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# BIODIVERSITY OF PERIPHYTIC COMMUNITY IN A FRESH WATERBODY OF ALIGARH

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*Abstract:* **The present investigation on Diggi Pond, located at a distance of about 2 km south-east of the university campus (Lat.27$^0$-54`N long.78-04´ E), was conducted during May, 2007-April, 2008 for studying the biodiversity of periphytic community along with various physico-chemical parameters. During the entire study, periphytic community showed a seasonal distribution. Maximum density of periphyton was found in winter (2253 No. /cm$^2$) on natural substrata and in post-monsoon (1191 No. /cm$^2$) on artificial substrata, whereas minimum periphyton density was observed during post winter (479 No. /cm$^2$) on natural substrata and during post winter (842 No. /cm$^2$) on artificial substrata.**

**Periphytic community on natural substrata was found to be more diversified than that of artificial substrata. During the entire period of the study, five groups of plantperiphyton, namely *Bacillariophyceae (*18 *species*), *Chlorophyceae* (24 *species*), *Myxophyceae* (10 *species*), *Euglenophyceae* (2 *species*) and *Xanthophyceae* (3 species), and four groups of zooperiphyton i.e. *Protozoa* (2 *species) Rotifera (15 species), Cladocera* (4 species) and *Copepoda* (4 *species)* were found to be present on natural substrata. On artificial substrata, three groups of plantperiphyton i.e. *Bacillariophyceae (*17 *species) Chlorophyceae (*13 *species), Myxophyceae* (7 *species*) and two groups of zooperiphyton i.e. *Protozoa (2 species)* and *Rotifera* (5 *species)* were found to be present on all the three types of artificial substrata i.e. wooden block, stone and glass substrata. During the entire study, among total periphyton density, *bacillariophyceae* was the only group which was found as dominant group through out the year.**

*Keywords:* **Periphyton, biodiversity, plantperiphyton and zooperiphyton.**

## I. INTRODUCTION

Periphyton are the microscopic organisms growing on stones, sticks, aquatic macrophytes and other submerged surfaces, and are useful in assessing the effect of pollutants on lakes, streams and estuaries (APHA,1998). According to Wetzel (1983), the term periphyton is usually referred to describe the micro floral growth on the submerged objects Cole (1983) used the term periphyton to describe micro flora attached to submerged objects along with other living forms like bacteria, fungi and animals like vorticella and the branched carchesium (protozoan). Periphytic communities are sensitive to environmental conditions (Besch et al., 1972) and mainly composed of heterogeneous and diverse assemblage of algal forms forming an important food niche in an aquatic ecosystem. Periphyton being a community in itself has its own cycle of abundance having role to play in the trophic structure and function even though some of the members are common to plankton, bottom biota and periphyton (Singh et al., 2003). Because of its almost universal presence in water and the conspicuous quantity often produced, periphyton play an important role in limnological process of a lake or stream

(Welch, 1952). A wide range of fish mainly hill stream fish and benthic invertebrates including snails, chironomids, mayflies, oligochaetes and several groups of crustaceans subsit on periphyton and form their main diet (Jones et al., 1997). Some information on periphyton from Indian waters include works of Mishra and Singh (1968) Krishna Rao (1990), Sukumaran and Karthikeyan (1999), Singh et al. (2003), Jha (1979) and Laal et al.(1982). Besides entrapping organic detritus, periphyton removes nutrients from the water column and helps to control the dissolved oxygen concentration and pH of the surrounding water (Azim et al., 2002; Dodds, 2003; Bender et al., 2004; Rashid and Pandit, 2005; Cattaneo et al., 2012; Kumar et al., 2013; Nelson et al., 2013). Periphyton successional stage is used as a bioindicator of stream health (Jyrkänkallio-Mikkola et al. 2018; Piggott et al. 2015; Pillsbury et al. 2019; Welsh & Ollivier, 1998).

In the present investigations, detailed study of biodiversity of periphytic community in a fresh water body of Aligarh was undertaken to study the species composition, seasonal variations and seasonal succession of such community in relation to physico-chemical parameters during the period between May, 2007-April, 2008. Besides entrapping organic detritus, periphyton removes nutrients from the water column and helps to control the dissolved oxygen concentration and pH of the surrounding water (Azim et al., 2002; Dodds, 2003; Bender et al., 2004; Rashid and Pandit, 2005; Cattaneo et al., 2012; Kumar et al., 2013; Nelson et al., 2013).

The studied Diggi pond is a perennial fresh water sewage fed pond located at a distance of about 2 km south-east of the university campus. (Lat27$^0$-54`N long 78-04´ E). It is a shallow eutrophic waterbody and the usual source of its replenishment is sewage water which is fed through small nullahas present on the four corners of the pond and through surface run-off from the surrounding areas during rainy season. It has a more or less flat basin covering an area of 0.8 hectares. The pond is used as a drainage basin into which drainage water sweeps from the surrounding localities. The water of the pond is turbid with luxuriant growth of microscopic algae sometimes forming blooms on the water surface.

## II. MATERIAL AND METHODS

Samples were collected from the pond fortnightly between 9-10 a.m. from May, 2007 to April, 2008 to workout parameters like air temperature, water temperature, pH, D.O., $CO_2$, alkalinity and periphyton.

Physico-chemical characteristics of the water body were analyzed after following the works of Theroux et al. (1943), Trivedy & Goel (1984) and APHA (1998). In order to analyze the periphytic flora and fauna of the pond, samples were collected from the natural substrates by scrapping submerged stones, sticks and parts of macrophytes.

