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Algal community structure and species Diversity of fresh water bodies of Kohima, Nagaland

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Abstract

The phytoplankton community structure and species diversity were studied from one lentic and two lotic water bodies from Kohima district of Nagaland. A total of 71 algal species were recorded from all the study sites. Species richness varied considerably in between lentic and lotic systems. Species richness and diversity was high in Thizama pond (43 species and 3.6 respectively) and low species richness and diversity were recorded from Phesama stream (26 species and 3.1 respectively). The distributional pattern of algal community in Thizama pond was dominated by Chlorophyceae member while in Phesama and Khuzama stream it was dominated by Bacillariophyceae member. The physico-chemical parameters like nitrate and phosphate were high in Phesama stream as compared to the other study sites. The dominant species were *Cosmarium speciosum*, *Cosmarium subcrenatum*, *Cosmarium dubium*, *Closterium angustatum*, *Navicula rhynchocephala*, *Nitzschia linearis* and *Fragillaria crotonensis*. Phytoplanktonic study is very important because they act as primary producers, food for variety of aquatic organisms and an efficient bio-indicator for water quality.

Algae commonly known as Phytoplankton is the basic component in the aquatic ecosystems which traps almost all the energy and is one of the most important contributor of primary productivity, playing a key role in supporting the entire life forms in any aquatic ecosystem[15,20]. Free floating phytoplankton on the surface of water thus maintain the equilibrium between abiotic and biotic components of any an aquatic system[22] and help to regulate atmospheric temperature via photosynethesis[19]. Phytoplankton floats freely in the water column and are unable to maintain population in a fast flowing streams. They can however develop sizable populations in slow moving rivers[1]. The distribution of phytoplankton communities are usually governed by factors like light, pH, water

current, temperature and nutrient[11]. In some cases, it was observed that a slight stress in the environment like increase in nutrient loading, adversely affected the entire algal communities altering the species composition and their density[6,18]. Excessive nutrient accumulation in aquatic ecosystems by carrying of anthropogenic sources mainly rich in phosphorus and nitrogen creates a series of changes in their structure and functions in the direction of deterioration of water quality known as eutrophication. Among the structural changes caused by the eutrophication there is the dominance of the Cyanobacteria and Euglenophyceae members in the freshwater ecosystem such as lakes and reservoirs. The oligotrophic lakes or rivers are characterized by the presence of Chlorophyceae members particularly desmids[23] and their abundance are positively correlated with low nutrient concentrations and healthy condition of the water body. Kolkwitz and Marsson were the pioneers who classified algal species based on the tolerance to various kinds of pollution[14]. Palmer published a composite rating of algal species that could be used to indicate clean and polluted waters[21].

Algae are very sensitive to pollution and are used as indicators of water quality[27]. Many authors have used species diversity which combine species richness as qualitative and abundance of species as quantitative measure of different groups of algae to determine the trophic status of many water bodies[3, 9]. A high diversity count suggest a healthy ecosystem, the reverse indicate a degraded ecosystem.

Very little work has been done in north east region regarding the water quality and the algal flora from North Eastern region mainly Nagaland. Therefore the present work was taken to enumerate the algal species from different water bodies of Kohima District in relation to its water quality.

Study Sites: One lentic and two lotic freshwater bodies were selected for study. Thizama pond is situated at an altitude of 1314m asl, with the geographical coordinates at latitude of 25°14'943" N and 091°43'951"E. Phesama stream is situated at an altitude of 1622m asl, with the geographical coordinates at latitude of 25°37'633"N and 094°06'080"E. Khuzama stream is situated at an altitude of 1176m asl, with the geographical coordinates at latitude of 25°44'224"N and 094°06'611"E.

Physico-chemical parameters such as water temperature, pH and conductivity were measured on the spot. Phosphate and nitrate were estimated in the laboratory following standard methods[2]. The algae were collected from the surface water by a plankton net having mesh size of 45 μm. The collected samples were transferred into a 1 litre polyethylene sample container which was washed thoroughly with field water. Taxonomic identification up to species level was mainly carried out with the help of different Floras and Monographs[10,23,26].

Data Analysis :

Species diversity Index was calculated by using **Shannon-Wiener diversity index** following the formula:

$$H' = \sum_{i=1}^{s} Pi \ln Pi$$

Where; s = total number of species.
Pi is ni/N, ln Pi is normal log of Pi
ni = Number of individuals belonging to the i^{th} species.
N = total number of individual of all the species.

