ANSF APPLIED AND NATURAL SCIENCE FOUNDATION

Journal of Applied and Natural Science
17(2), 518 - 529 (2025)
ISSN : 0974-9411 (Print), 2231-5209 (Online)
journals.ansfoundation.org

Research Article

Ecology, abundance and richness of zooplankton in Chandubi Wetland, Assam, Northeast India

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Article Info
https://doi.org/10.31018/jans.v17i2.6164
Received: September 04, 2024
Revised: April 28, 2025
Accepted: May 09, 2025

How to Cite
Pathak, J. and Goswami, M. M. (2025). Ecology, abundance and richness of zooplankton in Chandubi Wetland, Assam, Northeast India. *Journal of Applied and Natural Science*, 17(2), 518 - 529. https://doi.org/10.31018/jans.v17i2.6164

Abstract
Zooplankton, being the primary consumers in an aquatic ecosystem, convert plant proteins into animal proteins and play a significant role in nutrient cycling. Northeast India is endowed with numerous wetlands but limnological evaluation of most of these wetlands remains unattended or leaves gaps and information on zooplankton diversity is insufficient. The present study aimed to assess the zooplankton diversity and temporal variation in their richness and abundance in relation to the physico-chemical attributes of Chandubi wetland for period of one year in 2021. The investigation revealed the occurrence of 79 species belonging to 7 groups: Protozoa (20 species), Gastrotricha (2 species), Rotifera (32 species), Copepoda (8 species), Cladocera (15 species), Conchostraca (1 species), and Ostracoda (1 species). The abundance of these groups was ranked as: Rotifera (67.3%) > Cladocera (14.6%) > Copepoda (9.2%) > Protozoa (8.2%) > Conchostraca and Ostracoda (> 1%). The trend of zooplankton richness in different seasons was- monsoon > retreated monsoon > pre-monsoon > winter, while their abundance was- pre-monsoon > winter > retreated monsoon > monsoon. Zooplankton density showed a significant ($p<0.05$) positive correlation with pH, Dissolved oxygen and Secchi disk transparency while it showed a negative correlation with temperature and free carbon dioxide. CCA plot revealed the abundance of Protozoa in the sampled wetland was influenced by calcium, total hardness and water temperature, while that of Rotifera by phosphate, Copepoda by total hardness and calcium, and Cladocera by nitrate content of the water. High dominance of rotifers indicated the prevalence of eutrophic conditions in the wetland.

Keywords: Abundance, Chandubi, Richness, Wetland, Zooplankton

INTRODUCTION

Zooplankton is comprised of a diverse array of organisms that serve as primary consumers and play a key role in the nutrient flow in aquatic ecosystems. Besides being the food for zooplanktovorous fishes, several zooplankton species act as bio-indicators and depict the ecological status of water bodies. Environmental variables influence the diversity and community structure of zooplankton, thereby they exhibit temporal variations in their richness and abundance (Welch, 1952; Wetzel, 2001; Kalff, 2002; Aranguren-Riano *et al*., 2011; Nandy and Mandal, 2019; Singh and Sharma, 2020; Xiong *et al*., 2020).

The northeastern region of India is a biodiversity hotspot and encompasses many good floodplain lakes or wetlands (locally known as beel). These wetlands play an important role in groundwater recharge, storage of flood water, nutrient recycling, maintenance of food chain and fisheries production. Limnological assessments of most of these wetlands have remained unattended, and no management policies have been planned. As such, a few of them have undergone rapid succession to become terrestrial habitat. Nonetheless, Goswami (1985, 1988) and Goswami *et al*. (1999) carried out many limnological investigations in certain floodplain wetlands of Assam and documented important baseline data on the hydrography, water quality and plankton community of these wetlands. Later, Sharma (2011) studied the zooplankton community of the Deepor *beel* wetland and Sharma and Hatimuria (2017) recorded the zooplankton diversity in three wetlands of Majuli Island, Assam . Afterwards, works on zooplankton from the wetlands of this region has remained paused, and no recent findings have been available. In view of this paucity in limnological work, the present study was intended in Chandubi wetland.

MATERIALS AND METHODS

Study area

Chandubi wetland is located on the Assam-Meghalaya border and spans approximately 91°24' to 91°25' longitude and 25°52' to 25°53' latitude between the southern Brahmaputra valley in the Kamrup district of Assam, India (Fig. 1). The wetland is tectonic in origin (Oldham, 1899) with irregular shoreline and holds several dendrites. Initially covering approximately 712 hectares, the current basin area of the wetland has shrunk to about 271 hectares due to siltation and succession processes, and the catchment area is approximately 56 square kilometers.

Physico-chemical parameters of water

To monitor monthly fluctuations in physico-chemical parameters, water samples were collected for a year (from January to December 2019) from the epilimnion of the open water region of the wetland. Selected physicochemical parameters included Water Temperature (WT), pH, Transparency (ST), Dissolved Oxygen (DO), Free Carbon Dioxide (FCO), Total Alkalinity (TA), Total Hardness (TH), as well as nutrient content analysis for Nitrate (NO_3), Phosphate (PO_4), Calcium (Ca), and Ammonium (NH_4). WT and pH were measured using field probes, transparency was assessed using a Secchi disc, DO was determined using a modified Winkler's method (Winkler,1888), and other parameters were analyzed according to APHA (1992).

Study of zooplankton

For qualitative and quantitative zooplankton studies, separate samples were collected monthly. Qualitative samples were obtained through towing, while quantitative samples involved filtering 1000 litres of water using a nylobolt plankton net (No. 25) through entire length of the wetland at random locations. Bottom samples were collected using Mayer's water sampler, and a common sample was prepared by mixing them with surface samples. Before mixing, each sample was gently and carefully shaken to maintain homogeneity. Subsequently, 50ml each of surface and bottom samples were mixed to create a 100ml plankton sample. The collected samples were preserved in 4% formalin and later analyzed in the laboratory using a Labomed stereoscopic microscope. Zooplankton species were identified with the aid of standard keys from Pennak (1953), Edmondson (1959), and Battish (1992). Quantitative samples were analyzed using a Sedgwick Rafter Plankton Counter (SRPC) with a 1ml capacity, following the method outlined by Welch (1948).

