus ***Bosmina*** s.str. Baird, 1845

3. *Bosmina (B.) longirostris* (O. F. Müller, 1776)
Material examined: 16 exs., 0.26-0.38 mm, 24.vii.2018, Coll. B. Sinha, APRC-CL-0050.
Distribution: INDIA: Arunachal Pradesh- E. Kameng (Sinha et al, 2002), L. Subansiri (Saikia et al, 2023; Sinha, 2024b), U. Dibang Valley (Sinha, 2024c), Papumpare (Sinha, 2025a, *in press*); almost throughout India.
Elsewhere: Cosmopolitan.

Family **Moinidae**
Genus ***Moina*** Baird 1850

4. *Moina micrura* Kurz, 1874

Material examined: 3 exs., 0.43-0.51 mm, 27.x.2018, Coll. B. Sinha, APRC-CL-0109; 3 exs., 0.37-0.49 mm, 25.vi.2019, Coll. B. Sinha, APRC-CL-0111.
Distribution: INDIA: Arunachal Pradesh-E. Kameng (Sinha et al, 2002), L. Subansiri (Saikia et al, 2023; Sinha, 2024b), L. Dibang Valley (Sinha, 2025b, *in press*), Papumpare (Sinha, 2025a, *in press*); throughout India.
Elsewhere: Cosmopolitan.

Family **Macrothricidae**
Genus ***Macrothrix*** Baird, 1843

5. *Macrothrix spinosa* King, 1853
Material examined: 3 exs., 0.28-0.37 mm, 25.vi.2019, Coll. B. Sinha, APRC-CL-0113.
Distribution: INDIA: Arunachal Pradesh-L. Subansiri (Saikia et al, 2023; Sinha, 2024b), Tawang (Sinha, 2018), Papumpare (Sinha, 2025a, *in press*); almost throughout India.
Elsewhere: Cosmopolitan.

6. *Macrothrix triserialis* Brady, 1886
Material examined: 1 ex., 0.43 mm, 24.vii.2018, Coll. B. Sinha, APRC-CL-0107.
Distribution: INDIA: Arunachal Pradesh-L. Subansiri (Saikia *et al*. 2023), E. Kameng, Papumpare (Sinha 2025a, *in press*); almost throughout India.
Elsewhere: Circumtropical.

Family **Ilyocryptidae**
Genus ***Ilyocryptus*** Sars, 1862

7. *Ilyocryptus spinifer* Herrick, 1882
Material examined: 1 ex., 0.49 mm, 24.vii.2018, Coll. B. Sinha, APRC-CL-0051.
Distribution: INDIA: Arunachal Pradesh- L. Subansiri (Sinha, 2024b), L. Dibang Valley (Sinha, 2025b, *in press*), Tawang (Sharma et al, 2017), Papumpare (Sinha, 2025a, *in press*); almost throughout India.
Elsewhere: Cosmopolitan.

Family **Chydoridae**
Subfamily **Aloninae**
Genus ***Alona*** Baird, 1843

8. *Alona guttata* G.O. Sars, 1862
Material examined: 1 ex., 0.37 mm, 28.i.2021, Coll. B. Sinha, APRC-CL-0120.
Distribution: INDIA: Arunachal Pradesh-E. Kameng (Sinha et al, 2002), L. Subansiri (Saikia et al, 2023; Sinha, 2024b), Papumpare (Sinha, 2025a, *in press*); Assam, Bihar, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Rajasthan, Tamil Nadu, Tripura, Uttarakhand, Andaman & Nicobar Islands, Jammu & Kashmir and Ladakh.
Elsewhere: Cosmopolitan.

Genus ***Coronatella*** Dybowski & Grochowski, 1894

9. *Coronatella rectangula* (Sars, 1862) s. lat.
Material examined: 2 exs., 0.31-0.33 mm, 28.i.2021, Coll. B. Sinha, APRC-CL-0121.
Distribution: INDIA: Arunachal Pradesh-Papumpare (Sinha, 2025a, *in press*); almost throughout India as *Alona rectangula*.
Elsewhere: Cosmopolitan (Van Damme and Dumont, 2008).

