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PHYTOPLANKTON DIVERSITY FROM DISSIMILAR HABITATS IN SAVITRI RIVER

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Abstract

Any aquatic habitat's phytoplankton population is reliant on physicochemical and biological factors. Lotic water bodies with waste inflow are split into upstream and downstream habitats with variable levels of water parameters. The Maharashtra Industrial Development Corporation (MIDC) Mahad releases effluents into the Savitri River in Mahad, which is then divided into two distinct upstream and downstream zones. The current investigation was conducted between June 2014 and December 2016 with this main aim in mind. The phyoplanktons were collected from the upstream water from Savitri River near village Isane kamble (Spot S1) and downstream of Savitri River near Dadali bridge belonging to Dadali village (Spot S2). Over the course of the investigation, an average of 2745 phytoplanktons were collected from site S1. There were 36 genera and 27 families in the 2745 phytoplanktons. Amphipleuraceae family dominated all other families. In all, 2995 phytoplanktons were collected on average from location S2 during the study period. There were 35 families and 40 genera among 2995 phytoplanktons. Zygnemataceae family dominated all other families,

Keywords: *Phytoplankton diversity; Industrial effluents; Riverine fauna, Savitri river, Dissimilar habitat*

Introduction:

The hydrosphere of the globe includes the oceans, estuaries, rivers, streams, lakes, ponds, and other bodies of water. The Earth's main characteristic is its profusion of water, which covers 71% of its surface. Only 1.5% of the planet's total water is fresh, 2.15 percent of it is frozen, and 92.2% of it is found in the oceans, seas, and estuaries. Marine ecosystems and freshwater estuaries both exhibit synchronised fluctuations in their resident fauna. Although there are many different types of water in India, such as rivers, streams, lakes, and reservoirs, 70% of this water is now contaminated (Basu, 1986). Historical shallow water bodies such moats, temple tanks, reservoirs, and ponds have been the subject of hydro-biological research by Chacko and Krishnamurthy (1945), Ganpati (1956, 1968), Vijayaraghvan (1971), Goel et al. (1985), Mule and Gaikwad (1999), and Pailwan (2005). The most significant supplies of fresh water have always been rivers, and this dependence still exists for the majority of developmental operations.

The polyphyletic group of phytoplankton has a great deal of variation in terms of size, shape, colour, type of metabolism, and life history characteristics. Our understanding of phytoplankton has undergone a significant transformation as a result of new information about the nutritional capacity of microbes (Flynn et al., 2013). Microorganisms called phytoplanktons float or swim in water. The primary producers that make up the first tropical level of the food chain are phytoplanktons. In example, in relation to silica and other nutrients, phytoplankton diversity responds quickly to changes in the aquatic environment (Chellappan, 2008). The phytoplankton is crucial to the aquatic environments' faunal biodiversity. According to Sabater and Nolla (1991), phytoplanktons are a good source of food for fish, which in turn provide food for waterfowl. The primary energy source in a freshwater environment is phytoplankton. They serve as food to primary consumers, such as zooplankton, finfish, shellfish, and others, to start the fresh water food chain (Tas et al., 2007). There is an inverse relationship between phytoplankton biomass and river discharge (Jones, 1984; Jones and Barrington, 1985; Reynolds, 1988). Other investigations have concluded that nitrogen concentrations have a stronger influence on river phytoplankton. River phytoplankton number and total phosphorus concentration have been found to have a substantial positive association (Soballe and Kimmel, 1987; Moss et al, 1989; Basu and Pick, 1996; Van Nieuwenhuyse and Jones, 1996). Light conditions may limit river phytoplankton formation due to the turbulent and often turbid conditions prevalent in many rivers (Krogstad and Lovstad, 1989; Cole et al, 1992).

River pollution is caused by the discharge of manure, industrial and municipal waste water, and runoff (Toman, 2009; Suthar et al., 2010). Rivers play a significant role in digesting or transporting these pollutants.

