RESEARCH REVIEW JOURNALS
Volume-04
Issue-05
May-2019

ISSN: 2455-3085 (Online)
RESEARCH REVIEW International Journal of Multidisciplinary
www.rrjournals.com[UGC Listed Journal]

Analysis of Diatoms of Fresh Water bodies in Manipur (India)

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ARTICLE DETAILS

Article History
Published Online: 15 May 2019

Keywords
Diatoms, Pennales, Centric, Water Bodies, Manipur.

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ABSTRACT

Manipur is located at the northeastern part of India having an alpine climate, very cold in winters and the temperature falls down into zero degrees Celsius while in the summer the temperature goes to 32 degree Celsius. In the present study, the samples were collected from different water bodies (H-1 to H-40) comprising ponds, lakes, rivers, dams, drains, and canals are assessed. At these various types of water bodies, there were 19 genera and 28 species found with 5 centric diatoms and 23 pennales. These were recorded during the month of January and February in 2014. In order to pennales, the dominating diatoms were Nitzschia, Navicula, Synedra, Amphora, Pleurosigma, Mastogloia and Chaetoceros. In order to centric, the dominating diatom was only Cyclotella. Pennales diatoms were dominant than centric diatoms.

1. Introduction

Manipur is situated in northeastern India, with Imphal as capital. As one might say without hesitation, the land is paradise come true on earth. Literally meaning ‘‘the jeweled land". Pt. Nehru described it as “Jewel of India”. Manipur is surrounded by Upper Myanmar in the east, Cachar district of Assam in the west, Nagaland in the north and Mizoram in the south. The natural vegetation occupies an area of about 14,365km^2 which is nearly 64% of the total geographical area of the state. The impact of the topography of the region is clearly seen on the climate of the region. Manipur is a wedge between hills on all sides. Manipur is present at 790 meters above from sea level. In summer season the temperature reaches 32 degree Celsius while in winters the temperature falls below zero degree Celsius which brings frost and snowfall. In Manipur there are a large number of rivers, ponds, lakes, canals, drains; dams etc. This is a first-time study on diatoms in Manipur.

2. Materials and Methods

Diatoms collection and methods were the ease and of low cost. Samples could be archived easily for a long period of time for future analysis and long-term records.

A. Sample Collection

Fortnight sampling was conducted consecutively for three months from January 2014 to March 2014. The name of the 40 stations where the sample is collected is used as a code H-1-H-40. The sample is collected from 7 hillslope area and 33 plain areas. Diatom samples were collected (ponds, drains, lakes, rivers, dams, canal, etc) with the help of planktonic mesh net (pore size 40µm). From each site, different pebbles and boulders were sampled within a defined 10-meter reach. Pebbles and boulders (>250 mm), free from siltation and filamentous algae were selected for sampling.

Samples were collected in 250 ml. sample bottle which is suspended in distilled water. Diatoms were collected with the help of hard toothbrush and epilithon from the upper surface of the pebbles and boulders. (Kelly *et al*., 1998).

All the samples were preserved in the Forensic Science Laboratory, Institute of Forensic Science and Criminology, Bundelkhand University, Jhansi.

Table 1
Collection of 40 Water Samples From the Different Regions of Manipur

Site No.	Name of the Station	Water Body	Geographical Area
1	Kawa Path	Lake	Plain
2	Imphal Turel	River	Plain
3	Kongba Rural Turel	River	Plain
4	Loktak Path	Lake	Hill Slope
5	Tonjam Pukhree	Pond	Plain
6	Khongun Turel	River	Plain
7	City Khongban Esing	Drain	Plain
8	Ulou Turel	River	Plain
9	Salong Pukhree	Pond	Hill Slope
10	Porompat Police Pukhree	Pond	Plain
11	Likli Turel	River	Hill Slope
12	Bijoy Govinda Path	Lake	Plain
13	Iril Turel	Lake	Hill Slope
14	Lairik Yengfam Mamang Pukhree	Pond	Plain
15	Samurou Dam	Dam	Plain
16	Laifamkhunou Mamang Pukhree	Pond	Plain
17	Nambul Turel	River	Plain
18	Ethakhun Turel	River	Plain
19	Sinda Dam Canal	Canal	Hill Slope
20	Sinda Dam	Dam	Hill Slope
21	Irum Turel	River	Plain
22	Pukhreechao Pukhree	Pond	Plain
23	Ningthoukhong Canal	Canal	Plain
24	Lamshang Canal	Canal	Plain
25	Hiyangthang Pukhree	Pond	Plain
26	Epum Turel	River	Plain
27	Thangapath	Lake	Plain
28	Lakoipath	Lake	Hill Slope
29	Lamshang Village Khongban	Drain	Plain
30	Rajbaari Pukhree	Pond	Plain

