



A Preliminary Study on Biodiversity of Cyanobacteria of Agniar Estuary, Pudukkottai

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Abstract

In the present study, a total of 38 species belonging to 12 classes were recorded. Among the various classes, *Oscillatoriaceae* recorded maximum diversity by recording 10 species followed by *Phormidiaceae* recording five species and *Nostocaceae* by four species; while *Chroococcaceae*, *Merisporopodiaceae* and *Microcystaceae* recorded three species each, *Scytonemataceae* and *Pseudoanabaenaceae* were represented by two species and classes *Dermocarpaceae*, *Synechococcaceae* and *Xenococcaceae* were represented only by one species each. A familywise comparison reveals that *Phormidiaceae* and *Sycotomateaceae* preferred February to record their highest counts, while *Dermococcaceae* preferred May and *Merisporopodiaceae* recorded the maximal counts in June. However, *Synechococcaceae* registered their maxima in July while *Nostococcaeae* preferred July and August and *Chroococcaceae* recorded their maxima in October.

Keywords

Agniari estuary, Cyanobacteria, biodiversity, Tamil Nadu

INTRODUCTION

Estuaries are unstable ecosystems generally having a limited number of organisms (Selvam *et al.*, 2013). However, they support a high abundance of organisms due to their high productivity. They are one of the richest and most productive areas of organic detritus and form the base of the food chain. However, the hydrodynamic conditions in an estuary are quite complex as they are influenced by river flow, tide, wind and density factors. Further, they are modified due to earth rotation, bottom friction and the geometric properties of the estuarine system (Srilatha *et al.*, 2012).

Due to the unique feature of salinity in the estuaries, both freshwater and marine ecosystems can be encountered here. However, the different conditions present in these systems also result in high mortality of the eggs and larvae of the organisms living in these habitats. Estuaries being unique environments harbour diverse groups of microorganisms due to high amount of biodegradation of organic matter. Hence, various groups of bacteria and fungi such as nitrogen fixers, phosphate solubilizers, cellulose decomposers etc. are prevalent in this system (Holguin *et al.*, 2001). These organisms support these systems in many ways; on the one hand, they help in

biogeochemical cycling of the nutrients in the system and on the other hand act as an important source of food for a variety of organisms besides maintaining its positive nature.

In India, the brackish water available has been estimated to be around 12 million hectares (Heran *et al.*, 1992) of which about 65,000 ha are under aquaculture. Tamil Nadu has a brackish water spread of about 63000 ha. A hydrobiological study is a prerequisite to the assessment of the potentialities, distribution of flora and fauna and also to understand its realities between the different tropic levels and food webs. It is in this context the present study was attempted to assess the cyanobacterial diversity of Agniar Estuary system in Pudukkottai District, Tamil Nadu, India.

MATERIALS AND METHODS

Study Area

The Agniar estuary is situated in the Palk Strait on the East-coast of India (Latitude 10° 20' N; and Longitude 79° 23' E). It is a true estuary and the exchange of water occurs between the estuarine and the adjoining neritic realm of the Bay of Bengal throughout the year. The river mouth is open throughout the year. It is highly productive and rich in fish, prawns, hermit crabs, crabs clams and oysters.

Cyanobacterial Analysis

Surface water samples were collected with the help of a satin net (pore diameter 4.5 μ) fitted to an aluminium frame between 7:00 and 8:00 am for a period of two years (June 2016 to December 2018). Collection was done on a monthly basis for both the water bodies. The samples were immediately transferred to glass containers for later microscopic analyses. Lugol's solution was also added as a preservative. Care was also taken to observe some fresh samples. The counting of cyanobacteria was done using a Sedgwick-Rafter Counting Cell (Saxena, 1987). Samples were isolated and identified by standard manuals (Desikachary, 1959; Starmach, 1966; Pennak, 1978; Adoni, 1985; Trivedy *et al.*, 1987; Sridharan, 1989). While cyanobacterial population was estimated by drop method as described by Pearsall *et al.* (1946), further counting and identification of cyanobacteria were done by following Pennak (1978), Adoni (1985) and Trivedy *et al.* (1987). In addition, diversity indices were also calculated following Trivedy *et al.* (1987). Finally, the results obtained in the present study were statistically treated for a meaningful discussion.