Mahad is a town which is located at latitude 1805' North and longitude 73025' East. It is approximately 175 kilometres south of Mumbai. The Savitri River begins at Tiger Point in Mahabaleshwar and flows east to west through Raigad and Ratnagiri districts before reaching the Arabian Sea at Harihareshwar (Bankot estuary). In 1987, the Maharashtra Industrial

Development Corporation (MIDC) established an industrial belt on 426.39 hectares of land in Mahad. There are approximately 73 operational industries that produce pesticides, pharmaceuticals, paints, petrochemicals, paper, plastics, heavy metals, food materials, and other materials, as well as discharge gases, liquids, and solid wastes into the air, water, and soil, polluting local and adjacent environments. All this industrial waste, municipal waste, agricultural waste etc mixed with this river water.

Materials and methods

For the current study, two spots, S1 and S2, were chosen. S1 is located near the village of Isane Kamble. It is nearly two kilometres away and abovefrom the MIDC area. Although there is little chance of sewage or untreated effluent from industrial mixing, some anthropogenic activities such as washing clothes, domestic animals, and vehicles have been observed. The S1 spot is referred to as the upstream spot.

S2 is located near Dadali Bridge and Dadali Village. As estuarine water from Bankot mixes with savitri water, the water here is moderately saline. Industrial effluents, after CETP treatment, are frequently released here. On the bank of the river, about 500 metres from the spot, there is a crematorium. Mahad's municipal sewage is discharged near this location. Some anthropogenic activities were observed, such as washing clothes, domestic animals, and vehicles. Crocodiles thrive in this area as well. This area is home to nearly 80 crocodiles. There is a fish market and a slaughter market (meat market) on the bank of Spot S2. It is also a location where Ganesha idols and floral offerings are immersed. About 500 mt area was covered to collect samples from both spots.

Spot S1 located on 1805’11 North latitude and 73028’19 E longitude

Spot S2 located on 1804’28 North latitude and 73025’14 E longitude

A year's worth of phytoplanktons, from June 2014 to December 2016, were collected monthly. From 9 to 11 a.m. every month, water samples were taken. In a pristine PVC container, a 5 litre sample was collected. Sample was filtered using a plankton net with a 25-mesh size. The plankton was gathered and stored. 50 ml of the 100 ml of concentrated solution were utilised for phytoplankton. For the preservation of phytoplanktons Per 100 ml of sample, 0.7 ml of Lugol's solution was used. Samples were kept in sampling vials with the appropriate labels on them. To track seasonal fluctuations, planktonic analysis and identification were carried out in the lab (Adoni et al., 1985). Unable-to-identify phytoplanktons were stored and submitted to Nikhil lab in Sangli for further qualitative and quantitative analysis. Seasonal phytoplankton populations were examined statistically and subjectively. Calculated is the average number per 100 ml.

The physicochemical parameters viz. Temperature, pH, Turbidity, Transparency, Total Dissolved Solids, Total Solids, Gross Primary Productivity, Net Primary Productivity, Dissoved Oxygen (DO), Biological Oxygen Demand (BOD), Free CO2, Chemical Oxygen Demand (COD), Total Acidity, total Alkalinity, total Hardness, Chlorides, Phosphate Phosphorus and Nitrates were estimated using standard methods (APHA, 2005).

RESULT:

Table: 1 Average seasonal diversity of Phytoplankton genera at spot S1 in Savitri River during June 2014 to December 2016

