Nat. Volatiles & Essent. Oils, 2021; 8(4): 3042-3058

Seasonal Variation And Diversity Of Fresh Water Microalgae And Cyanobacteria Form Gomuki Dam, Kallakurichi, Tamil Nadu – India

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Abstract

Algae are distributed worldwide in the sea, in freshwater and also in wastewater. Most are microscopic, but some are quite large. In the study the samples were collected from fresh water, moist soils and stone scrapings etc., totally 40 samples were collected in the different seasons from in Gomuki dam located in Villupuram, origin from Kalvarayan hills, Eastern Ghats range Latitude: 11˚46'41.21"and Longitude: 78˚49'49.88. The samples were screened for the presence of microalgae by plating on BG^{11}, BBM and AC medium. The isolates were further identified based on their morphological characteristics. Among the 40 samples 53 genera and 127 species of various microalgae were identified among that 34 species belong to Bacillariophyceae, 30 species belong to Cyanophyceae, 25 species belong to Chlorophyceae, 12 species belong to Zygnematophyceae, 06 species belong to Conjugatophyceae, 06 species belong to Trebouxiophyceae, 05 species belong to Euglenophyceae, 05 species belong to Mediophyceae, 02 species belong to Coscinodiscophyceae, 01 species belong to Charophyceae, 01 belong to Ulvophyceae families are observed under the microscope. During summer seasons the predominant algal group following that Zygnematophyceae and cyanophyceae was isolated. During rainy seasons the Coscinodiscophyceae were predominant group. During winter most of algae family is less due to climatic changes. The growths are noted under favorable condition for the algal growth. It is the first inclusive taxonomical and diversity study in Gomuki dam and rich of algal species were present also further investigations were needed.

Key words: Algae, Chlorophyta, Bacillariophyta, Cyanoprocaryota, Euglenophyta, Diatoms.

Introduction

Initial researches from 17th century to 18th century the algae were made to define and taxonomic importance. First algae report was a diatom (Tabellaria flocullosa), According to Royal Botanical Society, London, it was collected by an unknown English gentleman in 1703 and found it as epiphytic to roots of an aquatic weed Lemna (Round, 1981). It has been estimated that about 2,00,000 – 8,00,000 species exist of

which about 35,000 species are described by Cheng (2011). There are above 30,000 species of microalgae were isolated and identified as a value-added products that useful in many industrial applications so for by the scientists (Amal, 2021), About 30% work on plant biodiversity and less than 2% of the workforce on microalgae diversity research it is insufficient records and leads to loss of their potential usages (Magurran, 2010).

Algae play an important role in any aquatic ecosystem viz. freshwater bodies, backwaters, saline, estuaries, oceans, effluents and Polar Regions (Narchonai et al., 2019). This organisms is a highly potential, utilized for food, feed, cosmetics, fuel etc., (Nithya et al., 2014). Phytoplanktons not only serve as food, but also play an important role in maintaining the environmental factors and quality of water and contain rich source of protein, lipid and carbohydrate and also highly value added products such as biodiesel, bioethanol, biobutanol, biohydrogen etc (Oscar et al., 2014, Halder et al., 2019).

Freshwater algae of India, there are diverse number of microalgae are reported. The present investigation was carried out as an attempt to assess the diversity status of phytoplankton that present in aquatic ecosystems present in Gomuki dam. It is the first inclusive taxonomical study in dam Gomuki, and rich of algal species are accumulated. Further this study gives a basic idea on utilizing these microalgae for biofuel production and other biotechnological applications.

MATERIALS AND METHODS:

Sampling Site

These areas are seasonal in nature, usually containing water in the months June. These samples are typically distributed along with altitudinal; transects of interest are collected from random positions Gomuki dam. Sample identification was performed according to the morphology of algae.

Collection of samples

40 samples were collected from Gomuki dam seasonal variation (summer, winter, autumn, and rainy seasons), the river origin from Kalvarayan hills. Samples were taken from by scraping rocks, fine gravel, moist soil, pools, riffles, pebbles, dead twigs, roots and stems of some macrophytes. Phytoplankton was collected by towing plankton net into the river. The collected water samples were stored in a sterile 15 ml plastic bottle.

Cultivation of microalgae

The algae samples were scraped and transferred into a sterile plastic bottles using sterile blades and forceps and were transported to the Department of Microbiology, Periyar University, Salem-11, India, for

taxonomic and cultural studies. One set of samples were preserved in 4% formaldehyde and then observed under a light microscope. Samples were transferred to Erlenmeyer flasks containing BG[11], BBM medium. They were maintained in culture room.

Isolation of microalgae

The collected each samples were initially inoculated into 100 ml conical flask containing 50ml of BG 11 medium and BBM medium. After inoculation the flasks were incubated at 24+/-2˚C under 37.5 µmol-1m-1sec-1intensity with 16:8h photoperiod for 15 days (Dayananda et al., 2010).

