

Influence of mattresses washing on the water quality and phytoplankton diversity in selected industrial outlets of Tamil Nadu

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Abstract

The impact of anthropogenic activity of mattresses washing on the quality of two lotic water bodies of Cuddalore SIPCOT industries outlet water bodies two different stations were analysed. The industrial waste water currents battered along the Freshwater ecosystem near SIPCOT industries. Hence an attempt was made to record outlet water bodies two different stations were analysed. The water samples were collected during summer (April-June, 2021) and winter seasons (Oct-Dec 2021) and analysed for various physicochemical parameters. Decrease in dissolved oxygen concentrations along with tremendous increase in electrical conductivity in both the water bodies, was observed due to mattresses washing by using detergents. Heavy metals like lead, cadmium and nickel were absent throughout. The values of iron was increased while manganese was traced out after this activity. This proved that water quality was found to be hampered in both the stations. A total of 65 species of phytoplankton belonging to different taxonomic groups were identified. Among these, 25 species belong to Bacillariophyceae, 20 species to Chlorophyceae, 15 species to Cyanophyceae and 5 species to Euglenophyceae. The numerical superiority of phytoplankton reveals that *Nitzschia* sps. (6.66×10^3 units/l) is dominant in SIPCOT industries water outlet. The maximum value of Simpson index (SR) or species richness (0.55) was recorded in Cuddalore SIPCOT industry. The high value of species evenness index (J) was also recorded (0.69) in Cuddalore SIPCOT industry. The maximum value of Shannon's overall index (H') of species diversity (1.38) was recorded in industrial outlet. *Microcystis aeruginosa*, *Anabaena*, *Oscillatoria*, *Merismopedia*, *Aphanizomenon*, *Chlorella*, *Cosmarium*, *Scenedesmus*, *Closteridium*, *Navicula* and *Nitzschia* were observed in two stations. These are pollution indicator species used for monitoring the environment.

Keywords: Physiochemical parameters; Phytoplankton; Lotic water bodies; Anthropogenic activity

1 Introduction

The lotic water bodies are major resource of water for consumption by humans and livestock, mainly for drinking and domestic purposes. The changes in water chemistry are mainly due to mud, silt and human activities like washing and bathing (Jeeji Bai and Lakshmi, 1999). Therefore qualities of water from these water bodies are not always consumable or useful. So there is a need of serious characterization of water physicochemically before use. Due to the ineffectiveness of purification systems, waste waters may become seriously dangerous, leading to the accumulation of toxic products in the receiving water bodies with potentially serious consequences on the ecosystem. Tremendous washing of the mattresses is being done in the month of April 2021 before summer season by the people from surrounding areas of SIPCOT industries and vicinity. The conservation of freshwater environment is of paramount importance and the monitoring of their pollution is highly essential (Mohapatra and Rengarajan, 1995). The natural conditions are by no means constant, living organisms have developed adaptive mechanisms, with which they are able to cope with natural variability. As a result, species composition often changes under stress. Causing some species to increase in prominence

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and others to decline or disappear (Squires et al., 1979). Phytoplankton are the major constituents of the food-webs in the freshwater ecosystems. Amongst phytoplankton occupy a unique place and are predominant in aquatic environments.

Phytoplankton, being the primary producers in the food chain of fresh water ecosystem, play a key role in bio-monitoring the ecological disturbances caused by a number of physico-chemical factors, sewage pollutants and other anthropogenic factors. Study of planktonic diversity contributes to an understanding of the environmental status of a water body. Much work has been carried out in India on the phytoplankton of fresh water habitats (Lund and Tailing, 1957; Sreenivasan, 1976; Reynolds, 1984; Gajaria and Harish Kumar, 1992; Senthilkumar and Sivakumar, 2008; Sivakumar and Senthilkumar, 2008; Rani and Sivakumar, 2013; Aranganathan and Sivakumar, 2019; Sagaya Johnpaul Joseph *et al.*, 2022). However, works on statistical ecology including species richness Simpson index (SR), species evenness and Shannon and Weiner's index of species diversity (H') in the industrial outlet water are scanty. Therefore, an attempt has been made to study the quantitative indices of phytoplankton species diversity and pollution indicators in the two chosen perennial water bodies of Cuddalore SIPCOT town in the Tamil nadu.