Sr. No.	Family	Plankton genera	Pre-Monsoon	Monsoon	Post Monsoon	Total
		Phytoplankton				
1	Amphipleuraceae	Diatoms	102	134	135	371 13.51%
		Stephanodiscus	0	10	2	12
		Frustulia	17	72	43	132
		Pinnularia(diatom)	0	6	1	7
2	Cladophoracae	Rhizoclonium	4	23	0	27
		Cladophora	18	0	0	18
3	Zygnemataceae	Mougeotia	42	18	25	85
		Spirogyra	14.5	4	0	19
		Zygnema	0	19	0	19
4	Oocystaceae	Kirchneriella	0	11	57	68
		Ankistrodesmus	15	0	10	25
5	Chlamydomonadaceae	Protococcus	48	5	41	94
		Polytoma	5	0	0	5
6	Scenedesmaceae	Coelastrum	0	9	51	60
		Scenedesmus	55	83	105	243 8.85%
7	Hydrodictyaceae	Pediastrum	72	22	4	98
08	Oedogoniaceae	Bulboehaete	0	5	0	5
09	Closteriaceae	Closterium.	2	0	1	3
10	Characiaceae	Characium	0	11	0	11
11	Neidiaceae	Neidium	0	18	17	35
12	Ophiocytiaceae	Ophiocytium	4	1	0	5
13	Microsporaceae	Microspora	2	0	0	2
14	Chlorellaceae	Chlorella	35	78	37	150
15	Phormidiaceae	Spirulina	26	9	25	60
16	Bacillariaceae	Nitzschia	0	0	14	14
17	Dictyosphaeriaceae	Botryococcus	0	0	24	24
18	Flagilariaceae	Synedra	55	10	27	92
19	Catenulaceae	Amphora	0	30	21	51
20	Cocconeidaceae	Cocconeis	0	39	14	53
21	Eunotiaceae	Eunotia	0	0	32	32
22	Rhopalodiaceae.	Epithemia	25	23	16	64
23	Euglenaceae	Euglena	0	6	20	26
24	Desmidiaceae	Staurastrum	2	20	182	204
25	Gomphonemataceae	Gomphonema	50	43	0	93

26	Tabellariaceae	Tebelaria	13	0	0	13
27	Naviculaceae	Navicula	126	211	188	525 19.12%
	TOTAL		**733**	**920**	**1092**	**2745**

Chart: 1- Seasonal fluctuation in average density of phytoplankton on spot S1, of Savitri river during June 2014 to December 2016.

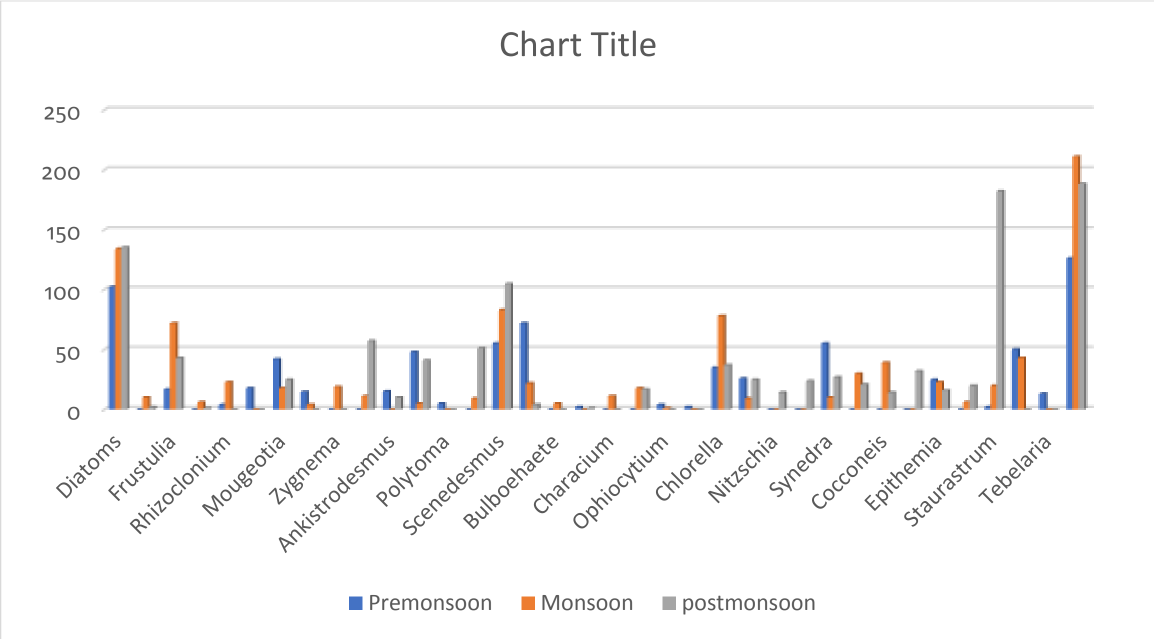
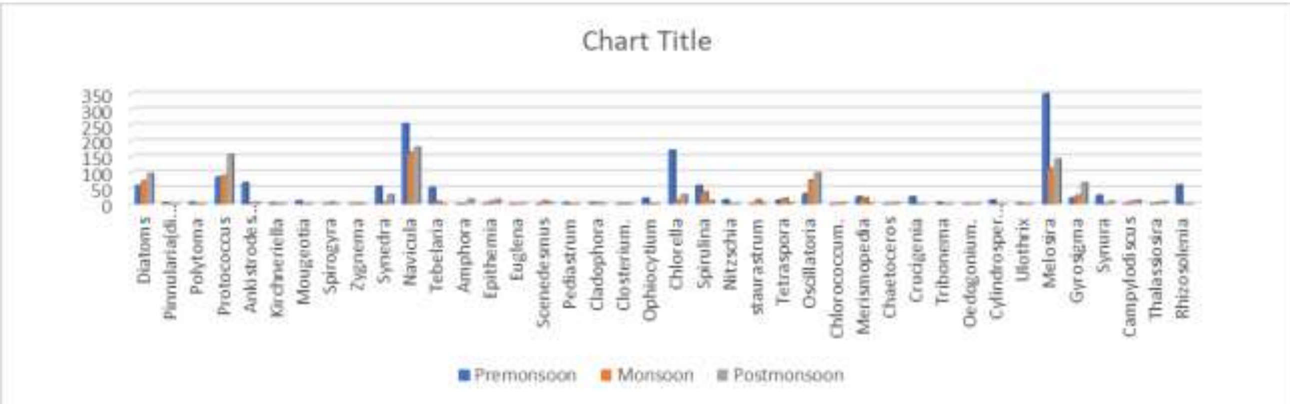