Statistical analysis

Zooplankton diversity was assessed using the Shannon -Weaver diversity index, Dominance, Margalef richness, and Evenness index. Multivariate correlation analysis was conducted to determine ecological relationships between all biotic and abiotic parameters. Canonical correspondence analysis was employed to assess the cumulative influence of eleven abiotic parameters (WT, pH, ST, DO, FCO, TA, TH, NO_3, PO_4, Ca, and NH_4) on zooplankton assemblages. Statistical

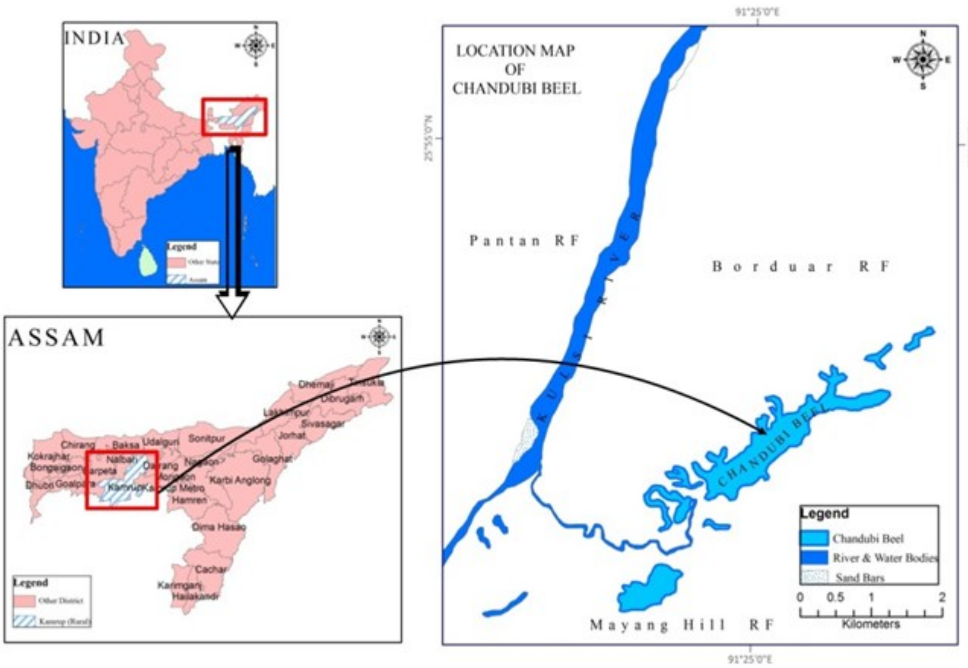

Fig. 1. *Geographic location map of Chandubi wetland (Beel)*

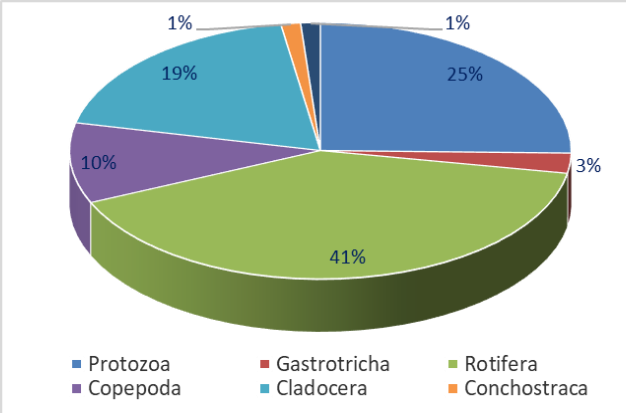

Fig. 2. *Percentage distribution of richness of zooplankton groups in Chandubi wetland*

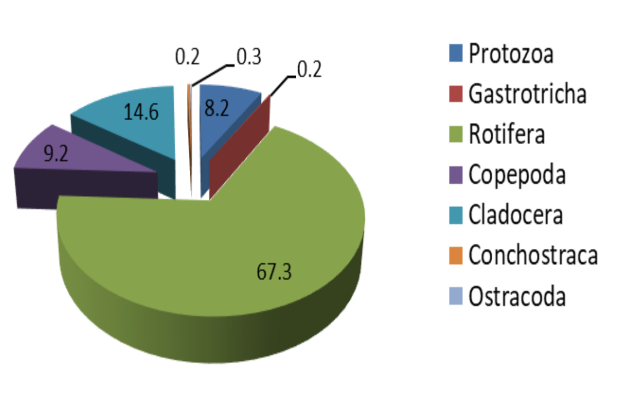

Fig. 3. *Percentage contribution of zooplankton groups to overall abundance in Chandubi wetland*

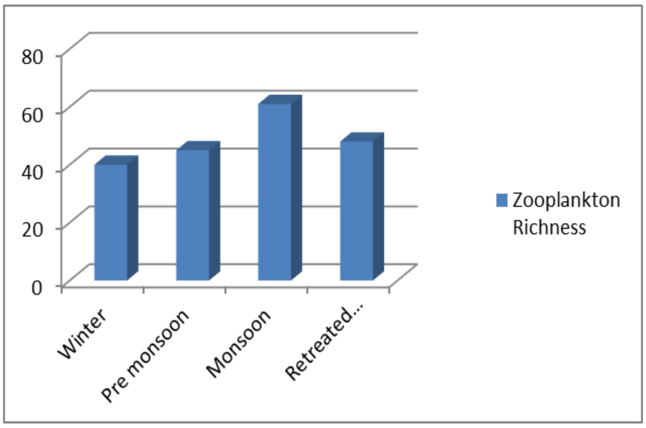

Fig. 4. *Seasonal variation in zooplankton richness in Chandubi wetland*

analyses were performed using PAST software (version 3.02).

RESULTS

A total of 79 species of zooplankton (Table 1) were found in Chandubi wetland, categorized into 7 groups: Protozoa (6 families, 20 species), Gastrotricha (2 families, 2 species), Rotifera (10 families, 32 species), Copepoda (2 families, 8 species), Cladocera (6 families, 15 species), Conchostraca (1 family, 1 species), and Ostracoda (1 family, 1 species). Among these groups, Rotifera exhibited the highest richness, comprising 40.5% of the species composition, followed by Protozoa (25.3%), Cladocera (19%), and Copepoda (10.1%). The groups Gastrotricha (2.5%), Conchostraca (1.2%), and Ostracoda (1.2%) exhibited minimal richness (Fig. 2).

The total abundance of zooplankton during the study period is 9599 n l^{-1} with a monthly abudance between 491 $nl^{-1}$and 1128 $n.l^{-1}$ (standard deviation = ± 225 $n.l^{-1}$) (Table-3). The percentage contribution of zooplankton groups to the overall population density revealed the highest in the Rotifera group (67.3%), followed by Cladocera (14.6%), Copepoda (9.2%), and Protozoa (8.2%). Meanwhile, the groups Gastrotricha, Conchostraca, and Ostracoda exhibited a meagre contribution (<1%) (Fig. 3).

Temporal variation of zooplankton richness and abundance is evident in the four seasons: winter (December to February), pre-monsoon (March to May), monsoon (June to August), and retreated monsoon (September to November). The amplitude of richness in different seasons can be expressed as monsoon > retreated monsoon > pre-monsoon > winter (Fig. 4). In contrast, zooplankton abundance in the wetland is minimal in the monsoon season, after reaching its peak during the pre-monsoon. However, as the monsoon receded, abundance increased successively in the retreated monsoon and winter seasons. The trend of seasonal variation in abundance was as pre-monsoon > winter > retreated monsoon > monsoon (Fig. 5).