RESULTS AND DISCUSSION

In the present study a total of 38 species belonging to 12 classes were recorded. Among the various classes, Oscillatoriaceae recorded maximum diversity by recording 10 species followed by Phormidiaceae recording five species and Nostocaceae by four species; while Chroococaceae, Merismopediaceae and Microcystaceae recorded three species each, Scytonemataceae and Pseudoanabaenaceae were represented by two species and classes Dermocarpaceae, Synechococaceae and Xenococaceae were represented only by one species each.

Chroococaceae recorded only one perennial species (*Chroococcus turgidus*) while the others were seasonal. As a group, they preferred October to record their highest count and was dominated by *C. turgidus*.

Oscillatoriaceae was represented by 10 species belonging to three genera. While the genus *Oscillatoria* was represented by 4 species of which two were perennial (*O. salina* and *O. tenuis*) with *O. salina* dominating in terms of count. The genus *Lyngbya* was represented by 3 species of which only *L. major* was perennial. The genus *Plectonema* was also represented by 3 species of which only *P. stagnina* was perennial. Among the various species in this group *L. major* was the most dominant organism in terms of number closely followed by *O. salina*.

The class Phormidiaceae was represented by 5 species belonging to two genera, while the genus *Phormidium* was represented by 4 species of which only *P. tenue* was perennial, the genus *Trichodesmium* was represented by a single perennial species *T. erythraeum*. Within this group *P. tenue* was the most dominant species. As a group, the most preferred month was February when they recorded their highest count.

Nostocaceae was represented by 4 species belonging to the genus *Anabaena* of which only *A. variabilis* was perennial and was also the dominating species in terms of count. As a group, they recorded their highest count in July and August.

Merismopediaceae recorded 3 species belonging to 3 genera of which only *Synechocystis salina* was perennial and dominated in terms of count. As a group they recorded their highest counts in January. Microcystaceae also recorded 3 species belonging to 2 genera of which only *Microcystis aeruginosa* was perennial and dominated over others in terms of number. As a group, they recorded their highest count in September. Rivulaceae was also represented by 3 species belonging to two genera of

which only *Diclothrix bauriana* was perennial. As a group they recorded their preference in June by recording the highest count.

Scytonemataceae was represented by two species belonging to the genus *Scytonema* of which only *S. varium* was perennial. As a group, they recorded the highest count in June. Pseudoanabaenaceae was also represented by two species belonging to the genus *Spirulina* of which only *S. major* was perennial and was also the dominant species. As a group, they recorded the highest count in February.

The classes Dermocarpaceae, Synechocaceae and Xenococcaceae were all represented by a single species. While Dermocarpaceae recorded its highest count in May, Synechocaceae recorded its peak in July and Xenococcaceae registered its peak in July.

A perusal of literature reveals that marine Cyanobacteria constitute an integral and major component of the microbiota in all estuarine systems (Potts, 1979; Hussain and Khoja, 1993; Kathiresan and Bingham, 2001; Palaniselvam and Kathiresan, 2002; Sakthivel, 2004; Silambarasan *et al.*, 2012). Silambarasan *et al.* (2012) also suggested that they occupy a wide range of illuminated ecological niches in terrestrial, marine and freshwater environments. Further many workers suggested that many marine forms grow along the shore as benthic vegetation between the high and low tide marks (Humm and Wicks, 1980; Palaniselvam, 1998; Kathiresan and Bingham, 2001) even though many of the species are truly marine (Nagarkar *et al.*, 2000). Thajuddin and Subramanian (1991, 1992) reported that 75% of the species recorded from the southern east coast of India have originally been reported in freshwater also (Smith, 1950; Desikachary, 1959; Humm and Wicks, 1980; Silambarasan *et al.*, 2012). In addition, Kawabata *et al.* (1993) also suggested that pelagic algal communities make important contributions to the smooth functioning of estuarine system.