Table: 2. Average seasonal diversity of Phytoplankton genera at spot S2 in Savitri River during June 2014 to December 2016.

Sr. No.	Family	Plankton genera	Pre-Monsoon	Monsoon	Post Monsoon	Total
		Phytoplankton				
1	Amphipleuraceae	Diatoms	58	73	96	227
	Amphipleuraceae	Pinnularia(diatom)	3	0	0	3
2	Chlamidomonadaceae	Polytoma	4	0	0	4
	Chlamydomonadaceae	Protococcus	85	90	157	332 11.08%
3	Oocystaceae	Ankistrodesmus	67	1	4	72
	Oocystaceae	Kirchneriella	2	0	0	2
4	Zygnemataceae	Mougeotia	9	0	0	9
	Zygnemataceae	Spirogyra	0	4	0	4
	Zygnemataceae	Zygnema	0	1	0	1
5	Flagilariaceae	Synedra	55	4	29	88
6	Naviculaceae	Navicula	254	163	180	597 19.93%
7	Tabellariaceae	Tebelaria	52	8	0	60
8	Catenulaceae	Amphora	0	0	15	15
9	Rhopalodiaceae.	Epithemia	0	8	14	22
10	Euglenaceae	Euglena	0	0	1	1
11	Scenedesmaceae	Scenedesmus	0	9	3	12
12	Hydrodictyaceae	Pediastrum	3	0	0	3
13	Cladophoraceae	Cladophora	3	3	0	6
14	Closteriaceae	Closterium.	0	1	0	1
15	Ophiocytiaceae	Ophiocytium	18	0	0	18