Identification of Microalgae

The isolated microalgae were observed microscopically using light microscope and identified. The fixed algal species were identification in laboratory using compound microscope and texts (Bellinger 2010). The strains were examined under a light microscope. The sample bottle was mixed by shaking, and transferred a volume of 500 µL for each bottle into a 1.5 ml Eppendorf, a few drops were loaded on a slide and was observed under 400× magnification. Identification of the microalgae species was performed per microscopic fields in the multiple of 10 when no new species have been identified after the 10 fields; the diversity analysis is completed. The identified taxa were subjected to purification using BG [11] medium (Rippka et al., 1979), BBM (Bold, 1973).

Results

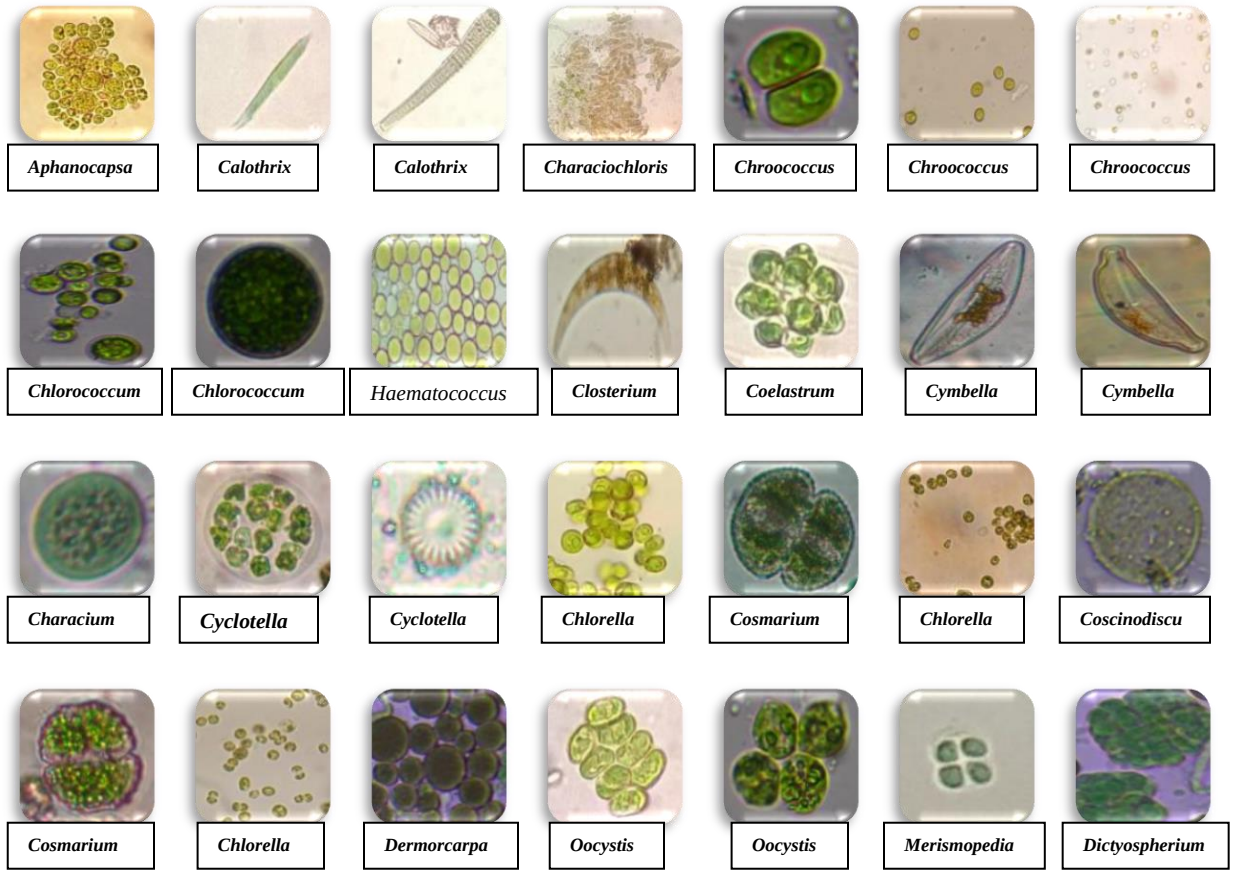
The microalgal components of phytoplankton community, 40 samples were collected from Gomuki dam, by scraping rocks, fine gravel, moist soil, pools, riffles, pebbles, dead twigs, roots and stems of some macrophytes, were diverse. Taxonomic evaluation of the collected material indicated the presence of 53 genera (sample collection site - Fig 1).