Artificial substrates of different objects like wood block, stone and glass slide were also suspended in the pond water at a depth of about 50 cm with the help of nylon thread and two iron rods. These artificial substrates include glass slides (7.5x2.5 cm), wooden blocks (7.5x2.5cm) and stones (7.5x2.5 cm). Each substratum was suspended in triplicate so that the average values of periphytic communities attached to particular substratum may give almost a correct quantity and the average of this has been expressed in terms of No. /cm$^2$. The average of the values of periphytic communities in months was taken in each season.

After the completion of incubation period each substratum was taken out and with the help of scalpel and brushes the organisms were detached from the substratum and transferred into plastic viols. All these were fixed in formaldehyde solution and then analyzed under the inverted microscope. Wherever it was possible to identify the organisms up to species level, it was done, otherwise it was taken as single species (sp.) or several species (spp.)

**Calculation:** for the densities of periphytic organisms per unit area of the surface water was made using the following formula:

Periphyton/cm$^2$=Ax V/v x 1/S; where

A=average no. of organisms per ml,

V=volume of scrapings (ml),

v = volume of one drop (ml), and

S=area of scrapping (in cm$^2$)

## III. RESULTS AND DISCUSSION

The physico-chemical and biological parameters showed a wide range of seasonal fluctuations. The fluctuations in most of the parameters led to the fluctuation in the periphyton density in space and time. Variation in the physico -chemical parameters also affected the density of periphyton on different substrates with different intensity. High values of Dissolved Oxygen (4.7-15.7 mg/L), pH (8.3-9.1), Carbonates (153-250mg/L), Bicarbonates (240-387mg/L) and Hardness (95-195 mg/L (Table-1) of the pond were found to be associated with the higher density of periphyton.

Statistical analysis was also carried out to find out the periphyton relationship with temperature, transparency and dissolved oxygen. Periphyton both on natural and artificial substrata showed significant positive correlation with water temperature. Transparency was negatively correlated with periphyton both on natural and artificial substrata.

Dissolved oxygen showed positive correlation with periphyton on natural substrata whereas negative correlation with periphyton on artificial substrata. This may be due to impact of several environmental factors interacting & influencing collectively both quality & quantity of periphyton. Many other environmental factors such as disturbance, resources, environmental conditions and grazing pressure collectively interact and influence both distribution and species composition of periphyton. Due to this complex regulation, the relative importance and contribution that each factor may exert in shaping the periphytic community is difficult to evaluate and quantify. (Lowe, 1996)

The complexity between water chemistry and periphytic algae makes it difficult to draw explicit conclusions on the relationship. However the result presented here indicates that within the investigated nutrient range eutrophication has a great effect on the temporal and spatial distribution of periphyton.

Seasonal distribution of periphyton showed a peak in winter (2253 No. /$cm^2$, Table-2) on natural substrates and in post monsoon (1191 No. /$cm^2$**,** Table- 3**)** on artificial substrates. The minimum periphyton density was observed during post winter (479 No. /$cm^2$, table-**2)** on natural substrates and on artificial substrates it was observed during post winter (842 No. /$cm^2$, Table-3). Several studies have, however, reported periphytic assemblages throughout winter (Meulemans, 1988; Burkholder& Wetzel, 1989; Gustina & Hoffmann, 2000) but few have explored dynamics and relative changes in these winter communities (Carpenter & Kitchell, 1987).

Natural substrates showed more periphyton diversity than that of artificial substrates. During the entire period of study, five groups of algae namely Bacillariophyceae, *Chlorophyceae, Myxophyceae, Euglenophyceae and Xanthophyceae* and four groups of zooperiphyton i.e. *Protozoa, Rotifer, Cladocera,* and *Copepod* were found to be present on natural substrates. On artificial substrates three groups of algae i.e.*Bacillariophyceae, Chlorophyceae, Myxophyceae* and two groups of zooperiphyton i.e. *Protozoa and Rotifer* were found to be present on all the three types of artificial substrates i.e. wooden block, stone substrate and glass substrate. The maximum no. of periphyton were found to dominate on the surface of stones and wooden blocks as compared to the glass substratum.

Among all the groups of plantperiphyton, observed on both natural and artificial substrates, dominant group was Bacillariophyceae. In winter, post winter and post monsoon, periphyton is often dominated by diatoms, whereas a greater abundance of green algae and cyanobacteria is typically found in post monsoon month. Bacillariophyceae, on natural substrates, contributed about 27.85%-71.91% (Fig.1) and, on artificial substrates, its contribution was about 28.18%-63.38%.(Fig.4,5,and 6) In accordance to the seasonal patterns of phytoplankton most studies reported dominance of diatoms in winter, spring and autumn and a greater abundance of periphytic green algae and cyanobacteria during summer. (Gons, 1982; Cattaneo, 1987; Burkholder& Wetzel, 1989; King et al., 2002). A sudden dramatic decline in the periphyton biomass sometimes occurs for thick and old communities because the algal mat deteriorates and sloughs from the substrates. (Liboriussen, 2003). Experimental studies have shown that low- growing and tightly-adhering diatom taxa are much more resistant to sloughing than taller-growing filamentous green algae (Peterson & Stevenson, 1992). Periphyton standing crop typically decreases with increased grazing pressure (Feminella, 1995). The same is observed in the present study. As the grazing pressure of grazers, like Cladocera, Copepoda, and Rotifera, increases, the diatoms density decreases. Increased grazing rates can not be rejected as being partly responsible for the decline of periphyton density. In artificial substrates data, the wooden block substratum showed a highest contribution of Bacillariophyceae (41.02%-62.93%)( Fig.4) of the total periphyton whereas on the stone substratum Bacillariophyceae contributed about 40.83%-63.38%(Fig.5). The minimum contribution of this group was found on glass substratum (28.18%-61.58%)(Fig.6).