31	Ningthem Pukhree	Pond	Plain
32	Sinda Dam Turel	River	Plain
33	Naoremthong Pukhree	Pond	Plain
34	Thangjourik Turel	River	Plain
35	Ningthoukhong Turel	River	Plain
36	Naga Rural River	River	Plain
37	Patsoi Canal	Canal	Plain
38	Naga Mapal Canal	Canal	Plain
39	Pangei Canal	Canal	Plain
40	Elangbam Leikai Pukhree	Pond	Plain

B. Preparation and Identification

The samples were allowed to settle for 24 hrs and the supernatant decanted. Samples were first examined to establish if a considerable number of dead cells were present. This was done, as only living cells will be able to provide a reflection of recent water quality. The samples were then oxidized in a saturated solution of potassium permanganate. Carbonates were removed using concentrated (32%) hydrochloric acid (Taylor *et al*, 2005 and Karthik *et al*, 2010). Samples were then rinsed with distilled water and collected by centrifugation, using five successive runs 2500 RPM. Clean valves were then mounted in DPX. Diatoms were identified under phase contrast using an oil immersion lens at 1000x magnification (100x oil immersion objectives in combinations with 10x eyepiece). During enumeration, the dimensions of diatom valve characteristics, like its length, width and striae densities in 10µm were measured.

Identification of diatoms is carried out using taxonomic guides (Husedt, 1959; Gandhi, 1988; Prescott, 1975; Desikachary, 1989; Round *et al*, 1990, Anand, 1998; Lange-Bertalot, 2001; Krammer, 2002; Taylor, 2007; Karthick *et al*., 2008). Photomicrographs were taken using a Nikon Labophot-2 with H-3 photographic attachment.

C. Diatom Identification

All the Diatom species were observed at 100X observation using a Leica DM 2500 compound microscope fitted with Leica EC3 digital camera. The diatom genera were identified using various keys of du Buf (2002), Pollanen (1998), Round *et al*. (1990), Hustedt (1930, 1959, 1961-1966), Patrick and Reimer (1966 and 1975), Krammer and Lange-Bertalot (1986, 1988, 11991a, a991b), Simonsen (1987), and Gandhi (1959).

3. Result and Discussion

A diatom community of Manipur ponds, lakes, rivers, drains, and canal comprised of 28 species representing 5 centric and 23 pennate forms of which the genera were *Nitzschia* (4), *Navicula* (3), *Synedra* (2), *Amphora* (2), *Cyclotella* (2), *Pleurosigma* (2), *Mastogloia* (2), *Chaetoceros* (2) and single species of the following diatoms: *Skeletonema, Thalassionema, Podosira stelligera, Hemidiscus , Paralia sulcata, Cymatonitzschia marina, Plagiogramma antillarum, Trachyneis , Grammatophora* and *Caloneis madraspatensis*. Most of the species were solitary while some were colonial. The presence of these eutrophic species is the clear indication of the organically rich water.

During the monsoon season, some diatom species (centric) like *Amphora, Coscinodiscus, Stephanodiscus, Melosira* and *Cyclotella* were most dominant whereas some genera of pennate diatoms like *Nitzschia, Navicula, Synedra, Mastogloia* and *Pleurosigma* were dominant during the winter season.

Data of diatom count reveals that diatom growth is maximum in the month of January (winter season), declines gradually and shows its lowest value in the month of May (rainy season). Philipose (1960) also reported diatom peaks in winter. Karikal (1995) reported the maximum population of Bacillariophyceae during the winter season. Low count of alga in monsoon is attributed to precipitation that dilutes the water and disturbs the structure and composition of the aquatic system. The disturbance influenced by the high flow of water on aquatic life is additionally been studied by many scientists (Stevenson et al., 1996; Biggs et al., 1998). Diatom population though varied with season, it also showed varied results depending upon the physical parameters like pH, Salinity and Temperature. It was observed that though diatom population was high in summer and autumn, it was low in winters and again increased in spring.

