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# Zooplankton fauna of Moraghat forest, a territorial forest of Jalpaiguri district, West Bengal, India

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**ABSTRACT**

*In the present study the zooplankton fauna at diverse water bodies of Moraghat forest was investigated from March, 2013 to November, 2014. Five study sites were selected at total forest range, of which three are lentic and two are lotic systems. Seasonally samples were collected from the selected study sites: $S_1$ (Pond of Totapara beat), $S_2$ (pond of Khuttimari beat), $S_3$ (Pond of Gossaihat beat), $S_4$ (Garati River which passes out through the forest) and $S_5$ (Nonai River which passes through the Sonakhali beat). A total 53 established holoplanktons species and 5 meroplankton representatives were recorded throughout the entire study. Of these 53 holoplanktons, Sarcomastigophora and Ciliophora are the phyla of kingdom Protista contributed 3 representatives; Rotifer added 26 species with 24 Arthropods. The species richness in five sampling sites showed considerable variation. $S_3$ (47 species) and $S_2$ (46 species) were the most biologically diverse. $S_5$ had 44 and $S_4$ had 40 species whereas $S_1$ had 36 representatives. The species diversity index of different sampling sites was ranged from 1.347 to 1.791. In the study, maximum diversity index was recorded higher in $S_3$ ($\bar{H}$ =1.791) as compared with $S_2$ ($\bar{H}$=1.711), $S_5$ ($\bar{H}$ =1.637), $S_4$ ($\bar{H}$ =1.223) and $S_1$ ($\bar{H}$ = 0.874). This may be due to the physicochemical properties of water, substratum soil features and phytoplankton loads.*

**Key words:** Zooplanktons, Holoplanktons, Moraghat Forest.

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## INTRODUCTION

The zooplanktons, heterogeneous assemblage of microscopic animals in the trophic dynamics of fresh water ecosystems, have long been recognized as secondary producer by occupying almost middle position of food chain and also indicate environmental status in a given time [1]. In fresh water, they have been recognized as an important energy resource for small sized fish that, in turn, provide energy to piscivorous fish consumers higher up in the food web [2]. Zooplankton is known to respond quickly to environmental conditions, and only a few attempts have been made to use the zooplankton community to evaluate the quality of aquatic ecosystems [3 and 4]. Studies on the freshwater zooplankton fauna of North East India including Northern West Bengal have been conducted by several researchers [5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22 and 23]. However, this type of investigation has not yet been carried out in respect of Moraghat Forest of Northern West Bengal. Objectives of the research were to study the zooplankton diversity and their community structure analysis.

## MATERIALS AND METHODS

**Physiographic of study area:**
The Moraghat forest range (latitude26°47'28.04"N to 26°37'48.33"N, longitude 88°59'.57.38"E to 89°.00'.55.65"E and 473 to 267 ft. elevation.) is a territorial forest of Jalpaiguri district and is located near Gairkata. Total range area is 5511.37 hectors. This range is totally recommended for plantation of commercially important timber plants like Sal, Tick, Jarul etc. and Silviculture. It has four beats i.e. Totapar, Khuttimari, Gossaihat and Sonakhali (Figure 1).

**Collection, Preservation and Identification of zooplanktons:-**
For zooplankton fauna diversity study, water bodies of the forest was demarcated by Google earth and Google Map software (Version-2013 and 2014). In the total forest range, five stations (Figure 2) were selected of which three are lentic and two are lotic systems. Seasonally samples were collected from five selected study sites. These have been designated as $S_1$ (Pond of Totapara beat), $S_2$ (Pond of Khuttimari beat), $S_3$ (Pond of Gossaihat beat), $S_4$ (Garati River which passes out through the forest) and $S_5$ (Nonai River which passes through the Sonakhali beat). Qualitative zooplankton samples were collected with the aid of plankton net of mesh size 55 µm through vertical and horizontal hauls from the five stations. Quantitative samples were collected by filtering 100 litre of water. Collected specimens were transferred carefully to a tube, narcotized with 4% formalin, preserved in 4% buffered formalin and added a few drops of Rose Bengal solution which colors the zooplanktons and make them conspicuous. Detailed taxonomic identification was carried out with the help of the authentic literatures [1, 24, 25 and 26].

**Community study:-**
Total count of zooplankton was carried out using Sedgwick Rafter plankton counting cell. The Shannon-Weiner index ($\bar{H}$) [27] was applied to detect the utmost and least diversity sampling stations.