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During the entire period of the study, the minimum contribution of zooperiphyton was on both natural and artificial substrates. Among zooperiphyton, the dominant group was Rotifera, followed by Protozoa, Cladocera and Copepoda on natural substrates and on artificial substrates; Rotifera and Protozoa, both were found to be in equal density

**Table 1: VARIATION IN THE AVERAGE VALUES OF PHYSICO-CHEMICAL PARAMETERS IN DIFFERENT SEASONS IN DIGGI POND**

| PARAMETERS | WINTER | POST WINTER (SPRING) | SUMMER | MONSOON | POST MONSOON (AUTUMN) |
|---|---|---|---|---|---|
| PH | 9.05 | 8.3 | 9.2 | 9.03 | 8.9 |
| Temperature of water °C | 17.5 | 21.0 | 27.0 | 33.66 | 27.3 |
| Temperature of air °C | 18.0 | 24.5 | 27.0 | 36.33 | 25.8 |
| Transparency (cm) | 21.0 | 20.75 | 21.0 | 16.08 | 19.5 |
| Dissolved oxygen (mg/L) | 8.4 | 15.7 | 15.6 | 4.73 | 11.33 |
| Free $CO_2$ (mg/L) | __ | __ | __ | __ | _ |
| $OH^-$ Alkalinity (mg/L) | __ | _ | __ | __ | __ |
| $CO_3^-$ (mg/L) | 228.0 | 250.0 | 195 | 153.3 | 181.3 |
| $HCO_3^-$ (mg/L) | 387.0 | 305.0 | 320 | 240.0 | 290.3 |
| Total Alkalinity (mg/L) | 615.0 | 555.0 | 515 | 393.3 | 471.6 |

**Table 2a: VARIATIONS IN THE AVERAGE VALUES OF PLANT PERIPHYTON (No/cm$^2$) ON NATURAL SUBSTRATA IN DIGGI POND**

| GROUP | WINTER | POST WINTER | SUMMER | MONSOON | POST MONSOON |
|---|---|---|---|---|---|
| ***Bacillariophyceae*** | | | | | |
| Achnanthes lanceolata | 21 | _ | 5 | 21 | 11 |
| Amphora sp. | 69 | 11 | 16 | 21 | 32 |
| Asterionella formasa | 16 | _ | _ | 48 | 11 |
| Cyclotella sp. | 27 | 21 | 5 | 75 | 32 |
| Cymbella sp. | 53 | 16 | _ | 85 | 27 |
| Closteriopsis longissisma | 27 | _ | _ | 32 | _ |
| Cocconeis placentula | 21 | 5 | 11 | 37 | 11 |
| Diatoma sp. | 832 | 75 | 101 | 155 | 283 |
| Eunotia sp. | 21 | 11 | 27 | 53 | 21 |
| Frustulia sp. | 32 | 21 | 5 | 27 | 27 |
| Fragilaria sp. | 27 | 27 | _ | 16 | 27 |
| Gomphonema sp. | 53 | 5 | _ | 21 | 11 |
| Pinnularia sp. | 53 | 5 | 11 | 48 | 48 |
| Navicula spp. | 181 | 107 | 80 | 139 | 203 |
| Nitzschia spp. | 32 | 5 | 48 | 37 | 16 |
| Stauroneis sp. | 32 | 5 | _ | 43 | 16 |
| Synedra spp. | 80 | 16 | 11 | 107 | 48 |
| Tabellaria sp. | 43 | _ | _ | 27 | 21 |
| **No./cm$^2$** | **1620** | **330** | **320** | **992** | **845** |
| ***Chlorophyceae*** | | | | | |
| Actinastrum sp. | – | – | 5 | – | 5 |
| Ankistrodesmus sp. | 21 | – | 21 | 16 | 16 |
| Chlorella sp. | 11 | 5 | – | 16 | – |
| Coelastrum sphaericum | 16 | – | – | – | 32 |
| Cosmarium sp. | 5 | – | – | – | – |
| Closterium sp. | 32 | 11 | 5 | 21 | 27 |
| Crucigenia colony | 16 | – | 5 | 37 | – |
| Hormidium subtile | 16 | – | 37 | 37 | – |

| | | | | | |
|---|---|---|---|---|---|
| Kircheneriella sp. | 11 | – | 5 | – | – |
| Microspora sp. | 11 | 16 | 16 | 16 | 21 |
| Oedogonium sp. | 16 | 11 | – | 11 | 5 |
| Pediastrum sp. | 48 | – | – | 91 | 37 |
| Pedinomonas minor | – | – | 11 | 11 | – |
| Palmella sp. | – | 5 | – | 5 | – |
| Protococcus colony | 21 | 11 | 16 | 32 | 43 |
| Scendesmus sp. | 11 | 5 | 5 | – | 16 |
| Selanastrum sp. | 11 | – | – | 16 | 16 |
| Spirogyra sp. | – | – | – | 37 | – |
| Sphaeroplea annulina | – | – | 5 | 11 | – |
| Tetraspora sp. | 11 | 5 | – | 11 | 21 |
| Chlorococcum humicola | – | 5 | – | 11 | – |
| Ulothrix zonata | 11 | – | 11 | 32 | 11 |
| Volvox sp. | – | – | 5 | 5 | 11 |
| Zygnema sp. | – | 5 | – | 11 | – |
| **No./cm$^2$** | **268** | **79** | **147** | **427** | **261** |
| ***Myxophyceae*** | | | | | |
| Microcystis sp. | 43 | 37 | – | 53 | 59 |
| Anabaena sp. | 11 | – | – | – | – |
| Aphanocapsa sp. | - | – | – | – | – |
| Closteridium lunula | 16 | 11 | – | – | 37 |
| Agmenellum sp. | – | 5 | 5 | – | 11 |
| Nostoc sp. | 5 | – | – | 16 | – |
| Oscillatoria sp. | 16 | 16 | – | 11 | – |
| Rivularia sp. | 11 | 16 | 11 | 5 | 27 |
| Spirulina sp. | – | 5 | – | 21 | 53 |
| Tetrapedia sp. | – | 5 | – | 11 | |
| **No./ cm$^2$** | **102** | **95** | **16** | **117** | **187** |
| ***Euglenophyceae*** | | | | | |
| Euglena sp. | – | – | 11 | – | 21 |
| Phacus sp. | 27 | 37 | 53 | 106 | 37 |
| **No./ cm$^2$** | **27** | **37** | **64** | **106** | **58** |
| ***Xanthophyceae*** | | | | | |
| Chrysocapsa planctonica | 11 | 5 | 5 | 21 | 11 |
| Ophiocytium sp. | 16 | 16 | 5 | 165 | 37 |
| Uroglena sp. | – | – | – | 16 | 11 |
| **No. /cm$^2$** | **27** | **21** | **10** | **202** | **59** |