Table 2
Presence or Absence of Diatoms in Various Water Bodies

Sr. No.	Name Of The Station	Water Body	Geographical Area	Diatoms
H- 1	Kawa path	Lake	Plain	Nil
H-2	Imphal turel	River	Plain	Found
H-3	Kongba Rural turel	River	Plain	Nil
H-4	Loktak Path	Lake	Hill Slope	Found
H-5	Tonjam Pukhree	Pond	Plain	Nil
H-6	Khongun Turel	River	Plain	Found
H-7	City khongban Esing	Drain	Plain	Found
H-8	Ulou Turel	River	Plain	Nil
H-9	Salong Pukhree	River	Hill Slope	Found
H-10	Porompat Police Pukhree	Pond	Plain	Nil
H-11	Likli Turel	River	Hill Slope	Found
H-12	Bijoy Govinda Path	Lake	Plain	Nil

H-13	Iril Turel	River	Hill Slope	Nil
H-14	LarikYengbam Mamang Pukhree	Pond	Plain	Nil
H-15	Samurou Dam	Dam	Plain	Found
H-16	Laifamkhunou Mamang pukhree	Pond	Plain	Found
H-17	Nambul Turel	River	Plain	Found
H-18	Ethakhun Turel	River	Plain	Found
H-19	Sinda Dam Canal	Canal	Hill Slope	Found
H-20	Sinda Dam	Dam	Hill Slope	Found
H-21	Irum Turel	River	Plain	Nil
H-22	Pukhreechao Pukhree	Pond	Plain	Found
H-23	Ningthoukhong Canal	Canal	Plain	Found
H-24	Lamshang Canal	Canal	Plain	Found
H-25	Hiyangthang Pukhree	Pond	Plain	Nil
H-26	Epum Turel	River	Plain	Found
H-27	Thangapath	Lake	Plain	Nil
H-28	Lakoipath	Lake	Hill Slope	Nil
H-29	Khori Faabi Turel	River	Plain	Found
H-30	Rajbaari Pukhree	Pond	Plain	Nil
H-31	Ningthem Pukhree	Pond	Plain	Nil
H-32	Lamshang Village Khongban	Drain	Plain	Found
H-33	Naoremthong Pukhree	Pond	Plain	Found
H-34	Thangjourik Turel	River	Plain	Found
H-35	Ningthoukhong Turel	River	Plain	Found
H-36	Naga Rural Turel	River	Plain	Found
H-37	Patsoi Loukhong	Canal	Plain	Found
H-38	Naga Mapal Canal	Canal	Plain	Nil
H-39	Pangei Loukhong	Canal	Plain	Found
H-40	Elangbam Leikai Pukhree	Pond	Plain	Found

Table 3
Diatoms Found In Different Samples of Manipur

Sr. No.	**Genera/Species**	
	CENTRIC DIATOMS	**PENNATE DIATOMS**
1.	*Cyclotella meneghiniana*	*Amphora ovalis*
2.	*Cyclotella striata*	*Amphora insecta*
3.	*Hemidiscus cuneiformis*	*Caloneis madraspatensis*
4.	*Paralia sulcata*	*Chaetoceros lorenzianus*
5.	*Podosira stelligera*	*Chaetoceros borealis*
6.	-	*Cymatonitzschia marina*
7.	-	*Grammatophora oceanic var.macilenta*
8.	-	*Hemidiscus cuneiformis*
9.	-	*Mastogloia triconfusum var. lanceolata*
10.	-	*Mastogloia quinquecostata*
11.	-	*Navicula cryptocephala*
12.	-	*Navicula directa*
13.	-	*Navicula viridula*
14.	-	*Nitzschia guinensis*
15.	-	*Nitzschia interruptestriata*
16.	-	*Nitzschia kurta*
17.	-	*Nitzschia vidovichii*

16.	-	*Plagiogramma antillarum*
17.	-	*Pleurosigma directum*
18.	-	*Pleurosigma formosum*
19.	-	*Skeletonema costatum*
20.	-	*Synedra hennedyana*
21.	-	*Synedra robusta ralfs*
22.	-	*Thalassionema nitzschioides*
23.	-	*Trachyneis aspera vulgaries*

Table No. 4
Frequency of various species of Diatoms in Different Rivers of Manipur