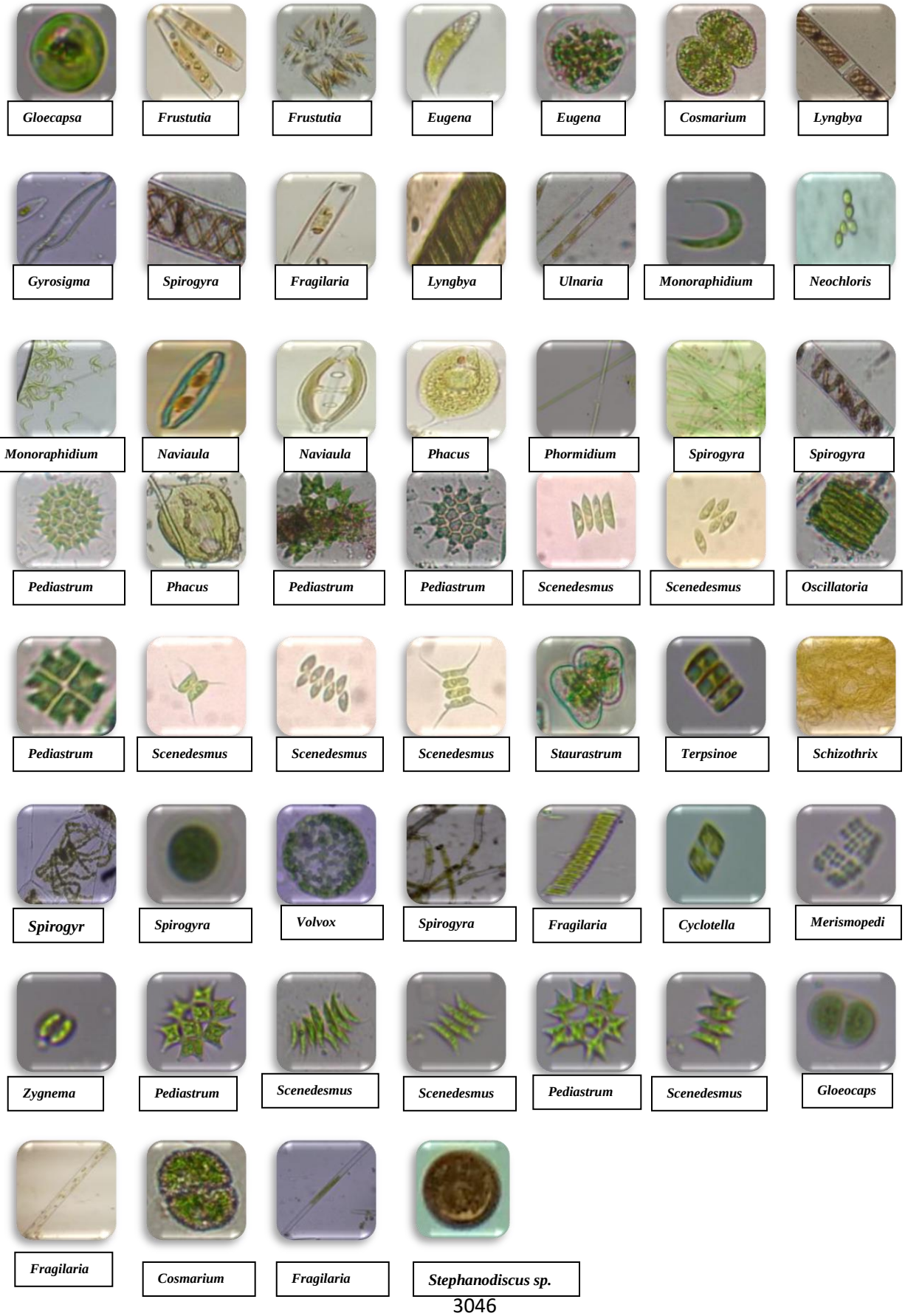
Fig. 1: Site of the study area

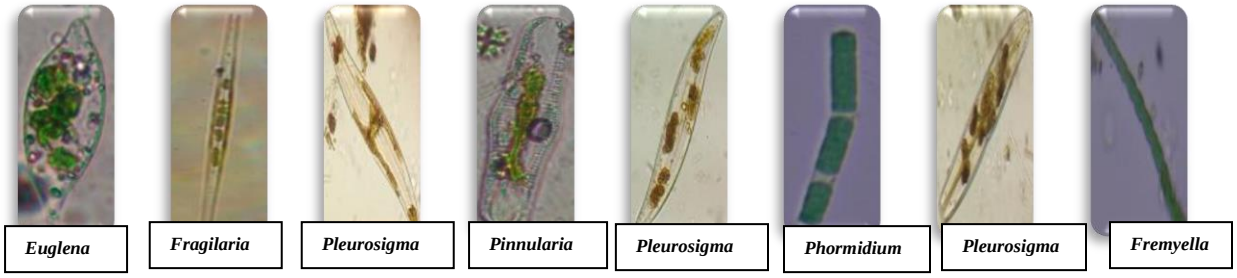
Among the 40 samples, 53 Genera and 127 species of various microalgae were identified and observed under microscope (Fig 2). In this study showed that the temperature ranges from 28-36°C (in water 25-34°C); pH ranges from 6-7.5 were recorded (Table 1).