2 Material and methods

Water samples were collected from Sambankuppam (Lat. $11^{\circ}65'280''N$, Long. $79^{\circ}74'493''$), Kodandaramapuram (Lat. $11^{\circ}62'681''N$, Long. $79^{\circ}72'931''E$), Poondyankuppam (Lat. $11^{\circ}62'144''N$, Long. $79^{\circ}75'348''N$) Summer (April, 2021) and winter (November 2021) mattresses washing (Figs. 1a, b, c, d and e). These samples were brought to the laboratory and analysed within 24 hours. Physicochemical properties like pH (using Systronics Elico pH meter model Li-lot), EC (using Systronics electrical conductivity meter 304), temperature, hardness, alkalinity, dissolved oxygen, chloride, phosphate and nitrate were studied by standard methods suggested by APHA (1989), Trivedy and Goel (1984). Calcium, potassium, magnesium, sodium and were analysed on Atomic Absorption Spectrophotometer (Pekin Elmer A - Analyst 300 model) in the water and soil analysis Laboratory, Semmandalan, Cuddalore, Government of Tamil Nadu.



(a) Sambankuppam (Longi: $79^{\circ}7449307$, Lati: $11^{\circ}6528024$)



(b) Sambankuppam (Longi: $79^{\circ}7449363$, Lati: $11^{\circ}652759$)



(c) Kodandaramapuram (Longi: 79°7293114, Lati: 11°6268123)

Figure 1 a, b and c: Cuddalore SIPCOT Industrial Outlet (Station – I)



(d) Poondyankuppam (Longi: 79°7534813, Lati: 11°6214462)



(e) Poondyankuppam (Longi: 79°77496, Lati: 11°7139983)

Figure 1 d and e: Cuddalore SIPCOT Industrial waste water outlet mixed with nearby lotic water bodies (Station – II)

Hundred liters of industry outlet water was collected at a depth of 1 to 1.5 m and filtered through a conical hand net (mouth diameter 0.35) made of nylon bolting mesh size 60 μ m). Samples were preserved with 4% formalin for further observation. Phytoplankton was identified by referring to the keys of Desikachary (1955), Prescott (1964), Alfred *et al.* (1975), Adoni *et al.* (1985), Anand (1998) and Cox (1996). The quantitative analysis for planktonic organisms was carried out using Sedgewick-Rafter's plankton counting chamber. Species diversity index (H') was calculated using Shannon and Weiner's (1949) formula. Species richness (SR) was calculated as described by Simpson index, species evenness (J) was calculated by the formula of Pielous (1966).

2.1 Scanning Electron Microscopic Studies

Phytoplankton samples were fixed in 3% glutaraldehyde in 0.1 M phosphate buffer at pH 6.8. Specimens were dehydrated through a graded series of alcohol at 12-15 minutes interval at 4°C up to 70% of alcohol. Then dehydrated phytoplankton sample was treated with critical point drier (CPD) and fixed on a stub and the specimens were coated to examine in Joel JSM-56010 LV (INSA-EDS). Electron micrographs was taken selectively from the computer screen (Hayet, 1990; Sivakumar and Senthilkumar, 2008).

3 Results and discussion

To study the impact of mattresses washing on the quality of water, certain physicochemical parameters were analysed and are depicted in Table 1 and Figs.2 a, b.

Figure 2 Physico-chemical parameters of Station I and Station II summer and winter mattresses washing.

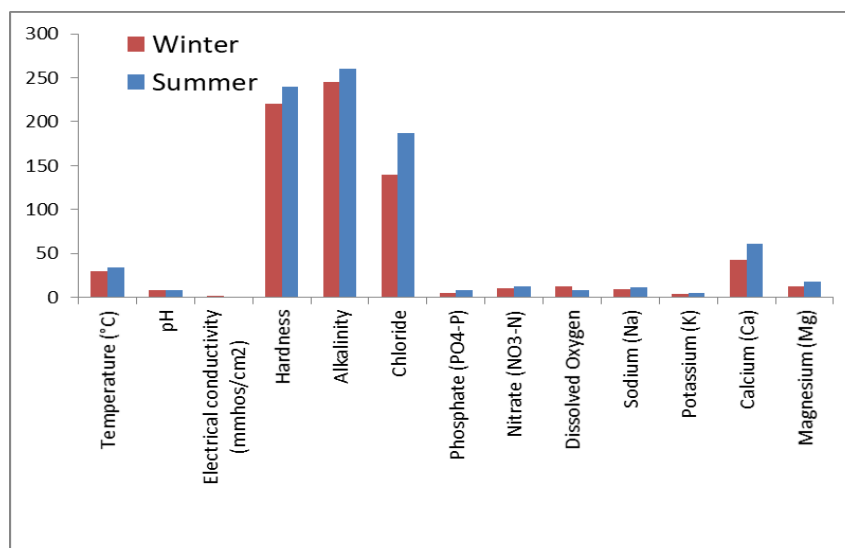


Figure 2a Effect of anthropogenic activity of mattresses washing in Cuddalore SIPCOT Industrial Outlet