16	Chlorellaceae	Chlorella	170	13	29	212
17	Phormidiaceae	Spirulina	58	38	11	107
18	Bacillariaceae	Nitzschia	13	0	0	13
19	Desmidiaceae	staurastrum	0	13	0	13
20	Tetrasporaceae.	Tetraspora	12	17	2	31
21	Oscillatoriaceae	Oscillatoria	33	76	98	207
22	Chlorococcaceae.	Chlorococcum.	0	2	2	4
23	Merismopediaceae	Merismopedia	23	19	1	43
24	Chaetocerotaceae	Chaetoceros	0	1	3	4
25	Trebouxiophyceae	Crucigenia	23	0	0	23
26	Tribinemataceae	Tribonema	4	0	0	4
27	Oedogoniaceae.	Oedogonium.	0	0	1	1
28	Nostocaceae	Cylindrospermum	12	0	0	12
29	Ulotrichaceae	Ulothrix	2	0	0	2
30	Melosiraceae	Melosira	349	111	142	602 20.10%
31	Pleurosigmataceae	Gyrosigma	19	27	67	113
32	Synuraceae	Synura	27	0	8	35
33	Surirellaceae	Campylodiscus	0	8	12	20
34	Coscinodiscophyceae	Thalassiosira	0	4	8	12
35	Rhizosoleniaceae	Rhizosolenia	60	0	0	60
	TOTAL		**1418**	**694**	**883**	**2995**

Chart: 2- Seasonal fluctuation in average density of phytoplankton on spot S2, of Savitri River during June 2014 to December 2016.



Phytoplankton analysis was done for two years and seven months, June 2014 to December 2016. For phytoplankton analysis samples of phytoplanktons were collected monthly. Result shows season wise average analysis.

Average number of phytoplanktons collected from spot S1, during the study period were included 2745 phytoplankton. In 2745 phytoplanktons, there were 27 families and 36 genera. Among all families Amphipleuraceae family was dominant, which included 4 genera, after that family Zygnemataceae was dominant including 3 genera. Families Cladophoracae, Oocystaceae, Chlamydomonadaceae and Scenedesmaceae contained 2 genera each. Rest all the families included one genus each. Among 36 genera of phytoplankton, reported from spot S1 , genus Navicula (19.12%) was dominant, followed by Diatoms (13.15%) and Scenedesmus

(8.85%), (Table 1). Navicula was amply available in monsoon. Diatoms and Scenedesmus were abundant in postmonsoon. Overall maximum population of phytoplanktons was observed in postmonsoon (1092), and minimum in premonsoon (733). 12 genera of phytoplankton are exclusively found in S1 spot.

Average number of phytoplanktons collected from spot S2, during the study period were included 2995 phytoplankton. In 2995 phytoplanktons, there were 35 families and 40 genera. Among all families Zygnemataceae family was dominant, which included 3 genera, after that family Amphipleuraceae Oocystaceae, and Chlamydomonadaceae contained 2 genera each. Rest all the families included one genus each. Among 40 genera of phytoplankton, reported from spot S2, genus Melosira (20.10%) was dominant, followed by Navicula (19.93%) and Protococcus (11.08%), (Table 2). Melosira and Navicula was amply available in premonsoon. Protococcus was abundant in postmonsoon. Overall maximum population of phytoplanktons was observed in premonsoon (1418), and minimum in monsoon (694).

16 genera of phytoplankton are exclusively found in S2 spot.

Table: 3 Spot wise Average seasonal phytoplanktons.

Spots	Planktons	Premonsoon	Monsoon	Postmonsoon	Total
S1	Phytoplanktons	733	920	1092	2745
S2	Phytoplanktons	1418	694	883	2995

From above table (3) it was observed that, on spot S1, phytoplanktons were abundant in postmonsoon and least in premonsoon and on spot S2, those were abundant in premonsoon and least in monsoon. All these fluctuations in numbers may be due to salinity change in seasonally and diurnally due to tidal cycle on spot S2. Phytoplanktons (2745) on spot S1 were less in population than those (2995) were in spot S2.

Table 4: Minimum and Maximum range of physicochemical parameters of water samples collected from spot S1 and S2 in Savitri River during June 2014 to September 2016.