**Table 2b.: VARIATIONS IN THE AVERAGE VALUES OF ZOOPERIPHYTON (No. /cm$^2$) ON NATURAL SUBSTRATA IN DIGGI POND**

| GROUP | WINTER | POST WINTER | SUMMER | MONSOON | POST MONSOON |
|---|---|---|---|---|---|
| ***Protozoa*** | | | | | |
| Centrophyxis aculeata | – | – | 16 | 16 | – |
| Paramecium sp. | – | – | 16 | – | – |
| **No./cm$^2$** | **–** | **–** | **32** | **16** | **–** |
| ***Rotifera*** | | | | | |
| Ascomorpha sp. | – | 16 | 11 | 32 | – |
| Asplanchna priodonta | – | 27 | 16 | 21 | 16 |
| Asplanchnopus hyalinus | – | 11 | 11 | 11 | – |
| Brachionus spp. | – | 75 | 101 | 32 | 5 |
| Colurella adriatica | – | – | 21 | – | – |
| Epiphanes brachionus | – | – | 27 | – | – |

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| | | | | | |
|---|---|---|---|---|---|
| Lecane spp. | – | – | 59 | 37 | 11 |
| Lapedella spp. | – | – | 21 | – | – |
| Keratella spp. | – | 21 | 32 | 27 | – |
| Fillinia spp. | – | – | 69 | 37 | – |
| Monostyla sp. | – | – | 48 | 27 | 5 |
| Notholca sp. | – | – | 21 | – | – |
| Philodina sp. | – | – | 27 | – | – |
| Testudinella sp. | – | – | 21 | – | – |
| Trichocerca cylindrica | – | – | 16 | – | – |
| **No./cm$^2$** | **–** | **150** | **501** | **224** | **37** |
| ***Cladocera*** | | | | | |
| Bosmina sp. | – | 16 | – | – | – |
| Daphnia spp. | 11 | 27 | 11 | 16 | – |
| Moina spp. | 11 | – | – | – | – |
| Canthcamptus | – | – | – | – | – |
| **No./ cm$^2$** | **22** | **43** | **11** | **16** | **–** |
| ***Copepoda*** | | | | | |
| Eudiaptomus sp. | 53 | – | 5 | – | 11 |
| Cyclops spp. | 27 | 11 | – | – | – |
| Diaptomus spp. | 80 | – | 16 | 16 | 11 |
| Naupli larvae and eggs | 27 | 43 | 27 | 27 | 21 |
| **No./cm$^2$** | **187** | **54** | **48** | **43** | **43** |

**Table 3a: VARIATIONS IN THE AVERAGE VALUES OF PLANT PERIPHYTON (No. /cm$^2$) ON ARTIFICIAL SUBSTRATA IN DIGGI POND**

| **GROUP** | **WINTER** | | | **POST WINTER** | | | **SUMMER** | | | **MONSOON** | | | **POST MONSOON** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Bacillariophyceae*** | **W*** | **S*** | **G*** | **W** | **S** | **G** | **W** | **S** | **G** | **W** | **S** | **G** | **W** | **S** | **G** |
| Achnanthes lanceolata | 11 | 5 | – | – | 21 | 11 | 5 | 21 | – | – | 21 | 11 | 11 | 5 | – |
| Amphora sp. | 16 | – | 11 | 21 | 16 | – | 11 | 5 | – | 16 | 5 | – | 21 | 11 | – |
| Asterionella | 5 | 32 | – | – | – | 5 | 5 | 32 | 5 | 11 | 27 | 5 | – | 32 | 21 |
| Cyclotella sp. | – | 21 | – | 11 | 5 | 5 | 5 | 11 | – | 5 | 37 | 5 | 21 | 11 | 11 |
| Cymbella sp. | – | 11 | 5 | – | 16 | – | 16 | 43 | – | 16 | 11 | – | – | 5 | 5 |
| Cocconeis plancentula | – | – | 5 | 5 | 11 | 5 | 11 | 11 | – | – | 5 | 16 | – | 32 | 11 |
| Diatoma spp. | 27 | 43 | – | 21 | 64 | 11 | 5 | 21 | 32 | 16 | 75 | 48 | 32 | 85 | 53 |
| Eunotia sp. | – | 11 | – | 5 | – | – | 16 | 5 | – | 5 | 5 | – | – | 11 | – |
| Fragilaria sp. | – | 16 | – | 5 | 5 | – | 11 | – | – | – | 16 | 21 | – | 21 | – |
| Frustulia sp. | – | 5 | – | 11 | 5 | – | 5 | – | – | 16 | 5 | 11 | 16 | 32 | 11 |
| Gomphonema sp. | – | 16 | 5 | 5 | – | – | 11 | 21 | 5 | 5 | – | 5 | – | 5 | 27 |
| Navicula sp. | 37 | 21 | 5 | 27 | 21 | 32 | 11 | 5 | – | 27 | 53 | 43 | 32 | 16 | 21 |
| Nitzschia sp. | – | – | – | 5 | 11 | – | 5 | 11 | – | 16 | – | 11 | – | 11 | 5 |
| Stauroneis sp. | – | 5 | – | 5 | – | – | 11 | 27 | 5 | – | – | 5 | 5 | 5 | – |
| Synedra sp. | – | 11 | – | – | 5 | – | 5 | 5 | – | 16 | 27 | – | 11 | 5 | 11 |
| Tabellaria sp. | – | 5 | – | – | 5 | 5 | 11 | 11 | 5 | 5 | – | – | 27 | – | 21 |
| Pinnularia sp. | – | 11 | – | 5 | 5 | 5 | 16 | 37 | 5 | 5 | 16 | 5 | 16 | 11 | 11 |
| **m$^2$** | **96** | **213** | **31** | **126** | **190** | **79** | **160** | **266** | **57** | **159** | **303** | **186** | **192** | **298** | **208** |