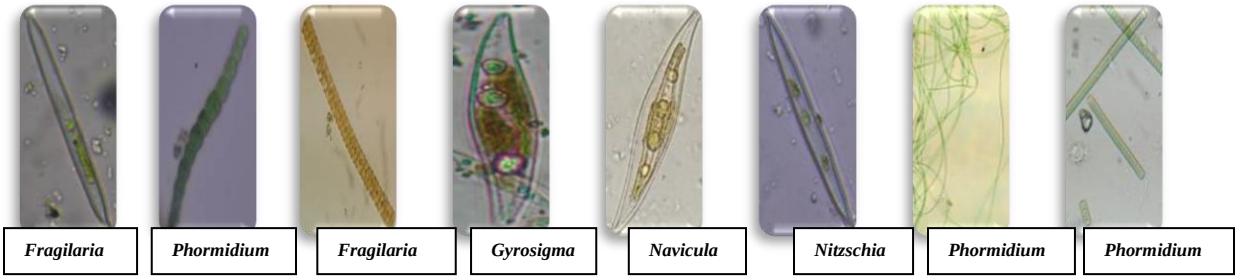
SL	Parameters	Water
1	Colour	Almost colorless
2	Odour	Almost no smell
3	Atmospheric temperature	20°C to 37°C
4	Water temperature	15.1°C to 30.5°C
5	Turbidity	Clear
6	pH	6.8
7.	Nature	Drinking & irrigation

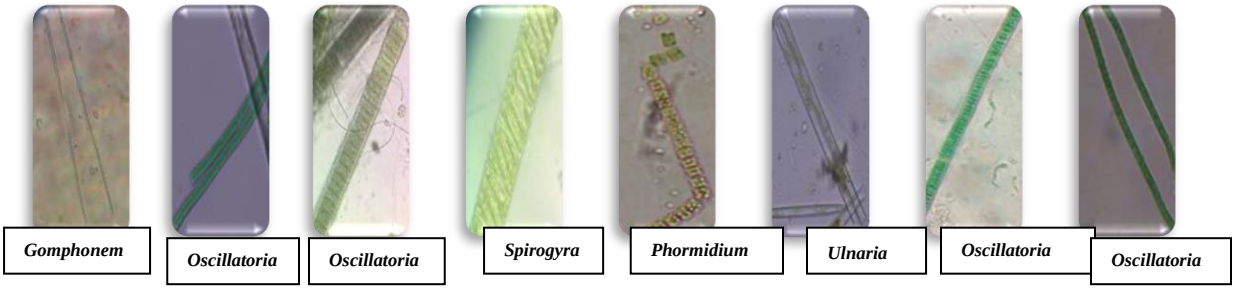
Table-1: The parameters of selected were discussed in the localities of Gomuki dam, Kallakurichi (DT), India.

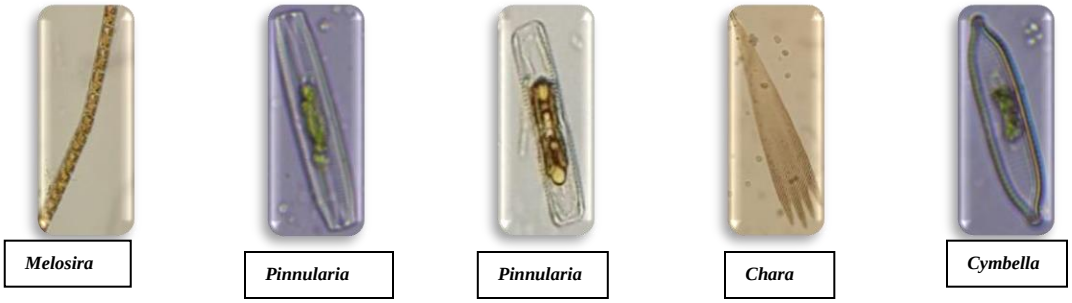



Gloecapsa
Frustutia
Frustutia
Eugena
Eugena
Cosmarium
Lyngbya
Gyrosigma
Spirogyra
Fragilaria
Lyngbya
Ulnaria
Monoraphidium
Neochloris
Monoraphidium
Naviaula
Naviaula
Phacus
Phormidium
Spirogyra
Spirogyra
Pediastrum
Phacus
Pediastrum
Pediastrum
Scenedesmus
Scenedesmus
Oscillatoria
Pediastrum
Scenedesmus
Scenedesmus
Scenedesmus
Staurastrum
Terpsinoe
Schizothrix
Spirogyr
Spirogyra
Volvox
Spirogyra
Fragilaria
Cyclotella
Merismopedi
Zygnema
Pediastrum
Scenedesmus
Scenedesmus
Pediastrum
Scenedesmus
Gloeocaps
Fragilaria
Cosmarium
Fragilaria
Stephanodiscus sp.