In the present study, even though Cyanobacteria as a group was recorded throughout the period of study, a family-wise comparison reveals that each family preferred to choose a certain period of time to record their highest count. Thus, while Phormidiaceae and Sycotomateaceae preferred February to record their highest counts, Dermococcaceae preferred May and Merispopediaceae June to record their maximal counts. However, Synechocaceae registered their maxima in July while Nostococcaeae preferred July and August to record their maxima. On the other hand, Chroococcaceae recorded their maxima in October. Literature reveals that algal species show wide spectro-temporal variations due to the

different effect of hydrographical factors on individual species (Gouda and Panigraphy, 1996). Many scientists also suggest that salinity plays an important factor in limiting the distribution of organisms as its variation in salinity caused by dilution and evaporation influences the flora of this region (Gibson, 1982; Balasubramanian and Kannan, 2005; Sridhar *et al.*, 2006; Saravanakumar *et al.*, 2008). A perusal of the correlation between Cyanobacteria and salinity reveals a strong positive correlation (Mugilan, 2017) indicating their relationship. According to Das and Panda (2010) total phosphate, nitrate and chloride contents also play a major role in the distribution of algae. Correlation between cyanobacteria and phosphate (Sivakami *et al.*, 2017), as well as nitrate (Mugilan, 2017) in the present study also reveals a positive relationship which reflects their influence on the growth and distribution of Cyanobacteria. Nevertheless, El-Gindy and Dorghan (1992) stated that algal growth depends on several environmental factors which are variable in different seasons and regions.

In the present study, a total of 38 species belonging to 12 classes were recorded. Among the various classes, Oscillatoriaceae recorded maximum diversity by recording 10 species followed by Phormidiaceae recording five species and Nostocaceae by four species; while Chroococcaceae, Merispopediaceae and Microcystaceae recorded three species each, Scytonemataceae and Pseudoanabaenaceae were represented by two species and classes Dermocarpaceae, Synechocaceae and Xenococcaceae were represented only by one species each.

A familywise comparison reveals that Phormidiaceae and Sycotomateaceae preferred February to record their highest counts, while Dermococcaceae preferred May and Merispopediaceae recorded the maximal counts in June. However, Synechocaceae registered their maxima in July while Nostococcaeae preferred July and August and Chroococcaceae recorded their maxima in October.

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Table-1: Diversity of Cyanobacteria of Agniar Estuary

No.	Species	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
I. Chroococcaceae														
1.	Chroococcus tenax	2017	10	20	50	40	10	-	-	10	20	40	30	20
		2018	20	30	60	30	20	-	-	-	20	30	40	10
2.	Chroococcus varius	2017	-	-	-	-	-	20	30	40	10	-	-	-
		2018	-	-	-	-	-	-	60	20	10	-	-	-
3.	Chroococcus turgidus	2017	10	20	10	20	40	50	90	110	140	180	120	120
		2018	30	20	10	20	30	70	120	120	120	140	120	120
II. Dermocarpaceae														
4.	Dermocarpa leibleinea	2017	-	-	10	30	60	40	-	-	-	-	-	-
		2018	-	-	10	20	50	30	-	-	-	-	-	-
III. Merismopediaceae														
5.	Aphanocapsa litoralis	2017	-	-	30	70	60	40	10	-	-	-	-	-
		2018	-	-	20	80	30	30	20	-	-	-	-	-
6.	Merismopedia aeruginea	2017	-	-	-	-	-	10	20	-	-	-	10	20
		2018	-	-	-	-	10	20	10	-	-	-	10	20
7.	Synechocystis salina	2017	140	120	110	20	20	40	60	60	80	100	110	130
		2018	160	120	110	10	20	30	40	70	80	80	100	120
IV. Microcystaceae														
8.	Gloeocapsa aeruginosa	2017	10	40	50	20	-	-	-	-	-	-	-	-
		2018	30	40	60	20	10	-	-	-	-	-	-	-
9.	Microcystis litoralis	2017	40	60	70	100	160	60	70	30	-	-	-	-
		2018	30	60	80	140	150	80	60	10	-	-	-	-
10.	Microcystis aeruginosa	2017	160	200	240	260	460	510	670	700	800	300	140	160
		2018	170	210	220	270	440	600	700	800	860	340	200	140

continued...