**Physico-Chemical Characteristics of Water**:-
In addition, some physical and chemical parameters of water of these study sites were determined during the entire study. Water temperature at the depth of 6″ was detected by ordinary mercury thermometer. Physical properties of water ($_P$H, Electrical Conductivity, TDS and Turbidity) were estimated in the field by Multi Parameter Water Testing Kit of HIMEDIA & Multi-Parameter Testr 35 Series (Eutech PCSTEST35-01X441506/Oakton-10). Water samples obtained from five sampling stations were analyzed in the laboratory of department of Zoology, Ananda Chandra College to know the chemical properties like dissolved oxygen, biochemical oxygen demand, total hardness, free $CO_2$, total alkalinity. Additionally, the occurrences of few trace metals (Cu, Ni, Zn, Hg, Pb and Cd) and their concentration were estimated. Water samples were digested as per the reference of APHA [28] and concentrations were estimated by the AAS (Model: AA-303) of Thermo Fisher Scientific India Pvt. Ltd.

## RESULTS AND DISCUSSION

**Physico-Chemical Characteristics of Water**:
Table 1 represents the range of values of physico-chemical parameters of water quality in different water bodies. The water temperature was ranged between 20– 34°C at $S_1$, 18 -28°C at $S_2$, 19-33°C at $S_3$, 22-28°C at $S_4$ and 18 - 27°C at $S_5$ correspondingly. The light intensity varied on the basis of turbidity of water whose values ranged from 5-10 NTU at all stations. The pH value ranged from 6.7-8.45 at $S_1$, 6.7 – 7.8 at $S_2$, 6.8-7.85 at $S_3$, 7.2-7.85 at $S_4$ and 7.52-8.25 at $S_5$ respectively. The Electrical conductivity (EC) values of water ranged from32-72µS at $S_1$, 44.2-60 µS at $S_2$, 46-67.6 µS at $S_3$, 54.6-75 µS at $S_4$ and 115.4-166 µS at $S_5$. The TDS (Total Dissolved Solid) values of water ranged from 22.7-54ppm at $S_1$, 30-36.6 ppm at $S_2$, 30-48 ppm at $S_3$, 39.2- 45.4 ppm at $S_4$ and 81.9-99.1 ppm at $S_5$. The total hardness defined as calcium and magnesium concentration and both expressed as CaCO3 mg/lit. At Moraghat forest range, total hardness ranged from 12.86 -25ppm at lentic systems and 20-65ppm at lotic systems. Dissolved oxygen in water indicates water quality and diversity of living things and its concentrations varied from3.45-11.34 ppm at $S_1$, 0.46-8.21ppm at $S_2$, 3.65-6.08ppm at $S_3$, 5.36-8.76ppm at $S_4$ and 3.96-6.5 ppm at $S_5$. In the present study, the free carbon dioxide concentration ranged from 1.47-9.9 ppm at $S_1$, 1.9-7.33 ppm at $S_2$, 1.26-10.06ppm at $S_3$, 1.47-5.5 at $S_4$ and 1.47-8.8 ppm at $S_5$ respectively. Average total alkalinity (TA) values were observed 10-32.86ppm at lentic water bodies and 18.57 - 85ppm at lotic systems. The biological oxygen demand (BOD) gives an idea of the quantity of biodegradable organic matter present in an aquatic system which is subjected to aerobic decomposition by microbes and accordingly it provides a direct measurement of the state of pollution. The concentration of BOD ranged from 0.02-2.05 ppm at $S_1$, 0.24-1.06 at $S_2$, 0.21-2.55ppm at $S_3$, 0.22-2.08 at $S_4$ and

0.14-3.96 at $S_5$. Of the six metals (Cu, Ni, Zn, Hg, Pb and Cd), only Cu and Zn showed positive response and their range of concentration has been mentioned in the table 1.

