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Filamentous Algae of a Hill Stream Of Kerala, India

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Abstract: *The diversity of filamentous algal flora of a minor stream of Thodupuzha river, Kerala was studied. During the study period thirteen freshwater algal species were observed. They comprised species of Cyanobacteria, Chlorophyta and Charophyta. Presence of certain algae can indicate the pollution status in the stream.*
Key Words*-Stream, Cyanobacteria, Chlorophyta, Charophyta., Filamentous algae*

I. Introduction

Filamentous algae are important components of the river vegetation of small streams mostly attached to substrates as periphyton or in pools of the stream as metaphyton. Stevenson (1996) has grouped the filamentous benthic algae of river into the taxonomic groups Cyanobacteria, Rhodophyta, Chrysophyta, Xanthophyta, Phaeophyta, Bacillariophyta and Chlorophyta [1]. The functional role of filamentous algae is related to autotrophic production and support of food web (Biggs and Smith, 2002[2]; Januer and Dokulil, 2006[3]; Shields *et al*., 2008[4]). The stream algae also influence the oxygen budget as well as the nutrient cycling (Munn and Tesoriero, 2010[5]; Wetzel, 2001[6]; Ziglio *et al*., 2006[7]).

The biomass of periphyton is related to the characteristics of the flowing water. The structure and dynamics of the periphyton communities have been used to classify waterways (Denicola *et al*., 2004[8]; Wargo and Holt, 2004[9]). Generally warmer temperature, high nutrient load and reduced flows support their luxuriant growth (Baba *et al*., 2011[10]; Cascallar *et al*., 2003[11]; Giorgi and Malacalza, 2002[12]). Their proliferation negatively impact macro invertebrate abundance and consequently the food web (Biggs, 2000[13]; Dangles and Guerold, 1999[14]). The capacity of certain species to tolerate high nutrient state has led to their application in waste water treatment (Abdel-Raouf *et al*., 2012[15]; Marinelarena and Giorgi, 2001[16]).Moreover in the commercial production of microalgae the filamentous forms are the better biomass producers and more economical to harvest (Christenson and Sims, 2011[17]; Khanal *et al*., 2010[18]; Markou and Georgakakis, 2011[19]).

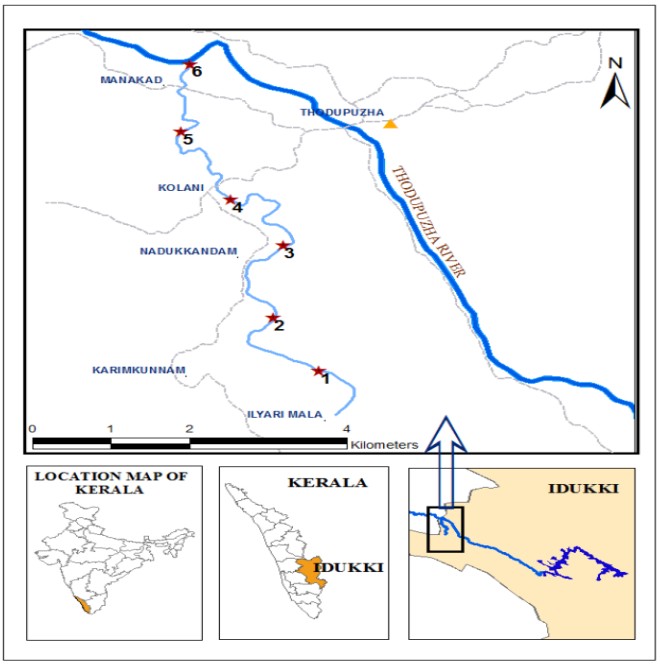

Fig.1.Location map of study area (hill- Stream of Thodupuzha River)

The present study is an investigation of the occurrence of filamentous algae in a hill stream in Kerala, India. The geographic location is 11°37′0″N 76°13′0″E. The stream under investigation is a seasonal flow

originating from the hills of Iliyari Mala of Idukki district, Kerala, India, and flows six kilometers downstream to join Thodupuzha river at Manakad (Fig.1). The lower reach of this stream gets cut off as a pond in summer when the upstream flow ceases, and the pond develops a floating scum of filamentous algae. It is this observation that led to this investigation to discover the diversity of filamentous algal species in this seasonal stream, and their probable water quality indication.