Cluster analysis performed on the abundance of zooplankton groups revealed two major groups: a dry group (winter and pre-monsoon) and a wet group (Monsoon and retreated monsoon) (Fig. 6).

Diversity indices of zooplankton estimated in different seasons are presented in Table 2. The maxima of all indices were recorded in the monsoon season. At the same time, their respective minima are noted in the pre-monsoon season, except for the Berger-Parker dominance index, which records the highest in the retreated monsoon and the lowest in the monsoon season. Besides, Evenness showed the lowest in the retreated monsoon. Among the zooplankton groups, Rotifera was ranked the highest in the Shannon index, Simpson index of diversity, and Margalef richness index. However, Cladocera recorded the highest in the Evenness, while Copepoda appeared the highest in the Berger-Parker index.

The data on physico-chemical attributes of water are presented in Table 3. The results of Canonical correspondence analyses performed between the abundance of zooplankton groups and 11 abiotic parame-

Table 1. List of Zooplankton species recorded in Chandubi wetland in Assam

Phylum	Class	Order	Family	Name of the Zooplankton	Occurrence
Protozoa	Lobosa	Testacealobosa	Arcellidae	1. *Arcella vulgaris* Ehrenberg1830	+++
				2.*Arcella polypore* Penard, 1890	+
				3. *A. discoides* Ehrenberg, 1843	+
				4. *A.megastoma* Penard, 1890	+
			Difflugidae	5.***Galeripora dentata*** (Ehrenberg, 1830)	+
				6. *A. mitrata* Leidy, 1876	+
				7. *Difflugia lebes* Penard, 1899	+
				8. *D. urceolata* Carter, 1864	+
				9. *D. acuminata* Ehrenberg, 1838	+
				10. *D. corona* Wallich, 1864	+
				11. *D. rubiscence*	++
				12. *D. bacilifera*	+
				13. *Netzelia tuberculata* (Wallich, 1864)	++
			Centropyxi-dae	14. *Centropyxis ecornis* (Ehrenberg, 1841)	+
				15. *C. arcelloides* (Penard, 1902)	+
		Testaceafilosa	Eugliphydae	16. *Euglypha sp.*	+
				17. *Pareuglypha sp.*	+
	Ciliata	Holotrichida	Parame-cidae	18.*Paramecium caudatum* Ehrenberg, 1833	+++
				19. *P. bursaria* (Ehrenberg, 1831)	+
		Spirotrichida	Stentoridae	20. *Stentor roeseli* Ehrenberg 1835	+
Gastrotricha		Chaetonotoidae	Chaetono-tudae	21. *Chaetonotus sp.*	+
			Neo-gosseidae	22. *Neogossea sp.*	+
Rotifera	Monog-ononta	Ploima	Brachio-nidae	23. *Brachionus falcatus* Zacharias, 1898	+
				24. *B. angularis* *Gosse, 1851*	+++
				25. *B. diversicornis* (Daday, 1883)	+
				26. *B. forficula* Wierzejski, 1891	+
				27. *B. calyciflorus* Pallas, 1766	+++
				28. *B. quadridentatus* Hermann, 1783	+
				29. *B. rubens* Ehrenberg,1838	+
				30. *B. falcatus* Zacharias 1898	++
				31. *B. caudatus* Barrois and Daday, 1894	+
				32. *Keratella tropica* (Apstein, 1907)	+++
				33. *K. cochlearis* (Gosse, 1851)	++
			Asplanchni-dae	34. *Asplanchna priodonta,* Gosse,1850	+
			Lecanidae	35.*Lecane lunaris* (Ehrenberg, 1832)	++
				36. *L. quadridentata* (Ehrenberg, 1830)	+
				37. *L. depressa* (Bryce, 1892)	+
				38. *L. closterocerca* (Schmarda,1859)	+
				39. *L. bulla* (Gosse, 1851)	+

Contd…...

Table 1. Contd….

Rotifera	Monog-ononta	Ploima	Lepadellidae	*40. Lepadella patella* (Muller, 1773)	+
			Synchaeti-dae	*41.Polyarthra multiappendicula*	+
				42. P.vulgaris, Carlin, 1943	+
			Trocho-spaeridae	*43. Filinia longiseta* (Ehrenberg, 1834)	+++
				44. *F. opoliensis* **(**Zacharias 1898**)**	+
		Flosculariaceae	Testudinelli-dae	45.*Testudinella patina* (Hermann, 1783)	+
				46. T. emarginula (Stenroos, 1898)	+
			Hexarthridae	*47.Hexarthra mira* (Hudson, 1871)	+
			Trichocerci-dae	*48.Trichocerca similis* (Weirzeski, 1893)	++
				49. T. longiseta (Schrank, 1802)	++
				50. T. insignis (Herrick, 1885)	+
				51. T. cylindrical (Imhof, 1891)	+
				52. T. capucina (Weirzeski-Zacharias, 1893)	+
		Collothecaceae	Collothe-cidae	*53. Collotheca sp.*	+
				54. Cupelopagis vorax (Leidy, 1857)	+
Arthropoda	Crusta-cea	Copepoda	Diaptomidae	*55.Heliodiaptomus sp.*	+++
				56. *Neodiaptomus handeli* (Brehm, 1921)	+++
				57.*Neodiaptomus schmackeri* (Poppe & Richard, 1892)	+++
				58. Phyllodiaptomus sp.	+
			Cyclopidae	*59. Tropocyclops sp.*	+
				60. Cyclops viridis, Jurin 1820	+++
				61. Mesocyclop leuckarti (Claus, 1857)	+++
				62. M. hyalinus (Rehberg, 1880)	+
		Cladocera	Sididae	*63.Diaphanosoma sarsi* Richard, 1894	++
			Daphnidae	*64.Daphnia carinata King, 1853*	+++
				65. D. pulex Leydig, 1860	+
				66. Ceriodaphnia reticulata	+
			Moinidae	*67.Moina brachiate* (Jurine, 1820)	+++
				68. Moinodaphnia macleayi (King, 1853)	+
			Bosminidae	*69.Bosmina longirostris* (Muller, 1785)	+++
				70. Bosmina coregoni Baird, 1857	+
				71.Bosminopsis deitersi Richard, 1895	++
			Macrothri-cidae	*72.Macrothrix rosea* (Jurine, 1820)	++
				73. M. triserialis Brady, 1886	+
			Chydoridae	*74. Alona affinis* (Leydig, 1860)	+
				75. A. monocantha Sars, 1901	+
				76. Alonella dentifera Sars, 1901	+
				77. Chydorus sphearicus(Muller, 1776)	+
		Conchostraca	Cyclesthe-riidae	*78. Cyclestheria hislopi* Baird, 1859	+
		Ostracoda	Cypridae	*79. Centrocypris sp.*	+

