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CONTRIBUTION TO THE ALGAL FLORA (CHLOROPHYTA) OF FRESH WATERS OF DISTRICT SWAT. N.W.F.P., PAKISTAN

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Abstract

In this study 138 Chlorophycean species belonging to 56 genera, 25 families and 9 orders were recorded. Among these 74 species (53.6%) belong to 22 genera and 7 families of order Chlorococcales. Four species (3%) belong to 3 genera and 1 family of order Cladophorales. Three species (2.2%) belong to 3 genera and 3 families of order Chaetophorales. One species (0.7%) belong to 1 genus and 1 family of order Sphaeropleales. Two species (1.5%) belong to 2 genera and 1 family of order Oedogoniales. Fourteen species (10.2%) belong to 8 genera and 3 families of order Tetrasporales. Eight species (5.8%) belong to 4 genera and 3 families of order Ulotrichiales. Eleven species (8%) belong to 7 genera and 3 families of order Volvocales. Twenty one species (15%) belong to 6 genera and 3 families of order Zygnematales. The maximum 74 species (53.6%) belong to order Chlorococcales, followed by Zygnematales with 21 species (15%) and 1 species (0.7%) from order Sphaeropleales.

Introduction

The Valley of Swat a part of Malakand Division covers estimated 5737 square kilometers The elevation of the valley is 630 to 3000m above sea level. Swat is located at a distance of 170 km from Peshawar and 270 km from Federal capital of Islamabad. Sarim & Zaman, (2005), carried out an extensive study and reported 89 species belonging to 31 genera of Chlorophyceae, Bacillariophyceae, Xanthophyceae and Cyanophyceae, from District Charsadda. Ali *et al., (*2005), studied monthly variations in biological and Physico-chemical parameters of brackish water fishpond, Muzaffar Garh Multan, Pakistan. Diversity of plankton life was used as a measure of water quality of a brackish water aquaculture pond. They reported 48 genera in which 38 genera were of Phytoplanktons. Sarim (2005), recorded 54 species belonging to genera *Spirogyra*, *Zygnema*, *Cosmarium*, *Merismopedia*, *Aphanocapsa*, *Basicladia*, *Closterium*, *Gomohoshaeria*, *Lyngbya*, *Mougeotia*, *Nostoc*, *Oscillatoria*, *Rhizoclonium*, *Trachelomonas*, *Zygogonium*, *Synedra*, *Cymbella*, *Fragilaria*, *Gomphonema*, *Navicula*, *Nitzscgia*, *Cyclotella*, *Gyrostigma*, *Pinnularia* and *Rhoicosphenia* from Bara River, Peshawar. Reshmi (2004), conducted a detailed study on Chlorophycean biodiversity in Wet lands on Satna (M.P.) India. The study revealed 32 genera and 52 species belonging to 18 families and 7 orders of Chlorophyceae. Shankar & Hosmani (2004), worked on fresh water algal blooms. They concluded that Chlorophycean members occur in all kinds of waters. Dere. *et al.*, (2002), completed their study on the Epiphytic Algae of the Nilufer Stream (Bursa). Leghari *et al.*, (2001) worked on Chlorococcales (Chlorophyta) of Sindh, Pakistan. The work examined the algal mass present as a source of nutrient in the lakes and ponds for fishes in lower Sindh region. Leghari (2001), reported 31 species of Chlorophyta and *Dinobryon cylindricum* of Chrysophyta from fresh water riverian ponds. Ertan & Morkoyunlu (1998), recorded the algal flora of Aksu Stream (Isparta, Turkey). The flora consisted of 73 taxa belonging to the Bacillariophyta, Chlorophyta, Cyanophyta and Euglenophyta divisions.

Materials and Methods

More than 100 algal/phytoplankton samples were collected from the 20 various localities of District Swat i.e., Saidu Sharif, Kanju, Aligrama, Kabal, Ningolai, Matta, Khuwaza Khela, Madian, Behrain and Kalam. Euplankton, phytoplankton, nanoplankton, tychoplankton, potomoplankton, meroplankton etc., were collected with help of phytoplankton net mesh size 5–10 μ meter and its number 25 made in Japan. Epiphytic algal samples were collected by two methods. First: Algal samples were collected with the help of pippet from aquatic plants mainly from *Nitella, Chara, Potomogeton, Hydrilla, Ceratophyllum* etc. Second: Aquatic plants were taken in polythene bag along with little quantity of water, the mouth of the polythene bag was closed and the material was crushed till it got completely mixed with water and it was then pored into plastic bottles. Filamentous algae were collected with help of forceps. Desmid flora was collected with the help of pippet. Macro-algae and aquatic plants were picked up with hands from the collection sites. Epilithic flora was collected with the help of tooth brush and knife from rock surfaces near water bodies. All the collected samples were preserved according to standard method (Anon., 1985). Phytoplankton as well as other plankton was preserved in 2 to 3% formaline. Algal samples were preserved in 4% formaline (Mason, 1967). Aquatic plants were preserved in 8% formaline.

