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Article

Periphytic Forms of Lotic Water System under Tropical Climatic Conditions

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Abstract: Periphyton is sessile biota attached to submerged substrata which includes algae, invertebrates, detritus and microorganisms. It consists of mainly algae but also include bacterial and fungal matter. Diversity and abundance of algae is considered as indicator of water quality of aquatic systems. In lotic habitats, attached algal communities (periphyton) are often the only primary producers. The present study is based on the study of Periphyton population under tropical climatic condition. The present study was carried out at Hoshangabad site of River Narmada situated in Madhya Pradesh. Four sampling stations were selected viz. Shahgang (Site-1), Bandra Bandh (Site-2), Sethani Ghat (Site-3) and Bandra Bandh-2 (Site-4). During the present study a total 45 species of Periphytic forms were recorded from 13 different classes. In the present study high species diversity of Periphytic forms were recorded at the site having abundance of macrophytic vegetation.

Keywords: periphyton, water quality, tropical climatic conditions.

1. Introduction

Periphyton may be defined as the complex of sessile aquatic biota with associated detritus, attached to submerged substrate. It includes sessile algae, micro fauna and other bottom organism in combination with microbial bio-films (van Dam *et.al.*, 2002). Thus, not only the minute sessile organisms living within a slimy matrix on submerged objects but also the free living organisms associated with this matrix have been greatly treated as periphyton. Periphyton has become a universally

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accepted expression for all organisms attached to a submerged substrate. However the word biofilm is used synonymous with periphyton to indicate the attached microbial population in aquatic environment. The structure of algal assemblages which are the primary producers in lotic systems mainly river and streams depend on variations in ambient environmental factors [physical and nutrient concentration]. Diversity and abundance of algae have since long been considered as indicator of water quality as they are known to reflect the ecological conditions of aquatic systems (Palmer,1969, Cascallar *et.al*.,2003, Denicola *et.al*, 2004). Periphyton is considered as an important food component for fishes. Nutrients are channelized through periphyton. Periphyton grows on various substratums in aquatic environment and support fish production. In search of low cost aqua farming, a range of substrate based aquatic systems have been developed for both fin fish and shell fish culture to provide shelter and increases periphyton production as food and thereby increasing aquaculture production. The development of such periphyton based aquaculture technology appears to be feasible and it can bring about major advances in the development of low cost farming in aquaculture with no additional feed and reduction of pollutants.

In fast-flowing, oligotrophic lotic habitats, attached algal communities (periphyton) are often the only primary producers, and play an important role in the food web through the transformation of energy (Biggs 1996).

Most previous studies of periphyton have focused on biomass accrual. Relatively little effort has been placed on determining relationships between trophy and periphyton community structure. And yet, excessive periphyton biomass has been associated not only with nutrient enrichment but also with the growth of particular filamentous taxa such as Cladophora (Biggs and Price 1987; Dodds 1991).

In rivers Periphytic algae inhabit various natural (epiphyton, epilithon) and artificial substrates, e.g. those of human constructions in waters. The most important factors influencing the development of plant periphyton in rivers include water discharge, substrate type, nutrient concentrations, and grazing (Cattaneo 1983, Pringle 1990, Biggs 1996, Szlauer 1996, Perrin and Richardson 1997, Komulaynen 2006, Stevenson *et.al.* 2006, Szabo *et.al.*, 2007). Substrate structure and chemical composition are essential factors in determining periphytic algal biomass (Lowe and Gale 1980, Biggs 1996, Komulaynen 2002, Szabo *et.al.*, 2007, Komulaynen 2009, Belyaeva 2010, Morin et al. 2010). Periphytic algae are a food source for several invertebrate and fish species (Cattaneo *et.al*, 1993). Herbivorous invertebrates can influence periphytic algae directly by grazing, and indirectly by nutrient regeneration. General studies of relationships between plant periphyton and invertebrates have been analyzed previously in rivers (Lewis 1986, Perrin and Richardson 1997, Winter and Duthiel 1998, Komulaynen 2006, Morley *et.al.*, 2008, Coe *et.al*, 2009). Gastropods also play an important role in shaping periphyton biomass, species composition, and productivity (Bronmark 1989, Tuchman and Stevenson 1991). Even on homogeneous substrates, the grazing effect contributes to a mosaic of periphyton communities

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(Kawata et al. 2001).It is hypothesized that damming the river has influenced the growth conditions of gastropods grazing on periphytic algae inhabiting both natural and artificial substrates.