*Note:

**W**=wooden block substratum

**S**=stone substratum

**G**=glass substratum

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**Continued**

| GROUP | WINTER | | | POST WINTER | | | SUMMER | | | MONSOON | | | POST MONSOON | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Chlorophyceae** | **W** | **S** | **G** | **W** | **S** | **G** | **W** | **S** | **G** | **W** | **S** | **G** | **W** | **S** | **G** |
| Ankistrodesmus sp. | 5 | 16 | 5 | – | 11 | – | 11 | 21 | – | – | 5 | 11 | 16 | 11 | 5 |
| Chlorella sp. | 5 | – | 11 | – | – | – | 11 | 5 | 5 | 16 | 11 | – | 48 | – | 5 |
| Coelastrum sphaericum | – | 32 | – | 5 | 5 | – | 5 | 27 | 5 | – | 5 | 16 | 11 | 32 | 5 |
| Cosmarium sp. | – | 21 | – | 5 | 16 | – | 11 | 16 | 11 | 27 | 11 | 5 | – | 5 | 11 |
| Closterium | – | 37 | 16 | 5 | 5 | – | 5 | – | – | 16 | – | – | – | 21 | 11 |
| Oedogonium sp. | 5 | – | – | – | – | 11 | – | – | 5 | 27 | 11 | 5 | – | 16 | 5 |
| Pediastrum sp. | 11 | 27 | 5 | – | – | 16 | 5 | 11 | 16 | – | 5 | – | – | 5 | 5 |
| Scendesmus sp. | – | 48 | – | – | 32 | 11 | 11 | 5 | 5 | – | 21 | 5 | – | – | 5 |
| Selanastrum sp. | – | 5 | 16 | 5 | 21 | 5 | 11 | 16 | 11 | – | – | 11 | – | 27 | 5 |
| Tetraspora sp. | – | 11 | – | 5 | 11 | 5 | 11 | 27 | – | 11 | 5 | 5 | – | 11 | 5 |
| Ulothrix Zonata | – | 27 | 5 | 11 | 11 | – | 5 | 11 | – | 16 | 11 | 5 | 11 | 11 | – |
| Volvox sp. | – | 27 | – | 5 | 16 | 5 | – | 5 | – | 5 | 5 | 5 | – | 11 | – |
| Zygnema sp. | – | 5 | – | 5 | 5 | 16 | 5 | 27 | 11 | – | 5 | – | – | 5 | 11 |
| **No./cm2** | **26** | **234** | **58** | **46** | **133** | **69** | **91** | **171** | **69** | **118** | **95** | **68** | **86** | **155** | **73** |
| **Myxophyceae** | | | | | | | | | | | | | | | |
| Anabaena sp. | 5 | 21 | – | – | 5 | – | 16 | 11 | – | – | 5 | – | – | 21 | 11 |
| Microcystis sp. | 21 | 16 | 5 | 21 | 5 | 16 | 27 | 10 | – | 16 | 11 | 10 | 5 | 10 | – |
| Agmenellum sp. | – | 5 | – | 11 | 11 | 5 | – | 11 | 5 | 5 | – | 5 | – | 11 | – |
| Oscillatoria sp. | – | 11 | – | 5 | 27 | 5 | – | – | 16 | – | 16 | 5 | 11 | 16 | 5 |
| Rivularia sp. | 11 | 16 | – | 21 | – | – | – | – | 5 | – | 11 | – | – | 5 | – |
| Spirulina sp. | 21 | 5 | 11 | 11 | – | 16 | 5 | 5 | 5 | 5 | 11 | 5 | – | 11 | 5 |
| Nostoc sp. | 11 | – | 5 | 5 | 5 | – | 21 | 11 | 5 | 5 | 5 | – | – | 5 | 5 |
| **No./cm2** | **69** | **74** | **21** | **74** | **53** | **31** | **69** | **48** | **36** | **31** | **59** | **25** | **16** | **79** | **26** |

**Table 3b VARIATIONS IN THE AVERAGE VALUES OF ZOOPERIPHYTON (No. /cm$^2$) ON ATIFICIALSUBSRATA IN DIGGI POND**

| GROUP | WINTER | | | POST WINTER | | | SUMMER | | | MONSOON | | | POST MONSOON | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Protozoa*** | W | S | G | W | S | G | W | S | G | W | S | G | W | S | G |
| Centrophyxis aculeata | 16 | – | – | 5 | – | – | – | 11 | – | – | 5 | – | – | – | 5 |
| Paramecium sp. | – | 5 | – | – | – | – | – | – | – | 5 | – | – | – | – | – |
| **No./cm$^2$** | **16** | **5** | **–** | **5** | **–** | **–** | **–** | **11** | **–** | **5** | **5** | **–** | **–** | **–** | **5** |
| ***Rotifera*** | | | | | | | | | | | | | | | |
| Epiphanes sp. | – | – | – | – | – | 5 | 5 | – | – | 5 | – | – | – | – | 5 |
| Colurella sp. | – | – | – | – | 5 | 5 | 11 | – | 5 | – | – | 5 | 11 | – | – |
| Brachionus sp. | – | – | – | – | 16 | – | 27 | 5 | – | – | 5 | – | – | 5 | 16 |
| Lecane sp. | – | – | – | – | 5 | – | 16 | 5 | – | 5 | 11 | 11 | – | 5 | 11 |
| Rotaria | – | – | – | – | – | – | 11 | – | – | – | – | 5 | 5 | – | – |
| **No./cm$^2$** | **–** | **–** | **–** | **–** | **26** | **10** | **70** | **10** | **5** | **10** | **16** | **21** | **16** | **10** | **32** |

