'Study On Distribution Of Epibionts In Leaves From Freshwater Ecosystem From February 1–15, 2020'

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Abstract- Freshwater ecosystems are a subset of the Earth's aquatic ecosystems. They include lakes, ponds, rivers, streams, springs, bogs, and wetlands. Freshwater ecosystems provide a comfortable habitat for many organisms. The present study entitled 'STUDY ON DISTRIBUTION OF EPIBIONTS IN LEAVES FROM FRESHWATER ECOSYSTEM FROM FEBRUARY 1–15, 2020' was conducted to identify epibionts. We collected samples from a pond in Kodumon, which is a village in Adoor Taluk of Pathanamthitta district in the state of Kerala, India. A pond ecosystem refers to a freshwater ecosystem where there are communities of organisms dependent on each other within the prevailing water environment for their nutrients and survival. Samples were collected by scraping a 1 cm patch of moist film from leaves that were collected from the surface of the pond and preserved into a sterile 15 ml collecting bottle containing 5 ml of 3% formalin. A total of 10 samples were prepared from the pond from each collection. Similarly, a total of two collections were done for the study of epibionts from February 1 to 15 (15 days). Scraping was done by a soft brush and samples were preserved for further counting and identification of organisms. The physiochemical parameters of the water were also measured for the study. Simpson's diversity indices and Sorenson's similarity index were used to explain the species diversity in the pond.

From the collection, 16 genera were identified and recorded. They include Ciliates, Rhizopoda, Rotifers, Bacillariophyceae, Cyanophyceae, and others such as Nematodes, Copepods. The result of the study concluded that the second collection showed greater species diversity than the first collection. Their occurrence and abundance were not uniform and showed a fluctuating tendency during the period of collection in the whole study area. This is because of the interaction between the organisms and also the changes effected by the physiochemical parameters of the water.

Index Terms- Epibionts,freshwater,leaves,rotifers.

I. INTRODUCTION

Water is one of the essential substances on Earth. All plants and animals must have water to survive. If there were no water, there would be no life on Earth. Water can be broadly separated into saltwater and freshwater. Saltwater constitutes 97% of all water on Earth and is found mostly in oceans and seas. Any naturally occurring water except seawater and brackish water is freshwater. Freshwater is vital to life, and yet it is a finite resource. Of all the water on Earth, just 3% is freshwater. Freshwater is found in glaciers, lakes, reservoirs, ponds, rivers, streams, wetlands, and even as groundwater.

1.1 Freshwater ecosystem

Freshwater ecosystems are a subset of the Earth's aquatic ecosystems. They include lakes, ponds, rivers, streams, springs, bogs, and wetlands. They can be contrasted with marine ecosystems, which have a larger salt content. Freshwater habitats can be classified by different factors, including temperature, light penetration, nutrients, and vegetation. Freshwater ecosystems can be divided into lentic ecosystems (still water) and lotic ecosystems (flowing water). Limnology is the study of freshwater ecosystems. It is a part of hydrobiology. Many microorganisms are found naturally in freshwater. These include Bacteria, Cyanobacteria, Protozoa, Algae, and tiny animals such as Rotifers. These organisms can be important in the food chain that forms the basis of life in water. Photosynthetic algae and Bacteria use light as energy to thrive in this zone.

A pond is a body of freshwater smaller than a lake. Ponds are naturally formed by a depression in the ground, filling and retaining water. Ponds are usually landlocked and have no outflow. Because of this, they are considered to be self-contained ecosystems. These ecosystems are often teeming with rich vegetation and diverse organismal life. Ponds can be very different from one another, depending on their location and climate.

Temperatures can vary from moderately warm in the summer to completely freezing during the winter. Usually, ponds have a pH of approximately 7 but can be as low as 6 or as high as 10 depending on many factors. Large populations of algae and other aquatic plants can change a pond's pH depending on the time of day. These organisms can take up more dissolved carbon dioxide through photosynthesis during the day and emit carbon dioxide during the night through respiration. Higher amounts of carbon dioxide help to maintain pH at around 7 by dissociating into bicarbonate ions. With a large organic demand for carbon dioxide, the bicarbonate ion concentration and thus buffering capacity of the pond can be significantly reduced, and the risk of a rapid pH change can be increased.

Ponds are considered small, shallow standing water bodies. They may be permanent or temporary. Thermal stratification is absent in ponds. Light penetration is possible up to a certain depth, depending on the turbidity. Temperature varies seasonally and as per depth. The oxygen content of lentic systems is less than the lotic ecosystem. The lower water may be deficient in oxygen due to Zooplankton composition. The physiochemical and zooplankton analysis of the Shendurni river, Kerala, was studied (Sahib, 2004). The DO level was observed to be highly saturated, and a direct correlation between DO level and zooplankton population was found.