*+ sparingly present, ++ present throughout the year with low abundance, +++ present throughout the year with high abundance

Table 2. Diversity indices of zooplankton in Chandubi wetland in Assam across various seasons

Seasons	Diversity indices	Protozoa	Rotifera	Copepoda	Cladocera
Winter (December to February)	Simpson_1-D	0.73	0.91	0.69	0.80
	Shannon_H	1.41	2.60	1.33	1.66
	Evenness_e^H/S	0.82	0.75	0.75	0.87
	Margalef	1.04	2.55	0.99	1.13
	Berger-Parker	0.36	0.19	0.45	0.26
Pre Monsoon (March to May)	Simpson_1-D	0.73	0.86	0.79	0.86
	Shannon_H	1.41	2.18	1.69	2.05
	Evenness_e^H/S	0.82	0.74	0.77	0.86
	Margalef	0.96	1.68	1.39	1.62
	Berger-Parker	0.39	0.24	0.33	0.23
Monsoon (June to August)	Simpson_1-D	0.90	0.92	0.71	0.83
	Shannon_H	2.46	2.67	1.55	1.91
	Evenness_e^H/S	0.84	0.80	0.67	0.75
	Margalef	3.27	2.84	1.50	1.82
	Berger-Parker	0.19	0.16	0.46	0.25
Retreated Mosoon (September to November)	Simpson_1-D	0.85	0.90	0.69	0.81
	Shannon_H	2.07	2.49	1.31	1.85
	Evenness_e^H/S	0.79	0.80	0.74	0.64
	Margalef	2.09	2.32	0.99	1.95
	Berger-Parker	0.27	0.15	0.45	0.28

Table 3. Physico-chemical parameters of water in Chandubi wetland

Water Parameters	Range	Mean	Standard deviation
Temperature (^{0}c)	11.5 - 30.6	22.75	6.36
Dissolved Oxygen	4.0 - 7.1	5.71	0.82
Free Carbon dioxide	2.0 - 8.0	4.83	1.99
pH	6.2 - 9.3	7.34	0.94
Total hardness (mg/l)	20.0 - 80.0	31.21	17.07
Carbonate hardness (mg/l)	20.0 - 80.0	62.50	17.65
Nitrate (NO_3) (mg/l)	15.0 - 60.0	37.50	12.30
Calcium (Ca) (mg/l)	4.0 - 28.0	11.04	6.11
Phosphate (PO_4) (mg/l)	0.04 - 0.25	0.06	0.09
Ammonium (NH_4) (mg/l)	0.05 - 0.1	0.15	0.04
Alkalinity (mg/l)	8.8 - 42.5	15.20	9.34
Transparency (cm)	50.0 - 90.6	72.66	15.80

ters of the sampled wetland were presented in Fig. 7. The CCA biplot revealed that the two canonical axes- Axis 1 (83.26%) and Axis 2 (14.74%) together explained around 98% of the total variance.

Temporal variation of zooplankton abundance in total and different groups showed significant correlations with certain physico-chemical parameters of water (Table 4). The total abundance of zooplankton showed a significant ($p<0.05$) positive correlation with pH (R-Spearman=0.90, $p<0.01$), DO (R-Spearman=0.64, $p<0.01$), and Secchi disk transparency (R-Spearman=0.90, $p<0.01$), while it showed a negative correlation with temperature (R-Spearman=0.90, $p<0.01$) and free carbon dioxide (R-Spearman=0.71, $p<0.01$). Such significant correlations were also found in the Rotifera group, whereas Copepoda and Cladocera only showed significant positive correlations with pH.

DISCUSSION

The physicochemical principles of water play a crucial role in determining the community structure and diversity of aquatic organisms. Understanding these governing factors is essential for assessing the health of a wetland ecosystem. It has been established that water temperature significantly influences the physiological processes, behaviour, and ecology of aquatic organisms (Chandra *et al.,* 2009; Manickam *et al*., 2018; Sharma and Singh, 2018) and in sub-tropical lakes, seasonal changes in

Table 4. Correlation (Spearman-R) among environmental variables and abundance of zooplankton (nl^{-1}) with the p-values in Chandubi wetland

	WT	DO	FCO	pH	TH	CH	NO3	Ca	PO4	NH4	TA	ST	Proto	Roti	Cope	Clad	TZ
WT		0.00	0.00	0.00	0.58	0.21	0.78	0.68	0.41	0.54	0.53	0.00	0.61	0.00	0.20	0.56	0.00
DO	-0.76		0.22	0.04	0.64	0.64	0.76	0.61	0.13	0.95	0.76	0.01	0.78	0.02	0.40	0.90	0.03
FCO	0.79	-0.39		0.05	0.45	0.06	0.49	0.65	0.56	0.10	0.22	0.00	0.37	0.01	0.58	0.84	0.01
pH	-0.78	0.59	-0.58		0.35	0.87	0.34	0.22	0.12	0.68	0.41	0.00	0.18	0.00	0.04	0.61	0.00
TH	-0.18	0.15	-0.24	-0.29		0.31	0.02	0.01	0.59	0.57	0.00	0.66	0.22	0.97	0.19	0.80	0.99
CO_3	0.39	-0.15	0.55	0.05	-0.32		0.97	0.45	0.13	0.11	0.36	0.21	0.69	0.76	0.34	0.41	0.82
NO_3	0.09	0.10	0.22	0.30	-0.64	0.01		0.00	0.52	0.54	0.00	0.94	0.07	0.86	0.72	0.25	0.88
Ca	-0.13	0.16	-0.14	-0.38	0.70	-0.24	-0.85		0.39	0.35	0.00	0.99	0.09	0.93	0.29	0.94	0.84
PO_4	-0.26	0.46	0.19	0.47	-0.17	0.46	0.21	-0.27		0.53	0.21	0.53	0.45	0.14	0.04	0.20	0.10
NH_4	0.20	-0.02	0.50	-0.13	-0.18	0.48	-0.20	0.30	0.20		0.62	0.28	0.55	0.82	0.92	0.82	0.68
TA	-0.20	0.10	-0.39	-0.26	0.93	-0.29	-0.78	0.78	-0.39	-0.16		0.57	0.37	0.90	0.19	0.83	0.95
ST	-0.97	0.69	-0.86	0.80	0.14	-0.39	-0.02	0.00	0.20	-0.34	0.18		0.44	0.00	0.13	0.48	0.00
Proto	0.16	-0.09	0.28	-0.42	0.38	0.13	-0.55	0.51	0.24	0.19	0.29	-0.25		0.59	0.56	0.06	0.77
Roti	-0.93	0.67	-0.71	0.91	0.01	-0.10	-0.06	-0.03	0.45	-0.07	0.04	0.92	-0.18		0.04	0.29	0.00
Cope	-0.40	0.27	-0.18	0.60	-0.41	0.30	0.12	-0.33	0.60	0.03	-0.41	0.46	0.19	0.60		0.00	0.02
Clad	-0.19	-0.04	-0.07	0.17	-0.08	0.26	-0.36	0.02	0.40	0.07	-0.07	0.22	0.56	0.34	0.80		0.21
TZ	-0.90	0.64	-0.71	0.90	0.00	-0.07	-0.05	-0.07	0.50	-0.13	0.02	0.90	-0.09	0.99	0.65	0.39	