**Table 1: Water Quality parameters at different sampling sites of Moraghat Forest**

| Parameters | Sampling Stations | | | | |
|---|---|---|---|---|---|
| | **$S_1$** | **$S_2$** | **$S_3$** | **$S_4$** | **$S_5$** |
| Water Temperature ($^0$C) | 20-34 | 18-28 | 19-33 | 22-28 | 18-27 |
| Turbidity (NTU) | 5-10 | 5-10 | 5-10 | 5-10 | 5-10 |
| pH | 6.7-8.45 | 6.7-7.8 | 6.8-7.85 | 7.2-7.85 | 7.52-8.25 |
| Conductivity(µS) | 32-72 | 44.2-60 | 46-67.6 | 54.6-75 | 115.4-166 |
| Total Dissolved Solid(ppm) | 22.7-54 | 30-36.6 | 30-48 | 39.2-45.4 | 81.9-99.1 |
| Total Hardness(ppm) | 7.143-23.3 | 12.86-20.0 | 17.14-25 | 20-25 | 50-65 |
| Dissolved Oxygen(ppm) | 3.45-11.34 | 0.46-8.21 | 3.65-6.08 | 5.36-8.76 | 3.96-6.5 |
| Free Carbon dioxide (ppm) | 1.47-9.9 | 1.9-7.33 | 1.26-10.06 | 1.47-5.5 | 1.47-8.8 |
| Total Alkalinity(ppm) | 10-32.5 | 14.3-25 | 21.5-32.86 | 18.57-30 | 58.5-85 |
| Biological Oxygen Demand(ppm) | 0.02-2.05 | 0.24-1.06 | 0.21-2.55 | 0.22-2.08 | 0.14-3.96 |
| **Trace Metals** | | | | | |
| Cu(ppm) | 1.4-1.45 | 1.4-1.72 | 1.5-2.2 | 1.45-2.3 | 1.4-2.3 |
| Ni(ppm) | Nil | Nil | Nil | Nil | Nil |
| Zn(ppm) | 0.1-0.22 | 0.2-0.32 | 0.2-0.5 | 0.2-0.35 | 0.2-0.5 |
| Pb(ppm) | Nil | Nil | Nil | Nil | Nil |
| Hg(ppm) | Nil | Nil | Nil | Nil | Nil |
| Cd(ppm) | Nil | Nil | Nil | Nil | Nil |