Identification

One drop from each sample were taken with the help of small pipette put on the slide and covered with cover slip, under the light microscope BH-2 Olympus Made in Japan. The objectives were used 10^X, 20^X, 40^X, 100^X, but usually we used 20^X and 10^X eye piece. The eye piece was fitted with ruled ocular micrometer. The outer boundaries forming a square field which was divided into 100 smaller squares by the rulings. The specimens were identified with the help of available literature (Smith, 1950; Prescott, 1961; Siddiqi & Faridi, 1964; Tiffany & Britton, 1971; Akiyama & Yamagishi, 1981).

Results

Division: Chlorophyta
Class: Chlorophyceae
Order: Chlorococcales
Family: Oocystaceae

1. *Ankistrodesmus convolutes* Corda
2. *A. falcatus* (Corda) Ralfs
3. *A. falcatus* var. *acicularis* (A. Br.) West
4. *A. falcatus* var. *stipitatus* (Chod) Lemm.
5. *A. falcatus* var. *tumidus* (W.&W) West.
6. *Chlorella ellipsoidea* Gerneck
7. *C. vulgaris* Beyerinck
8. *Dactylococcus infusiomum* Naegeli
9. *Gloeotaenium loitelsbergerianum* Hansgirg
10. *Kircheneriella lunaris* (Kirch.) Moebius.
11. *K. subsolitoria* West.
12. *Nephrocytium agardhianum* Naegeli
13. *N. obesum* West & West
14. *Oocystis borgei* Snow
15. *O. crassa* Wittrock *in* Whittrock & Nordstedt
16. *O. elliptica* W. West.
17. *O. eremosphaeria* Smith
18. *O. gigas* Archer
19. *O. lacustris* Chodat
20. *O. parva* West & West
21. *O. pusilla* Hansgirg
22. *O. pyriformis* Prescott
23. *O. solitaria* Wittrock *in* Whittrock & Nordstedt
24. *Quadrigula lacustris* (Chod.) Smith.
25. *Selenastrum minutum* (Naeg.) Collins
26. *Tetraedron asymmetricum* Prescott
27. *T. caudatum* (Corda) Hansgirg.
28. *T. muticum* (A. Braun.) Hansgirg
29. *T. muticum f. punctulatum* (Reinsch) De Toni
30. *T. regulare* Kuetzing

31. *T. regulare* var. *incus* Teiling
32. *T. regulare* var. *torsum* (Turner) Braun.
33. *T. trigonum* (Naegeli) Hansgirg
34. *T. tumidulum* (Reinsch) Hansgirg
35. *T. victoriae* Woloozynska
36. *Trochiscia granulata* (Reinsch) Hansgirg
37. *T. obtusa* (Reinsch) Hansgirg.
38. *T. reticularis* (Reinsch) Hansgirg
39. *Westella botryoides* (W. & W.) de Wild

Family: Chlorococcaceae

40. *Chlorococcum humicola* (Naeg.) Rab.

Family: Dictyosphaeriaceae

41. *Dictyosphaerium ehrenbergianum* Naegali
42. *D. pulchellum* Wood
43. *Dimorphococcus lunatus* A. Braun

Family: Characiaceae

44. *Characium obtusum* A. Braun.
45. *C. curvatum* G. M. Smith
46. *C. rabenhorsti* De Toni

Family: Coelastraceae

47. *Coelastrum cambricum* Archer.
48. *C. microporum* Naegeli *in* A. Braun
49. *C. scabrum* Reinsch
50. *C. sphaericum* Naegeli

Family: Hydrodictyaceae

51. *Hydrodictyon reticulatum* (L.) Lagerheim.
52. *Pediastrum boryamum* (Turp.) Men.
53. *P. duplex* Meyen
54. *P. duplex* var. *clathratum* (A. Braun.) Lagerheim
55. *P. intergrum* Naegeli
56. *P. tetras* (Ehr.) Ralfs.