Species richness was calculated as the total number of species present in a given sample.

The physico-chemical parameters varied significantly among the three study sites. Water temperature was maximum in Thizama pond with 23°C and was low in khuzama stream with 12°C. The pH was slightly acidic with 6.08 in the pond whereas the pH of the streams where alkaline and ranged from 7.2-7.4 (Khuzama and Phesama stream respectively). The conductivity was high in Khuzama stream with 0.06 mS/cm and was low in Thizama pond with 0.01 mS/cm. Dissolved oxygen was high in Thizama pond with 7.2 mg/l and minimum in Phesama stream with 6.0 mg/l. Phosphate and nitrate were high in Phesama stream with 0.5mg/l and 0.6 mg/l respectively. Nutrient concentration was low in Thizama pond as compared to Khuzama stream (Table-1).

Phytoplankton community structure :

A total of 71 species were recorded from three different water bodies of Kohima, Nagaland. The phytoplankton community structure in Thizama pond was dominated by chlorophyceae with 22 species and bacillariophyceae with 11 species. Phesama and Khuzama streams were dominated by bacillariophyceae with 20 and 17 species respectively (Table 2). The dominant species were *Cosmarium speciosum*, *Cosmarium subcrenatum*, *Cosmarium dubium*, *Closterium* sp, *Navicula rhynchocephala*, *Nitzschia linearis* and *Fragillaria* sp.

Table-1. Physico-chemical parameters of different selected water bodies of Kohima, Nagaland

Parameters	Thizama (pond)	Phesama (stream)	Khuzama (stream)
Temperature (°C)	23±0.03	20±0.06	12±0.02
pH	6.08±0.02	7.4±0.04	7.2±0.01
Conductivity(mS/cm)	0.01±0.002	0.02±0.003	0.06±0.001
Dissolved oxygen (mg/l)	7.2±0.04	6.0±0.01	6.54±0.2
Nitrate (mg/l)	0.2±0.007	0.6±0.001	0.4±0.014
Phosphate (mg/l)	0.02±0.004	0.5±0.04	0.3±0.014

Table-2. Distributional patterns of Phytoplanktons in three water bodies

Class	Species	Thizama pond	Phesama stream	Khuzama-stream
Chlorophyceae	*Chlorococcum* sp	+	-	-
	Closterium angustatum	+	+	-
	Closterium kuetzingii	+	-	-
	Closterium sp	+	-	+
	Cosmarium baculum	-	-	+
	Cosmarium hammeri	+	-	-
	Cosmarium nitidulum	-	-	+
	Cosmarium ralfsii	+	-	-
	Cosmarium seteceum	+	-	-
	Cosmarium speciosum	+	-	-
	Cosmarium subcrenatum	+	-	-
	Desmidium sp	+	-	-
	Euastrum dubium	-	+	-
	Micrasterias oscitans	+	-	-
	Microspora sp	+	-	+
	Monoraphidium sp	+	-	-
	Onychonema uncinatum	+	+	-
	Oocystis sp	+	-	-
	Pleurotaenium trabecula	+	-	-
	Scenedesmus communis	+	-	-
	Sphaerocystis sp	+	-	-
	Spirogyra sp	+	-	-
	Staurastrum armigerum	+	-	-
	Staurastrum gracile	+	-	-
	Stauridium tetras	-	+	+
	Tetraedron minimum	+	-	-
Total		**22**	**4**	**5**
	Amphora ovalis	+	+	-
	Cymbella sp	-	+	+
	Cymbella tumida	+	+	-
	Cymbella tumida	+	-	-

Bacillariophyceae	*Diatoma* sp	-	-	+
	Fragilaria crotonensis	+	+	-
	Gomphonema constrictum	-	-	+
	Gomphonema parvulum	-	+	+
	Gyrosigma scalproides	+	-	-
	Gyrosigma sp	+	-	-
	Melosira varians	-	+	+
	Navicula rhyncosephala	-	+	+
	Navicula sp	+	+	-
	Nitzschia aciculais	+	+	-
	Nitzschia commutate	-	-	+
	Nitzschia frustulum	-	+	+
	Nitzschia linearis	-	+	+
	Nitzschia palea,	-	+	+
	Nitzschia reversa	-	+	-
	Nitzschia sigmoidea	-	+	+
	Gomphonema constrictum	-	+	-
	Hantzschia amphioxys	+	+	-
	Nitzschia palea	-	+	+
	Nitzschia sigmoidea	-	-	+
	Pinnularia nobilis	-	-	+
	Pinnularia nodosa	-	+	+
	Pinnularia sp	+	-	+
	Pinnularia subsimilis	-	+	-
	Pinnularia viridis	+	+	-
	Rhopalodia gibba	-	-	+
Total	**31**	**11**	**20**	**17**
Cyanobacteria	*Anabaena constricta*	+	-	-
	Merismopedia punctata	-	-	+
	Microcystis sp	-	-	+
	Oscillatoria limosa	-	-	+
Total	**4**	**1**	**0**	**3**
Euglenophyceae	*Euglena geniculate*	+	-	-
	Euglena sp 1	+	-	-