Table-1 continued...

Table 1 continued...

No.	Parameters	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
V. Nostocaceae														
11.	<i>Anabaena torulosa</i>	2017	-	-	-	-	-	10	60	30	-	-	-	-
		2018	-	-	-	-	-	20	60	80	30	-	-	-
12.	<i>Anabaena variabilis</i>	2017	110	100	70	60	20	30	40	50	60	90	140	120
		2018	120	90	50	20	30	20	30	60	70	100	160	140
13.	<i>Anabaena sphaerica</i>	2017	-	-	-	-	10	40	20	-	-	-	-	-
		2018	-	-	-	-	10	50	10	-	-	-	-	-
14.	<i>Anabaena iyengar</i>	2017	-	-	10	30	20	-	-	-	-	-	-	-
		2018	-	-	10	40	20	-	-	-	-	-	-	-
VI. Oscillatoriaceae														
15.	<i>Oscillatoria cortiana</i>	2017	-	-	-	-	-	-	-	-	-	-	-	-
		2018	10	40	20	-	-	-	-	-	-	-	-	-
16.	<i>Oscillatoria salina</i>	2017	60	70	80	100	120	60	40	30	30	40	50	60
		2018	70	80	90	110	130	70	30	40	20	40	40	50
17.	<i>Oscillatoria tenuis</i>	2017	10	30	10	10	10	10	10	80	90	20	10	10
		2018	30	20	10	10	10	10	10	70	60	30	40	10
18.	<i>Oscillatoria formosa</i>	2017	20	20	10	-	-	-	-	-	-	-	-	-
		2018	20	30	10	-	-	-	-	-	-	-	-	-
19.	<i>Lyngbya major</i>	2017	80	90	110	120	70	80	70	60	40	70	80	90
		2018	70	90	120	140	80	90	30	30	50	80	90	100
20.	<i>Lyngbya majuscula</i>	2017	-	-	10	80	20	-	-	-	-	-	-	-
		2018	-	-	-	-	-	-	-	-	-	-	-	-
21.		2017	10	20	40	30	10	-	-	-	-	-	-	-

No.	Parameters	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
22.	<i>Lyngbya mesotricha</i>	2018	10	40	60	30	20	-	-	-	-	-	-	-
	<i>Plectonema stagnina</i>	2017	30	40	60	70	80	90	110	30	30	40	20	20
		2018	40	50	40	60	90	100	90	40	30	40	30	30

continued...

Table-1 continued...

No.	Parameters	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
23.	<i>Plectonema terebrans</i>	2017	-	-	-	-	-	-	-	-	10	60	70	40
		2018	-	-	-	-	-	-	-	-	10	70	80	30
24.	<i>Plectonema putuale</i>	2017	40	70	30	20	-	-	-	-	-	-	-	-
		2018	40	30	20	20	-	-	-	-	-	-	-	-
VII.	Phaomidiaceae													
25.	<i>Phormidium ambiguum</i>	2017	20	20	20	10	10	-	-	-	20	40	10	10
		2018	30	40	10	10	10	-	-	-	10	30	20	20
26.	<i>Phormidium tenue</i>	2017	100	160	70	40	30	40	60	40	20	40	40	30
		2018	120	170	90	30	20	50	60	30	20	50	50	20
27.	<i>Phormidium fragile</i>	2017	-	-	-	-	-	-	-	-	-	30	40	60
		2018	-	-	-	-	-	-	-	-	20	40	60	70
28.	<i>Phormidium valderianum</i>	2017	10	40	20	10	-	-	-	-	-	-	-	-
		2018	10	40	10	10	-	-	-	-	-	-	-	-
29.	<i>Trichodesmium erythraeum</i>	2017	20	20	20	20	20	20	40	30	20	20	20	20
		2018	30	30	30	30	30	40	80	30	30	30	30	30
VIII.	Pseudanabaenaceae													
30.	<i>Spirulina subsalsa</i>	2017	80	90	100	120	140	30	-	-	40	80	30	70
		2018	70	80	160	200	160	40	-	-	30	60	20	40
31.	<i>Spirulina major</i>	2017	710	910	700	600	400	300	200	100	700	800	900	600
		2018	860	1020	800	600	600	400	300	200	600	800	960	800
IX.	Rivulariaceae													
32.	<i>Calothrix brevissima</i>	2017	-	-	-	-	60	70	60	30	-	-	-	-
		2018	-	-	-	-	40	80	60	30	-	-	-	-
33.	<i>Calothrix bharadwaja</i>	2017	-	-	-	-	-	-	-	-	10	40	20	-
		2018	-	-	-	-	-	-	-	-	-	-	-	-