Family: Scenedesmaceae

57. *Actinastrum hantzschii* Lagerheim
58. *Crucigenia apiculata* (Lemm.) Schmidle
59. *C. irregularis* Willi
60. *C. lauterbornii* Schmidle
61. *C. quadrata* Morren
62. *C. rectangularis* (A. Braun.) Gay
63. *C. tetrapedia* (Kirch.) West & West
64. *C. truncate* Smith
65. *Scenedesmus abundans* (Kirch.) Chodat
66. *S. acutiformis* Scroeder
67. *S. arcuatus* Lemm.
68. *S. arcuatus* var. *platydisca* Smith
69. *S. bijuga* (Turp.) Lagerheim
70. *S. dimorphus* (Turp.) Kuetz.
71. *S. longus* Meyen
72. *S. obliquus* (Turp.) Kuetz.
73. *S. quadricauda* (Turp.) Breb., in de Breb. & Godey
74. *S. quadricauda* var. *parvus* Smith

Order: Cladophorales
Family: Cladophoraceae

75. *Basicladia chelomum* (Collins) Hoffiman & Tilden
76. *Cladophora glomerata* (L.) Kuetz.
77. *Pithophora oedogonia* (Mon.) Wittrock.
78. *P. varia* Wille. Phyc. Bor.-Amer.

Order: Chaetophorales
Family: Chaetophoraceae

79. *Chaetophora elegans* (Roth) Agardh

Family: Chaetosphaeridiaceae

80. *Chaetosphaeridium pringsheimii* Klebahn.

Family: Coleochaetaceae

81. *Coleochaete orbicularis* Pringsheim

Order: Sphaeropleales
Family: Sphaeropleaceae

82. *Sphaeroplea annulina* (Roth) Agardh.

Order: Oedogoniales
Family: Oedogoniaceae

83. *Oedogonium angustissimum* W. & W.
84. *Bulbochaete gigantea* Pringsheim

Order: Tetrasporales
Family: Palmellaceae

85. *Asterococcus limneticus* Smith
86. *Gloeocystis ampla* Kuetz. Legerheim
87. *G. major* Gerneck ex. Lemm.
88. *G. vesiculosa* Naegeli
89. *Palmella mucosa* Kuetz.
90. *Palmodictyon viride* Kuetz.
91. *Sphaerocystis schroeteri* Chodat

Family: Cocomaxaceae

92. *Elakatothrix gelatinosa* Wille
93. *E. viridis* (Snow) Printz.

Family: Tetrasporaceae

94. *Tetrospora cylindrica* (Wahl.) Agardh.
95. *T. lacustris* Lemm.
96. *T. lubrica* (Roth.) Agardh.
97. *Schizochlamys compacta* Prescott.
98. *S. gelatinosa* A. Braun *in* Kuetzing

Order: Ulotrichales
Family: Ulotrichaceae

99. *Geminella crenulatocolis* Prescott
100. *G. ordinata* (W. & West) Heering.
101. *Ulothrix aequalis* Kuetz.
102. *U. subconstricta* West.
103. *U. tenuissima* Kuetz.
104. *U. zonata* (Web. & Mohr.) Kuetz.

Family: Microsporaceae

105. *Microspora tumidula* Hazen.

Family: Cylindrocapsaceae

106. *Cylindrocapsa geminella* Wolle. var. *minor* Hansgirg.

Order: Volvocales

Family: Chlamydomonadaceae

107. *Chlamydomonas epiphytica* Smith
108. *C. globosa* Snow
109. *C. pseudopertyi* Pascher.
110. *C. polypyrenoideum* Prescott

Family: Haematococcaceae

111. *Haematococcus lacustris* (Girod) Rostaf.

Family: Volvocaceae

112. *Gonium pacturale* Mueller
113. *Eudorina elegans* Ehr.
114. *Pandorina morum* (Muell.) Bory
115. *Pleodorina illinoisensis* Kafoid.
116. *Volvox globator* Linnaeus
117. *V. tertius* A. Meyer

Order: Zygnematales

Family: Desmidiaceae/Closterieae

118. *Closterium acerosum* (Schrank) Ehrenberg
119. *Cl. dianae* Ehrenberg
120. *Cl. ehrenbergii* Menegh
121. *Cl. leibleinii* Kuetzing
122. *Cl. moniliferum* (Bory) Ehrenberg

Sub-family: Cosmarieae

123. *Cosmarium constrictum* Delponate
124. *C. crenatum* Ralfs
125. *C. granatum* Brebisson
126. *C. moniliforme* (Turpin) Ralfs
127. *C. nitidulum* DeNotaris
128. *C. turpinii* Brebisson
129. *C. puntulatum* Brebisson
130. *Staurastrum puntulatum* Brebisson
131. *S. dilatum* Ehrenberg