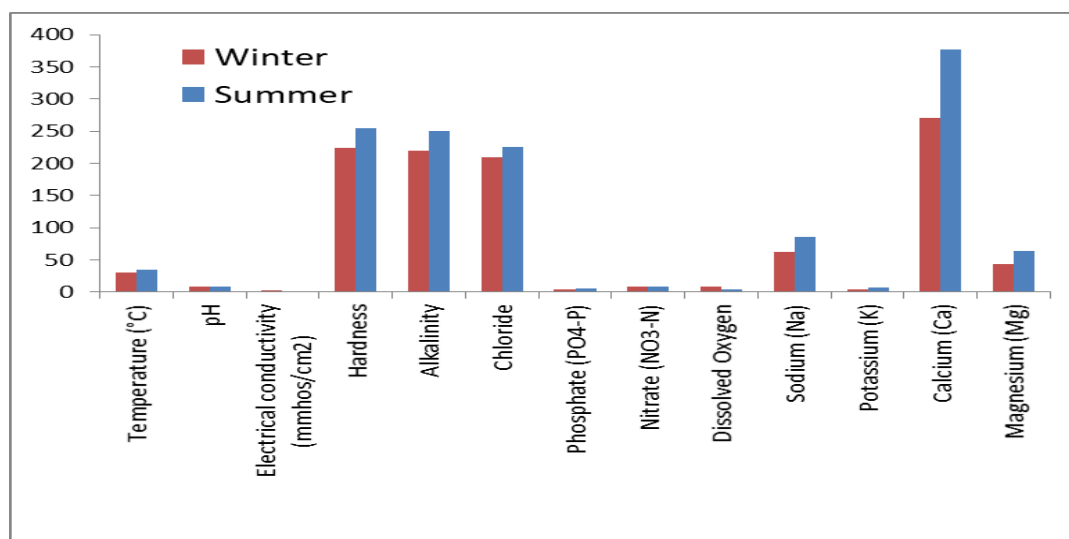


Figure 2b Effect of anthropogenic activity of mattresses washing in Cuddalore SIPCOT Industrial waste water outlet mixed with nearby lotic water bodies

Table 1 Physicochemical parameters of summer and winter mattresses washing Cuddalore SIPCOT Industrial effluents

Parameter	Station-I		Station-II	
	Winter	Summer	Winter	Summer
Temperature (°C)	30	34	30	34
pH	8	8.36	8.1	8.7
Electrical conductivity (mmhos/cm ²)	1.2	0.70	3.1	1.4
Hardness	220	240	224	255
Alkalinity	245	260	220	250
Chloride	140	186.5	210	226
Phosphate (PO ₄ -P)	5.3	8.07	3.67	5.44
Nitrate (NO ₃ -N)	10.5	12.12	7.9	8.42
Dissolved Oxygen	12.5	8.07	8.25	4.02
Sodium (Na)	9.42	11.5	62.3	85.2
Potassium (K)	4.17	5.12	4.28	6.77
Calcium (Ca)	42.8	60	270	371
Magnesium (Mg)	12.7	18	42.7	63.5

All values are in mg/l except given .

The alkaline pH of lotic water was found to be increased (8-8.36) in SIPCOT industrial outlet water (Figs.1a,b,c) Station-I as well as (8.1-8.7) in the nearby lotic water bodies of surrounding areas (Figs.1d,e) Station-II. The alkaline pH is a usual feature of productive water bodies as reported earlier by Hutchinson (1957), Verma (1967), Mishra and Yadav (1978), Saxena and Adoni (1973), Ayappan and Gupta (1981). Increase in temperature was found from 30-34°C in both the lotic water bodies. According to Welch (1952) the life processes have direct or indirect effects due to variation in the water temperature. Tremendous increase in the electrical conductivity ranging from 0.70-1.2 mmhos/cm² in SIPCOT industrial outlet and from 1.4-3.1 mmhos./cm² in nearby surrounding areas. A sudden rise in conductivity in water will indicate addition of some pollutants so it (Trivedy and Goel, 1984). High values of EC designates pollution status of the lake (Kadam, 1990).