	Euglena sp 2	+	-	-
	Euglena sp 3	+	-	-
	Euglena sp 4	-	-	+
	Menoidium pellucidum	-	-	+
	Trachelomonas volvocina	+	-	-
Total	**7**	**5**	**0**	**2**
Xanthophyceae	*Goniochloris smithii*	+	+	-
	Ophiocythium sp	+	-	-
	Tribonema sp	+	+	-
Total	**3**	**3**	**2**	**0**
Dinophyceae	*Glenodium* sp	+	-	-
Total	**1**	**1**	**0**	**0**
Grand total	**71**	**43**	**26**	**27**

The species richness and diversity was maximum in Thizama pond with 43 species and 3.6 respectively and minimum in Phesam stream with 26 species and 3.1 respectively (Fig. 1).

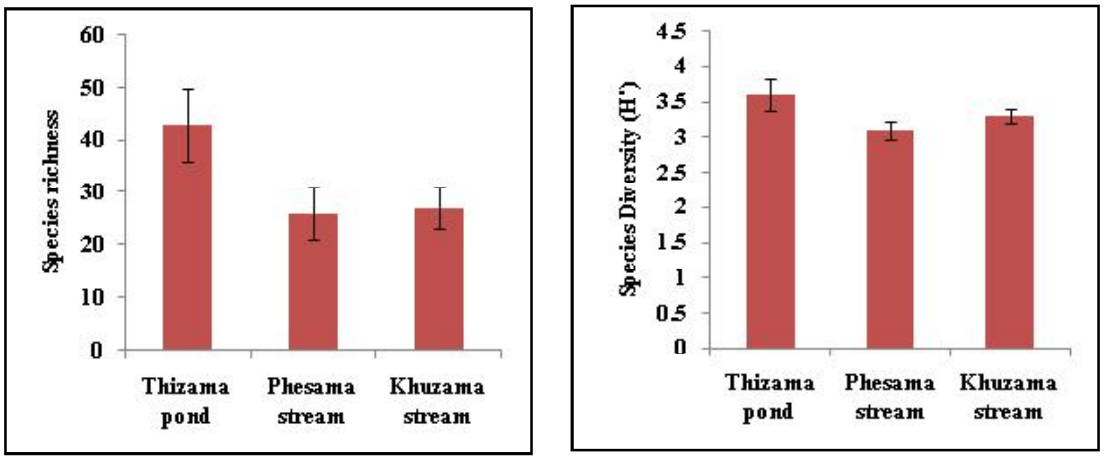

Figure 1: Species richness and diversity in three selected water bodies of Nagaland.