continued...

Table-1 continued...

No.	Parameters	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
34.	<i>Dichothrix bauriana</i>	2017	170	140	120	110	110	110	110	110	110	140	160	180
		2018	180	130	130	120	120	120	120	120	120	160	170	190
X.	Scytonemataceae													
35.	<i>Scytonema chiastum</i>	2017	-	-	-	-	10	40	20	10	-	-	-	-
		2018	-	-	-	-	10	50	20	10	-	-	-	-
36.	<i>Scytonema varium</i>	2017	10	20	30	10	10	10	10	10	10	40	30	10
		2018	10	30	10	10	10	10	10	10	10	50	20	10
XI.	Synechococcaceae													
37.	<i>Synechococcus elongatus</i>	2017	140	140	140	150	160	130	130	130	130	140	160	130
		2018	150	140	140	160	170	140	140	130	130	140	140	140
XII.	Xenococcaceae													
38.	<i>Myxosarcina concinna</i>	2017	-	-	-	-	-	30	60	30	-	-	-	-
		2018	-	-	-	-	10	60	70	30	20	-	-	-

Table-2: Total classwise count of Cyanobacteria of Agniar Estuary

No.	Family	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
TOTAL														
I.	Chroococcaceae	2017	20	40	60	60	50	70	120	160	170	220	150	140
		2018	50	50	70	50	50	70	180	140	150	170	160	130
II.	Dermocarpaceae	2017	-	-	10	30	60	40	-	-	-	-	-	-
		2018	-	-	10	20	50	30	-	-	-	-	-	-
III.	Merismopediaceae	2017	140	120	140	90	80	90	90	60	80	100	120	150
		2018	160	120	130	90	60	80	70	70	80	80	110	140
IV.	Microcystaceae	2017	210	300	360	380	620	570	740	730	800	300	140	160
		2018	230	310	360	430	600	680	760	810	860	340	200	140
V.	Nostocaceae	2017	110	100	80	90	50	80	120	80	60	90	140	120
		2018	120	90	90	60	60	90	100	140	100	100	100	140
VI.	Oscillatoriaceae	2017	250	340	350	430	310	240	230	200	200	230	230	220
		2018	290	380	370	370	330	270	160	180	170	260	280	220
VII.	Pharmidiaceae	2017	150	240	130	80	60	60	100	70	60	130	110	120
		2018	190	280	140	80	60	90	140	60	110	140	150	150
VIII.	Pseudanabaenaceae	2017	790	1000	800	720	540	300	200	100	740	880	930	70
		2018	930	1100	960	800	760	440	300	200	830	860	980	840
IX.	Rivulariaceae	2017	170	140	120	110	170	180	170	140	120	180	180	180
		2018	180	130	130	120	160	200	180	150	120	160	170	190
X.	Scytonemataceae	2017	10	20	30	10	20	50	30	20	10	40	30	10
		2018	10	30	10	10	20	60	30	20	10	50	20	10
XI.	Synechococcaceae	2017	140	140	140	150	160	130	130	130	130	140	160	130
		2018	150	140	140	160	170	140	140	130	130	140	140	140
XII.	Xenococcaceae	2017	-	-	-	-	-	30	60	30	-	-	-	-
		2018	-	-	-	-	10	60	70	30	20	-	-	-
Total Count		2017	1990	2440	2940	2960	2110	1920	2100	1750	2390	2210	2190	1900
		2018	2310	2630	2410	2190	2330	2210	2130	1930	2580	2300	2370	2100