The seasonal trends in biotic factors in Govindgarh lake in Rewa, Madhya Pradesh (Aswathi and Tiwari, 2004), was studied, and an inverse relationship was observed between dissolved oxygen and temperature. The lake was perennial and alkaline in nature. The parameters were found to show marked seasonal variation, including transparency, pH, DO, free carbon dioxide, alkalinity, etc. The study revealed that Govindgarh lake was polluted. The impact of urbanization on Balladur lake, Bangalore, was studied by Chandrashekar et al. (2003). The research showed higher values of BOD, COD, alkalinity, and low levels of DO, indicating the polluted nature of lake.

In the study of seasonal fluctuation of zooplankton community in relation to physiochemical parameters in Ramjan river of Kisangani, Bihar (Pandey et al., 2004), it was observed that pH, DO, transparency, and copepods showed a negative correlation with pH and transparency. This indicated that several abiotic factors exert a considerable effect on zooplankton influence.

It may also contain domestic sewage and industrial wastes (Abba and Arya, 1997). Ponds are very common to Kerala and are widely used as a source of drinking and for domestic use. The components of the pond ecosystem are very diverse. However, it can be divided into several basic units: (1) Abiotic subunits, which includes non-living components like oxygen, nitrogen, carbon dioxide, phosphorous, magnesium, calcium, amino acids, humic acid, etc. The rate of release of these nutrients in a pond depends on other physical factors like pH, sunlight penetration, temperature, photoperiod climate factor, etc. (2) Biotic compounds include producers, consumers (primary, secondary, tertiary), decomposers, etc. Some physical tests should be performed for testing its temperature, color, odor, pH, turbidity, and total dissolved solids. And chemical tests should be performed for determining its BOD, COD, DO, alkalinity, hardness, and other characters.

The term 'epibiont' (from the ancient Greek meaning 'living on top of') includes organisms that, during the sessile phase of their life cycle, are attached to the surface of a living substratum (Threlkeld et al., 1993). An epibiont is, by definition, harmless to its host, and in this sense, the interaction between the two organisms can be considered naturalistic or commensalism. The organism on which the epibiont settled was referred to as a basibiont, which provides the attachment surface and is generally larger than the epibiont (Gregorio Femandez, 2009). This phenomenon is very common in the aquatic ecosystem, where very few hard substrates were available for sessile organisms (Wahl, 1989; Gill et al., 1993). Epibionts are beneficial for epibiont protozoa, which can be transported to the area where maximum food is present and least competition with their hosts (Evans et al., 1979), and the area where oxygenated sites are maximum (Smith, 1986). Although there is no direct effect of the epibiont to the host, there are often indirect effects resulting from this interaction and change in the surface of the host. This is especially important to marine and aquatic organisms as surface qualities impact necessary ecological functions such as drug, radiation, absorption, nutrient uptake, etc. Examples of common epibionts are Protista and Algae, many of which live on the surfaces of larger marine organisms such as whales, shark, turtles, molluscs and mangrove trees. Epibionts were fixed on moving substrates that avoid predation by Zooplankton (Henebry and Ridgeway, 1979). Kudo (1996) stated that the dislocation of the host increases the growth of epibionts due to the increased flow of water containing food items and have proper physiochemical conditions. Wahl (1989) opined that more intense water flow with more excellent nutritional supply also enhances the dispersion of epibionts. Lynn and small (2006) reported that several species of protozoa belonging to the groups of flagellates, suctorians, ciliates, etc., colonized and lived on several metazoan species, including cnidarians, rotifers, annelid worm, and crustacean. Most of the ciliate protozoans are not harmful to their host. In higher density, they can interfere in the mobility of the host, or cause stress, which makes the host more susceptible to contaminants.

1.2 Water Quality Analysis

Water is a universal solvent. Water is essential for plant growth and plays a vital role in the living system. Nearly three-fourths of the Earth's surface is covered by water. Water is a precious resource for human beings—March 22 is celebrated as the world water day. Water resources are of critical importance to both the natural ecosystem and human development. It is essential for agriculture, industry, and human existence. A healthy aquatic ecosystem is dependent on the physiochemical and biological characteristics. The quality of water in any ecosystem provides significant information about the available resources for supporting life in that ecosystem. Due to the increased human population, industrialization, use of fertilizers in agriculture, and man-made activities, the natural aquatic resources are facing heavy and varied pollution leading to poor water quality and depletion of aquatic biota. It is, therefore, necessary that the quality of drinking water should be checked at regular time intervals. Due to use of contaminated drinking water, the human population suffers from a variety of water-borne diseases. The physiochemical characters of the freshwater affect the life of the freshwater microorganisms.