Periphyton plays an important role in flowing waters because it is virtually the only primary producer in the ecosystem. It has been demonstrated that the contribution of periphyton to carbon fixation and nutrient cycling can be significant, particularly in lotic systems (Wetzel 2005). Periphyton in streams and rivers are an important component of aquatic ecosystems, providing food for invertebrates, and thus fish, in local and downstream ecosystems (Finlay *et.al.* 2002). Periphyton growth can be light-limited (Quinn *et.al*, 1997a, b; Kiffney and Bull, 2000) or nutrient-limited (Cascallar *et.al.*, 2003; McCormick and Stevenson, 1998; Perrin and Richardson, 1997), or both, and is influenced by temperature (Francoeur *et.al.*, 1999; Morin *et.al.*, 1999; Robinson and Minshall, 1998; Weckstroem and Korhola, 2001). Periphyton assemblages can be spatially complex and temporally variable depending on a wide range of environmental and biological factors (Biggs and Kilroy 2004).

2. Materials and Methods

Narmada River is fifth largest river in the Indian sub-continent. The Narmada River bounded between Vindhya and Satpura ranges extends over an area of 98,796km² and lies between east longitudes (72° 32' to 81° 45') & North latitudes (21° 20' to 23° 45') lying on the northern extremity of the Deccan plateau. This basin covers large area in the State of Madhya Pradesh.

The entire district Hoshangabad is drained by Narmada River and its tributaries. Thus the area falls in the Narmada Basin. The river Narmada flows along the northern boundary of the district. The river Narmada originates from the Amarkantak plateau and after flowing through Hoshangabad, Mandla, and Jabalpur from the north-eastern part. The Tawa River is the major tributary of the Narmada River and flows from south to North West before merging into the Narmada River. Denwa River originates from south-eastern part of the Hoshangabad district and flows district and flows from east to west direction before joining the Tawa River (south of Rainpur) where Tawa dam has been constructed. The important nalas are Keolari, Hather and Indra Nadi. The rivers draining the area in the western part are Morand, Banjal and Ajnal. The Morand River joins the Ganjal River near Chhidgaon and flows towards Narmada river. The present study is based on the study of Periphyton population. The present study was carried out during September to November 2017.

Four sampling stations were selected for carrying out present study viz.

1) Site-1 Shahganj

2) Site-2 Bandra bandh

3) Site-3 Sethani ghat

4) Site-4 Bandra bandh (2)

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Fig. 1. Location of sampling stations

2.1. Physico Chemical Analysis

Physical properties of water in any aquatic system are largely regulated by the existing meteorological conditions and chemical properties. Water quality affects the abundance, species, composition, stability, productivity and physiological conditions of indigenous population of aquatic organisms. Therefore, the nature and the health of the aquatic communities is an expression of the quality of water. Taking this into consideration physico-chemical analysis of Narmada River was carried out by following methods of Adoni *et al.*, 1985.

2.2. Periphyton Collection

The sampling of periphyton was done on monthly basis during day time mainly from September to November 2017. The samples were collected by scraping the 4 cm^2 surface area of stones, boulders, cemented edges using blade and brushes.

2.3. Preservation

The collected samples were preserved in Lugol's iodine and stored in small vials having capacity of 25 ml and raised to the volume of 25 ml by adding distilled water.

2.4. Identification

The process of identification of periphyton up to generic level was carried under digital microscope with standard works APHA (1998), and Biggs and Kilroy (2000).

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3. Results and Discussion

Some Physico-chemical parameters were analyzed for the selected four stations of Narmada River (Hoshangabad form the month of September to November 2017.

3.1. Air Temperature

During the present study the minimum air temperature 24°C was recorded at site-2 in the month of November, while as maximum 35°C was recorded in the month of September at site-3.The average air temperature recorded was 30.33°C (fig. 2).

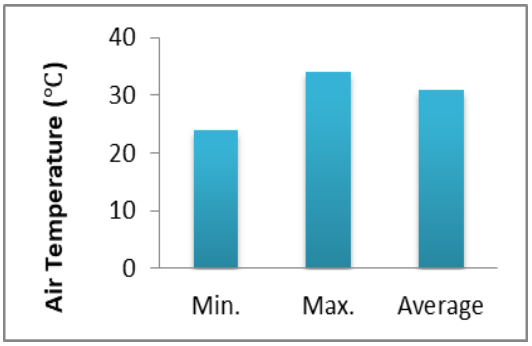

Fig. 2. Variations in air temperature

3.2. Water Temperature

A maximum of 32°C water temperature was observed at site-1, site-3 and site-4 during the month of September and site-2, site-3 during October. While minimum of water temperature was observed at site-2 in the month of November. The average water temperature recorded was 29.66°C (fig. 3).