Increase in the values of hardness were found in Station-I from 220-240 mg/l. It may be due to high load of carbonates and bicarbonate in water by industrial outlet (Agarkar, 1998). Sorub and Ebanesae (2003) in fresh water pond of Tamil Nadu. Dissolved oxygen was decreased in Station-I from 12.5-8.07 mg/l and from 8.25-4.02 mg/l in Station-II. Decrease in DO in both the stations was found to be an interesting feature, which may be due to heavy load of mattresses washings. Low oxygen concentrations were generally associated with heavy contamination by organic matter (Trivedy and Goel, 1984). Alkalinity was found to be increased from 245-260 mg/l in Station-I and from 220-250mg/l in Station-II. Various types of industrial outlet water, detergents and other materials might help to increase the alkalinity of water (Kadam 1990).

Chloride levels fluctuated from 140 to 186.5 mg/l Station-I and from 210 to 226 mg/l in Station-II. Arvind Kumar (1997) reported high chloride value (110.25mg/l) and correlated it with high degree of sewage discharge and human interferences. Increased levels of phosphate from 5.3-8.07mg/l in Station-I and 3.67-5.44 mg/l in Station-II were found, might be due to mattresses washing by outlet waters. Along with this nitrate was also found to be increased from 10.5-12.12 mg/l in Station-I and from 7.9-8.42 mg /l in Station-II. The water bodies polluted by organic matter exhibit higher values of nitrate (Kodarkar, 1995). The major sources of phosphate and nitrate were domestic sewage, detergents and waste waters (Trivedy and Goal, 1984).

There was increase in calcium from 42.8 mg/l to 61 mg/l in Station-I and 270-377 mg/l in Station-II. Along with this, increase in the levels of sodium and magnesium were also recorded. Increase in calcium, sodium and magnesium might be due to SIPCOT industry outlet and disposal of waste water.

Species representatives from Oscillatoriales and Nostacales were dominant during summer indicating in nitrate and phosphate concentration (Paertel *et al.*, 2015). The physicochemical parameters were known to correlate with the microalgal species. The temperature of the water was relatively low in two station during summer and winter.

This favours high oxygen dissolution making it suitable for diverse planktonic growth (Ray *et al.*, 2020). The pH value ranged from 8 to 8.7, which depicts the alteration in any ecosystem. The divalent ions of Calcium and Magnesium were recorded high during summer in SIPCOT industries water out let Station-I and nearby lotic water bodies Station-II might be attributed to increased Ca and Mg because of the confluence from nearby canals and river belts and the excessive leaching from waste water during winter season (Badrakh, 2008).

3.1 Phytoplankton

A total of 65 species of phytoplankton were identified during the study period from the two sampling stations. Out of the 65 species recorded 25 species belong to diatoms (Bacillariophyceae), 20 species to greens (Chlorophyceae), 15 species to blue green (Cyanophyceae) and 5 species to Euglenophyceae. Analysis of numerical superiority of phytoplankton reveals that *Nitzschia* sps. (6.66×10^3 units/l) is a dominant species in Station-I. Dominant species are reported to be the most important ecological indicators, as they receive the full impact of the habitat for over longer period and manifest different levels of sensitivity (Sharma, 1995). Ecological indicators are the effective tools in environmental monitoring which is required to assess the changes caused by anthropogenic activities.

3.2 Diversity indices

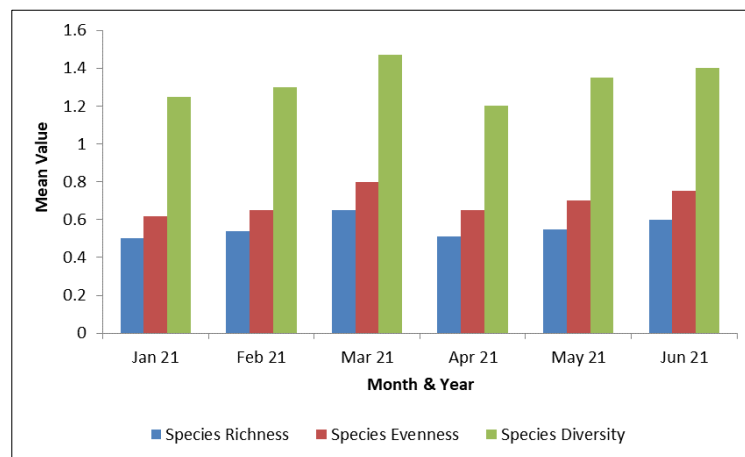


Figure 3a Phytoplankton Richness (SR), Evenness (SE) and Diversity (Station-I)