II.METHODOLOGY

Kodumon is a village in Adoor Taluk of Pathanamthitta district in the state of Kerala, India. Pond ecosystem refers to the freshwater ecosystem where there are communities of organisms that depend on each other and with the prevailing water environment for their nutrients and survival.

2.1 Collection Method

Samples were collected by scraping a 1 cm patch of moist film from the leaves collected from the surface of the pond and preserved in a sterile 15 ml collecting bottle containing 5 ml of 3% formalin. A total of 10 samples were prepared from the pond from each collection. Two collections were done for the study of epibionts from February 1 to 15 (15 days). Scraping was done by a soft brush and samples were preserved for further counting and identification of organisms.

2.2 Laboratory Analysis

Identification of organisms was done by examination under light field microscope and followed systemic scheme. Photographs were taken for further study. The enumeration of these organisms was made by taking a 1 ml sample from the preserved bottle to a Sedgwick cavity chamber for the study of population density. This direct enumeration can be employed as much as possible for the sedentary organisms; more precise information can be obtained with less effort.

2.3 Statistical Analysis

Statistical analysis was employed to understand the diversity indices of epibionts such as the Simpson's diversity index and the Sorenson's similarity index.

(a)

(b)

Figure 1:(a) Pond where the study was conducted and (b) Sample collection from leaves taken from the surface of pond water.

III. Observations and Results

3.1 Species Composition

A total of 16 genera of epibionts were identified from the study period. They include rhizopoda, diatoms, ciliates, rotifers, algae, copepod, and nematodes. Of these Rotifers, Protozoans and Diatoms were the most abundant groups. Nematodes are the free-living organisms found on all substrata. Among these samples, two rhizopoda, six rotifers, one alga, three diatoms, four ciliate, and one copepod were identified and recorded (Table 1 and Table 2). Rotifers, Protozoans and Diatoms were the most abundant groups found during the study period.

Rhizopod
Two genera of Rhizopods were identified: Arcella and Centropyxis.

Bacillariophyceae (Diatoms)
Three Diatoms were identified: Pinnularia, Pennate, and Coscinodiscus.

Ciliates
Four Ciliates were identified: Lacrymaria, Vorticella, Euplotes, and Colpoda.

Rotifer
Six Rotifers were identified: Platyias, Monommata, Argonotholca, Cephalodella,
Adineta, and Lepadella.

Others
Some free-living organisms also recorded, which included Nematodes and Copepods.

3.2 Population Density

Out of a total of 16 genera of epibionts, the maximum density of organisms by diatoms. Of these, the highest density recorded was that of Pennate (263 no/cm2). From both collections, the least abundant organism was Coscinodiscus (168 no/cm2). In the present study, only a few Rhizopoda were observed (138 no/cm2).

3.3 Percentage Composition

The percentage composition of different groups of epibionts is given separately from two collections. The percentage composition of each group in the sample can be calculated by the following formula.

$$Percentage\ composition = \frac{Number\ of\ organisms\ in\ the\ group}{Total\ number\ of\ organisms\ in\ the\ sample} \times 100$$

First Collection
During the first collection, Protozoans (44.10%) dominated over diatom (24.55%), rotifer (21.08%), among others.

Second Collection
The percentage composition of second-fortnight collection recorded higher abundance than the first. Here diatoms were the most abundant group. Diatoms showed 49% abundance. In the present study, Pennate was the most abundant species within diatom.

Table 1: Population density (no/cm2) of epibiont on leaves from the February 1, 2020, collection.

Name of Organisms	SAMPLES					
Class/Genus	1	2	3	4	5	Total
Rhizopoda						
Centropyxis	18	14	16	11	18	77
Ciliates						
Lacrymaria	30	31	28	20	30	139
Vorticella	15	10	16	-	8	49
Euplotes	10	12	14	17	-	53
Total	55	53	58	37	38	241
Bacillariophyceae						
Pinnularia	20	22	14	10	18	84
Pennate	22	18	14	17	22	93
Total	42	40	28	27	40	177
Rotifers						
Platyias	14	8	7	5	-	34
Monommata	12	6	-	8	7	33
Argonotholca	15	-	10	8	10	43
Cephalodella	8	8	-	14	12	42
Total	49	22	17	35	29	152
Cyanophyceae						
Cosmarium	4	-	-	3	4	11
Others						
Nematodes	12	10	13	18	10	63
Grand Total	180	139	132	131	139	721

Table 2: Population density (no/cm2) of epibiont on leaves from the February 15, 2020, collection.