**Table 4: BIODIVERSITY INDEX BOTH IN NATURAL AND ARTIFICIAL SUBSTRATA PERIPHYTON POPULATION**

| Biodiversity Index | For Natural Substrates | For Artificial Substances |
|---|---|---|
| Species richness (S) | 0.9198 | 0619 |
| Species diversity or Shannon-Wiener Index of diversity (H) | 1.53917 | 1.1620 |
| Species evenness (E) | 0.3492 | 0.3070 |
| Simpson’s Index of diversity (D) | 0.8205 | 0.740 |

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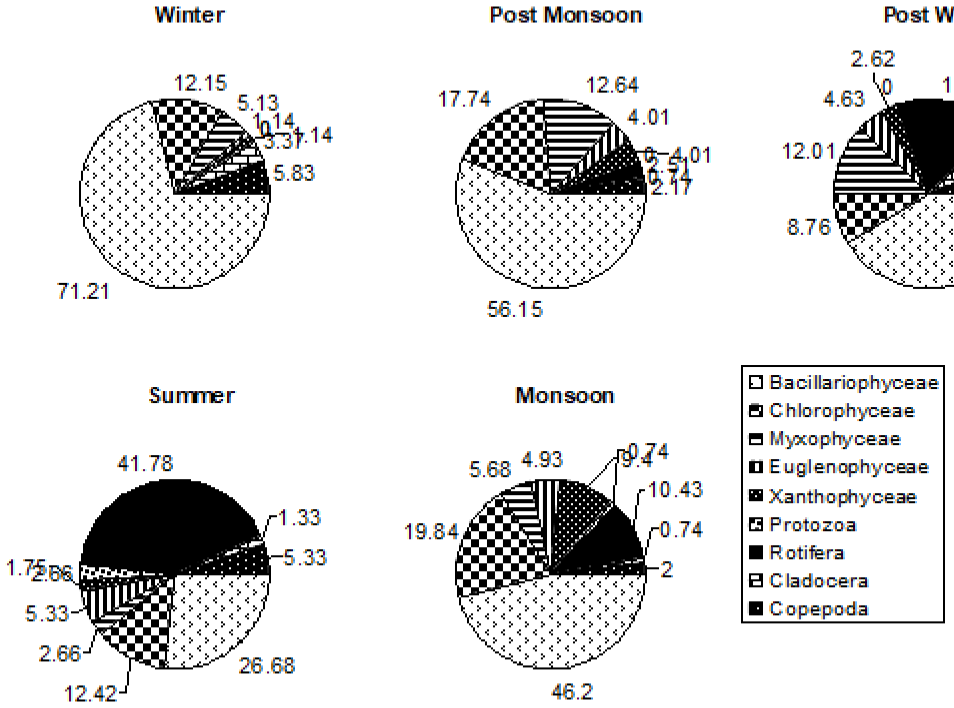


**Figure 1: % COMPOSITION OF DIFFERENT GROUPS IN TOTAL PERIPHYTON ON NATURAL SUBSTRATA IN DIFFERENT SEASONS IN DIGGI POND**

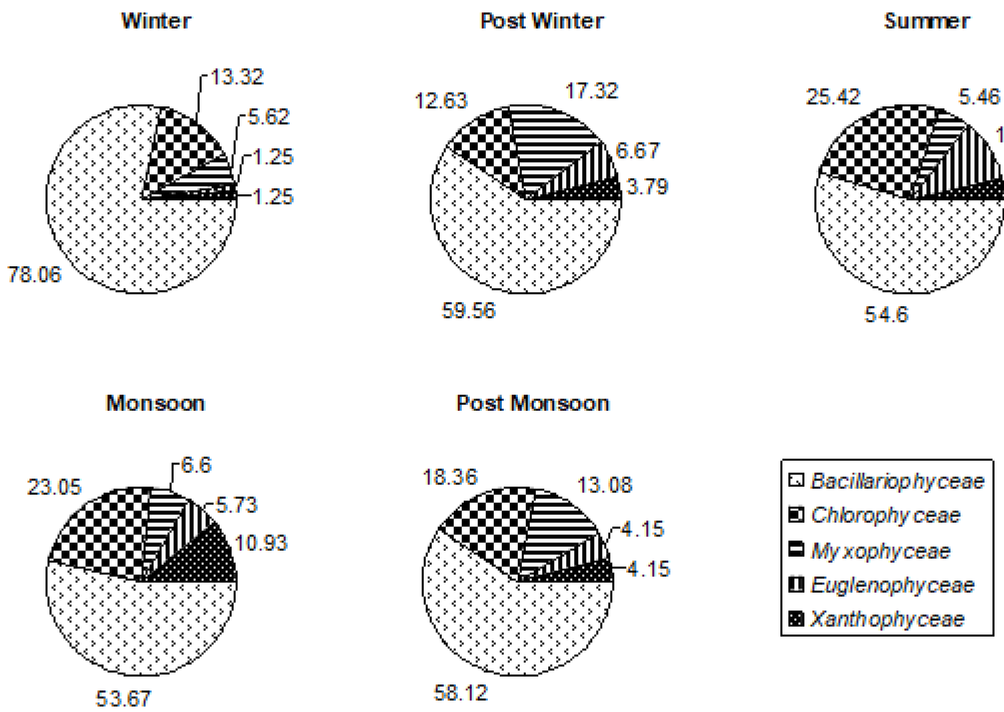


**Figure 2: % COMPOSITION OF DIFFERENT GROUPS IN TOTAL PLANT PERIPHYTON ON NATURAL SUBSTRATA IN DIFFERENT SEASONS IN DIGGI POND**