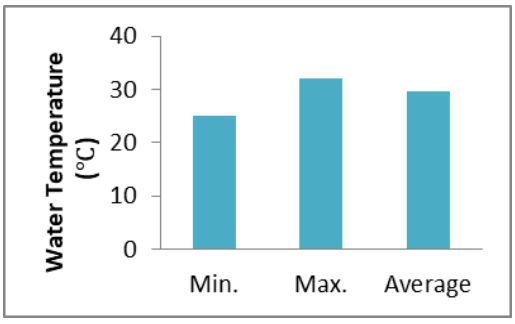

Fig. 3. Variations in water temperature

3.3. PH

pH showed a small variation at all the sites. The highest value of pH 8.6 was recorded at site-1 during the month of September and at site-4 respectively. While as the lowest value of pH 8 was observed at site-2 in September and November and site-1 in December respectively. While as the average value of pH recorded was 8.24 (fig. 4).

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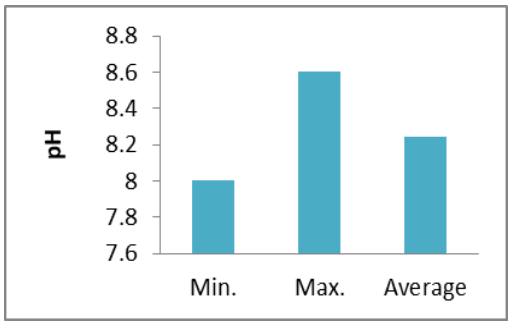

Fig. 4. Variations in pH

3.4. Total Dissolved Solids

In the present investigation, the highest value of TDS 200 mg/l was recorded at Site-1 during the month of September. The lowest value 107 mg/l was recorded at site-2 in the month of October. And the average value of TDS recorded was 133.91 mg/l (fig. 5).

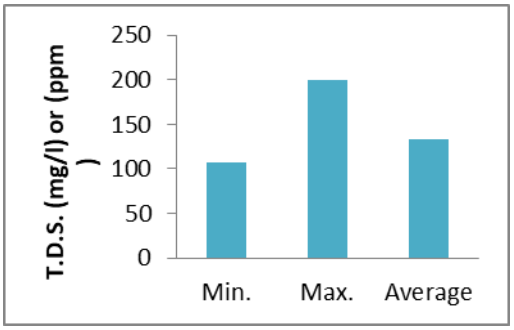

Fig. 5. Variations in T.D.S

3.5. Electrical Conductivity

The lowest value Electrical conductivity 200 µS/cm was recorded at site-1, site-2 and site-4 during the month of September. The maximum value of Electrical conductivity 300µS/cm was recorded at site-3 during the month of September and at site-1, site-2, site-3, site-4 in October and site-1, site-3 and site-4 during November. While as the average value of Electrical conductivity recorded was 260.83 µS/cm (fig. 6).

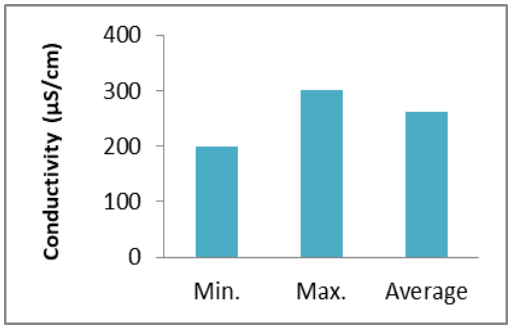

Fig. 6. Variations in conductivity

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3.6. Dissolved Oxygen

The value of D.O showed increase in concentration from site-1 to site-4 respectively during all the three months. The value of D.O ranged from 7.2 mg/l to 8.6 mg/l. The lowest value 7.2 mg/l was recorded at site-1 during the month of September and the highest value 8.8 mg/l was recorded at site-4 during November. The average value of D.O recorded was 8.005 mg/l (fig. 7).

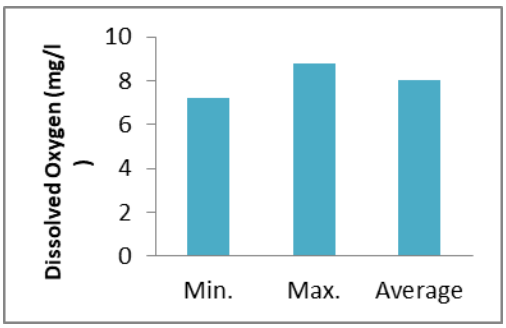

Fig. 7. Variations in DO

3.7. Free CO_2

During the present study free CO_2 was absent at all the sites in all the three month.

3.8. Total Alkalinity

During the present study maximum (80 mg/l) total alkalinity was recorded at site-3 in the month of October and minimum 42 mg/l at site-3 during November. The average value of total alkalinity recorded was 61.58 mg/l (fig. 8).