Name of Organisms	SAMPLES					
Class/Genus	1	2	3	4	5	Total
Rhizopoda						
Centropyxis	14	10	2	8	4	38
Arcella	8	4	5	-	6	23
Total	22	14	7	8	10	61
Ciliates						
Colpoda	8	6	8	9	10	41
Lacrymaria	20	21	18	10	20	89
Vorticella	5	8	10	-	6	29
Euplotes	5	6	8	10	8	37
Total	38	41	44	29	44	196
Bacillariophyceae						
Pinnularia	30	35	32	45	32	174
Coscinodiscus	40	31	28	37	32	168
Pennate	30	38	42	28	32	170
Total	100	104	102	110	96	512
Rotifers						
Platyias	4	7	6	5	6	28
Monommata	8	6	-	4	6	24
Argonotholca	7	-	8	7	6	28
Cephalodella	8	7	-	6	8	29
Adineta	8	8	-	4	3	23
Lepadella	8	7	9	8	7	39
Total	43	35	23	34	36	171
Cyanophyceae						
Cosmarium	10	7	8	6	12	43
Others						
Copepods	4	-	4	5	2	15
Nematodes	11	10	13	14	10	58
Total	14	10	17	19	12	73
Grand Total	228	211	201	206	210	1056

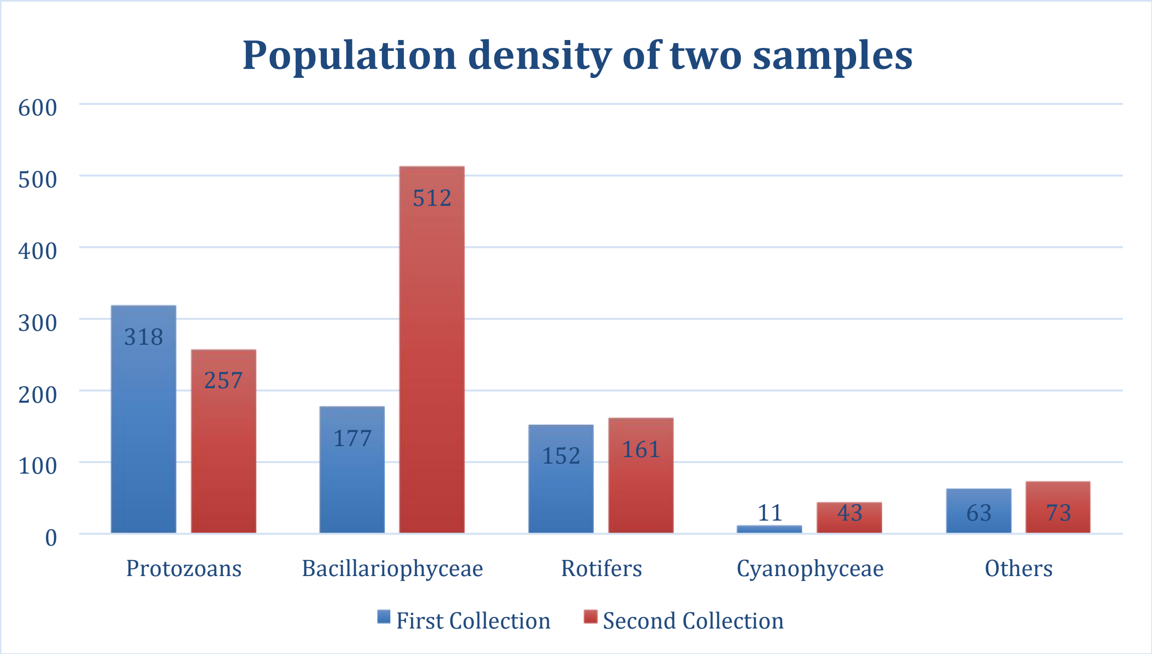
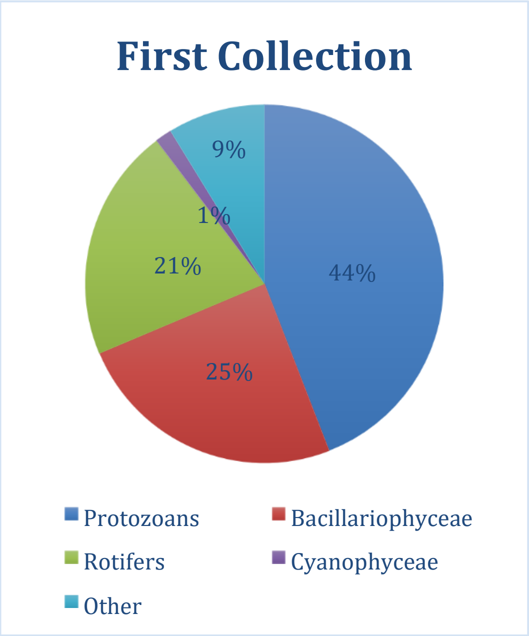


Figure 2: Population density (no/cm2) of epibionts on leaves from the first collection and second collection