Sr. No.	Site Code	Name Of The Station	Geographical Area	Name of Species Found
1	H-3	Kongba Rural turel	Plain	-
2	H-8	Ulou Turel	Plain	-
3	H-13	Iril Turel	Hill Slope	-
4	H-21	Irum Turel	Plain	-
5	H-2	Imphal turel	Plain	*Navicula viridula, Paralia sulcata*
6	H-6	Khongun Turel	Plain	*Navicula viridula, Cymatonitzschia marina*
7	H-9	Salong Pukhree	Hill Slope	*Navicula viridula, Cymatonitzschia marina*
8	H-17	Nambul Turel	Plain	*Amphora ovalis*
9	H-18	Ethakhun Turel	Plain	*Navicula viridula, Cymatonitzschia marina*
10	H-26	Epum Turel	Plain	*Podosira stelligera, Cyclotella meneghiniana*
11	H-29	Khori Faabi Turel	Plain	*Nitzschia interruptestriata, Navicula directa*
12	H-34	Thangjourik Turel	Plain	*Nitzschia kurta, Navicula directa, Pseudoeunotia doliolus, Navicula viridula*
13	H-35	Ningthoukhong Turel	Plain	*Navicula cryptocephala, Skeletonema costatum, Thalassionema nitzschioides Cyclotella meneghiniana,*
14	H-36	Naga Rural Turel	Plain	*Chaetoceros lorenzianus, Cyclotella meneghiniana, Skeletonema costatum*
15	H-11	Likli Turel	Hill Slope	*Caloneis madraspatensis, Navicula viridula, Cymatonitzschia marina, Navicula directa*

Table No. 5
Frequency of various species of Diatoms in Different Canals of Manipur

Sr. No.	Site Code	Name of The Station	Geographical Area	Name of The Species
1.	H- 1	Kawa path	Plain	–
2.	H-4	Loktak Path	Hill Slope	–:
3.	H-12	Bijoy Govinda Path	Plain	–
4.	H-27	Thangapath	Plain	–
5.	H-28	Lakoipath	Hill Slope	*Navicula viridula, Paralia sulcata*

Table No. 6:
Frequency of various species of Diatoms in Different Dams & Drains of Manipur

Sr. No	Site Code	Name of The Station	Geographical Area	Name of The Species
1.	H-38	Naga Mapal Canal	Plain	–
2.	H-19	Sinda Dam Canal	Hill Slope	*Pleurosigma formosum, Navicula viridula, Mastogloia quinquecostata, Amphora ovalis*
3.	H-23	Ningthoukhong Canal	Plain	*Skeletonema costatum*
4.	H-24	Lamshang Canal	Plain	*Hemidiscus cuneiformis, Mastogloia triconfusum var.lanceolata, Cyclotella meneghiniana*
5.	H-37	Patsoi Loukhong	Plain	*Thalassionema nitzschioides, Cyclotella striata*
6.	H-39	Pangei Loukhong	Plain	*Synedra hennedyana, Chaetoceros borealis, Pleurosigma directum, Nitzschia vidovichii*

Table No. 7
Frequency of various species of Diatoms in Different Lakes of Manipur

Sr. No.	Site Code	Name of The Station	Geographical Area	Name of The Species
1.	H-15	Samurou Dam	Plain	*Navicula viridula, Cymatonitzschia marina*
2.	H-20	Sinda Dam	Hill Slope	*Nitzchia interruptesstriata, Navicula viridula, Nitzschia guinensis, Thalassionema nitzschioides var.obtusa*
3.	H-7	City khongban Esing(Drain)	Plain	*Amphora ovalis*
4.	H-32	Lamshang Village Khongban(Drain)	Plain	*Navicula viridula, Amphora insect, Caloneis madraspatensis, Grammatophora oceanic var.macilenta*

Table No. 8:
Frequency of various species of Diatoms in Different Ponds of Manipur

Sr. No	Site Code	Name of The Station	Geographical Area	Name of The Species
1.	H-5	Tonjam Pukhree	Plain	–
2.	H-10	Porompat Police Pukhree	Plain	–
3.	H-14	LarikYengbam Mamang Pukhree	Plain	–
4.	H-25	Hiyangthang Pukhree	Plain	–
5.	H-30	Rajbaari Pukhree	Plain	–
6.	H-31	Ningthem Pukhree	Plain	–
7.	H-22	Pukhreechao Pukhree	Plain	*Mastogloia triconfusum var. lanceolata, Thalassionema nitzschioides*
8.	H-16	Laifamkhunou Mamang pukhree	Plain	*Thalassionema nitzchioides, Navicula viridula, Synedra robusta ralfs, Trachyneis aspera vulgaries*
9.	H-33	Naoremthong Pukhree	Plain	*Navicula directa, Cyclotella striata*
10.	H-40	Elangbam Leikai Pukhree	Plain	*Thalassionema.nitzschioides var.obtusa, Amphora.ovalis,Nitzschia interruptestriata, Cyclotella..meneghiniana, Plagiogramma antillarum, Thalassionema nitzschioides var.obtusa*