Euglena
Fragilaria
Pleurosigma
Pinnularia
Pleurosigma
Phormidium
Pleurosigma
Fremyella


Fragilaria
Phormidium
Fragilaria
Gyrosigma
Navicula
Nitzschia
Phormidium
Phormidium


Gomphonem
Oscillatoria
Oscillatoria
Spirogyra
Phormidium
Ulnaria
Oscillatoria
Oscillatoria


Melosira
Pinnularia
Pinnularia
Chara
Cymbella


Meridion
Nitzschia
Hantzschia
Nostoc
Lyngbya

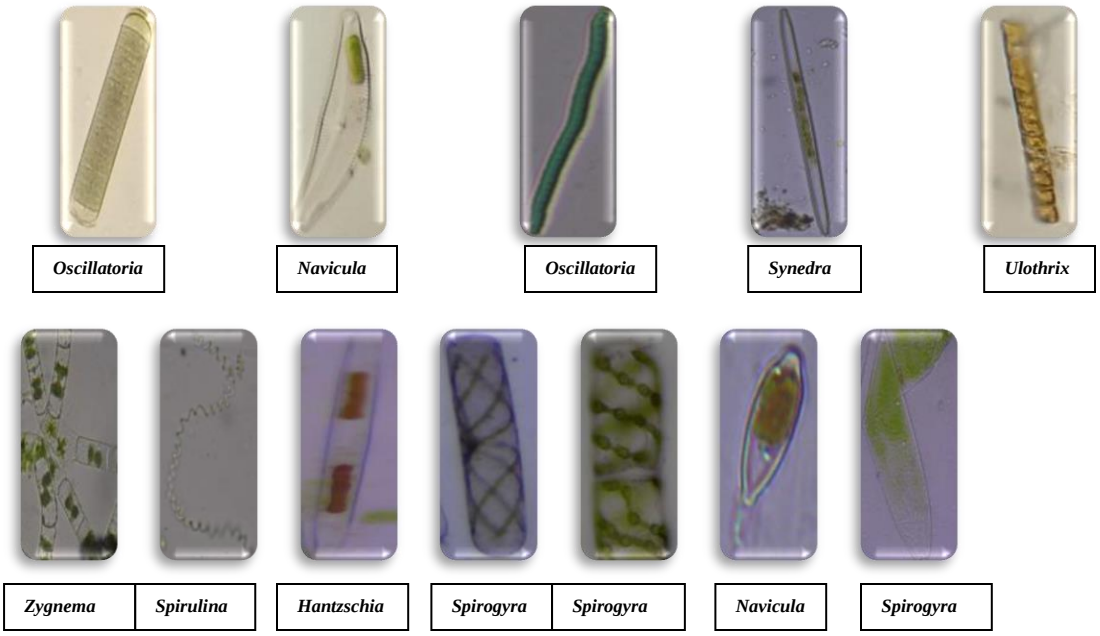


Fig. 2: Microscopic image of microalgae

Among that 127 species belong to 11 families of 34 (26.77%) isolates belong to the family Bacillariophyceae, 30 (23.62%) belong to the family Cyanophyceae, 25 (19.68%) belong to Chlorophyceae, 12 (09.44%) belong to the family of Zygnematophyceae, 06 (04.72%) belong to Conjugatophyceae, 06 (04.72%) belong to Trebouxiophyceae, 05 (03.93%) belong to Mediophyceae families, 5 (03.93%) belong to Euglenophyceae, 02 (01.57%) belong to Coscinodiscophyceae families, 1 (0.78%) belong to Charophyceae families, 1 (0.78%) belong to Ulvophyceae families are observed under the light microscope. The algae are described below (Fig:3, Table 2&3).