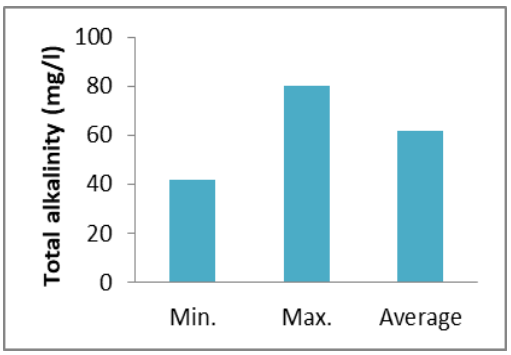

Fig. 8. Variations in total alkalinity

3.9. Total Hardness

Maximum of total hardness (132 mg/l) was observed at site-1 during the month of November and a minimum (54 mg/l) at site-3 during October. While as average value of total hardness recorded was (88.94) mg/l (fig. 11). The average value of total Hardness recorded was 88.94 mg/l (fig. 9).

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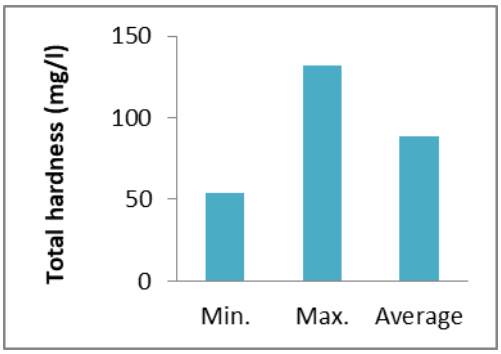

Fig. 9. Variations in total hardness

3.10. Calcium Hardness

The maximum value of calcium hardness (62.4mg/l) was recorded at site-3 in the month of September and minimum (33.28 mg/l) at site-4 during the month of October. The average value of calcium hardness recorded was 42.71 mg/l (fig. 10).

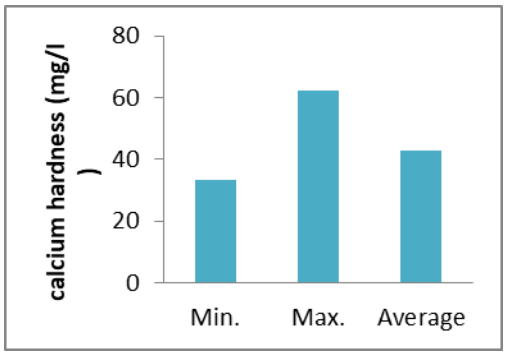

Fig. 10. Variations in calcium hardness

3.11. Magnesium Hardness

Maximum magnesium hardness (22.35mg/l) was recorded at site-1 in the month of November and minimum (1.84mg/l) at site-3 in the month of September. The average value of calcium hardness recorded was 10.48mg/l (fig. 11).

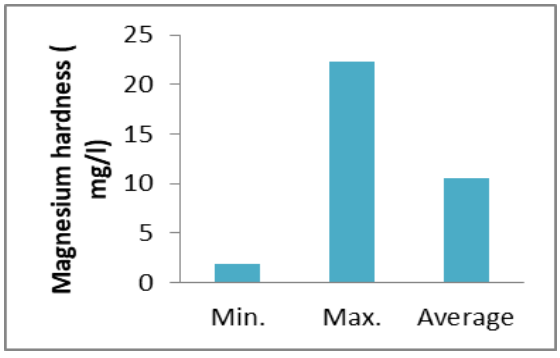

Fig. 11. Variations in magnesium hardness

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3.12. Chloride

In the present study the maximum value of chloride (33mg/l) was recorded at site-3 during the month of September and the minimum value of chloride (11.98 mg/l) at site-1 during September. The average value of chloride recorded was 20.36mg/l (fig. 12).

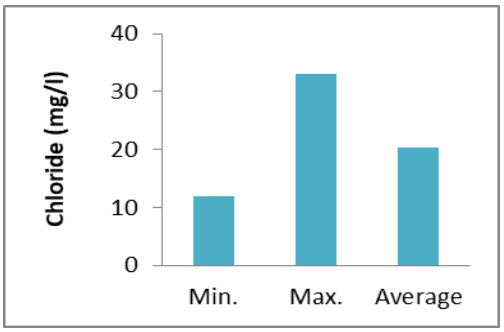

Fig. 12. Variations in chloride

3.13. Nitrite

The nitrite concentration during the present study ranged between (0.047mg/l to 0.484mg/l). The maximum value (0.484mg/l) of nitrite was recorded at site-3 during the month of September and minimum value (0.047mg/l) of nitrite was recorded at site-3 during October. The average value of nitrate recorded was 0.195mg/l (fig. 13).