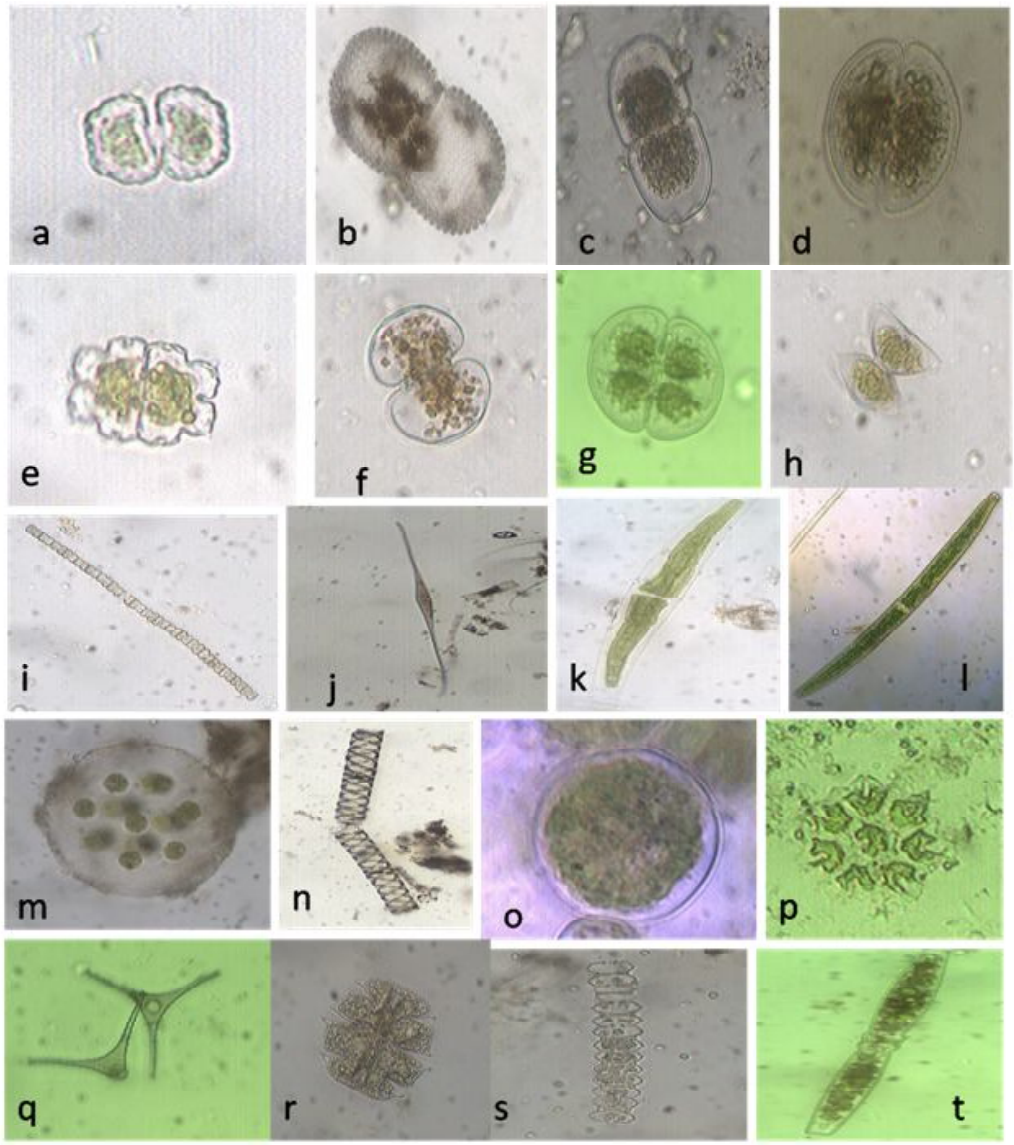

Plate1:Photographs of Chlorophyceae - a. *Cosmarium subcrenatum* , b. *Cosmarium speciosum,* c. *Cosmarium* sp, d. *Cosmarium* sp, e. *Cosmarium dubium,* f. *Cosmarium nitidulum,* g. *Cosmarium* sp, h. *Staurastrum lapponicum,* i. *Demidium* sp, j. *Closterium seteceum,* k. *Closterium jenneri,* l. Closterium angustatum, m. *Sphaerocystis* sp, n. *Spirogyra* sp, o. *Chlorococcum* sp, p. *Stauridium* sp, q. *Staurastrum gracile,* r. *Micrasterias oscitans,* s. *Onychonema uncinatum,* t. *Pleurotaenium trabecula* .