**Table 2: Station wise recorded Zooplankton species of Moraghat forest Range**

| Sl. No | Species | Station wise recorded zooplankton Species | | | | |
|---|---|---|---|---|---|---|
| | A: HOLOPLANKTONS | S1 | S2 | S3 | S4 | S5 |
| | **PROTOZOA** | | | | | |
| 1 | *Amoeba proteus* | - | + | + | - | + |
| 2 | *Euglena sp.* | + | + | + | - | + |
| 3 | *Paramecium sp.* | - | + | + | - | - |
| | **ROTIFERA** | | | | | |
| | **Order-Ploimida** | | | | | |
| | **Family-Brachionidae** | | | | | |
| 4 | *Brachionus angularis* Gosse,1851 | + | + | + | + | + |
| 5 | *Brachionus bidentata* Anderson,1889 | + | + | + | + | + |
| 6 | *Brachionus calyciflorus* Pallas,1776 | + | + | + | + | + |
| 7 | *Brachionus caudatus* (Hauer,1937) | + | + | + | + | + |
| 8 | *Brachionus falcatus* Zacharias,1898 | + | + | + | + | + |
| 9 | *Brachionus quadridentatus* Hermann,1783 | + | + | + | + | + |
| 10 | *Brachionus rubens* Ehrb, 1838 | - | + | + | - | - |
| 11 | *Keratella tropica* (Apstein,1907) | + | + | + | + | + |
| | **Family-Euchlanidae** | | | | | |
| 12 | *Euchlanis dilatata* Ehrb, 1832 | + | + | + | + | + |
| | **Family-Colurellidae** | | | | | |
| 13 | *Lepadella acuminata* (Ehrb,1834) | - | + | + | - | - |
| 14 | *Lepadella ovalis* (Muller,1786) | + | + | + | + | + |
| 15 | *Lepadella patella* (Muller,1786) | - | + | + | - | + |
| 16 | *Lepadella triptera* Ehrb,1830 | + | + | + | - | - |
| | **Family-Lecanidae** | | | | | |
| 17 | *Lecane aculeata* (Jakubski,1912) | + | + | + | + | + |
| 18 | *Lecane crepida* Harring,1914 | - | - | - | + | + |
| 19 | *Lecane curvicornis* Murray,1913 | + | + | + | + | + |
| 20 | *Lecane leontina* (Turner,1892) | + | + | + | + | + |
| 21 | *Lecane luna* (Muller,1776) | + | + | + | + | + |
| 22 | *Lecane ungulata* (Gosse,1887) | + | + | + | + | + |
| 23 | *Lecane bulla* (Gosse,1851) | + | + | + | + | + |
| 24 | *Lecane closterocerca* (Schmarda,1859) | - | - | + | - | + |
| 25 | *Lecane furcata* (Murray,1913) | + | + | + | + | + |
| 26 | *Lecane hamata* (Stokes,1896) | + | + | + | + | + |
| 27 | *Lecane lunaris* (Ehrb,1832) | - | - | - | + | + |
| 28 | *Lecane quadridentata* (Ehrb,1832) | + | + | + | + | + |
| | **Family-Asplanchnidae** | | | | | |
| 29 | *Asplanchna brightwelli* Gosse,1850 | + | + | + | + | + |
| | **ARTHROPODA** | | | | | |
| | **Order-Cladocera** | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Family-Sididae** | | | | | |
| 30 | *Pseudosida bidentata* Herrick,1884 | + | + | + | + | + |
| 31 | *Diaphanosoma sarsi* Richard,1895 | + | + | + | + | + |
| | **Family-Daphniidae** | | | | | |
| 32 | *Ceriodaphnia cornuta* Sars,1888 | - | + | + | - | - |
| 33 | *Daphnia lumholtzi* Sars,1885 | + | + | + | + | + |
| 34 | *Scapholeberis kingi* Sars,1903 | - | - | - | + | + |
| 35 | *Simocephalus exspinosus* (Koch,1841) | - | - | - | + | + |
| | **Family-Moinidae** | | | | | |
| 36 | *Moina micrura* Kurz,1874 | + | + | + | + | + |
| | **Family-Bosminidae** | | | | | |
| 37 | *Bosmina longirostris* (Muller,1776) | + | + | + | + | + |
| | **Family-Macrothricidae** | | | | | |