*Abbreviations: WT- Water temperature, DO- Dissolved oxygen, FCO- free carbon dioxide, TH-Total Hardness, TA- Total alkalinity, ST-Secchi disk transparency, Proto- Protozoa, Gastro- Gastrotricha, Roti-Rotifera, Cope-Copepoda, Clad- Cladocera, Con- Conchostraca, Ost- Ostracoda, TZ- Total zooplankton

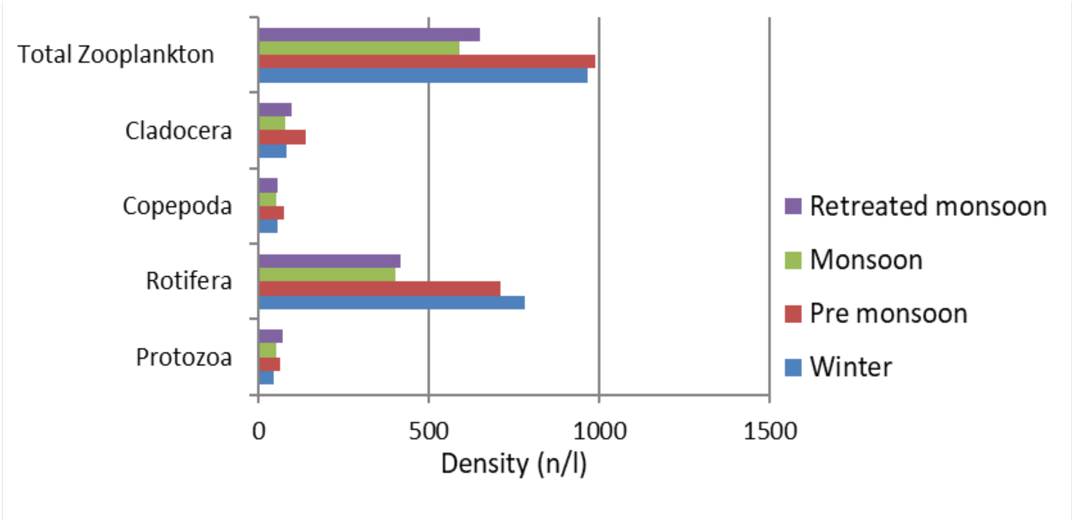

Fig. 5. *Seasonal variation in abundance of zooplankton groups in Chandubi wetland*

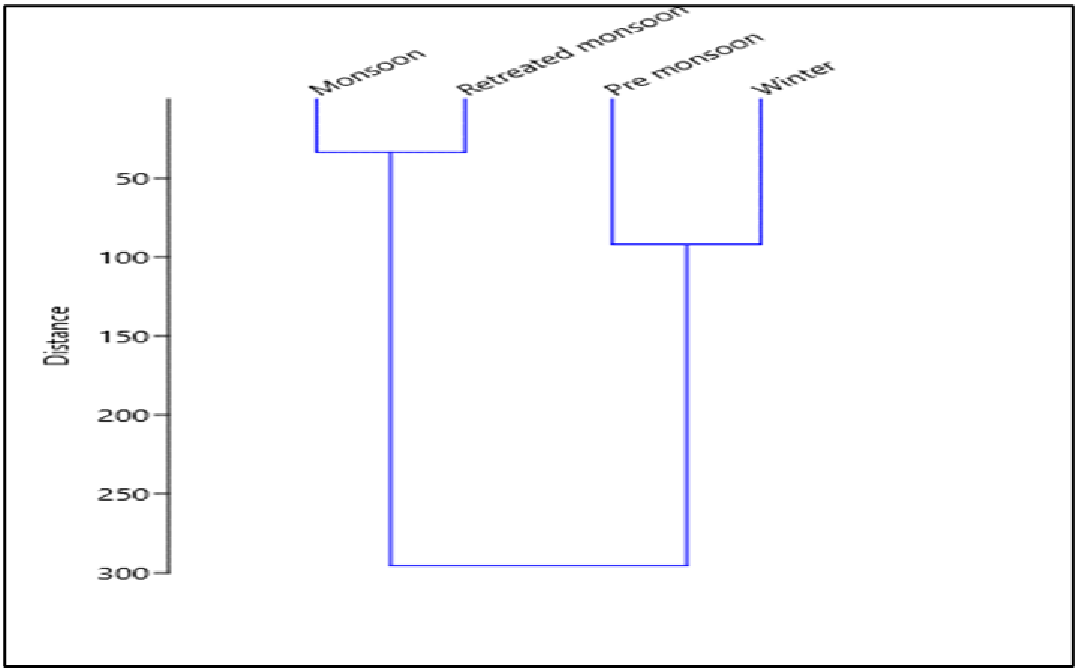

Fig. 6. *Cluster dendrogram depicting the seasonal variation in zooplankton abundance in Chandubi wetland*

water temperature play a key role in determining the community structure of zooplankton (Sharma and Sharma, 2005). The present study recorded that the water temperature in the sampled Chandubi wetland fluctuated seasonally, reaching its peak during the monsoon and dropping to a minimum during winter, which is in concurrent with the findings of Joshi *et al*. (2021) from four urban wetlands of Delhi-NCR and Singh *et al.* (2022) from seven wetlands of Punjab. Besides, temporal variation of water temperature exhibits a positive correlation with FCO2 (R-Spearman= 0.792, p<.01) and negative correlations with dissolved oxygen (DO) (R-Spearman= -0.760, p<.01) and pH (R-Spearman= -0.784, p<.01). The negative correlation between DO, temperature, turbidity, and total dissolved solids (TDS) has been documented by Thakur *et al*. (2013) from Prashar, Rewalsar and Kuntbhyog lakes of Mandi, Himachal Pradesh; Ganai and Parveen (2014) from Wular lake, Kashmir; Singh *et al*. (2022) from seven selected wetlands of Punjub, and Singh and Sharma (2020) in Dodital Lake, Garhwal, which supports the fact that oxygen saturation in water decreases with rising temperature (Welch, 1952).