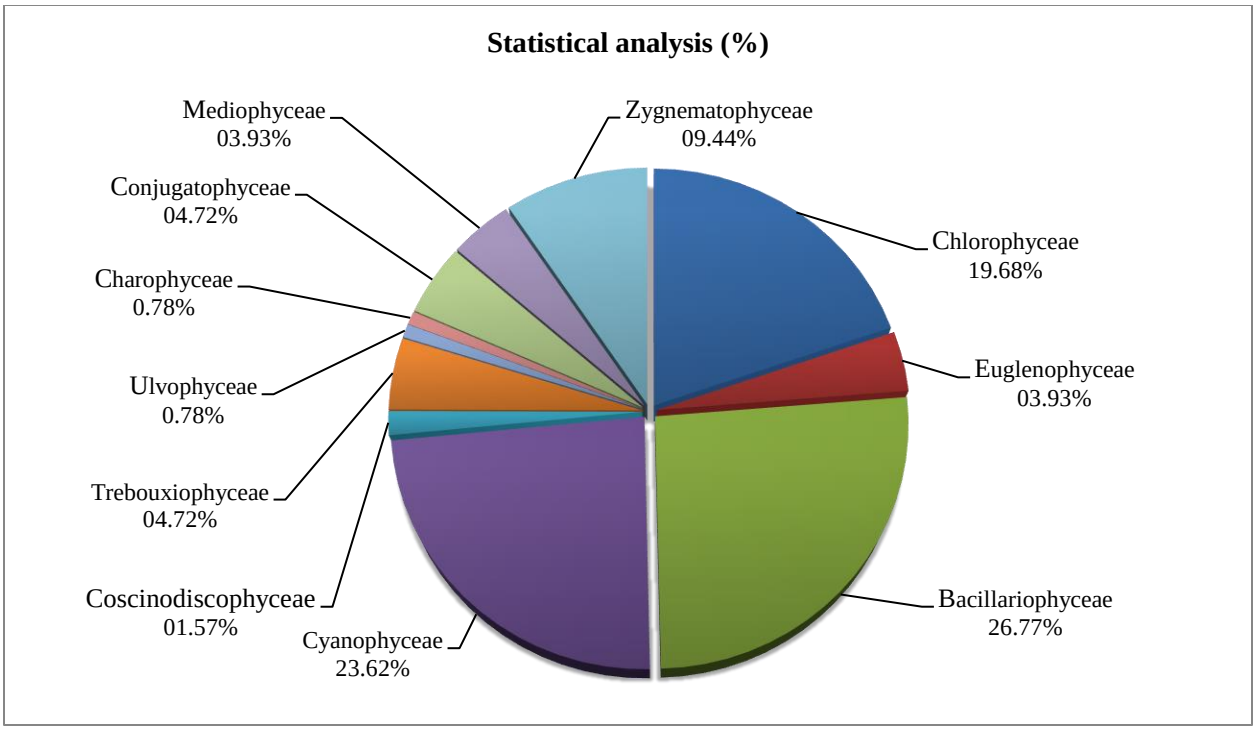


Fig 3. Algae diversity of study area

SL	Class	Number of Genera	Statistical analysis (%)	Number of Species	Statistical analysis (%)
1	Chlorophyceae	10	18.86	25	19.68
2	Euglenophyceae	02	03.77	05	03.93
3	Bacillariophyceae	13	24.52	34	26.77
4	Cyanophyceae	13	24.52	30	23.62
5	Coscinodiscophyceae	02	03.77	02	01.57
6	Trebouxiophyceae	03	05.66	06	04.72
7	Ulvophyceae	01	01.88	01	00.78
8	Charophyceae	01	01.88	01	00.78
9	Conjugatophyceae	03	05.66	06	04.72
10	Mediophyceae	03	05.66	05	03.93
11	Zygnematophyceae	02	03.77	12	09.44
Total		**53**	**99.87**	**127**	**99.96**

Table-2: Statistical analysis of genera and species of various algal classes.

S. No	Class		Genus	No of species
1	Bacillariophyceae	1.	Hantzschia	2
		2.	Nitzschia	2
		3.	Cymbella	3
		4.	Gomphonema	1
		5.	Fragilaria	7
		6.	Synedra	1
		7.	Ulnaria	2
		8.	Gyrosigma	2
		9.	Navicula	5
		10.	Frustulia	2
		11.	Pleurosigma	3
		12.	Pinnularia	3
		13.	Meridion	1
2	Coscinodiscophyceae	14.	Coscinodiscus	1
		15.	Melosira	1
3	Mediophyceae	16.	Terpsinoe	1
		17.	Cyclotella	3
		18.	Stephanodiscus sp.	1
4	Charophyceae	19.	Chara	1
5	Conjugatophyceae	20.	Cosmarium	4
		21.	Staurastrum	1
		22.	Closterium	1
6	Chlorophyceae	23.	Coelastrum	1
		24.	Scenedesmus	8
		25.	Characium	1
		26.	Pediastrum	6
		27.	Neochloris	1
		28.	Monoraphidium	2
		29.	Chlorococcum	3

		30.	Characiochloris	1
		31.	Volvox	1
		32.	Haematococcus	1
7	Trebouxiophyceae	33.	Dictyosphaerium	1
		34.	Chlorella	3
		35.	Oocystis	2
8	Ulvophyceae	36.	Ulothrix	1
9	Cyanophyceae	37.	Chroococcus	3
		38.	Gloeocapsa	2
		39.	Oscillatoria	6
		40.	Phormidium	6
		41.	Lyngbya	3
		42.	Dermorcarpa	1
		43.	Schizothrix	1
		44.	Aphanocapsa	1
		45.	Merismopedi	2
		46.	Nostoc	1
		47.	Fremyella	1
		48.	Calothrix	2
		49.	Spirulina	1
10	Euglenophyceae	50.	Euglena	3
		51.	Phacus	2
11	Zygnematophyceae	52.	Zygnema	2
		53.	Spirogyra	10
Total				**127**

Table-3: Number of genera and species.