Periphyton	1	2	3	4	5	6
Oscillatoria splendida	+	-	+	+	-	-
Oscillatoria acuminata	-	+	-	+	-	-
Oscillatoria rubescens	+	-	+	+	+	-
Oscillatoria laete-virens	-	-	+	-	-	-
Oscillatoria limosa	-	+	-	-	+	-
Phormidium tenue	-	-	+	+	-	-
Lyngbya shackletoni	-	-	-	+	+	-
Nostoc commune	-	-	+	+	-	-
Scytonema cinccinatum	-	-	-	+	-	-
Oedogonium sp.	+	+	-	-	-	-
Spirogyra sp.	-	+	+	+	+	+
Zygnema sp.	-	+	-	-	-	-
Ecballocystis sp.	+	+	-	-	-	-

II. Collection Of Sample

Algal samples were collected at six locations, every kilometer of the stretch of the stream from its origin to the point where it meets the Thodupuzha river during the period February to August 2009. Samples were collected by scraping pebbles, rocks and submerged vegetation, and brought to the laboratory immediately. The samples were studied fresh as far as possible and digital images of the algae were taken. Identification of taxa was restricted to the true filaments of green and blue-green algae as they were the abundant growth in the stream. The taxa were identified based on monographs (Desikachary, 1959[20]; Prescott, 1964[21]; Anand, 1989[22]; Guiry & Guiry, 2011[23]).Table 1. Periphyton species data at six sampling locations of the stream. presence (+), absence(-)

III. Results

Thirteen species of filamentous algae were recorded in the present study (Fig.2). Among these Cyanobacteria were represented by five genera, Chlorophyta were represented by two genera, and Charophyta were represented by two genera. The occurrence of these across the river in the sampling location is given in Table 1. *Spirogyra* sp. was the most widely distributed followed by *Oscillatoria rubescens.* The genus *Oscillatoria* was represented by five species. The bloom formation downstream was that of *Spirogyra* sp. It formed wide spread scum in the nearly stagnant region of the stream which got cut off as a pond during the summer months of April and May. The bloom was washed off by the monsoon rains in June-July when stream was in flood with turbid water and poor algal growth. The morpho-taxonomic description of the taxa is given below.

3.1. *Oscillatoria splendida* Grev.ex Gomont (Fig. 2A)

(Desikachary, 1959, p. 234, Pl. 37, Fig. 7 & 8)

Thallus blue green; trichome straight or curved, not constricted at the cross walls, at the end gradually attenuated, 2-3µ broad; cells 2-3 times longer than broad rarely quadrate, 3-8µ long; ends more or less bent; end cells capitate; nearly rounded.

3.2. *Oscillatoria acuminata* Gomont (Fig. 2B)

(Desikachary, 1959, p. 240, Pl. 38, Fig.7)

Thallus blue-green; trichome more or less straight, not constricted at cross-walls, 4-5µ broad, at the ends briefly tapering, sharply pointed, bent; cells longer than broad, 6-8µ long, sometimes granulated at the cross-walls.

3.3. *Oscillatoria rubescens* DC ex Gomont (Fig. 2C)
(Desikachary, 1959, p. 235 Pl. 42, Fig.12)
Trichome straight, at the ends gradually attenuated, 6-8µ broad, not constricted at the cross walls, cells $^{1}/_{2}$-$^{1}/_{3}$ as long as broad, 3-4µ long, often granulated at the septa, with gas vacuoles; end cells capitate.

3.4. *Oscillatoria laete-virens* (crouan) Gomont (Fig. 2D)
(Desikachary, 1959, p. 213 Pl. 39, Fig. 2 & 3)
Thallus thin, green, trichome, straight, slightly constricted at the cross walls, 3-4µ broad, apices attenuated; cells nearly long as broad, 2-4µ long.