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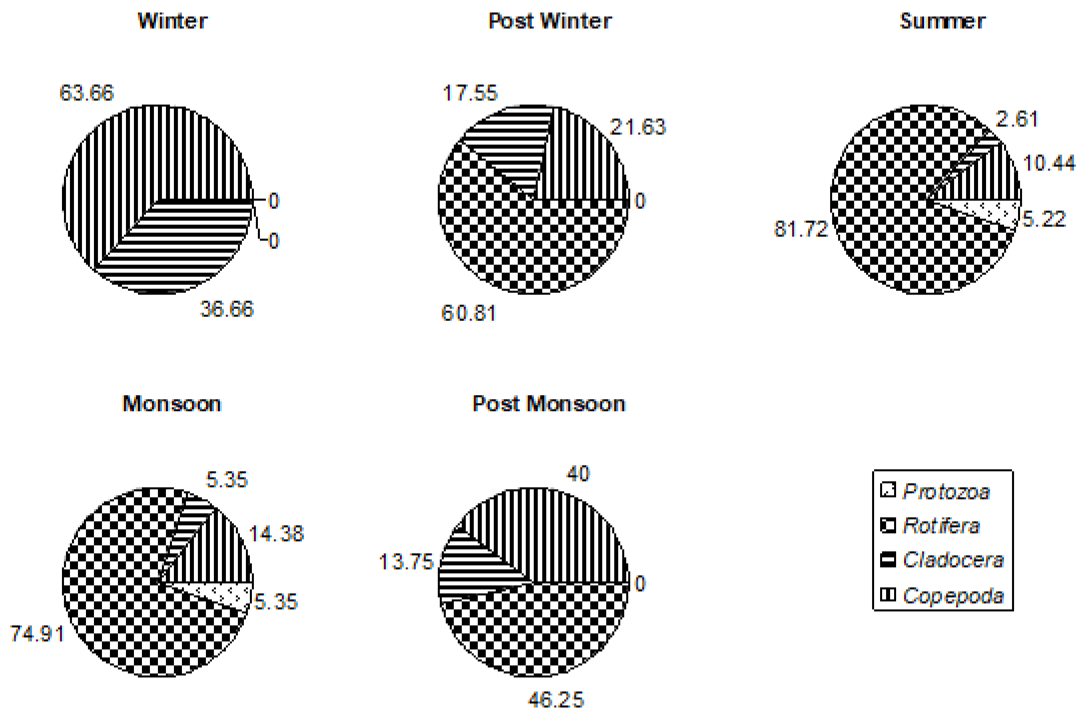


**Figure 3: % COMPOSITION OF DIFFERENT GROUPS IN TOTAL ZOOPERIPHYTON ON NATURAL SUBSTRATA IN DIFFERENT SEASONS IN DIGGI POND**

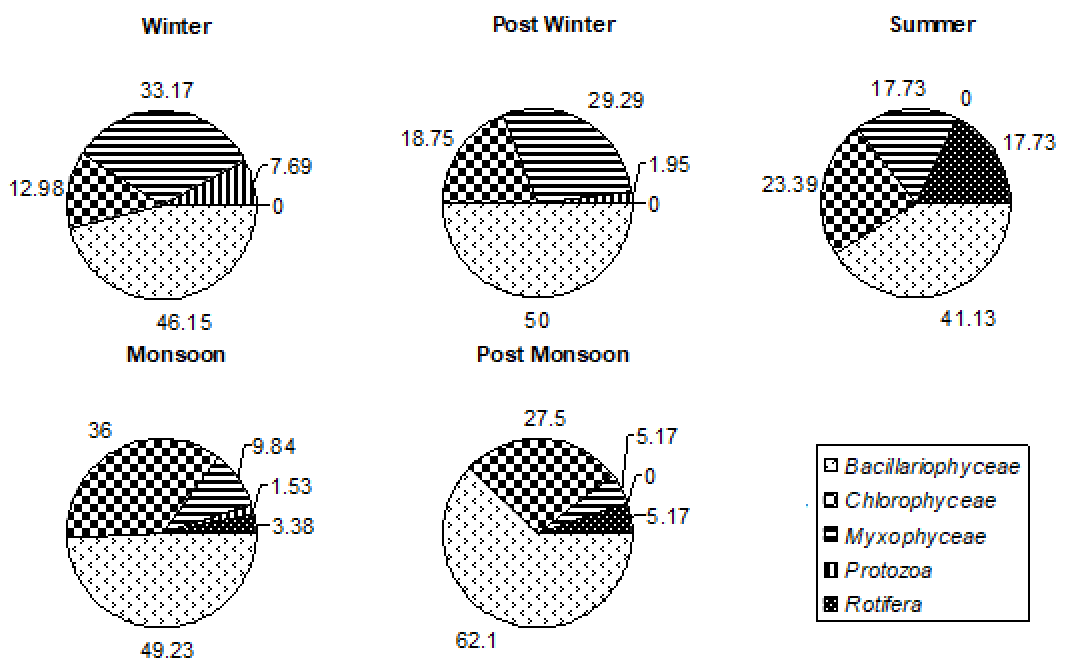


**Figure 4: % COMPOSITION OF DIFFERENT GROUPS IN TOTAL PERIPHYTON ON WOODEN BLOCK SUBSTRATUM IN DIFFERENT SEASONS IN DIGGI POND**