| 38 | *Macrothrix spinosa* King,1853 | - | + | + | - | - |
| 39 | *Macrothrix goeldii* Richard,1897 | - | - | - | + | + |
| 40 | *Echinisca triserialis* (Brady,1886) | + | + | + | + | + |
| | **Family-Chydoridae** | | | | | |
| 41 | *Pleuroxus similis* Vavra,1900 | + | + | + | + | + |
| 42 | *Pseudochydorus globosus* (Baird,1843) | - | + | + | - | - |
| 43 | *Alona quadrangularis* (Muller,1776) | + | + | + | + | + |
| 44 | *Alona pulchella* King, 1853 | + | + | + | + | + |
| 45 | *Camptocercus rectirostris* Schoedler,1862 | + | + | + | + | + |
| 46 | *Leydigia acanthocercoides* (Fischer,1854) | - | - | - | + | + |
| 47 | *Biapertura karua* (King,1853) | + | + | + | + | + |
| 48 | *Kurzia longirostris* (Daday,1898) | - | + | + | - | - |
| | **Class-Copepoda** | | | | | |
| | **Order-Calanoida** | | | | | |
| | **Family-Diptomidae** | | | | | |
| 49 | *Heliodiaptomus cinctus* (Gumey,1907) | + | + | + | + | + |
| 50 | *Heliodiaptomus contortus* (Gumey,1907) | + | + | + | + | + |
| 51 | *Heliodiaptomus viduus* (Gumey,1916) | - | + | + | - | - |
| | **Order-Cyclopoida** | | | | | |
| | **Family-Cyclopidae** | | | | | |
| 52 | *Mesocyclops leuckarti* (Claus,1857) | + | + | + | + | + |
| 53 | *Mesocyclops hyalinus* (Rehberg,1880) | + | + | + | + | + |
| | B: MEROPLANKTONS | | | | | |
| 54 | Nauplilius lravae | - | + | + | + | + |
| 55 | Glochidium larvae | - | + | + | - | - |
| 56 | Zoea larvae | + | + | + | - | - |
| 57 | Mysis larvae | + | + | + | - | - |
| 57 | Mysis larvae | + | + | + | - | - |
| 58 | Ichthyoplanktons | + | + | + | + | + |

*'+' = Present and '-' = Absent.*

**Zooplankton diversity:**

Qualitatively, a total of 53 established holoplanktons species and 5 meroplankton representatives were recorded throughout the entire study. Hloplanktons comprise four taxa: Sarcomastigophora, Ciliophora, Rotifera and Arthropoda (Table 1). Sarcomastigophora and Ciliophora are the phyla of kingdom Protista and have contributed three representatives. During monsoon and post monsoon they were sampled at all stations except $S_4$. It points out that these planktons prefer to live the habitats where maximum organic load and decaying plant materials present. Rotifer, the pseudocoelomate microscopic animals, are one of the oldest group of animals having world wide distribution and occur in an endless variety of aquatic and semi- aquatic habitats including the limnetic and deepest region of largest lakes and smallest puddles [29]. They are the integral components of the freshwater zooplankton communities of both lotic and lentic systems and contribute significant role in food chain. The Rotifer fauna of Moraghat forest range belonged to 26 species under 5 families. An analysis of taxonomic composition of rotifer suggests Lecanidae to be the most dominant family with 12 (46.15%) representatives. Brachionidae is the next dominate family with 8 (30.77%), Colurellidae with 4 (15.38%) correspondingly. Whereas, Euchlanidae and Asplanchnidae are the two families with single representative each and are less dominated families.