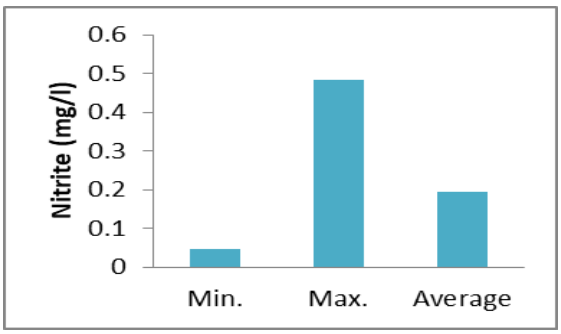

Fig. 13. Variations in nitrite

3.14. Nitrate

The nitrate concentration during the present study ranged between (0.058mg/l to 0.637mg/l). The maximum value (0.637mg/l) of nitrate was recorded at site-3 during the month of September and minimum value (0.058mg/l) was recorded at site-3 during October. The average value of nitrate recorded was 0.318mg/l (fig. 14).

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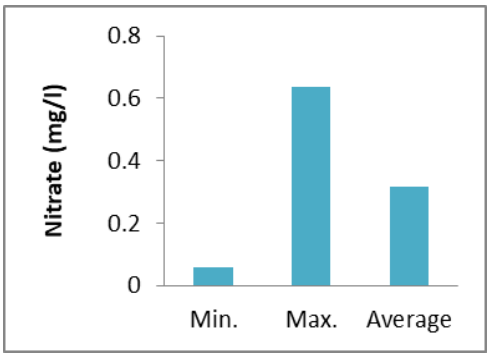

Fig. 14. Variations in nitrate

3.15. Orthophosphate

The orthophosphate concentration during the present study ranged between (0.063mg/l to 0.257mg/l). The maximum value (0.257mg/l) orthophosphate was recorded at site-3 during the month of September and minimum value (0.063mg/l) orthophosphate was recorded at site-1 during October. The average value of nitrate recorded was 0.141mg/l (fig. 15).

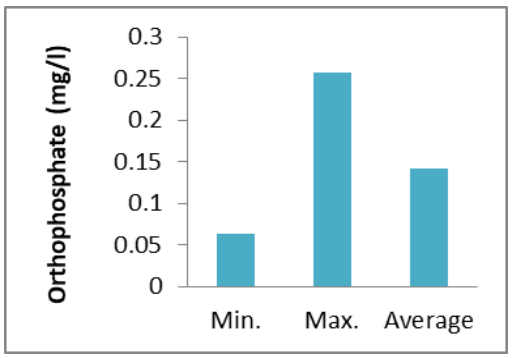

Fig. 15. Variations in orthophosphate

During the present study at site-1, class Chlorophyceae and class Bacillariophyceae were found dominant with 6 species each (table 5, fig. 16).

Bacillariophyceae=Chlorophyceae>Zygnematophyceae>Cyanophyceae>Fragilariophyceae>Xanthophyceae= Chrysophyceae=Compsopogonophyceae=Conjugatophyceae=Hormogonea.

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Table 5: Monthly variation in periphytic forms at site 1 (Shahganj).

Class	Family	Name of Genus	Month		
			Septembe	Octomber	Novembe
Class Zygnematophyceae	Family Zygnemataceae	*Zygnema* sp.	+	+	+
		Spirogyra sp.	+	+	+
	Family Desmidiaceae	*Staurastrum* sp.	+	+	−
	Family Closteriaceae	*Closterium* sp.	+	+	+
Class Chlorophyceae	Family Selenastraceae	*Ankistrodesmus* sp.	+	+	+
	Family Coccomyxaceae	*Nannochloris* sp.	−	+	−
	Family Chaetophoraceae	*Stigeoclonium* sp.	−	+	+
	Family Hydrodictyonaceae	*Hydrodictyon* sp.	+	+	+
	Family Tetrasporaceae	*Tetraspora* sp.	+	+	+
Class Hormogonea	Family Nostocaceae	*Anabaena* sp.	+	+	−
Class Bacillariophyceae	Family Tabellariaceae	*Tabellaria* sp.	−	+	+
	Family Fragilariaceae	*Asterionella* sp.	−	+	+
Class Bacillariophyceae	Family Tabellariaceae	*Tabellaria* sp.	−	+	+
	Family Fragilariaceae	*Asterionella* sp.	−	+	+
	Class Coscinodiscaceae	*Diatoma* sp.	+	+	+
	Family Naviculaceae	*Navicula* sp	−	−	+
	Family Gomphonemataceae	*Gomphonema* sp.	−	−	+
	Family Surirellaceae	*Surirella* sp	−	−	+
Class Xanthophyceae	Family Vaucheriaceae	*Vaucheria* sp.	+	+	−
Class Chrysophyceae	Family Chromulinaceae	*Chromulina* sp.	+	−	−
Class Compsopogonophyceae	Family Compsopogonaceae	*Compsopogon* sp.	+	−	−
Class Trebouxiophyceae	Family Chlorellaceae	*Chlorella* sp.	+	+	+
Class Fragilariophyceae	Family Fragilariaceae	*Synedra* sp.	+	+	+
Class Cyanophyceae	Family Rivulariaceae	*calothrix*	−	+	+
Class Ulvophyceae	Family Ulotrichaceae	*Ulothrix* sp.	−	+	+
Class Chlorophyceae	Family Oedogoniaceae	*Oedogonium* sp.	+	+	+
Class Cyanophyceae	Family Oscillatoriaceae	*Oscillatoria* sp.	+	+	+
	Family Gomphosphaeriaceae	*Gomphosphaeria* sp.	+	+	+