Sr No.	**Parameter**	**S1**	**S1**	**S2**	**S2**
		Min.	Max.	Min.	Max.
1	Temperature (°C)	27	31.5	27	31.9
2	pH	7.31	8.25	6.14	7.73
3	Turbidity (NTU)	0.008	0.04	0.014	0.08
4	Transparency (cm)	159.6	291.5	125.5	184
5	TDS (ppm)	43	158	54	8700
6	TS (ppm)	80	255	320	18170
7	GPP (mg/l)	0.718	2.81	0.229	2.13
8	NPP (mg/l)	0.269	1.9	0.007	1.9
9	DO (mg/l)	4.82	20.01	3.9	14.07

10	BOD (2 days) (mg/l)	0.41	15	1.18	16
11	Free CO_2 (mg/l)	2	46	4.4	44
12	COD (mg/l)	8	49	60	600
13	Total acidity (mg/l)	10	80	10	105
14	Total alkalinity (mg/l)	55.3	203	46	200
15	Hardness (mg/l)	24	151	44	4800
16	Chlorides (mg/l)	7.1	446.3	11.3	8011.7
17	PO4-P(mg/l)	0.02	13.2	NIL	12.5
18	NO_2-N mg/lit	0.01	138.78	0.4	148.98

Table 4 shows the examination of the physico-chemical parameters of water samples taken monthly from spot S1 and S2 during the study period. At site S2, the highest temperature (31.90C) was noted. The same location also reported a pH that was more acidic. Temperature, pH, turbidity, Transparency, Total Dissolved Solids (TDS), Total Solids (TS), Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Acidity, Hardness, Chlorides, and Nitrates contents were towards adverse levels at spot S2, whereas free CO2, Total Alkalinity, and PO4-P content at spot S1 were towards adverse levels.

Discussion.

Industrial effluents are frequently discharged into rivers, which has detrimental impacts on both aquatic life and human health (Tanner, 2001). Every industry produces a particular kind of effluent that could include heavy metals, organic materials, inorganic materials, and dangerous substances. Such pollutants change the physicochemical characteristics of water when they are released into an aquatic environment. Numerous physicochemical factors in riverine waters, such as DO, BOD, COD, Alkalinity, Total Hardness, Salinity, pH, Temperature, PO4-P, and NO3-N, provide information on the level of pollution present. For these criteria, many national and international organisations have established standard ranges (WHO, 1992). Khan et al. (2021) state that a water sample is considered polluted if certain water parameters are above the established limitations. Although temperature, pH, turbidity, DO, and total acidity were well within acceptable levels in the current investigation, other parameters as TDS, TS, BOD, COD, free CO2, total hardness, chlorides, PO4-P, and NO3-N were over the limits set by WHO (1990) and BIS (1991). This demonstrated that the S1 and S2 study locations water is contaminated. Between these research locations, Mahad MIDC effluents are dumped into the Savitri River, increasing pollution at location S2.

Navicula (19.12%) was dominant in spot S1. Same result was found by A. Babu *et a*l (2014) in Cauvery River Tamil nadu. According to Shekhar et al. (2008), Navicula serve as signs of sewage pollution.

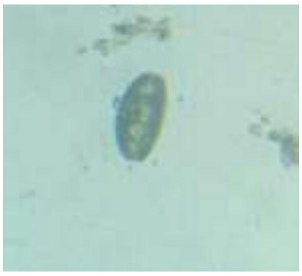
Less amount of phytoplanktons were observed in spot S1. According to prior research by Mathivanan and Jayakumar (1995), the grazing effect of fish and zooplankton may be the cause of the low production of phytoplankton. Another cause is related to upstream and downstream. Many other rivers have seen downstream increases in algal biomass (Greenberg, 1964; Capblancq and Descamps, 1978; Jones, 1984; Descy et al., 1987; de Ruyter van Steveninck etal, 1990a, b), and these increases have generally been associated with more time available for plankton to develop. Nutrient concentrations in rivers, on the other hand, rise downstream (Jones, 1984; Moss et al, 1984; Jones and Barrington, 1985; Gamier et al., 1995). Additionally, the phytoplankton count showed a greater value in the non-rainy months; this finding is supported by a finding made by Nazneen (1980). In spot S2 phytoplanktons were abundant in premonsoon were least in monsoon. However, the growth of the phytoplankton was regulated by factors such as temperature, nutritional enrichment, poisonous chemicals, water mixing, parasites, herbivores, and heterotrophic microorganism activities (Reynolds, 1987). Least amount of phytoplanktons in rainy season may be due to less light intensity and high turbidity. In freshwater lakes, Indian researchers have conducted numerous studies on the dispersion of phytoplankton in relation to light availability, physical, chemical, and biological characteristics (Singh & Sharma, 2012; Zafar, 1967; Munawar, 1974).