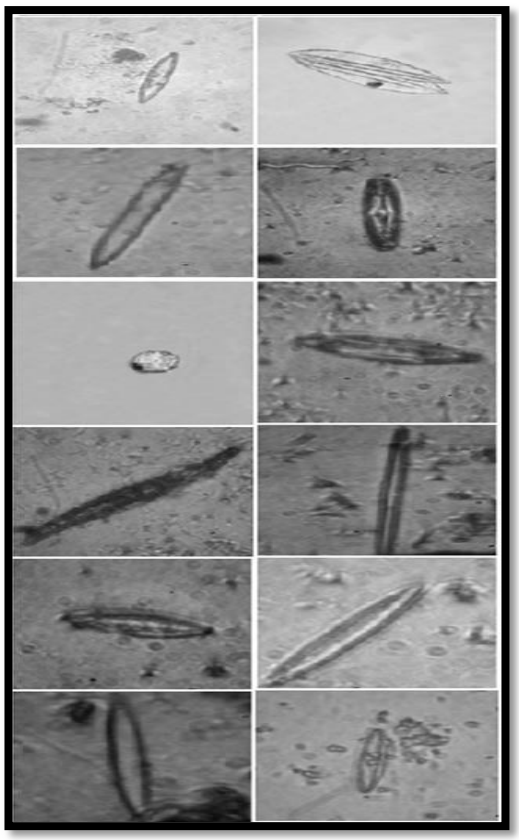

Fig. 1: Microscopic images of different species of Diatoms

4. Summary and Conclusion

The present study is based on the analysis of diatoms in freshwater bodies in Manipur in which 40 samples were collected. Out of 40 samples, in 25 samples diatoms were present while in 15 samples diatoms were absent. There were 5 centric diatoms and 23 pennate diatoms found in those 40 samples which are collected from Manipur. The 5 centric diatoms species were *Cyclotella meneghiniana, Cyclotella striata, Hemidiscus cuneiformis, Paralia sulcata & Podosira stelligera*. The 23 pennate diatoms species were *Amphora ovalis, Amphora insecta, Caloneis madraspatensis, Chaetoceros lorenzianus, Chaetoceros borealis, Cymatonitzschia marina, Grammatophora oceanic var.macilenta, Hemidiscus cuneiformis, Mastogloia triconfusum var. lanceolata, Mastogloia quinquecostata, Navicula cryptocephala, Navicula directa, Navicula viridula, Nitzschia guinensis, Nitzschia interruptestriata, Nitzschia kurta, Nitzschia vidovichii, Plagiogramma antillarum, Pleurosigma directum, Pleurosigma formosum, Skeletonema costatum, Synedra hennedyana, Synedra robusta ralfs, Thalassionema nitzschioides & Trachyneis aspera vulgaries*. There were total of 19 genera and 28 species found in the samples. The sample H-40 was found dominant than any other sample. Total 6 types of diatom species were found in the H-40 sample i.e. *Thalassionema nitzschioides, Amphora ovalis, Nitzschia interruptestriata, Cyclotella meneghiniana, Plagiogramma antillarum & Nitzchia interruptestriata*. The samples H-12, H-7 & H-17 had same diatom species i.e. *Amphora ovalis*, a single *Amphora ovalis*, double *Amphora ovalis* & a group of *Amphora ovalis*. The samples which showed positive result were H-2, H-4, H-6, H-7, H-9, H-11, H-15, H-16, H-17, H-18, H-19, H-20, H-22, H-23, H-24, H-26, H-29, H-32, H-33, H-34, H-35, H-36, H-37, H-39 & H-40. The samples which showed negative result were H-1, H-3, H-5, H-8, H-10, H-12, H-13, H-14, H-21, H-25, H-27, H-28, H-30, H-31 & H-38.

Diatom population though varied with season, it also showed varied results depending upon the physical parameters like pH, Salinity and Temperature. It was found that diatom population was higher in summer and autumn while it was lesser in winters and again increased in spring. When water samples were collected from Manipur in the month of January (winter season), it may the reason of getting the negative result in many samples which are found to be nil. There are total of eight tables in which table number six showed that 100% of diatoms are found in dam water sample & drain water sample.

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