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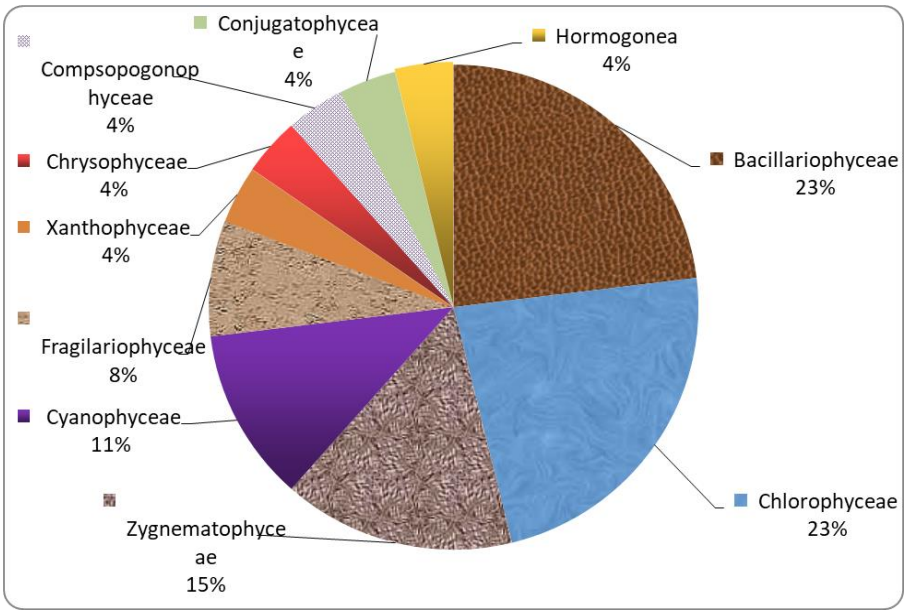

Fig. 16. Class wise percentage of periphyton at site-1

During the present study at site-2, class Chlorophyceae was found dominant with 3 species. Chlorophyceae>Zygnematophyceae=Cyanophyceae>Ulvophyceae=Xanthophyceae=Bacillariophyceae (table 6, fig. 17).

Table 6: Monthly variation of periphytic forms at Site-2 Bandrabandh (1).

Class	**Faimly**	**Name of Genus**	**Month**		
			September	**Octomber**	**November**
Class Chlorophyceae	Family Hydrodictyonaceae	*Hydrodictyon* sp.	+	+	+
	Family Microsporaceae	*Microspora* sp.			
Class Zygnematophyceae	Family Closteriaceae	*Closterium* sp.	+	+	+
Class Ulvophyceae	Family Cladophoraceae	*Rhizoclonium* sp.	+	+	−
Class Xanthophyceae	Family Tribonemataceae	*Tribonema* sp.	+	+	+
Class Bacillariophyceae	Family Tabellariaceae	*Tabellaria* sp.	−	+	+
Class Cyanophyceae	Family Nostocaceae	cylindrospermum sp.	−	−	+