Conclusion:

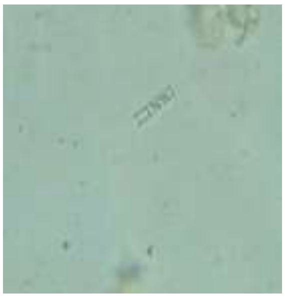
As compared to spot S1, phytoplankton diversity was more in spot S2, that may be due to diverse aquatic environment on spot S2. As estuarine water from Bankot mixes with savitri water, the water here is moderately saline. Salinity of this water changes because of tidal influence. In rainy season salinity decreases. Thus, there is fluctuation in aquatic environment on spot S2, so more genera of phytoplanktons are found on spot S2.

Figures:

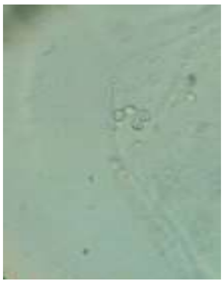
Phytoplanktons from spot S1



Amphora

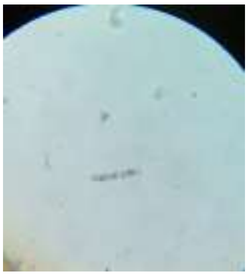


Zygnema



Protococcus

Cocconies

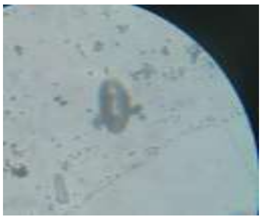


Microspora

Ankistrodesmus

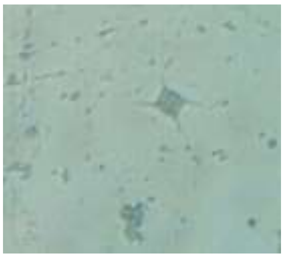
Pediastrum

Epithemia



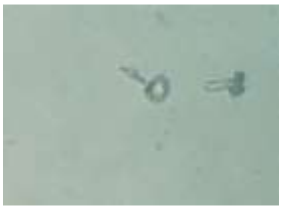
Pinnularia

Tabelaria

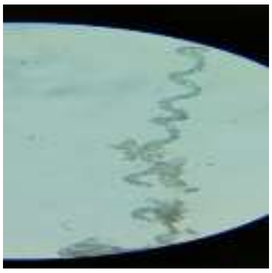


Scenedesmus

Frustulia

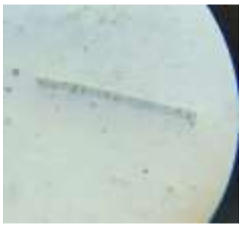


Kirchneriella



Spirulina

Bulboehaete



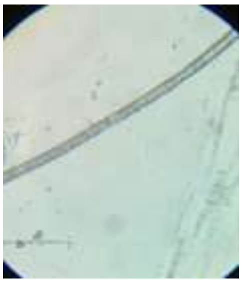
Diatoms

Trinema

Difflugia

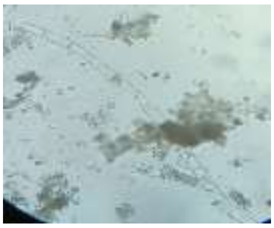
Phytoplanktons from spot S2

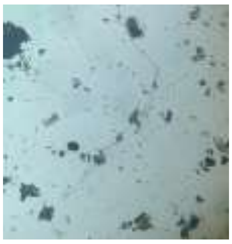

Nitzschia


Oscillatoria


Pledorina


Synura


Tribonema


Cladophora

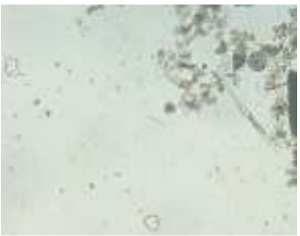

Merismopedia


Cylidrospermum


Tetraspora


Synura


Campylodiscus


Synedra


Gyrosigma


Ulothrix

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