3.5. *Oscillatoria limosa* Ag. ex Gomont (Fig. 2E)
(Desikachary, 1959, p. 206, Pl. 42, Fig.11)
Thallus dark blue green, trichome more or less straight, not constricted at the cross walls, 11-12µ broad, cross walls frequently granulated; cells $^{1}/_{3}$-$^{1}/_{6}$ as long as broad, 2-4 µ long; end cells flatly rounded with slightly thickened membrane.

3.6. Phormidium tenue (Menegh.) Gomont (Fig. 2F)
(Desikachary, 1959, p. 259, Pl. 43, Fig. 13-15 & Pl. 44, Fig. 7-9)
Thallus pale blue-green, thin, membraneous, trichome straight, slightly constricted at cross- walls, attenuated at the ends, cells 2-3 times longer than broad, 3-5 µ long, 1-2µ broad; sheath thin.

3.7. *Lyngbya shackletoni* W. et G. S. West (Fig. 2G)
(Desikachary, 1959, p. 296, Pl. 53, Fig. 13)
Filaments nearly straight, 12-12.5 µ broad; sheath firm, colourless, distinctly lamellated; trichome not attenuated at the ends, 8-9 µ broad; not constructed at cross- walls, cells 2-2.5 µ long, pale blue-green; end cells conical nearly as long as broad.

3.8. *Nostoc commune* Vaucher ex Born. et Flah. (Fig. 2H)
(Desikachary, 1959, p. 387, Pl. 68, Fig. 3)
Thallus firm, gelatinous, blue green; sheath mostly distinct only at the periphery, trichome 4-5 µ broad, cells short barrel-shaped to nearly spherical, heterocysts nearly spherical, 6-7 µ broad.

3.9. *Scytonema cincinnatum* Thuret ex Born.et Flah. (Fig. 2I)
(Desikachary, 1959, p. 453, Pl. 93, Fig.1)
Thallus brownish green; filaments 16-26µ broad; false branches mostly germinate; sheath firm, brownish; trichome 14-17µ broad, distinctly at cross-walls, cells 1/3 as short as broad; heterocysts depressed or quadrate, short cylindrical.

3.10. *Oedogonium* Link ex Hirn, 1990 (Fig. 2J)
(http://www.algaebase.org)
Unbranched uniseriate filaments, occasionally free-floating. Vegetative cells generally uniform in size and shape; usually cylindrical, uninucleate, cap cells present, 21-28 µ long, 16-18µ broad, highly vacuolated, and with a large reticulate, parietal chloroplast containing many pyrenoids.

3.11. *Spirogyra* Link, 1820 (Fig. 2K)
(http://www.algaebase.org)
Thalli comprised of unbranched uniseriate filaments, cylindrical cells, 18-22µ broad; length eqaual to or several times width; chloroplast two, spirally arranged ribbon like with numerous pyrenoids**.**

3.12. *Zygnema* Agardh, 1817 (Fig. 2L)
(http://www.algaebase.org)
Filaments unbranched with short cylindrical cells, 14-17 µ broad; two satellite chloroplasts with a prominent central pyrenoid, one on either side of a centrally situated nucleus.

3.13. *Ecballocystis* Bohlin, 1897 (Fig. 2M)
(http://www.algaebase.org)
Microscopic to macroscopic aggregations of cells with one to many celled dendroid to pseudofilamentous colonies attached at base by mucilaginous pad. Cells oval to spindle shaped or cylindrical, 15-20µ broad, 40-70 µ

broad, cell walls smooth with lamellated polar thickenings. Cells with single central nucleus; parietal chloroplasts , discoid to band shaped each with single pyrenoid.