Family: Zygnemataceae

132. *Spirogyra aequinocitialis* G. S. West
133. *S. crassa* Kuetzing
134. *Mougeotia gracilima* (Hass.) Wittrock
135. *M. sphaerocarpa* Wolle
136. *M. virescens* (Hass.) Borge
137. *M. viridis* (Kuetz.) Wittrock
138. *Zygnema sterile* Transeau *in* Transeau, Tiffany, Taft , & Li

Discussion

Algae are of tremendous importance to life on earth. As primary producers in almost all the ecosystems, they play a vital role in food chains. Algae are regularly contributing fresh oxygen to the atmosphere, where as animals are contaminating it by adding carbon dioxide. They directly or indirectly serve as food for fish and other aquatic animals important to man. Their luxuriant growth tells upon the taste and odor of water and sometimes they make it unfit for drinking. Physico-chemical factors play an important role in the distribution of Algal species and distribution of fish and fauna among them. Temperature is the most important physical factor which controls phytoplankton population. So, water temperature is important in terms of its effect on aquatic life. According to Welch (1952), the dissolved-oxygen content decreases with the rise in temperature, high temperature increases the metabolism and respiration activity. High temperature intensifies the effect of toxic substances in aquatic habitats. High temperatures have a direct effect on growth of algal species and communities and aquatic life. The Dissolved oxygen content of the freshwater dependent on several factors i.e., (i) water movement, (ii) pollution, (iii) temperature of water, (iv) addition of freshwater from other sources, (v) production of oxygen by plants and its consumption by plants, animals and bacteria (Hitchinson, 1957). The addition of silt in water also limits the amount of dissolved oxygen. However, throughout the year the amount of dissolved oxygen was sufficient to support production. The water was alkaline throughout the year, fluctuating between pH 7.7 and 8.6. In water, deviations in pH from 7 are primarily the result of the hydrolysis of salts of strong bases and weak acids, or *vice-versa*. Dissolved gases, such as carbon dioxide, hydrogen sulfide and ammonia, also affect the pH appreciably. pH value below 8 indicate an excess of carbon dioxide above the amount in equilibrium with that of air, (Atkins & Harris, 1924). The present study further clarifies the factors that affect the fresh water flora and in turn its impact on nutrition and diet of fauna. During the present study, pH does not reach up to strong basic so it counted in slight alkaline as a result water is rich in production with all respect. The salinity of waters fluctuated between 0.2–1.25 ppt. This amount is very low, so does not have any limiting effect on the flora and fauna in the water. Any increase in the salinity of the water due to the evaporation of water is reduced by the addition of rain-water from catchments area. According to Krogh (1931), dissolved substances including the chlorides are an important source of food especially for aquatic life, fishes and other herbivorous fishes. Total hardness of water is attributed to calcium and magnesium carbonate in water fluctuation between 180-190 ppm, in which calcium is favourable for growth of green phytoplankton and magnesium favour for making blooms, colonies mates, etc., as a whole favorable for blue green phytoplankton and other group of algae, which support fish growth (Akhtar *et al*., (1990). During the present study on Chlorophycean members of Swat, a wide range of thallus structure was observed. The total of 138 species were found to be Unicellular forms, colonial forms, un-branched filamentous forms, branched filamentous forms, pseudo filamentous forms, mesh like thallus, heterotrichous forms and irregular forms. This was primarily an eco-taxonomical study. These findings will be of great use to scientific workers in future who want to explore more and more about fresh water Chlorophyceae of Swat. This study reveals that comparatively lesser number of Chlorophycean members is found in fast running and cold waters. This was also noticed during the study of seasonal variation of Chlorophycean members. Most of the Chlorophycean members were found growing in summers and springs. The least numbers being found in winters. The number of algal species was lowest in few samples collected from Aligrama, Kalam and Fizaghat. This shows that aquatic pollution badly effects the Chlorophycean growth; especially the wastes from Marble factories in Aligrama are continuously sweeping the algal populations in water bodies. Chlorophycean members are of tremendous importance. Chlorophycean members along with other algae and green plants are responsible to release oxygen during photosynthesis. The fresh oxygen produced by them prevents foul or septic conditions which develop in water, by stimulating the aerobic bacteria. The oxygen available is utilized for respiration by all aquatic animals, from fish to Protozoa. These green algal members constitute a primary source for renewal of oxygen in these water bodies. The Chlorophycean members play an important role, by acting as primary producers. Chlorophycean members also increase the fertility of the soil in paddy fields. Our future plans include to study possible medicinal use of fresh water flora following Shinwari & Gilani (2003); Yousuf *et al*., (2006, 2008).

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