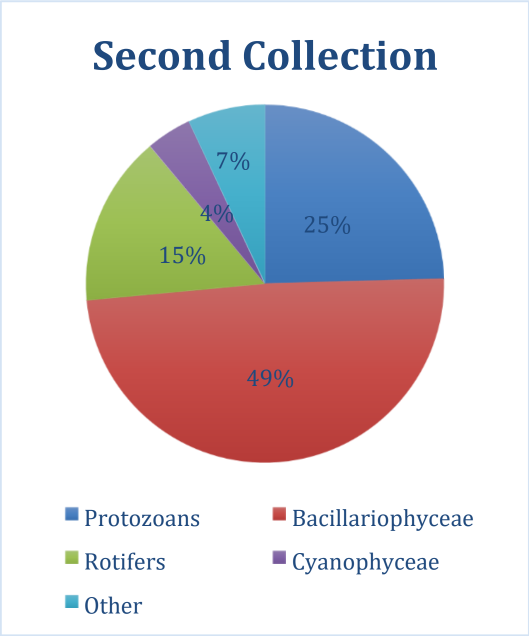


Figure 3: Percentage composition (no/cm2) of leaf epibionts on leaves from the first collection and second collection

3.4 Water Quality Analysis.

The water samples were collected during the study period in the early morning from two fortnight collections to analyze the pH, temperature, dissolved oxygen and dissolved carbon dioxide.

Table 3: Water quality parameters of collected samples from Kodumon freshwater ecosystem

Water samples	Temperature (0C)	pH	Dissolved Oxygen (mg/L)	Dissolved CO2 (mg/L)
Sample no:1	28	6	6.8	8.8
Sample no:2	27	6.2	6.5	9.8

3.4.1 Temperature

The temperature in the sites ranged from 27°C to 29°C during the study period.

3.4.2 pH

The pH was slightly acidic during collection. It ranged from 6.0 in the first collection to 6.2 in the second collection.

3.4.3 Dissolved oxygen

From the first collection, the amount of dissolved oxygen concentration was noted as 6.8 mg/L and from the second collection it was 6.5 mg/L.

3.4.4 Dissolved carbon dioxide

The maximum amount of dissolved carbon dioxide concentration found from the first collection was 8.8 mg/L and it was 10 mg/L from the second collection.

3.5Species Diversity Index

The Simpson's diversity index value for the samples obtained from two fortnight collections was 0.8972. The Simpson's diversity index ranged from 0 to 1, where a higher value indicates higher diversity. Here the value obtained from the study area was near to 1 (0.8972). It suggests that the study area possesses a higher diversity of epibionts and shows some dominant individuals coming under specific groups such as Protozoan and Diatom.

$$D = 1 - \left(\frac{\sum n(n-1)}{N(N-1)} \right)$$

n = the total number of organisms of a particular species

N = the total number of organisms of all species

The value of D ranges between 0 and 1, where 1 represents infinite diversity and 0 no diversity
Sorenson's similarity index explains to us that the two collections from the selected study area have 81% similarity. This higher value of similarity may be because the study area possesses more number of related individuals, particularly in protozoans and diatoms.

Sorenson's similarity index =

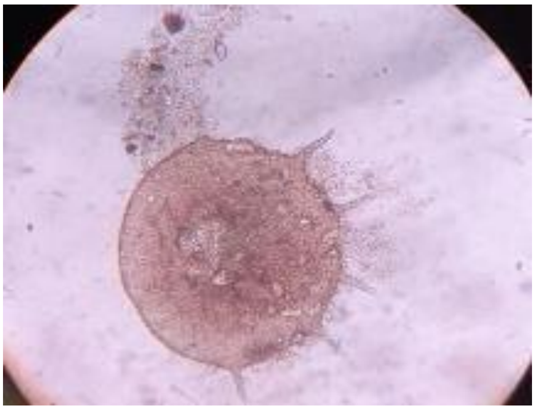
$$CC = \frac{2C}{(S1+S2)} = \frac{2\times 11}{(16+11)} = \frac{22}{27} = 0.8148$$

Where 'C'= No. of species from two collections have in common
S1= Total no. of species from first collection