Plankton samples from Chandubi wetland showed the occurrence of a diverse zooplankton biocoenosis with 79 species. The richness records a higher value in comparison to the earlier reports from other floodplain wetlands of Assam, such as Malini beel (Dutta *et al*., 2017); Das *et al*., 2018), Waithou Pat and Utra Pat floodplain wetlands in Manipur (Sharma, 2011), two lakes of the Kashmir Himalayas (Wanganeo and Wanganeo, 2006 a&b), the northern part of Vembanad lake,

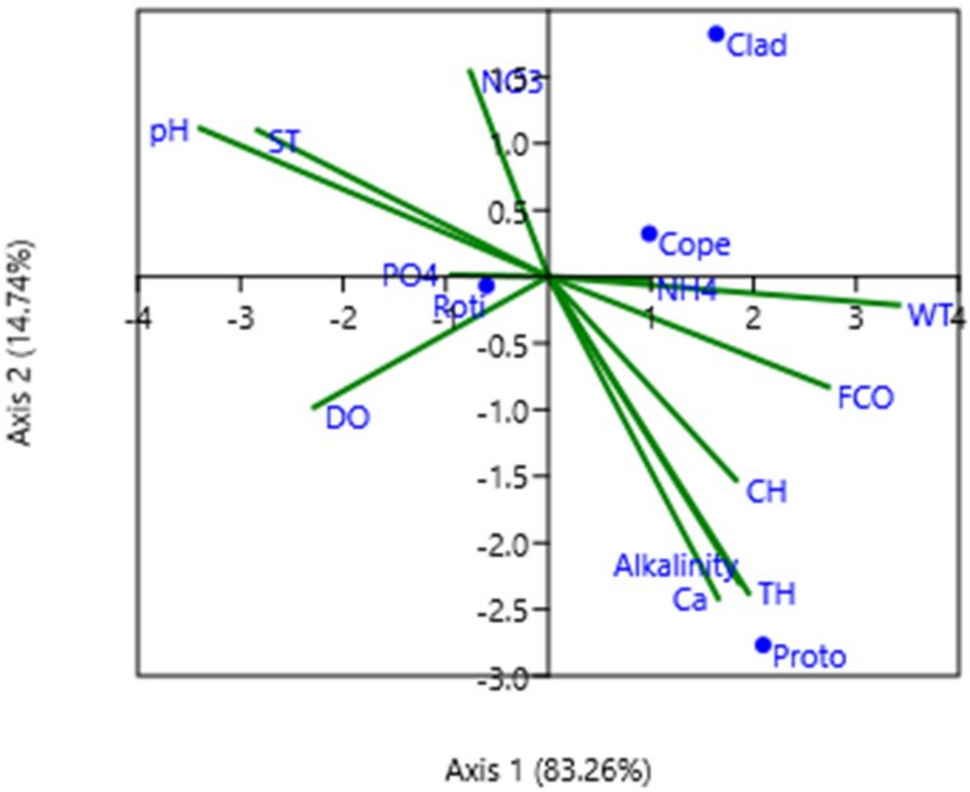

Fig. 7. *Canonical Correspondence Analysis (CCA) ordination of physicochemical parameters and zooplankton groups in Chandubi wetland*

Kerala (Ravi *et al*., 2020), and two floodplain lakes in southeastern West Bengal (Khan, 2003), while being comparable to that of Dal Lake (Zutshi and Vass, 1982), Wular wetland (Mir *et al*., 2008), and Purbasthali Bnour oxbow lake of West Bengal (Ganeshan and Khan, 2008). This substantial richness may be attributed to the environmental heterogeneity resulting from the dendritic morphometry and the eutrified pockets of the wetland, which influence the zooplankton community by providing favourable microhabitats (Jose de Paggi and Paggi, 2007; Eskinazi-Sant'Anna *et al*., 2020).

Among the zooplankton groups, Rotifera predominantly contributed to the zooplankton richness of the sampled wetland, which corroborates the previous reports on dominance of this group in mesotrophic to eutrophic lakes and reservoirs such as Kacharali Lake (Somani *et al*., 2012), Saheb bandh lake (Bera, 2021) etc. in the Indian subcontinent. Eutrophic lakes with high detritus content may provide favourable environments for the growth of rotifer species (Frutos *et al*., 2009).

Zooplankton richness exhibited its peak during the monsoon season with high water temperatures, elevated rainfall and flood. The flooded water brings decomposed organic matter from the eutrophic dendrites into the wetland, thereby enriching the water with nutrients that help in the proliferation of diverse zooplankton forms. Besides, increased water level during the monsoon reduces the predation pressure on zooplankton, contributing to richness (Liu *et al*., 2022). In the present stud, the monsoon peak in richness was primarily contributed by Rotifera and Protozoa.

The quantitative analysis of plankton samples revealed that the abundance of zooplankton records the peak during the premonsoon season. Sharma and Hatimuria, (2017) from the Bhereki, Ghotonga and Holmari wetlands of Assam and Ravi *et al*. (2020) from Vembanad Lake have also reported a higher abundance of zooplankton during the premonsoon period. The temporal variation of zooplankton abundance throughout the study period is chiefly contributed by the Rotifers in the studied wetland. Quantitative dominance of Rotifera has also been reported from two pond aquaculture systems (Pathak and Goswami, 2008), Deepor beel and Loktok Lake (Sharma and Sharma, 2014) and Sat beel (Kar and Kar, 2016) of Northeast India. The predominance of Rotifers in the abundance of zooplankton also indicates the eutrophic nature of the studied wetland (Tyor *et al*., 2014; Abbas and Talib, 2018; Manickam *et al*., 2018; Brraich and Akhtar, 2019).

The Cluster analysis of zooplankton population densities in Chandubi wetland revealed two groups: a dry group (winter and pre-monsoon) characterized by low rainfall, alkaline pH, and lower temperatures, and a wet group (monsoon and retreated monsoon) with higher

rainfall, neutral to acidic pH, and higher temperatures. This affirms the influence of abiotic factors on the abundance of zooplankton (Hessen *et al*., 2006; Sharma and Sharma, 2019; Lu, 2021; Goździejewska, 2024).
Canonical Correspondence Analysis (CCA) showed that parameters such as total hardness (TH), calcium (Ca), FCO_2, and water temperature (WT) were positively correlated with Axis 1 and negatively correlated with Axis 2, while DO exhibits a negative correlation with both axes. Protozoa abundance was influenced by Ca, TH, and WT, while Rotifera abundance was influenced by phosphate (PO_4), Copepoda by total hardness and calcium concentration, and Cladocera by nitrate (NO_3) content. Therefore, TH, Ca, WT, PO_4, and NO_3 were considered significant factors in zooplankton abundance in the wetland.