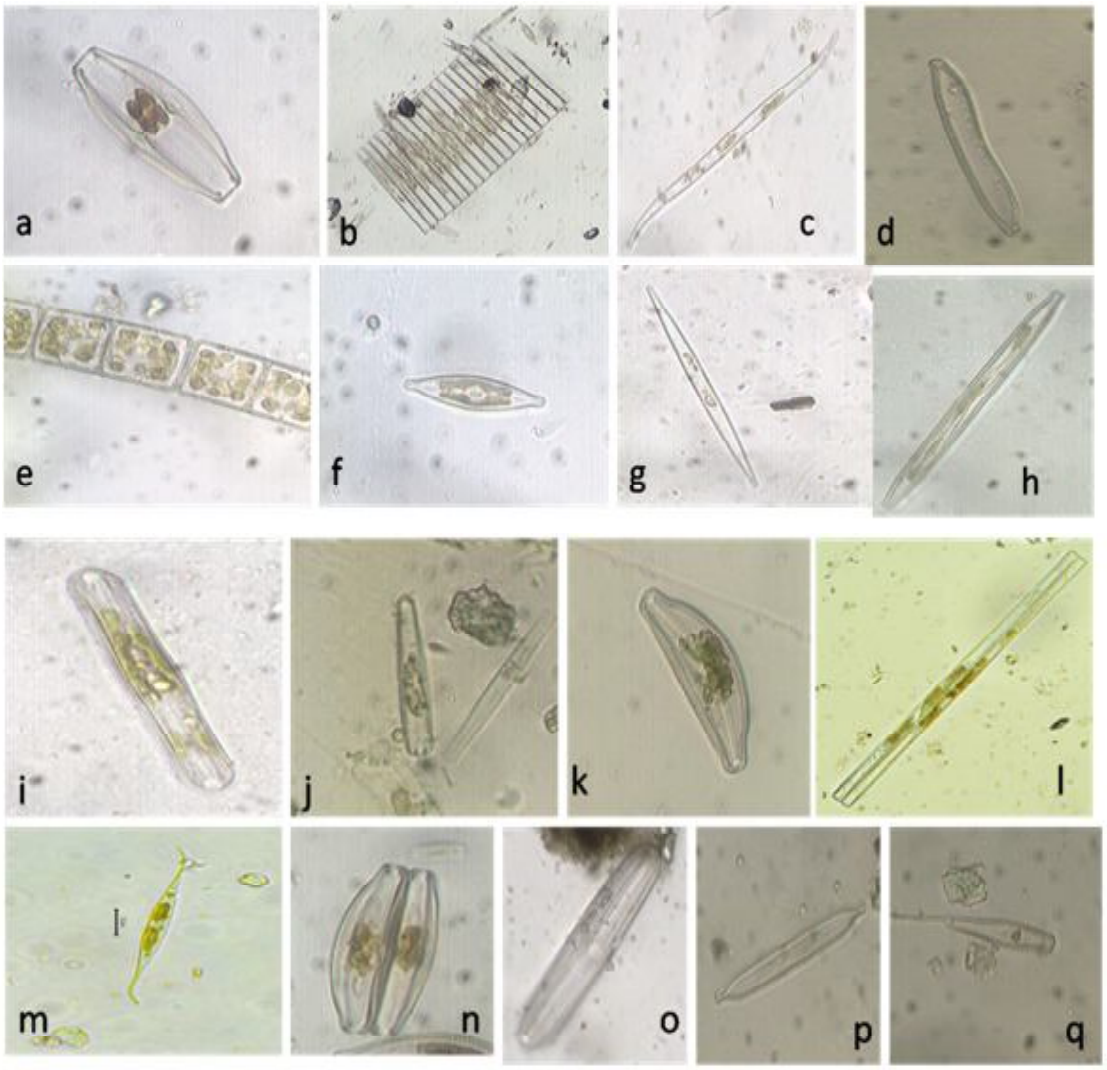

Plate 2: Photographs of Bacillariophyceae - a. *Amphora ovalis*, b. *Fragillaria* crotonensis, c. *Gyrosigma* sp, d. *Hantzschia amphioxys*, e. *Melosira varians*, f. *Navicula rhynchocephala*, g. *Nitzschia acicularis*, h. *Nitzschia linearis*, i. *Pinnularia subsimilis*, j. *Gomphonema parvulum*, k. *Cymbella tumida*, l. *Synedra ulna*, m. *Nitzschia reversa*, n. *Rhopalodia gibba*, o. *Pinnularia viridis*, p. *Nitzschia palea*, q. *Gomphonema constrictum*.

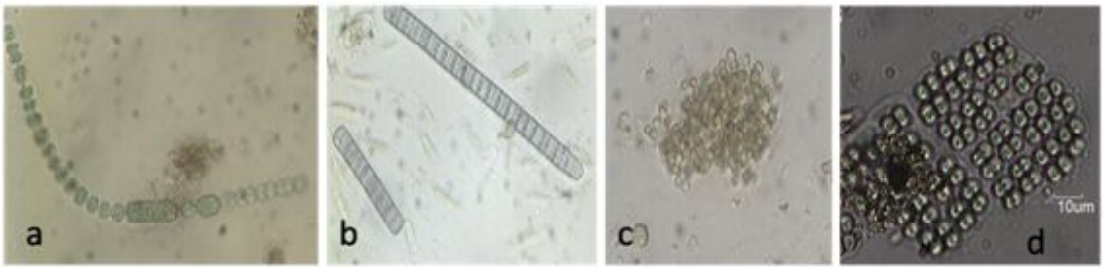

Plate 3: Photographs of Cynaobacteria- a. *Anabaena* constricta, b. *Oscillatoria limosa*, c. *Microcystis* sp, d. *Merismopedia punctata*.