S2= Total no. of species from second collection

3.6Epibionts identified from the freshwater ecosystem

➢RHIZOPODA

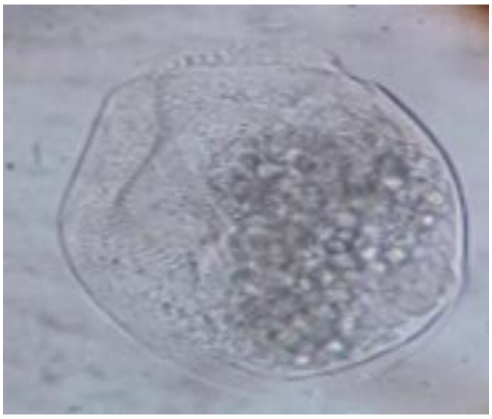


Centrophxis

Arcella

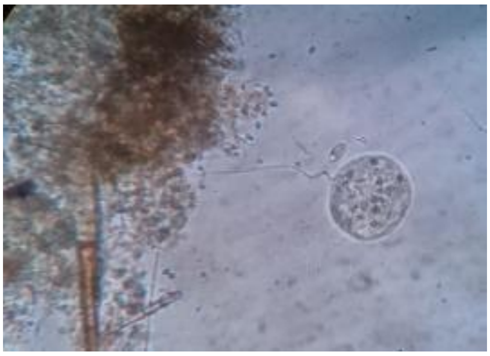
➢CILIATES

Colpoda



Euplotes

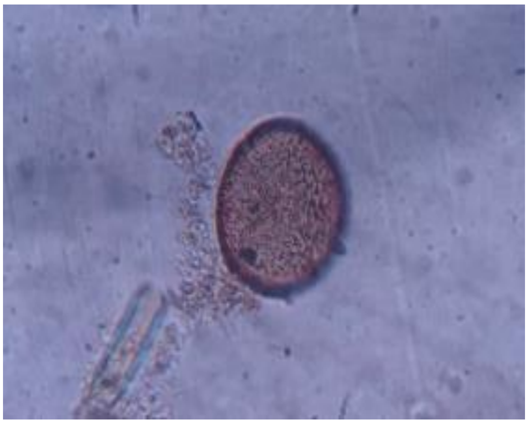
Lacrymaria



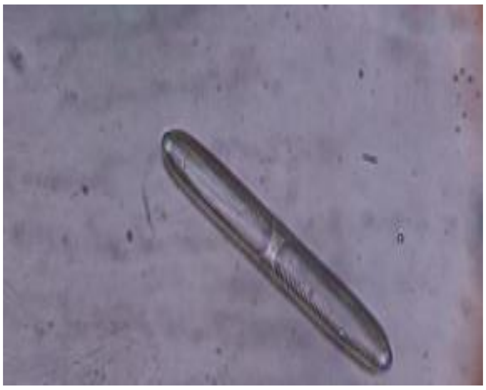
Vorticella

➢DIATOM

Pinnularia



Coscinodiscus

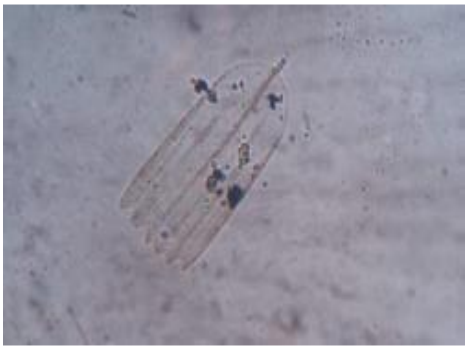


Pennate

➢ROTIFER

Platyias

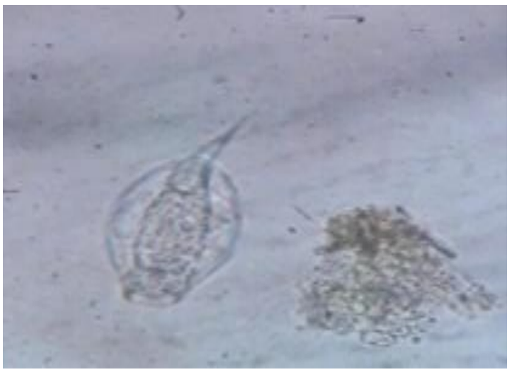
Monommata



Argonotholca

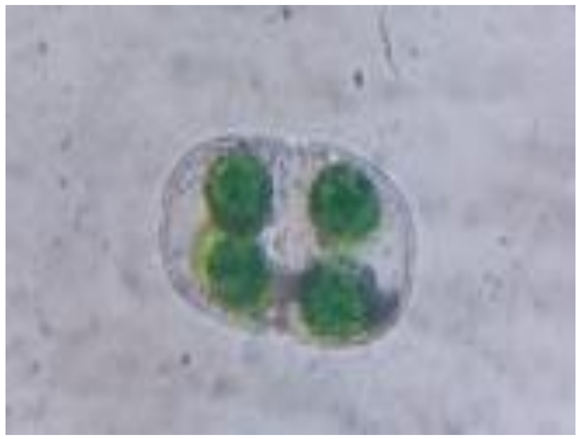
Cephalodella

Adineta



Lepadella

➢CYANOPHYCEAE



Cosmarium

IV. DISCUSSION AND CONCLUSION

A total of 16 genera of epibionts were reported in this study. In general, Protozoans and Diatoms were the most abundant forms from the first and second collections, respectively, followed by Rotifers, Rhizopoda, Cyanophyceae, and others such as nematodes, copepods, etc. Altogether 16 species of epibionts were identified from the pond. Six individuals belonged to the Protozoan group, six individuals were recorded under Rotifers, three individuals belonged to the group Bacillariophyceae, and one individual belonged to Cyanophyceae and nematodes, copepods were also identified. A total of 11 individuals were identified from the first collection: Protozoans (4), Rotifers (4), Bacillariophyceae (2), Cyanophyceae (1), nematodes, and copepods. A total of 16 individuals were identified from the second collection: Protozoans (6), Rotifers (6), Bacillariophyceae (3), Cyanophyceae (1), nematodes, and copepods.