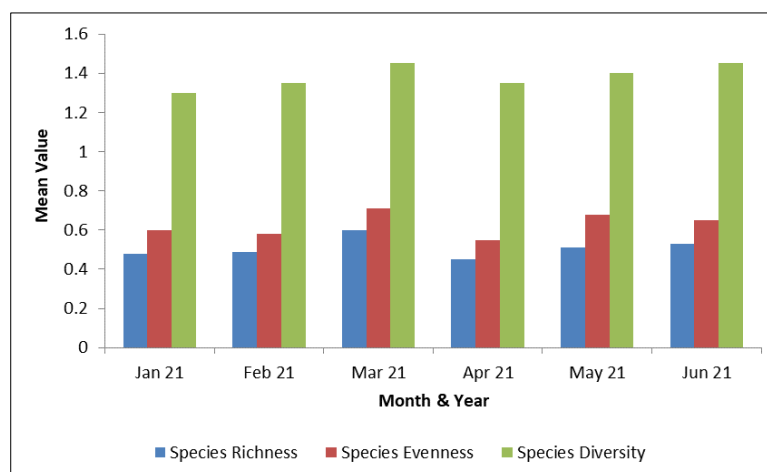


Figure 3b Phytoplankton Richness (SR), Evenness (SE) and Diversity (Station-II)