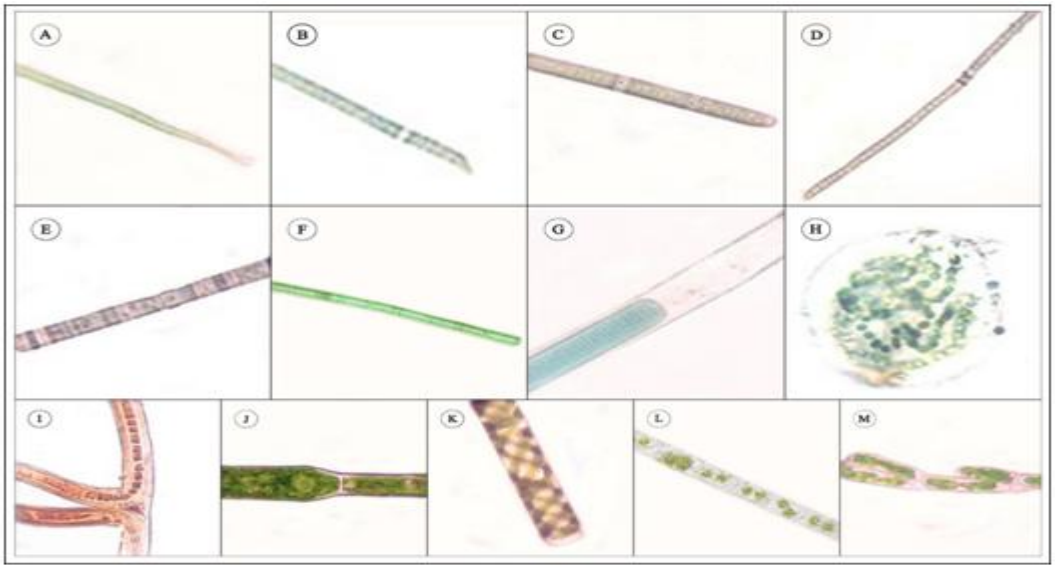

Fig.2. Filamentous algae of study site **A.** *Oscillatoria splendida* (1000X) **B.** *Oscillatoria acuminata* (400X) **C.** *Oscillatoria rubescens* (1000X) **D.** *Oscillatoria laete-virens* (400X) **E.** *Oscillatoria limosa* (1000X) **F.** *Phormidium tenue* (1000X) **G.** *Lyngbya shackletoni* (400X) **H.** *Nostoc commune* (400X) **I.** *Scytonema cinccinatum* (1000X) **J**. *Oedogonium sp.* (1000X) ***K.*** *Spirogyra sp.* (400X).**L.** *Zygnema sp.* (400X) **M.** *Ecballocystis sp*. (400X)

IV. Discussion And Conclusion

Thirteen species are recorded from this stream in this investigation. All of these have been reported from elsewhere in different rivers and wetlands of Kerala (Anand and Hopper 1987[24]; Arulmurugan *et al.*, 2010[25]; Jose 2008[26]; Jose and Patel 1990[27]; Ushadevi and Panickkar 1994[28]). *Oscillatoria* has the highest representation of species while *Spirogyra* is more widespread and form the summer bloom. *Spirogyra* and other Zygnemataceous taxa have a wide ecological range and they probably prefer soft water (Cambra and Aboal, 1992[29]). According to Palmers Algal genus index(1969) pollution index of *Oscillatoria* is five and *Phormidium* is one and the presence of these genera indicates organic pollution[30]. Presence of Anabaena is also an indicator of organic pollution in the water bodies (Jafari and Gunale, 2006[31). Water habitat with high conductivity seems to be suitable for growth and development of *Spirogyra* (Wongsawad *et al.*, 2012[32]). The observation of bloom of *Spirogyra* in the stagnant region of the hill stream is indicative of high dissolved load in the stream and that of *Oscillatoria* especially points to organic load in the system. This may be strongly correlated with human inhabitation, land use and disturbance in the uplands of Kerala such that even a hill stream is polluted. It may be concluded that many such small habitats considered pristine are left unexplored, and it may be necessary to document these ecosystems of local habitats for their conservation.

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