Conclusion

The diversity of zooplankton indicates the health of a wetland. High zooplankton diversity is essential to keep their population density stable, and thereby, a desired amount of food remains available to the zooplanktiphagous fish and other secondary consumers during different seasons. The present investigation revealed a high zooplankton diversity dominated by rotifers in Chandubi wetland, indicating the prevalence of eutrophic conditions of the wetland. The study also affirmed the influence of abiotic variables like temperature and pH and nutrient contents such as phosphorous and nitrates. Therefore, the present findings would support future assessment of Chandubi wetland to formulate an effective management plan for the sustainability of the wetland.

ACKNOWLEDGEMENTS

The authors acknowledge the Head of the Department of Zoology, B.Borooah College, and the Coordinator of the Biotech Hub of B.Borooah College for granting access to laboratories and providing necessary support. We express our heartiest gratitude to Mr. Pabitra Rabha of Rajapara village for his help in collecting water and zooplankton samples.

Conflict of interest

The authors declare that they have no conflict of interest.

REFERENCES

1. Abbas, M.I. & Talib, A.H. (2018). Community structure of zooplankton and water quality assessment of Tigris River within Baghdad, Iraq. Applied Ecology and Environmental Sciences 6(2), 63-69. DOI:10.12691/aees-6-2-4
2. Aranguren-Riano, N., Guisande, C., & Ospina, R. (2011). Factors controlling crustacean zooplankton species richness in Neotropical lakes. Journal of Plankton Research. 33(8), 1295-1303
3. APHA, (1992). Standard Methods for the examination of water and waste water. 18th Edition. Washington, D.C.1198pp.
4. Battish, S.K., (1992). Freshwater Zooplankton of India. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi. 233pp
5. Bera, B. (2021). Using zooplankton community to assess water quality and trophic condition of Lake Saheb Bandh, Purulia, West Bengal,India. International Journal of Aquatic Science. 12 (2): 4471-4498
6. Brraich, O.S., & Akhtar, S. (2019). Diversity and distribution of zooplankton in Ropar wetland (Ramsar Site), Punjub, India. Nature Environment and Pollution Technology 18 (2):451-458
7. Chandra, R.,· Nishadh K.A., & Azeez, P.A. (2010). Monitoring water quality of Coimbatore wetlands, Tamil Nadu, India. Environmental monitoring and Assessment, 169: 671-676. DOI:10.1007/s10661-009-1206-0
8. Das, U., Das, P., Kar, S., Chitra, J.,& Kar, D. (2018). An assessment on zooplankton diversity between three freshwater habitats of Barak valley, Assam. Uttar Pradesh Journal of Zoology 38(1): 26-34
9. Dutta, A., Kar, S., Das, P., Das, U., Das, S., & Kar, D. (2017). Studies on physico-chemical aspects and zooplankton diversity of a freshwater wetland in Cachar, Assam. Int J Sci Env 6(3): 1877-1885
10. Edmondson, W.T. (1959). Fresh Water Biology, 2nd ed. International Books and Periodical Supply Service, New Delhi, p.xx + 1248 p.
11. Eskinazi-Sant'Anna, E.M., Santos, G de S., Alves, N.J. de S, Brito, L.A.F., & Leite, M.G.P. (2020). The relative importance of regional and local factors in shaping zooplankton diversity in high altitude tropical shallow lakes. J Fresh Eco 35(1):203-221
12. https://doi.org/10.1080/02705060.2020.1770874
13. Frutos, S.M., Poi de Neiff, A.S.G.,& Neiff, J.J. (2009). Zooplankton abundance and species diversity in two lakes with different trophic states (Corrientes, Argentina). Acta. Limnol. Bras. 21(3):367-375.
14. Ganai, A.H & Parveen, S. (2014). Effect of physico-chemical conditions on the structure and composition of the phytoplankton community in Wular Lake at Lankrishipora, Kashmir. International Journal of Biodiversity and Conservation 6(1), 71-84.
15. Ganesan, L. & Khan, R.A. (2008). Studies on the ecology of zooplankton in a flood plain wetland of West Bengal, india. In: Sengupta M, Dalwani R ed., Proceedings of Taal,2007-The 12th World Lake Conference:67-73
16. Goswami, M.M. (1985). Limnological Investigations of a tectonic lake of Assam, India and their bearing on fish production. Unpublished Ph.D. Thesis, Gauhati University, Assam. 395 pp.
17. Goswami, M.M. (1988). Observations on the hydrography, thermal status and heat budget of a tectonic lake of Assam. J. Assam Sci. Soc.30(3):1-10
18. Goswami, M M, Deka, T.K., Sing, P.K., Sarma, P.K. & Kakati, M. (1999). Studies on some wetlands of Assam with reference to the eutrophic stress. J. Inland Fish. Soc. India. 31(2):39-43