S. No	Phylum	Class	Order	Family	Genus
			Bacillariales	Bacillariaceae	Hantzschia,

					Nitzschia
			Cymbellales	Cymbellaceae	Cymbella
				Gomphonemataceae	Gomphonema
			Fragilariales	Fragilariaceae	Fragilaria, Synedra
		Bacillariophyceae	Licmophorales	Ulnariaceae	Ulnaria
			Naviculales	Naviculaceae	Gyrosigma, Navicula
1	Bacillariophyta			Amphipleuraceae	Frustulia
				Pleurosigmataceae	Pleurosigma
				Pinnulariaceae	Pinnularia
			Tabellariales	Tabellariaceae	Meridion
		Coscinodiscophyceae	Coscino-discales	Coscinodiscaceae	Coscinodiscus
			Melosirales	Melosiraceae	Melosira
		Mediophyceae	Anaulales	Anaulaceae	Terpsinoe
			Stephano-discales	Stephanodiscaceae	Cyclotella, Stephanodiscus
2	Charophyta	Charophyceae	Charales	Characeae	Chara
		Conjugatophyceae	Desmidiales	Desmidiaceae	Cosmarium, Staurastrum
				Closteriaceae	Closterium
			Zygnematales	Zygnemataceae	Spirogyra, Zygnema
		Chlorophyceae	Sphaeropleales	Scenedesmaceae	Scenedesmus, Coelastrum
				Characiaceae	Characium
				Hydrodictyaceae	Pediastrum
				Neochloridaceae	Neochloris
				Selenastraceae	Monoraphidium
			Chlamydo-	Chlorococcaceae	Chlorococcum

3	Chlorophyta		monadales	Characio-chloridaceae	Characiochloris
		Trebouxiophyceae	Chlorellales	Chlorellaceae	Dictyochloropsis, Chlorella,
				Haemato-coccaceae	Haematococcus
				Oocystaceae	Oocystis
		Ulvophyceae	Ulotrichales	Ulotrichaceae	Ulothrix, Volvox
4	Cyanobacteria	Cyanophyceae	Chroococcales	Chroococcaceae	Chroococcus
				Microcystaceae	Gloeocapsa
			Oscillatoriales	Oscillatoriaceae	Oscillatoria, Phormidium, Lyngbya, Spirulina
			Pleurocapsales	Dermocarpellacea e	Dermorcarpa
			Synecho-coccales	Synechococcales	Schizothrix
				Merismopediacea e	Aphanocapsa, Merismopedi
			Nostocales	Nostocaceae	Nostoc
				Microchaetaceae	Fremyella
				Rivulariaceae	Calothrix
5	Euglenoidea	Mastigophyceae	Euglenoidi-dales	Euglenoidaceae	Euglena
6	Euglenozoa	Euglenophyceae	Euglenales	Phacaceae	Phacus

Table: 4 Classification of algae group

Based on the seasonal variation the microalgae were listed. For the growth of algae the pH and temperature is most important factor. Due to the climatic changes the algae grown rates are variable (Table 5).

Sl. No.	**Seasons** (Four)	**pH** (Acidic, Neutral, Acid)	**Temperature °C** (0 to 100 °C)

1	Summer (Mar, Apr, May	6.7 - 6.9	29 - 35°C
2	Raining (Jun, Jul, Aug)	6.5 - 6.8	25 - 29°C
3	Autumn (Sep, Oct, Nov)	7.0 - 7.5	20 - 25°C
4	Winter (Dec, Jan, Feb)	7.7 - 8.0	15 - 20°C

Table-5: The parameters of pH and Temperature during four seasons

Most of the bacillariophyceae family was grown during summer following this cyanophyceae, Zygnematophyceae, Trebouxiophyceae, chlorophyceae, Mediophyceae. During raining seasons the Coscinodiscophyceae were predominant growth. Cyanophyceae were grown mostly in autumn and summer time. During winter the algae growth rate was less due to climatic changes (Table 6).

Sl. No.	Family	Summer (Mar, Apr, May)	Raining (Jun, Jul, Aug)	Autumn (Sep, Oct, Nov)	Winter (Dec, Jan, Feb)
1	Bacillariophyceae	×××××	×××	×	××
2	Cyanophyceae	¤¤¤¤¤	¤¤	¤¤¤¤¤	¤
3	Chlorophyceae	****	**	**	*
4	Zygnematophyceae	ɔɔɔɔɔ	ɔ	-	ɔɔ
5	Conjugatophyceae	۵۵۵	-	۵۵	-
6	Trebouxiophyceae	¥¥¥¥	¥¥¥	¥¥	¥
7	Euglenophyceae	≈≈≈	≈≈≈	≈	-
8	Mediophyceae	◊◊◊◊	◊◊	◊◊◊	-
9	Coscinodiscophyceae	○	○○○○	-	○○
10	Ulvophyceae	●●●	●	-	●
11	Charophyceae	⌗⌗	-	-	⌗

Table-6: Seasonal variation of Microalgal diversity

The algae isolated from fresh water are Aphanocapsa sp., Calothrix sp., Cosmarium sp., Hantzschia sp., Nostoc sp., Phormidium sp., Schizothrix sp., Characiochloris sp., Chrococcus sp., Cymbella sp., Dictyochloropsis sp., Euglena sp., Oscillatoria sp., Pinnularia sp., Chlorococcum sp., Chlorella sp., Coelastrum sp., Oocystis sp., Scenedesmus sp., Closterium sp., Fragilaria sp., Melosira sp., Nitzschia sp., Spirogyra sp., Characium sp., Coscinodicscus sp., Cyclotella sp., Navicula sp., Chara sp., Dermorcarpa sp., Terpsinoe sp., Fremyella sp., Frustulia sp., Gloeocapsa sp., Gyrosigma sp., Gomphonema sp., Lyngbya sp., Phacus sp., Pleurosigma sp., Spirulina sp., Synedra sp., Haematococcus sp., Meridion sp., Monoraphidium sp., Merismopedia sp., Staurastrum sp., Pedistrum sp., Neochloris sp., Stephanodiscus sp., Ulothrix sp., Ulnaria sp., Volvox and Zygnema sp.,