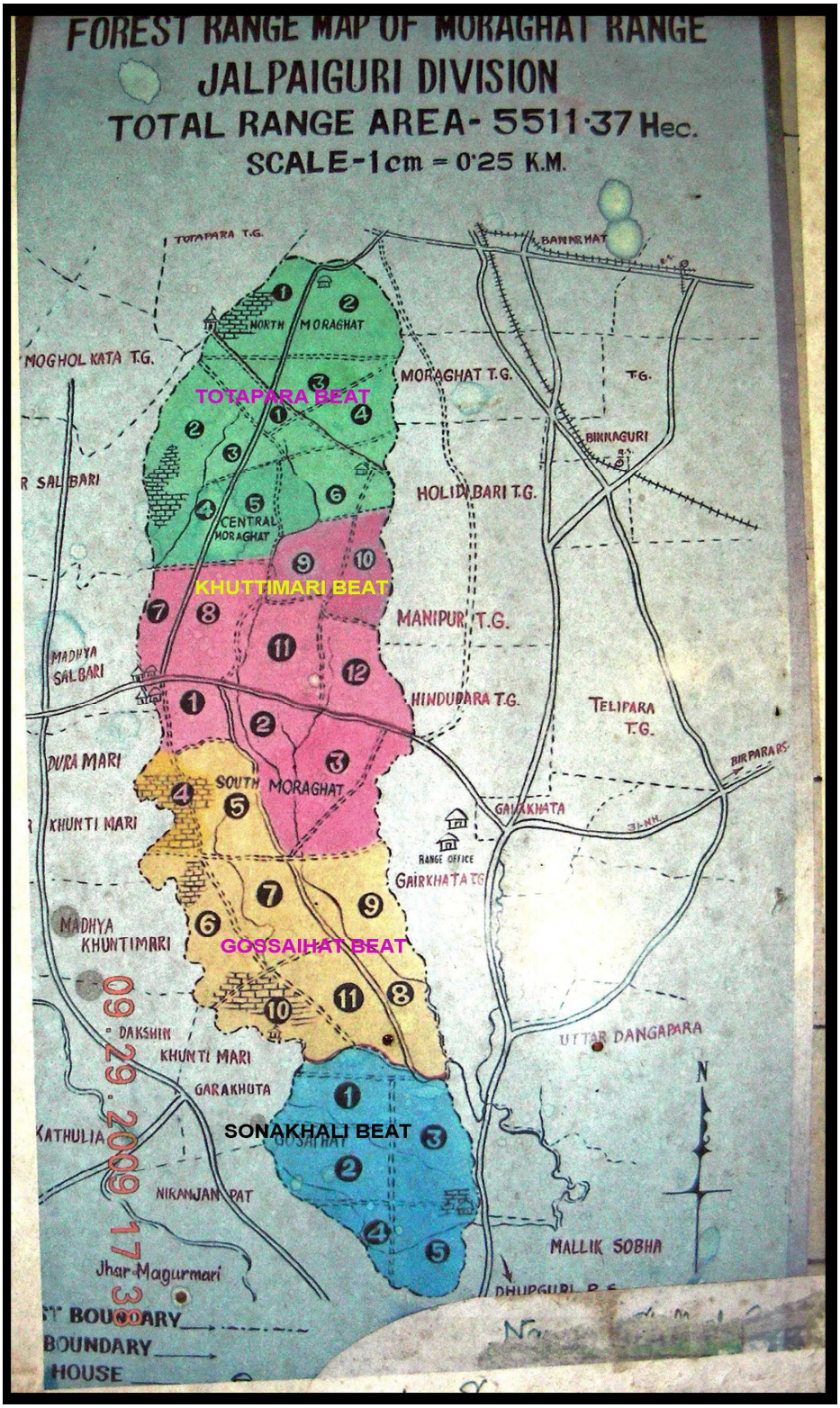
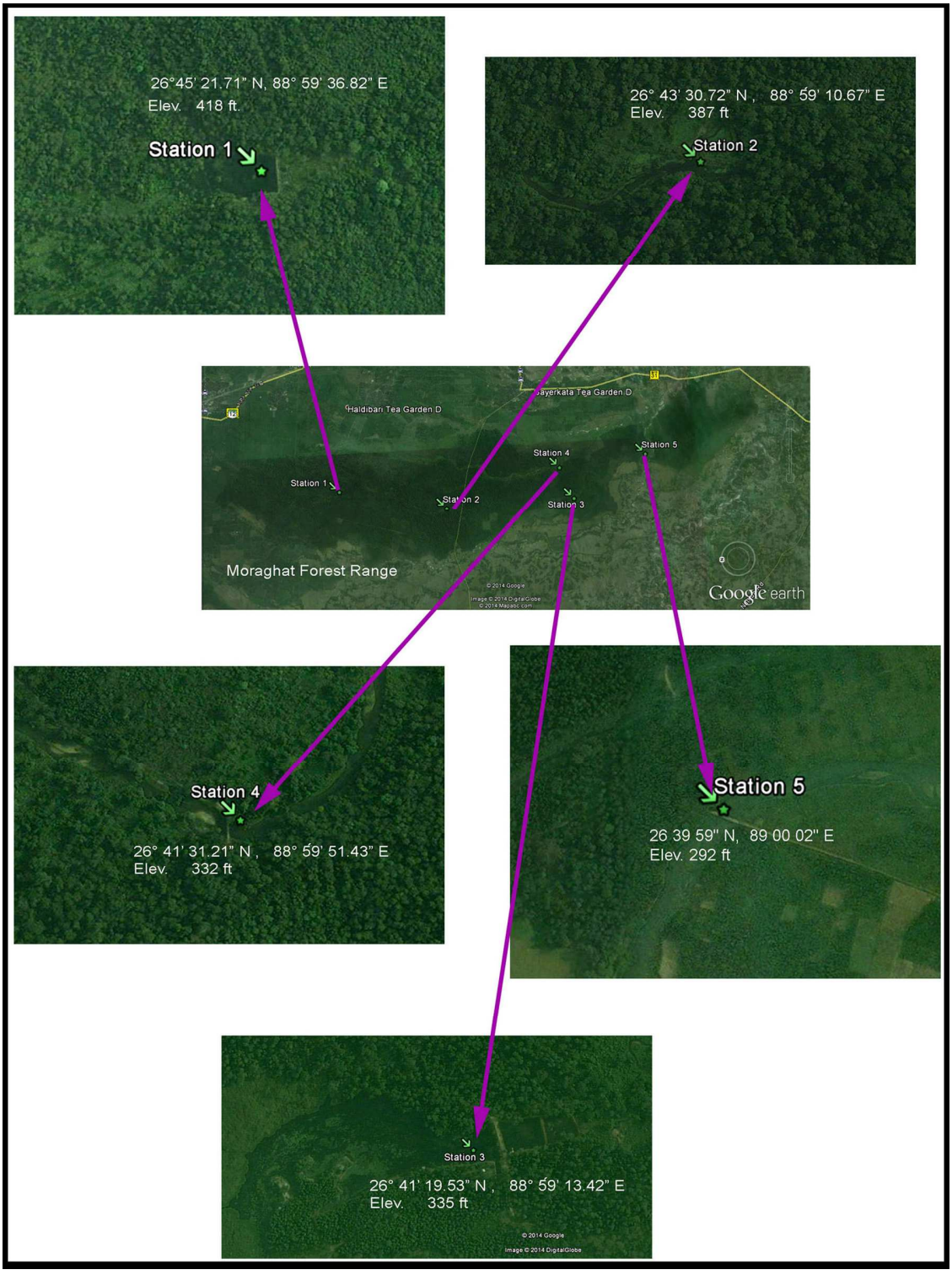