Protozoans (Ciliates, Rhizopoda) are one of the main groups recorded in the present study. Azam et al. (1983) emphasized that Protozoans are essential elements of the tropical food web in an aquatic ecosystem. In other studies, Lance and Hersha (2007), Tarbe et al. (2011), and Jack and Gilbert (1997) also gave emphasis to the importance of ciliates in fresh and marine water food webs. They consume bacteria, pico and nano photosynthetic plankton, diatoms, dinoflagellates and are eaten by animals such as zooplanktons like rotifers, copepods, and some larval fish. The food-capturing efficiency of ciliates depends upon the substrate and the increased flow of water creates a feeding current (Johnson et al., 2004; Shimeta et al., 2001). Some pelagic ciliates specialize in feeding large food particles such as diatoms (Beers, 1933). Purushothaman et al. (2017) studied the feeding habits of Ciliophora. They are essential food sources for Rotifers and Copepods that feed on ciliates.

The occurrence and colonization of epibionts showed marked variation during the period of collection, from day 1 to day 15. This is because of the interaction between the organisms. In the case of ciliates, four genera were recorded; these included Colpoda, Euplotes, Lacrymaria, and Vorticella. Out of these, Lacrymaria was found to be the most diverse.

Ciliated Protozoans are present in most water bodies (Pinheiro et al., 2007). Ciliates are the most successful heterotropic Protozoan group that respond very quickly to changing and extreme environmental conditions (Roberts et al., 2004). They are also used as bioindicators in rivers, lakes, and wastewater (Ajeagah and Menbohan, 2012), and to enrich oxygen in sewage water (Spoon, 1965 and Fischer, 1997).

Among Ciliates, Lacrymaria, Colpoda, and Euplotes showed maximum abundance. Vorticella is found in both fresh and marine water, and it is commonly attached by a highly contractile stalk to some submerged objects. They are also found in large groups and are independent of each other. The detached individuals swim freely by means of cilia (Robert Barnes, 1980; Ekambaranatha Ayyar, 1985).

In the second collection, Diatoms were the most prominent form. Diatoms are cosmopolitan and ubiquitous in distribution, occurring commonly in all types of freshwater, seawater, or brackish water and on or within the soil (Bilgrami, 1992). They also occur as epibionts on other algae and plants, epiphytic on substrates such as rocks, or any aquatic plant (Taylor, 2006).

Diatoms form a major part of the planktonic vegetation. Some colonial diatoms secrete a mucilage stalks that are attached to their substrate. Various studies revealed that the variation in the number and density of the diatom population might be due to the various physiochemical and biological factors. In the present study, the diversity of Diatom reported in the first collection was lower than in the second collection. Diatoms associated with any substrates are attractive food for many organisms. Diatom was reported as an indicator species of pollution by Kollwitz and Marson (1908) who pioneered this aspect of Diatom study. Moris (1968) and Chapman (1973) placed all diatoms under one single division, Bacillariophyta, having only one class Bacillariophyceae, which was found in the present study.

Three Diatoms were identified, which included Pinnularia, Pennate, and Coscinodiscus. During the first collection, Diatom was less in number because of the presence of a huge number of rotifers. Rotifers feed on Diatoms. But in the second collection, diatoms became diversified and increased in number. During the second collection, the number of diatoms increased, and the number of Protozoans and rotifers reduced. It shows the remarkable interaction between the organisms in the freshwater ecosystem.

In the present study, the density of rotifers was high in the first collection and low in the second collection. The density of Diatoms was reduced when Rotifers showed high density. They are mostly free-living organisms and found to be attached to all substrates. They comprise an integral link in the aquatic food chain and can act as valuable bioindicators to detect the level of water quality (Sharma, 1991; Molly Varghese, 2006). Regarding the occurrence and the distribution of rotifers, they can withstand desiccation from extreme climate, act as bioindicators (Arora, 1966 and Molly Varghese, 2006), and can feed on bacteria, ciliates, Vorticella, diatoms, and other small Protozoans (Sharma, 2010). In this study, the Rotifers, namely Platiyas, Monommata, Argonotholca, Cephalodella, Adineta, and Lepadella were identified and recorded. Also Argonotholca showed high density.