Genus ***Flavalona*** Sinev & Dumont, 2016

10. *Flavalona cheni* (Sinev, 1999)
Material examined: 02 exs., 0.41-0.49 mm, 24.vii.2018, Coll. B. Sinha, APRC-CL-0049.
Distribution: INDIA: Arunachal Pradesh, W. Kameng (Biswas, 1964 as *Alona costata*), unknown place (Sharma and Sharma, 2013), TWS in Lower Subansiri (Sinha, 2024b), MWS in L. Dibang Valley (Sinha, 2025b, *in press*); almost across India as *A. costata* (Sharma and Sharma, 2017).
Elsewhere: Oriental.
Remarks: *F. cheni* as such is known with certainty from Assam (Sharma and Sharma, 2013); Gujarat (Sinev, 1999) and Kerala (Subhash Babu and Thomas, 2007). All the Indian records of *A. costata* may be misidentifications of *F. cheni* or some other species of the *costata* group (Sharma and Sharma, 2017).

Genus ***Ovalona*** Van Damme & Dumont, 2008

11. *Ovalona cambouei* (Guerne & Richard, 1983) Sinev, 2015
Material examined: 1 ex., 0.36 mm, 24.vi.2018, Coll. B. Sinha, APRC-CL-0103.
Distribution: INDIA: Arunachal Pradesh-L. Subansiri (Sinha, 2024b), Papumpare (Sinha, 2025a, *in press*); Jharkhand, Maharasthra, Rajasthan, Tamil Nadu as *Alona cambouei*, Karnataka (Sinev, 2015).
Elsewhere: Circumtropical (Sinev, 2015).

Subfamily **Chydorinae**
Genus ***Chydorus*** Leach, 1816

12. *Chydorus pubescens* Sars, 1901
Material examined: 3 exs., 0.37-0.45 mm, 24.vii.2018, Coll. B. Sinha, APRC-CL-0106.
Distribution: INDIA: Arunachal Pradesh-Tawang (Sharma et al, 2017), Papumpare (Sinha, 2025a, *in press*); Assam, Bihar, Meghalaya, Tripura, West Bengal and Andaman & Nicobar Islands.
Elsewhere: Circumtropical (Smirnov, 1996).

13. *Chydorus sphaericus* (O. F. Müller, 1776)
Material examined: 2 exs., 0.31-0.37 mm, 25.vi.2019, Coll. B. Sinha, APRC-CL-0115.
Distribution: INDIA: Arunachal Pradesh-L. Subansiri (Saikia et al, 2023; Sinha, 2024b), L. Dibang Valley (Sinha, 2025b, *in press*), Pakke Kessang, Papumpare (Sinha, 2025a, *in press*), U. Dibang Valley (Sinha, 2024c), W. Kameng (Sinha, 2020), Tawang (Sharma et al, 2017); throughout India. **Elsewhere:** Cosmopolitan.

Genus ***Disparalona*** Fryer, 1968

14. *Disparalona rostrata* (Koch, 1841)
Material examined: 1 ex., 0.43 mm, 25.vi.2019, Coll. B. Sinha, APRC-CL-0118.
Distribution: INDIA: Arunachal Pradesh-Papumpare (Sinha, 2025a, *in press*), Tripura Venkatraman (1995).
Elsewhere: Oriental and Palearctic.

Genus ***Ephemeroporus*** Frey, 1982

15. *Ephemeroporus barroisi* (Richard, 1894)
Material examined: 1 ex., 0.27 mm, 25.vi.2019, Coll. B. Sinha, APRC-CL-0116.
Distribution: INDIA: Arunachal Pradesh-L. Subansiri (Saikia et al, 2023), Papumpare (Sinha, 2025a, *in press*); almost throughout India.
Elsewhere: Cosmopolitan.
Remarks: Saikia et al, (2023) reported this species from the paddy-cum-fish culture fields of Ziro Valley in Arunachal Pradesh with the generic name misspelt as '*Ephimrous*'.

Genus ***Picripleuroxus*** Frey 1993

16. *Picripleuroxus laevis* Sars, 1862 s. lat.
Material examined: 2 exs., 0.33-0.49 mm, 24.vii.2018, Coll. B. Sinha, APRC-CL-0104; 6 exs., 0.45-0.52 mm, 25.vi.2019, Coll. B. Sinha, APRC-CL-0117.
Distribution: INDIA: Arunachal Pradesh-L. Dibang Valley (Sinha, 2025b, *in press*), Papumpare (Sinha, 2025a, *in press*); Assam, Maharashtra, Manipur, Uttarakhand and Jammu & Kashmir.
Elsewhere: Afrotropical, Nearctic, Oriental (Indomalaya), Palaearctic.