**Figure 1: Map of Moraghat Forest Range showing its four Beats**




**Figurer 2: Image of Moraghat Forest showing five study sites ($S_1$ = Pond of Totapara beat, $S_2$ = Pond of Khuttimari beat, $S_3$ =Pond of Gossaihat beat, $S_4$ =Garati River and $S_5$ = Nonai River)**

The order Cladocera belongs to subclass Brachiopoda of class Crustacea and contributes substantially to planktonic composition of any freshwater body. They are commonly known as water fleas and occur in almost all types of

freshwater bodies (lotic and lentic). The greater significance of Cladocera in the aquatic food chain as food for both young and adult fish [29]. In addition to providing an important food source for planktivorous fish and invertebrates, they are important grazers on algae and detritus [30] and can play an important role in the recycling of nutrients in aquatic ecosystems [31 and 32]. During present investigation 19 commonly occurring species Cladocerans of 6 families were recorded. Taxonomic analysis suggests family Chydoridae is the most dominant family with 8 (42.1%) representatives. Daphnidae is the next dominate family with 4 (21.1%), Macrothricidae with 3 (15.79%) species and Sididae with 2 (10.53%) species respectively. While, Moinidae and Bosminidae are two families having single representative each and are designated as least dominant families.

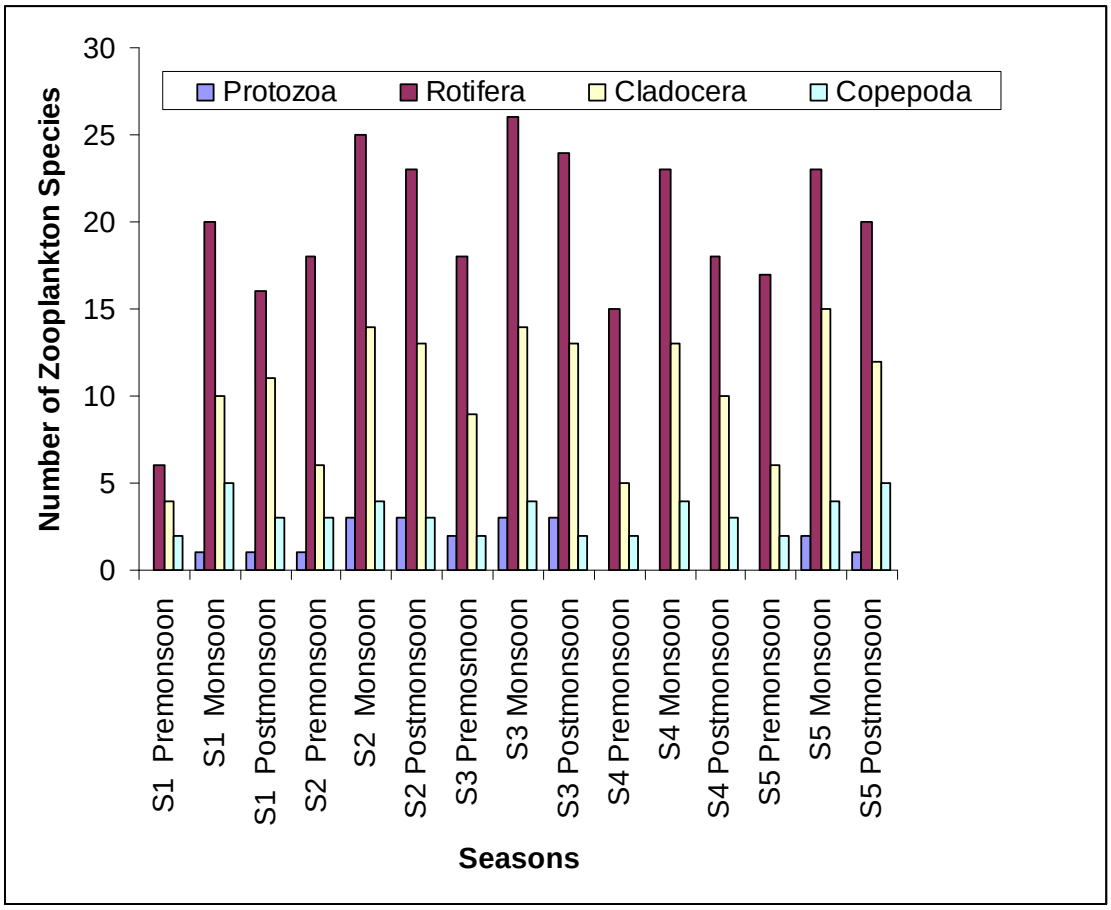



**Figure 3: Seasonal changes in the number of Zooplankton species at water bodies of Moraghat Forest**

Copepods are the most important planktonic constituent and form an essential link in the aquatic food chain of both marine and freshwaters. Out of six order of the sub class Copepoda, the free living planktonic forms belong to the orders Calanoida and Cyclopoida. Throughout present study, the diversity of copepods was not rich and represented by 5 species belonging to two families. Family Diptomidae added 3 delegates and Cyclopidae contributed 2 representative species.

Developmental stages (larval stages of invertebrates, fry and fingerlings of fin-fish) of few aquatic animals show the planktonic stage and they are commonly called meroplanktons.Nauplius, zoea, mysis, glochidium, and fry & fingerlings of cypriniformes fish were sampled during study.