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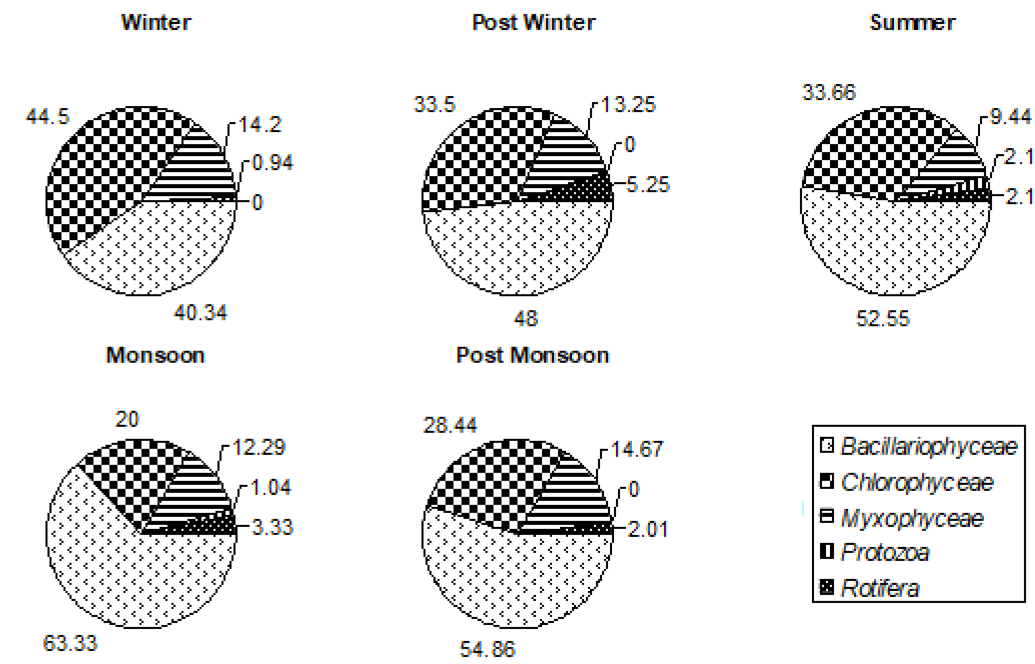


**Figure 5: % COMPOSITION OF DIFFERENT GROUPS IN TOTAL PERIPHYTON ON STONE BLOCK SUBSTRATUM IN DIFFERENT SEASONS IN DIGG POND**

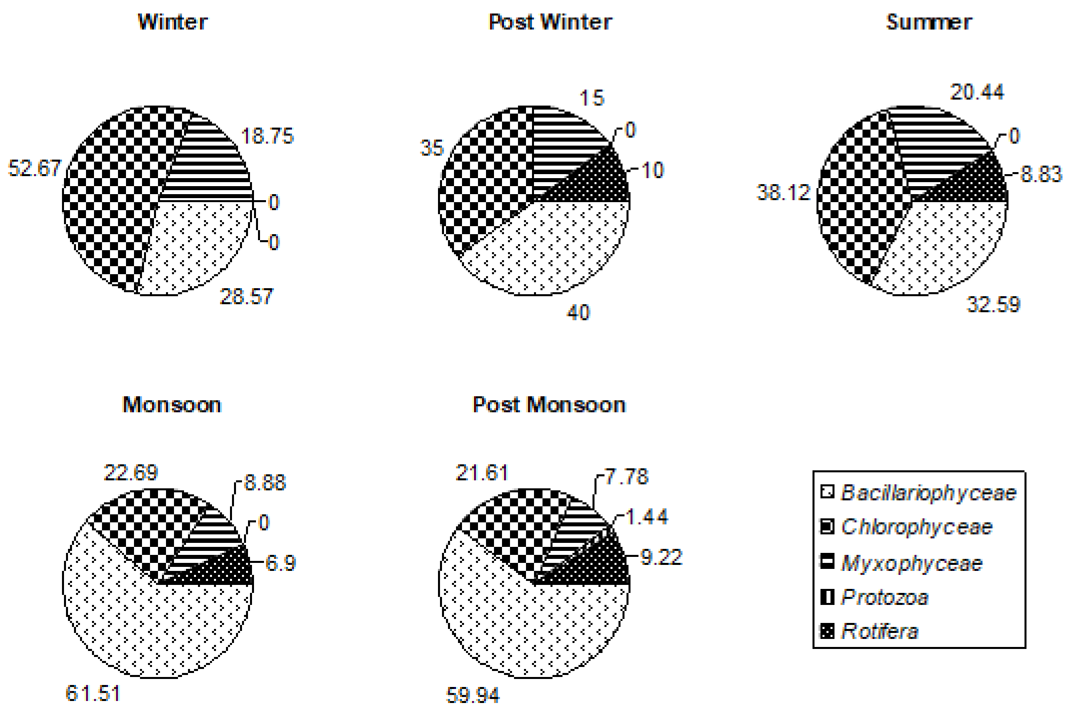


**Figure 6: % COMPOSITION OF DIFFERENT GROUPS IN TOTAL PERIPHYTON ON GLASS SUBSTRATUM IN DIFFERENT SEASONS IN DIGG POND**

## IV. CONCLUSION

Present findings conclude that seasonal variation in physico-chemical factors directly influenced the density, species richness and diversity of periphyton in this studied fresh waterbody besides providing the essential information regarding the species composition, abundance and distribution, such studies will help in finding the indicators and their association in a community as a whole.

Lastly, it can be concluded that periphyton communities are important structural and productive components of freshwater ecosystems. Although the research on periphyton has been intensified over the past decades, there is still an essential need for more information within several areas.

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