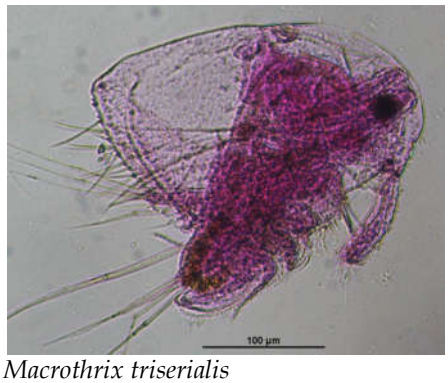
17. *Picripleuroxus similis* Vavra, 1900 s. lat.
Material examined: 3 exs., 0.41-0.47 mm, 24.vii.2018, Coll. B. Sinha, APRC-CL-0102.
Distribution: INDIA: Arunachal Pradesh-L. Dibang Valley (Sinha, 2025b, *in press*), Papumpare (Sinha, 2025a, *in press*); Assam, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Rajasthan, West Bengal, Andaman & Nicobar Islands and Jammu & Kashmir.
Elsewhere: Afrotropical, Nearctic and Oriental.

Photo Plate


Bosmina (B.) longirostris


Moina micrura

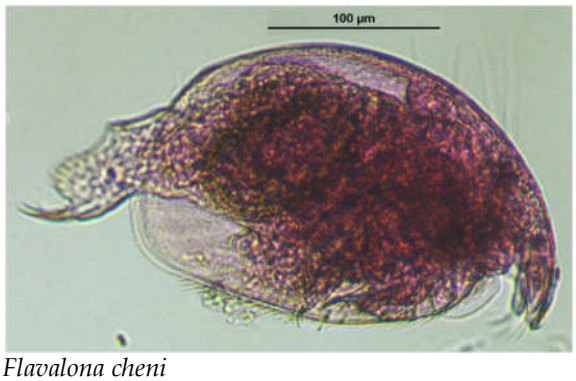

Macrothrix spinosa



Macrothrix triserialis

Ilyocryptus spinifer

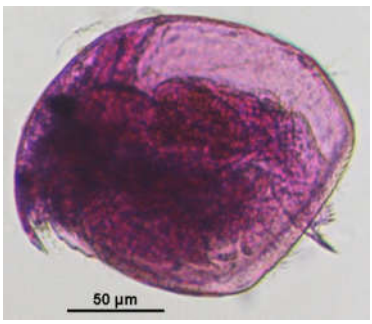
Coronatella rectangula



Flavalona cheni

Disparalona rostrata

Ovalona cambouei



Ephemeroporus barroisi

Picripleuroxus laevis

DISCUSSION AND CONCLUSION

In the present study, 17 species of Cladocera belonging to 13 genera under seven families have been recorded from Ganga Lake, in Itanagar, Arunachal Pradesh which has certainly enhanced our knowledge of the cladoceran diversity of the lake than the earlier only generic level reports of Nath (1987), Sarma et al (2017) and Nanda et al (2020). All the 17 species reported here are not only recorded for the first time from the lake but also from the district of Papumpare as a whole which lies in the central part of the state. This is in spite of the fact that the capital city Itanagar lies in this district and hosts quite a good number of academic and research institutes.

The Cladoceran diversity of Ganga Lake is comprised mainly of limnetic elements and is characterised by mostly cosmopolitan and circumtropical elements except one oriental endemics, *Flavalona cheni*. The cladocerans are an integral component of the aquatic food chain in lakes and an important link of the aquatic microfaunal food web. They are the major prey

items for innumerable aquatic invertebrates and vertebrates and invariably comprise foods of fry, fingerlings and adults of different native and economically important commercial species of fishes. As Ganga Lake is known to be used for rearing of commercial fishes including game fishes, an understanding of the diversity and density of zooplankton groups like the cladoceran community is quite essential. Further, as the lake is very close to the capital city, it is one of the major attractions among tourists resulting in a lot of anthropogenic interference. Thus, monitoring of cladoceran population of the lake may provide clues about the nature of the lake water as this group is widely used as an indicator of water quality and/or pollution.

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Declaration
Authors' contribution: The author is responsible for collection, identification of the species and preparation of the manuscript
Conflict of Interest: There is no conflict of interest.
Data availability statement: All the information regarding data availability is included in the manuscript.
Ethical Statement and approval, if any: There is no human participation in the study.
Informed consent statement, if applicable: There is no human participation in the study.
Declaration of AI: The study does not involve any use of AI.

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