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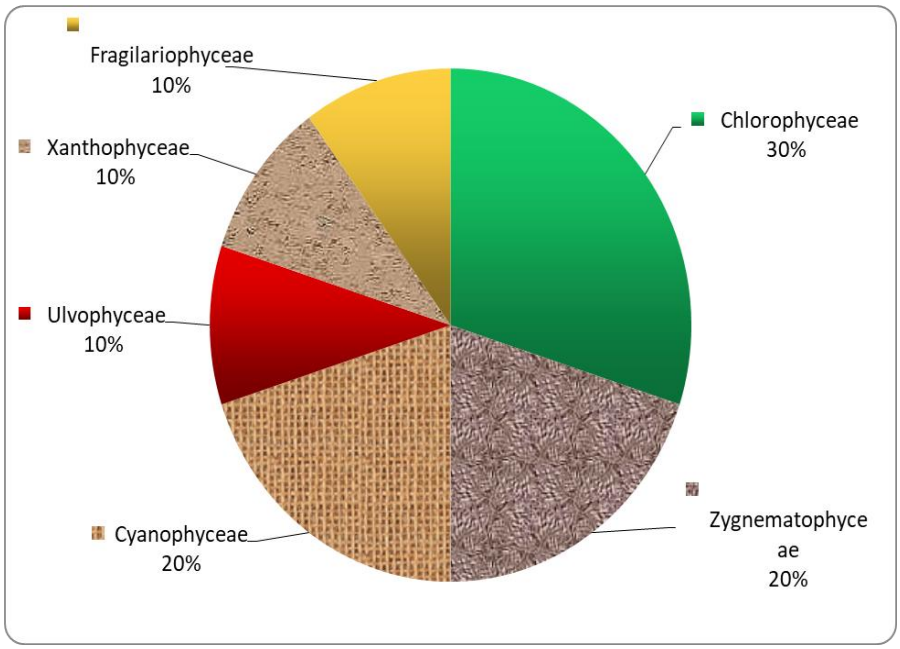

Fig. 17: Class wise percentage of periphyton at site-2.

During the present study at site-3, class Bacillariophyceae was found dominant with 6 species. Bacillariophyceae>Zygnematophyceae>Cyanophyceae>Fragilariophyceae>Xanthophycea (table 7, fig. 18).

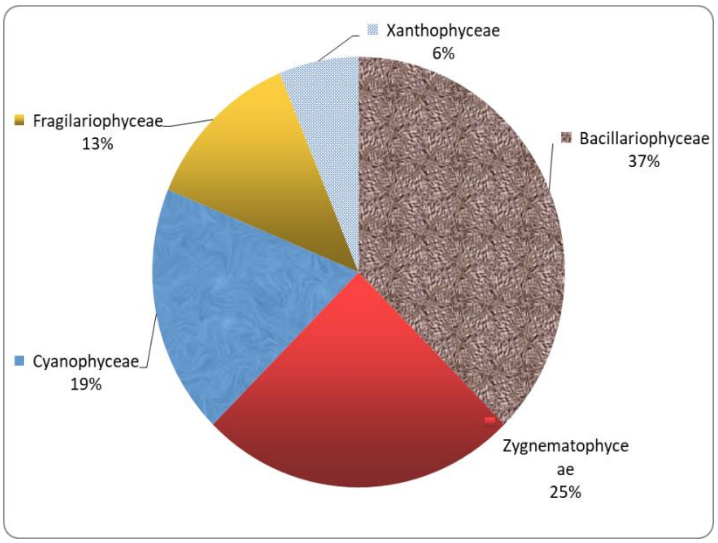

Fig. 18: class wise percentage of periphyton at site-3.

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Table 7. Monthly variation of periphytic forms at site 3 (Sathanighat).

Class	Faimly	Genus	Month		
			September	October	November
Class Zygnematophyceae	FamilyZygnemataceae	*Zygnema* sp.	+	+	+
		Spirogyra sp.	+	+	+
	Family Closteriaceae	*Closterium* sp.	+	+	+
	Family Desmidiaceae	*Staurastrum* sp.	+	+	−
	Family Selenastraceae	*Ankistrodesmus* sp.	+	+	+
Class Cyanophyceae	Family Aphanothecaceae	*Aphanothece sp.*	−	+	−
	Family Spirulinaceae	*Spirulina* sp.	−	+	−
Class Xanthophyceae	Family Tribonemataceae	*Tribonema* sp.	+	+	+
Class Bacillariophyceae	Family Bacillariaceae	*Nitczia* sp.	+	−	−
	Family Naviculaceae	*Navicula* sp	−	−	+
	Family Gomphonemataceae	*Gomphonema* sp.	−	−	+
	Family Surirellaceae	*Surirella* sp	−	−	+
	Family Cymbellaceae	*Cymbella* sp	−	−	+
Class Fragilariophyceae	Family Fragilariaceae	*Synedra* sp.	+	+	+
		Fragilaria sp	−	−	+
Class Conjugatophyceae	Family Zygnemataceae	Mougeotia	−	−	+
Class Chlorophyceae	Family Oedogoniaceae	*Oedogonium* sp.	+	+	+
Class Trebouxiophyceae	Family Chlorellaceae	*Chlorella* sp.	+	+	
Class Ulvophyceae	Family Ulotrichaceae	*Ulothrix* sp.	−	+	+
Class Cyanophyceae	Family Oscillatoriaceae	*Oscillatoria* sp.	+	+	+
Class Bacillariophyceae	Family Stauroneidaceae	*Stauroneis* sp.	−	−	+

During the present study at site-4, class Bacillariophyceae was found dominant with 8 species. Bacillariophyceae>Chlorophyceae>Zygnematophyceae>Cyanophyceae>Trebouxiophyceae=Fragilario phyceae> Xanthophyceae=Florideophyceae (table 8, fig. 19).