19. Goździejewska, A.M., Cymes, I. & Glińska-Lewczuk, K. (2024). Zooplankton functional diversity as a bioindicator of freshwater ecosystem health across land use gradient. Sci Rep 14, 18456. https://doi.org/10.1038/s41598-024-69577-z
20. Hessen, D. O., Faafeng, B. A., Smith, V. H., Bakkestuen, V. & Walseng, B. (2006). Extrinsic and intrinsic controls of zooplankton diversity in lakes. Ecology, 87(2):433-443
21. Jose de Paggi, S. & Cesar Paggi, J. (2007). Zooplankton. In: Iriondo M.H., Paggi J.C. and Parma M.J. (Eds.), The Middle Parana River: Limnology of a Subtropical Wetland, Springer-Verlag Berlin Heidelberg p. 229-249
22. Joshi, P., Siddaiah, N.S. & Dixit, A. (2021). Urban wetlands of Delhi, India: water quality and pollution status. Chemistry and Ecology, 37:2, 104-131, DOI: 10.1080/02757540.2020.1836164
23. Kalff, J. (2002). Limnology: Inland water ecosystems. Prentice Hall, Nature. 592pp.
24. Kar, S. & Kar, D.(2016). Zooplankton diversity in a freshwater lake of Cachar, Assam. International Journal of Applied Biology and Pharmaceutical Technology.7(1):301-305
25. Khan, R.A. (2003). Faunal diversity of zooplankton in freshwater wetlands of South-eastern West Bengal. Records of Zoological Survey of India, Occasional paper no. 204:1-107
26. Liu, B., Wu, J., Hu, W., Wang, G. & Chew, Y. (2022). Seven years study of the seasonal dynamics of zooplankton communities in a large subtropical flood plain ecosystem: A test of the PEG Model. Int J Environ Res Public Health , 19(2): 956 doi: 10.3390/ijerph19020956
27. Lu Q, Liu X, Qiu X, Liang T, Chen J, Zhao S, Ouyang S, Jin B. & Wu X. (2021). Changes and drivers of zooplankton diversity patterns in the middle reach of Yangtze River floodplain lakes, China. Ecol Evol...11(24):17885-17900. doi: 10.1002/ece3.8353.
28. Manickam, N., Bhavan, P.S., Santhanam, P., Bhuvaneswari, R., Muralisankar, T., Srinivasan, V., Asaikkutti, A., Rajkumar, G., Udayasuriyan, R. & Karthik, M. (2018). Impact of seasonal changes in zooplankton biodiversity in Ukkadam Lake, Coimbatore, Tamil Nadu, India, and potential future implications of climate change. Journal of Basic and Applied Zoology, 79(1): 15. //doi.org/10.1186/s41936-018-0029-3
29. Mir, A.R., Wanganeo, A., Yusuf, A.R. & Wanganeo, R. (2008). Zooplankton community in a through flow system of Kashmir Himalayan wetland. Nat Env Pll Tech 7(4): 627 -634
30. Nandy, T. & Mandal, S, (2020). Unravelling the spatio-temporal variation of zooplankton community from the river Matla in the Sundarbans Estuarine System. India. J. Oceanologia. 62. 10.1016/j.oceano.2020.03.005.
31. Oldham, R.D. (1899). Report of the great earthquake of 12th June, 1897. Memoirs of the Geological Society of India. K. Paul, Trench, Trübner & Co. XXIX 562p.
32. Pathak, J. & Goswami, M. M. (2008). A comparative study of the seasonal trend of heleoplankton in two freshwater aquaculture ponds of Guwahati. Aquacult, 9(2):157-165
33. Pennak, R.W. (1953). Freshwater invertebrates of the United States. Ronald Press Co. New York. 769 p.
34. Ravi, A., Aju, K.R., Sreekumar, K.M. & Varghes,e M. (2020). Diversity of zooplankton along the northern part of Vembanad lake, Kerala, India. J.Mar.Biol. Ass. India 62 (2):106-111. doi:10.6024/jmbai.2020.62.2.2155-13
35. Sharma, B.K. (2011). Zooplankton community of Deepor Beel(a Ramsar site), Assam (N.E. India): ecology, richness and abundance. Tropical Ecology 52(3):293-302.
36. Sharma, B.K. & Sharma, S. (2005). Biodiversity of freshwater rotifers (Rotifera: Eurotatoria) from North-Eastern India. Mitt. Mus.Nat. Kd. Berl. Zool. Reihe.pg 81-88
37. Sharma, S. & Sharma, B.K. (2008). Zooplankton diversity in floodplain lakes of Assam, India. Records of the Zoological survey of India, Occasional paper no.290:1-307
38. Sharma, B.K. & Sharma, S. (2014). Northeast India- An important region with a rich diversity of Rotifera, In: Sharma BK et al.(Eds), Rotifera XIII: Rotifer Biology- A structural and functional approach. International Review of Hydrobiology 99 (1-2): 20-37 DOI:10.1002/iroh.201301701
39. Sharma, B.K. & Hatimuria, M.K. (2017). Zooplankton diversity of three floodplain lakes (Beels) of the Majuli River Island, Brahmaputra River basin of Assam, Northeast India. J Aquac Mar Bio 6(1):00144 DOI:10.15406/jamb.2017.06.00144
40. Sharma, R.C. & Singh, S. (2018). Water quality and phytoplankton diversity of high altitude wetland, Dodi Tal of Garhwal Himalaya, India. Biodiversity Int J 2(6):484-493. DOI: 10.15406/bij.2018.02.00103
41. Sharma, A. & Sharma, M. (2019). Zooplankton Diversity in Relation to Physico-Chemical Parameters in Subtropical Pond of Jammu, Jammu and Kashmir, India. Biosciences Biotechnology Research Asia,16(2): 425-439 http://dx.doi.org/10.13005/bbra/2758
42. Singh, S. & Sharma, R. (2020). Zooplankton diversity and potential indicator species for assessment water quality of high altitude wetland, Dodi Tal of Garhwal Himalaya, India. Academ Arena 12(5):1-16 DOI:10.7537/marsaaj120520.01
43. Singh, Y., Singh, G., Khattar, J.S., Barinova, S., Kaur, J., Kumar, S. & Singh, D.P. (2022). Assessment of water quality condition and spatiotemporal patterns in selected wetlands of Punjab, India. Environmental Science and Pollution Research 29:2493–2509 DOI: 10.1007/s11356-021-15590-y
44. Somani, V., Quadros, G. & Pejaver, M.K. (2012). Occurrence of Rotifers and its relation to the water quality during the bioremediation process in Lake Kacharali, Thane, MS, India. ISCA J Biol Sci 1(3):54-58.
45. Thakur, R.K., Jindal, R., Singh, U.B. & Ahluwalia, A.S. (2013). Plankton diversity and aquatic quality assessment of three fresh aquatic lakes of Mandi (Himachal Pradesh, India) with reference to planktonic indicators. Env.Monit. Assess.185:8355-8373.
46. Tyor, A.K., Chopra, G. & Kumari, S. (2014). Zooplankton diversity in shallow lake of Sultanpur National Park, Gurgaon (Haryana). International Journal of Applied Biology and Pharmaceutical Technology 5(1): 35-40.
47. Welch, P.S. (1948). Limnological Methods, Blakiston, Philadelphia, 381p.
48. Welch, P.S. (1952). Limnology. Mc Graw Hill Book Co. New York and London: 471p.
49. Wanganeo, A., & Wanganeo, S. (2006 a). Plankton diversity in Kashmir Himalyan lakes: an overview trends in biodiversity and aquaculture. Daya Publishing House,

India, pp.130-160.
50. Wanganeo, A., & Wanganeo, S. (2006 b). Variation in zooplankton population in two morphometrically dissimilar rural lakes of Kashmir Himalayas. Proc. Nat. Acad Sci India 76(B):222-239.
51. Wetzel, R.G. (2001). Limnology. W.B. Saunders Co., Philadelphia, London, Toronto.1014p.
52. Winkler, L.W. (1888). The determination of dissolved oxygen in water. Berline Deutsch Chem. Gesollsch, 21: 2843 pp.
53. Xiong, W., Huang, X., Chen, Y., Fu, R., Du, X. & Chen, X. (2020). Zooplankton diversity monitoring in polluted freshwater ecosystems: A technical review. Env. Sc. Ecotech 1:1-11 https://doi.org/10.1016/j.ese.2019.100008
54. Zutshi, D.P. & Vass, K.K. (1982). Limnological studies on Dal Lake, Srinagar, III. Biological features. Proc. Ind. Nat. Sc. Acad, section B 48 (2): 234-241.