Only one species of algae was identified in the study. Cosmarium could be identified from both the collections, but comparatively it showed a higher density in the second collection.

In the present study, occurrence of meiobenthic forms like Nematodes and Copepods was also found. They act as predators of micro epibionts. Mostly they are free-living and occur in all substrates found in both fresh and marine water (Sébastien, 2003). Copepods have often been considered as detritus feeders. They feed on Bacteria, Protozoans, and Diatom cells (Olav Giere, 2009). Ray et al. (1992) reported that the meiobenthic forms like Nematodes, Copepods exhibit direct predator interaction with epibiont organisms like Protozoa. Larger Copepods is effective in causing significant mortalities of smaller epibionts species (Muaugh, 1981; Lehman and Branstrator, 1991).

The result of the study emphasizes that natural substratum provides a comfortable habitat for the growth of the epibionts. However, the small epibionts face predation from large epibionts like Zooplankton and also from juvenile or adult fish, resulting in scarcity of some species (Zaret, 1980; Jack and Thorpe, 2002).

In general, the present study revealed that the epibiont colonization occurred in natural substratum being composed of Ciliates, Rhizopoda, Diatoms, Algae, Rotifers, Nematodes, and Copepods. The Protozoans dominated the first collection and the Diatoms dominated the second collection. Interactions in the form of predation among the recorded epibiont groups have been reported earlier by several researchers (Beers, 1933; Brown and Austin, 1973, Admiral et al., 1984; Admiraal and Loes de Jong, 1984). In the present study, the meiobenthic forms like Nematodes and Copepods show interspecific interactions with the dominant epibiont community that constitutes Ciliates, Diatoms and Rotifers. This influences the distribution of epibionts in the present study.

Diversity index is a tool used to understand community structure and species richness. It is also used to characterize the species abundance relationship in a community. The species diversity indices revealed that the second collection has high species diversity. In this study, the Simpson’s diversity index and Sorenson's similarity index were taken to explain the species diversity of epibionts in pond ecosystem. The second collection showed maximum number of species. A similar study conducted by Barbour et al. (1999) revealed that an ecosystem which has greater H + value than 2 can be considered to have average to maximum diversity based on the number of species. Increasing diversity correlates with increasing health of the assemblage and suggests that niche space, habitat, and food source are adequate to support survival and propagation of many species. The mathematical expressions to measure the diversity and similarity of the species identified from the freshwater reveal that the second collection shows more species diversity than the first collection.

Simpson’s diversity index value for the samples obtained from two fortnight collections was 0.8972. Simpson’s diversity Index ranges from 0 to 1, where a higher value indicates higher diversity. Here the value obtained from the study area was near to 1 (0.8972). It suggests that the study area possesses a higher diversity of epibionts and contains some dominant individuals coming under specific groups such as Protozoan and Diatom.

Sorenson’s similarity index explains to us that the two collections from the selected study area have 81% similarity. This higher value of similarity may be because the study area possesses more number of related individuals, particularly in protozoans and diatoms.

The epibionts such as Ciliates, Rhizopoda, Diatoms, Rotifers, Algae, Nematodes and Copepods were identified from the collection. Their occurrence and abundance were not uniform and showed a fluctuating tendency during fortnightly collection in the whole study area. Their irregularity in occurrence and abundance during collections might be the effect of predation by the other forms of organisms belonging to the next trophic level. For example, predation by the next higher group of organisms such as Zooplanktons or other invertebrate larval forms reduced the abundance of other epibionts.

The interactions of various organisms among these two habitats, specifically in the form of predation, seem to be the supportive key factor for the small variation in the recorded abundance of the epibionts. Here the natural substratum provides habitat for different types of organisms.

In this study, physiochemical parameters of the freshwater were also used to analyze the growth of the organisms in the pond. The zooplankton abundance was influenced by physiochemical factors. Total zooplankton shows a positive relationship with temperature, dissolved oxygen, etc.; on the other hand, it shows a negative relationship with pH, free CO2, etc. The relationship between zooplankton and water quality parameters was varied from place to place depending upon the condition of the reservoir water. In this study, zooplanktons such as rotifers, nematodes show a positive relationship with temperature and dissolved oxygen and they show negative relationship with pH and dissolved CO2. But in the case of phytoplankton, they show positive relationship with dissolved CO2. For example, Diatoms’ abundance increases with increased dissolved CO2. This shows that the growth of epibionts in pond is affected by the physiochemical parameters of the pond water.

The result of the study concludes that the pond ecosystem contains a diverse group of epibionts. The growth of these organisms was affected by the physiochemical properties of the water. Their growth was also influenced by the interspecific interaction between them.

The natural substratum provides a comfortable habitat for the growth of the organisms. The study area is a good habitat for many organisms.

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