**Community Analysis: -**

The species richness in five sampling sites of this forest showed considerable variation. $S_3$ (47 species) and $S_2$ (46 species) were the most biologically diverse. $S_5$ had 44 and $S_4$ had 40 species whereas $S_1$ had 36 representatives. The vertical and horizontal seasonal distributions of zooplankton in all stations indicate that monsoon is the peak season

when maximum numbers of holoplanktons were sampled (Figure 3). The species diversity index of different sampling sites was ranged from 1.347 to 1.791 (Figure 4). In the study, maximum diversity index was recorded higher in $S_3$ ($\overline{H}$ =1.791) as compare with $S_2$ ($\overline{H}$=1.711), $S_5$ ($\overline{H}$ =1.637), $S_4$ ($\overline{H}$ =1.223) and $S_1$ ($\overline{H}$ = 0.874). This may be due to the physicochemical properties of water, substratum soil features and phytoplankton loads. Zooplanktons population fluctuation depends upon the some ecological parameters reported by some researchers [22, 33 and 34] and the present study is in agreement with similar ones reported by them. Further researches are required studying their tolerance in respect of different ecological ingredients.

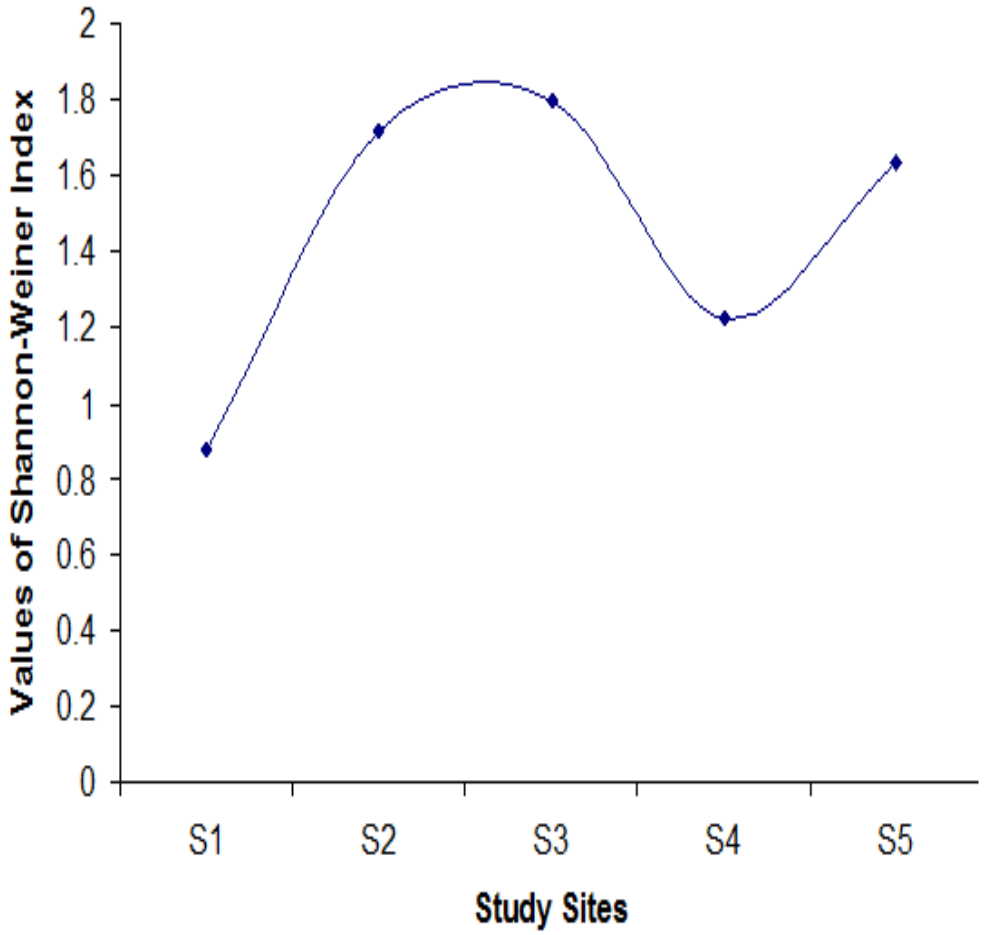



**Figure 4: Shannon-Weiner (S-W) Indices of Zooplanktons at Different Study Sites of Moraghat Forest**

## CONCLUSION

Zooplanktons are essential components of aquatic food webs and supply significantly to aquatic productivity in freshwater ecosystems. They have been studied from various inland aquatic environs of India. Till date it is unfortunate that the Moraghat Forest of Jalpaiguri District has not received any attention from the zooplankton aspect. The report gains importance of this forest for conservation strategy of wild lives.

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