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Table 8: Monthly variation in Periphytic forms at site 4 Bandrabandh(2).

Class	Faimly	Name of Genus	Month		
			September	October	November
Class Chlorophyceae	Family Chlorococcaceae	*Chlorococcum* sp.	−	+	−
	Family Oedogoniaceae	*Oedogonium* sp.	+	+	+
	Family Hydrodictyaceae	*Pediastrum* sp.	+	+	−
	Family Palmellaceae	*Sphaerocystis* sp.	+	+	−
	Family Chaetophoraceae	*Stigeoclonium* sp.	−	+	+
CLass Trebouxiophyceae	Family Chlorellaceae	*Chlorella* sp.	+	+	+
	Family Botryococcaceae	*Botryococcus* sp.	+	+	−
Class Cyanophyceae	Family Gomphosphaeriaceae	*Gomphosphaeria* sp.	−	+	+
	Family Oscillatoriaceae	*Oscillatoria sp.*	+	+	+
Class Bacillariophyceae	Family Surirellaceae	*Surirella* sp.	+	+	+
	FamilyFragilariaceae	*Asterionella* sp.	−	+	−
Class Ulvophyceae	Family Ulotrichaceae	*Ulothrix* sp.	+	+	+
	Family Cladophoraceae	*Cladophora* sp.	+	+	−
Class Zygnematophyceae	FamilyZygnemataceae	*Spirogyra* sp.	+	+	+
	Family Desmidiaceae	*Staurastrum* sp.	+	+	−
	Family Closteriaceae	*Closterium* sp.	+	+	+
Class Florideophyceae	Family Acrochaetiaceae	*Audouinella* sp.	+	+	−
Class Fragilariophyceae	Family Fragilariaceae	*Synedra* sp.	+	+	+
Class Bacillariophyceae	Family Naviculaceae	*Navicula* sp	−	−	+
	Family Gomphonemataceae	*Gomphonema* sp.	−	−	+
Class Conjugatophyceae	Family Zygnemataceae	Mougeotia	−	−	+
Class Xanthophyceae	Family Tribonemataceae	*Tribonema* sp.	+	+	+
Class Bacillariophyceae	Family Tabellariaceae	*Tabellaria* sp.	−	+	+
Class Cyanophyceae	Family Phormidiaceae	*Phormidium* sp	−	−	+
	Family Zygnemataceae	*Zygnema* sp.	+	+	+
		Spirogyra sp.	+	+	−

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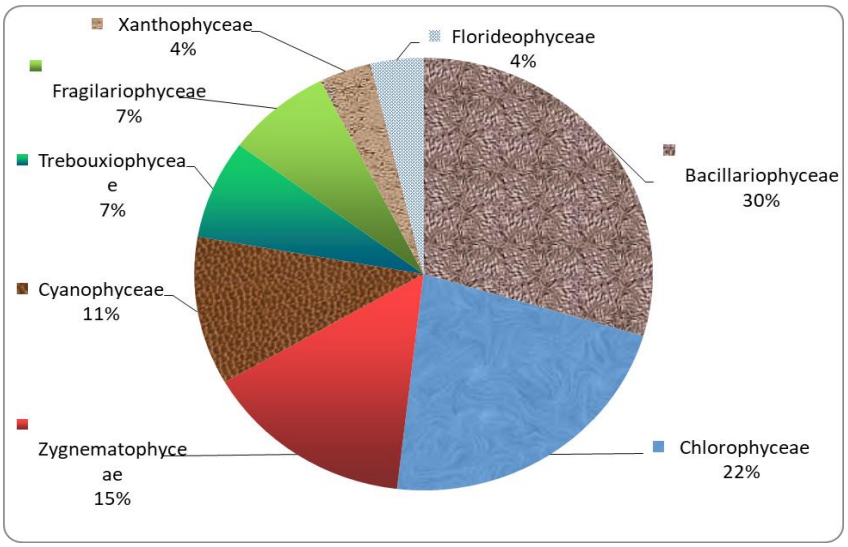

Fig. 19: class wise percentage of periphyton at site-4

4. Conclusion

During the present study a total 45 species of Periphytic forms were recorded from 13 different classes. It was concluded that high species diversity of Periphytic forms were recorded at the site having abundance of macrophytic vegetation.

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