Discussion

This is the first report the algae diversity in the Kalvarayan hills of Gomuki dam. There are also only few papers dealing with epilithic micoralgae of high mountain lakes and rock moist soil from other regions in Tamilnadu hill station (Suresh et al., 2012). The Western Ghats is one of the hotspot of biodiversity (Myers et al., 2000). Narmada river contain mostly of Chlorophyceae, Bacillariophyceae, Cyanophyceae, Euglenophyceae, the population of plankton vary in different seasons and months Sohani (2015).

In our study from 53 genera 127 species of microalgae were identified in this study. The diversity index showed that Bacillariophyceae members were dominant followed by Cyanophyceae, Chlorophyceae, Zygnematophyceae, Conjugatophyceae, Trebouxiophyceae Euglenophyceae Mediophyceae Coscinodiscophyceae Ulvophyceae and Charophyceae. In previous study a total of 39 genera of 70 species of microalgae diversity index showed that Chlorophyceae members were dominant followed by Cyanophyceae and Bacillariophyceae (Narchonai et al., 2021).

Cyanophyceae 4, Chlorophyceae 3 Bacillariophyceae 2, Trebouxiophyceae 2, Conjugatophyceae 1 and Euglenophyceae 1 results obtained from previous study of Amal, (2021).

Similar result was obtained earlier in another study Chlorophyceae and Cyanophycean genera are more abundant in winter season than in late summer (Halder et al., 2019). Bacillariophyceae Navicula sp., Pinnularia sp., Euglenophyceae Euglena sp., Phacus sp., (Ajayan, 2015).

Jindal et al., 2014, studied the diversity of Kuntbhyog lake total 48 species of planktons were repoted. Bacillariophyceae 55.98% and Chlorophyceae 27.68% formed the dominant variety, and following Cyanophyceae 13.49% and Euglenophyceae 2.85%.

Thakur et al., 2013, from three freshwater lakes 9 groups of algae having 148 species were studied over period of two years. Jha et al., 1985, had documented 65 Chloropytes and one Euglenophyte from

Govindsagar reservoir. From Jharkhand, India, 25 taxa of cyanobaacterial species rich in fresh water habitat of Bokaro thermal power station. It has been reported for the first time from this area (Arpana 2010).

44 algal species were recorded, chlorophyceae, bacillariophyceae, cyanophyceae. Since, the reservoir shows the presence of various algal species, it should be protected as a natural wealth (Ashish 2015). In total 35 chlorophytes, 10 cyanophytes and 4 bacillariophytes were isolated and described (Mohanapriya 2014).

42 species of Chlorococcales were recorded and described in area during January 2014 to Dec. 2015 reported in Lakhpat. In three sites total 25 taxa of class Cyanophyceae were recorded for the first time from Yelderi dam (Mulani 2015). There were 28 species of blue-green algae that belong to Mougeotia species and Spirogyra observed in Kuttanad, (Smitha 2017).

Water samples collected from Tiruchirappalli India, the six chosen sites during March 2014, 81 species of 35 species belongs to Chlorophyta, 9 species belongs to Bacillariophyta and 37 species belongs to Cyanophyta. 8 microalgal genera found predominant in the lake (Vijayan et al., 2014).

During summer month of June, 2004 sampling of 5 different freshwater ponds in and around from Thanjavur, Tamilnadu. Physico-chemical parameters of pond waters were analyzed and totally 39 species of cyanobacteria were recorded (Muthukumar et al., 2007). Chlorococcales reported from different region of India by many researches like, Bharat (1964); Still now so many workers did the study on algal biodiversity (Ambika, 2016).

Conclusion

Present study shows the richness microalgal species based on temperature, light intensity and quality of fresh water based on the seasonal variation. Variation of cellular organization prokaryotes to eukaryotes was noticed. In morphology there is great organization diversity from unicellular, colonial to coenobium form unbranched to branched thallus. Monitoring the algae diversity in the river provides the water quality, environmental pollution and the impact of human activity on natural resources, and enable conservation biology. Thus in a water body how this mechanic diversity occur is a matter of further study.

Acknowledgments

I would like to acknowledge, Department of Microbiology for provide necessary facilities. This work was supported by the University Research Fellow [DST-FIST (Ref No.SR/FST/LSI–640/2015(C)]; National Fellowship and Scholarship for Higher Education (NFST) [Award No: 201718-NFST-TAM-00157].

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