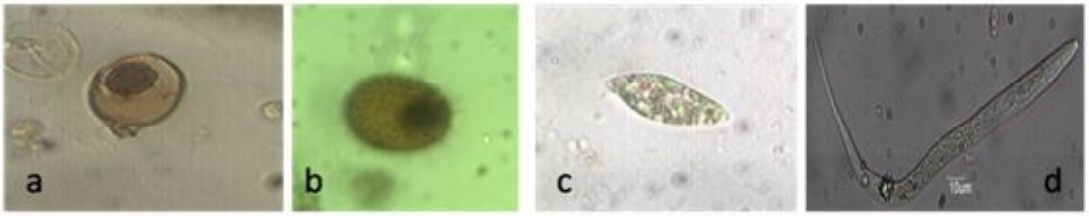

Plate 4: Photographs of Euglenophyceae - a. *Trachelomonas volvocina*, b. *Trachelomonas* sp, c. *Euglena geniculate, d. Euglena* sp.

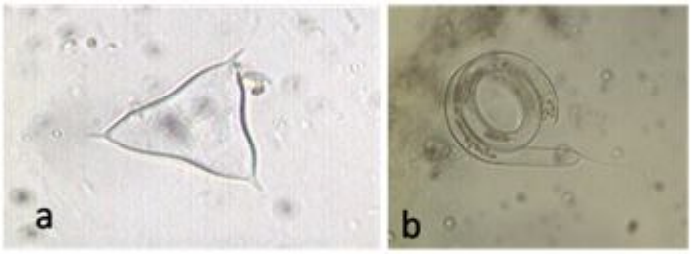

Plate 5: Photographs of Xanthophyceae - a. *Goniochloris smithii,* b. *Ophiocytium* sp

Plate 6: Photographs of Dinophyceae - *Glenodium* sp

Water parameters measured in three different types of water bodies i.e. Thizama pond, Khuzama and Phesama streams varied significantly. Temperature was high in pond as compared to both the stream which could be due to low water level, negligible flow rate of water and sediment deposition. Similar results like raise in temperature was reported in Nyalenda swamp in East Africa[17] and in Tharavai wetland in Tamil nadu[24]. Photosynthesis, respiration and decomposition processes contributed to pH fluctuations influencing carbondioxide level in water. In our present study, pH was slightly acidic to slightly alkaline in nature. High conductivity in Khuzama stream could be the results of anthropogenic activities. High electrical conductivity values due to high evaporation rate from Baiyangdian lake and lake of Bhopal respectively which increased the salt concentration[12]. Electrical conductivity in any water body increased with direct entry of sewage due to the presence of phosphate, nitrate and chloride[4]. Phosphate and Nitrate concentration were high in Phesama stream which might be due to the runoff water from the periphery of the stream. Similar results were also reported in lake and rivers[7,8]. The phytoplankton community structures in all the selected sites were dominated by Bacillariophyceae and chlorophyceae. The distributional patterns of algae in fresh water system depend mainly on the physico-chemical features of the system[5]. It is well known that diatoms are sensitive to a wide range of limnological and environmental variables and its community structure quickly respond to changing physical, chemical and biological conditions in the environment[16]. The Bacillario-phyceae (diatom) are usually the most common elements of shallow communities[25]. Presence of maximum desmids from Thizama pond indicate the oligotrophic status of water and Phesama and Khuzama streams support pollution indicator species like *Nitzschia palea, Nitzschia linearis* and *Gomphonema parvulum*. High desmids population was recorded in the upstream of Bhadra reservoir where turbidity and phosphate concentration was low and desmids were absent in downstream of Bhadra river as the water was polluted by industrial effluents and domestic wastes[13]. The species richness and diversity was also high in the Thizama pond which could be the results of oligotrophic nature of water which support diverse group of algae. A high diversity count suggest a healthy ecosystem, the reverse indicate a degraded ecosystem. Thizama pond harbor diverse algae then Phesama and Khuzama streams.

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