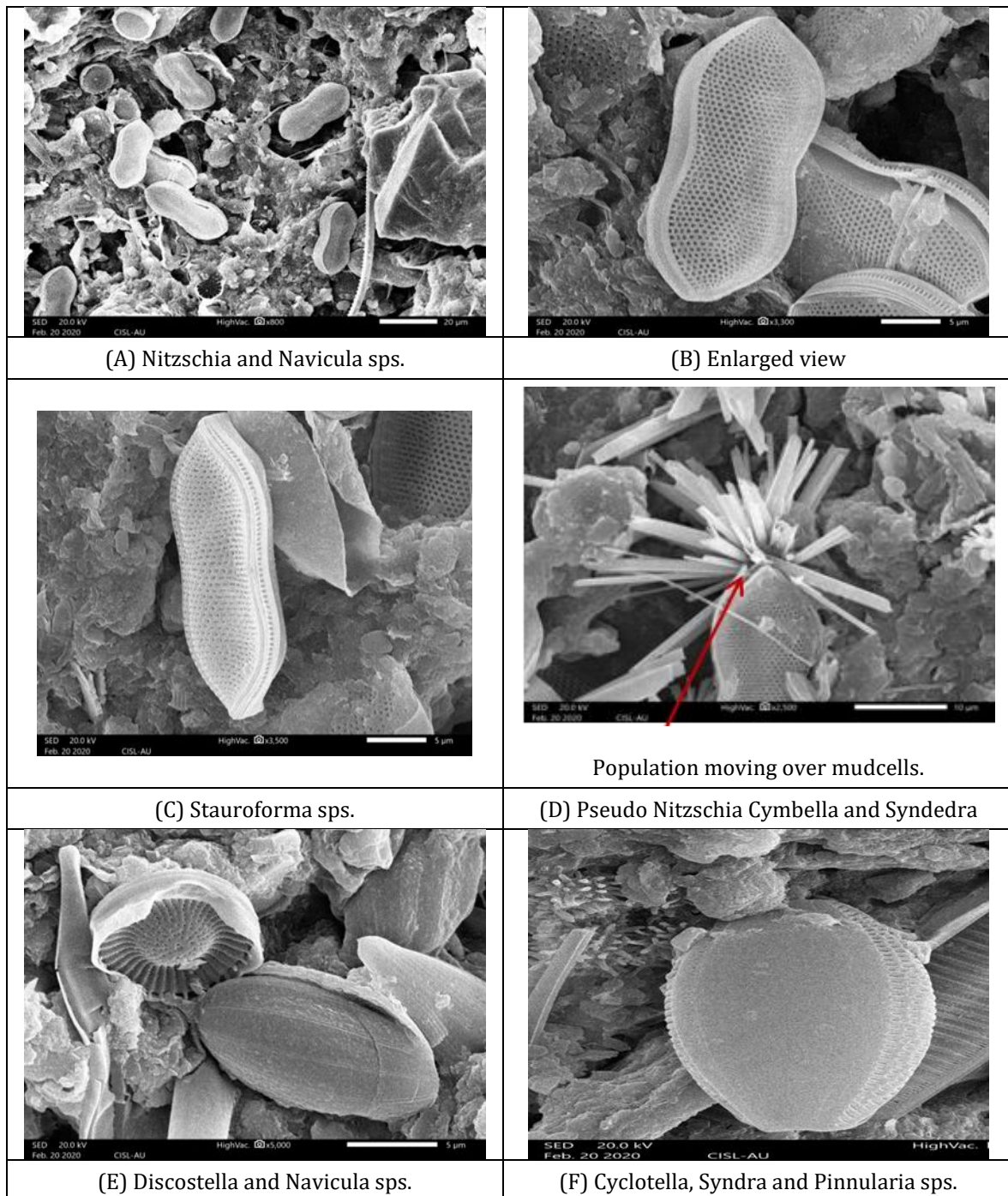


Figure 4 Scanning Electron Microscopic observation

Phytoplankton species richness index (PSRI) varied between 0.45 and 0.55 during the study period. Among the two sampling stations studied, the maximum mean value (0.55) of phytoplankton richness was found in Station-I. The total number of species (S) in a community is an index of species richness. However it depends on searching. Hence, Shannon and Weiner index was used to denote species richness independent of sample size. These are based on the relationship between (S) and the total number of individuals observed (N) which increase with the increasing sample size and time spent on searching. In SIPCOT industrial outlet the number of individuals in phytoplankton was higher (86 x 103 units/1) in January 2021. On spatial scale, the PSRI diminished in the following order: Station-I>Station-II (Figs.3a and 3b).

Evenness indices indicate where all species in a sample are equally abundant. In the present study, phytoplankton species equitability indices (PSEI) or evenness index values varied from 0.55 to 0.69 in all two sampling stations. In the present study, species evenness (SE) values 0.55 and 0.71 increased the value of species richness (0.48 and 0.55) in Station-I and Station-II respectively. The indices in the present study, phytoplankton species diversity index (PSDI) or Shannon's index (H') combines species richness and species evenness components as one overall index of the stability of the community. These diversity indices indicate that the SIPCOT industry outlet water under study have a well-balanced phytoplankton community that enjoys an even representation of several species indicating the dynamic nature of this aquatic ecosystem. However, remedial measure should be undertaken to minimize the impact of pollution load as revealed by the ecological indicators.

Some commonly occurring microalgae were subject to Scanning Electron Microscopic study to understand the morphology and occurring group of diatom (Fig.4) suggested that pollution tolerating algae beyond this limit. The most striking features of diatom cell wall enclosing the living contents, the walls of diatom are composed amorphous, opaline silica. Ever since microscopes become generally available scientist and others have been fascinated by the beauty and intricacy of the architecture and anatomy of these Siliceous walls.

4 Conclusion

Thus the anthropogenic activity of mattresses washing hampered the quality, of water and resulted in heavy load of pollution. So restriction on this activity is an urgent need of the day for conservation of nearby industrial area of Cuddalore, Tamil Nadu. The present study was attempted to record microalgal diversity in association with physiochemical parameters from lotic water bodies nearby SIPCOT industries, Cuddalore, Tamilnadu. Algal diversity was dwindled to a trickle during summer due to a excessive evaporation and no further flow – organic parameters like Megnesium, Calcium, Chloride and Phosphate were found to largely influences the population dynamics of algal flora. The study proved complete data on the relationship between environmental parameters and microalgal dynamics seasonally from the lotic water bodies of Cuddalore industrial area. Also concludes that these lotic water are enriched with nutrient sources, (mesotrophic) and are excellent source of many potential microalgal species which will be future prospect of this study, it is of particular concern to understand the influence of driving factors such as local, regional and cultural practices upon the phytoplankton community because of its wide distribution. Hence, this adds to the limitations of the present study and will help limnologists better understand this high spatial ecosystem. Ecological indicators are the effective tools in Environmental monitoring which is required to assess the changes caused by Anthropogenic activities.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

We declare that we have no conflict of interest.

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