

CONFIDENCE LIMITS FOR CHLOROPHYCEAN MEMBERS RECORDED FROM FRESH WATERS OF DISTRICT SWAT N.W.F.P. PAKISTAN

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Abstract

During the present study, 138 Chlorophycean species belonging to 56 genera, 25 families and 9 orders were recorded. The recorded Chlorophycean members were tested statically for the confidence limits. This statistical analysis is based on the Chlorophycean families from fresh waters of District Swat. Collection sites were Saidu Sharif, Kanju, Aligrama, Kabal, Ningolai, Matta, Khawazakhela, Madian, Behrain and Kalam. The confidence interval estimate is an interval calculated from a random sample of size n , that how much confident we are that the interval contain the proportion of Chlorophycean families of District Swat.

Introduction

The Valley of Swat is estimated to cover 5737 square kilometers (estimated). Politically it was a part of Malakand Division in NWFP. The elevation of the valley is 2000 to 9000 feet 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 an extensive study and a total of 89 species belonging to 31 genera of Chlorophyceae, Bacillariophyceae, Xanthophyceae and Cyanophyceae were recorded from various localities of District Charsadda. Ali *et al.*, (2005) carried out their studies on 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. Phytoplanktons were abundant as compared to zooplanktons. During the study period a total of 48 genera were observed 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*, *Nitzschgia*, *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, which were recorded from different wet lands of Satna. 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). In our study, water samples were taken monthly between August 1997 and June 1998 from six selected stations in the region, from the source of the Nilufer stream to the point where it joins the Marmara Sea. Leghari *et al.*, (2001) conducted their research 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 algal flora at 4 stations chosen on Aksu Stream was investigated between September 1993 and August 1994. 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, tycho plankton, 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 pipette from aquatic plants mainly from *Nitella*, *Chara*, *Potamogeton*, *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 were collected with the help of pipette. Macro-algae and aquatic plants were picked up with hands from the collection sites. Epilithic flora were 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 (APHA, 1985). Phytoplankton as well as other plankton were preserved in 2 to 3% formaline. Algal samples were preserved in 4% formaline (Mason, 1967). Aquatic plants were preserved in 8% formaline. The confidence interval estimate was calculated which is an interval calculated from a random sample of size n , that how much confident we are that the interval contain the proportion of Chlorophycean families of District Swat.

‘ p ’ represent the proportion of an Order in District Swat

‘ n ’ represent the number of families in that Order

‘ X ’ be the number of species of various families present in the sampled area

‘ \hat{p} ’, represent the proportion of that particular family in sample.

The sample proportion \hat{p} is given by:

$$\hat{p} = \frac{\text{the number of species of various families present in the sample}}{\text{the number of families in that Order}} = \frac{X}{n}$$

$$\& \hat{q} = 1 - \hat{p}$$

The confidence interval estimate of the proportion of an Order is given by:

$$\hat{p} - Z \frac{\alpha}{2} \sqrt{\frac{\hat{p}\hat{q}}{n}} < p < \hat{p} + \frac{\alpha}{2} \sqrt{\frac{\hat{p}\hat{q}}{n}}$$

Results

A Checklist of Chlorophycean members recorded from District Swat.

	Saidu Sharif	Kanju	Aligrama	Kabal	Ningoli	Matta	Khwaza Khela	Madian	Bahrain	Kalam
Division: Chlorophyta										
Class: Chlorophyceae										
Order: Chlorococcales										
Family: Oocystaceae										
1. <i>Ankistrodesmus convolutus</i> Corda	+	+	+	+	+	+		+	+	+
2. <i>A. falcatus</i> (Corda) Ralfs	+	+	+	+	+	+		+		+
3. <i>A. falcatus</i> var. <i>acicularis</i> (A. Br.) West	+	+	+	+	+	+		+	+	+
4. <i>A. falcatus</i> var. <i>stipitatus</i> (Chod) Lemm.	+		+	+	+	+		+	+	
5. <i>A. falcatus</i> var. <i>tunidus</i> (W.&W) West.			+	+	+	+		+		
6. <i>Chlorella ellipsoidea</i> Gerneck	+	+	+	+	+	+	+	+		
7. <i>C. vulgaris</i> Beyerinck	+	+	+	+	+	+				
8. <i>Dactylococcus infusiomum</i> Naegeli		+	+	+	+	+				
9. <i>Gloeoetaenium loitelsbergerianum</i> Hansgirg		+	+	+	+	+	+	+		+
10. <i>Kirchneriella lunaris</i> (Kirch.) Moebius.	+	+	+	+	+	+		+	+	
11. <i>K. subsolitaria</i> West.		+	+	+	+	+				
12. <i>Nephrocystium agardhianum</i> Naegeli	+	+	+	+	+	+	+			
13. <i>N. obesum</i> West & West	+	+	+	+	+	+	+			
14. <i>Oocystis borgei</i> Snow	+	+	+	+	+	+			+	+
15. <i>O. crassa</i> Wittrock in Whitrock & Nordstedt	+	+	+	+	+	+		+		
16. <i>O. elliptica</i> W. West.		+	+	+	+	+				
17. <i>O. eremosphaeria</i> Smith	+		+	+	+	+		+	+	+
18. <i>O. gigas</i> Archer		+	+	+	+	+		+	+	+
19. <i>O. lacustris</i> Chodat	+							+	+	
20. <i>O. parva</i> West & West.	+			+	+	+				
21. <i>O. pusilla</i> Hansgirg		+		+	+	+				
22. <i>O. pyriformis</i> Prescott			+	+	+	+		+		
23. <i>O. solitaria</i> Wittrock in Whitrock & Nordstedt	+			+	+	+		+	+	
24. <i>Quadrigula lacustris</i> (Chod.) Smith.					+	+	+	+		+
25. <i>Selenastrum minutum</i> (Naeg.) Collins		+	+	+	+	+				+

(Cont'd.). A Checklist of Chlorophyceae members recorded from District Swat.

	Saidu Sharif	Kanju	Aligrama	Kabal	Ningoli	Matta	Khwaza Khela	Madian	Bahrain	Kalam
26. <i>Tetraedron asymmetricum</i> Prescott			+	+	+	+		+	+	
27. <i>T. caudatum</i> (Corda) Hansgirg.				+		+	+	+	+	+
28. <i>T. muticum</i> (A. Braun.) Hansgirg				+		+	+	+	+	+
29. <i>T. muticum</i> f. <i>punctulatum</i> (Reinsch) De Toni							+	+	+	+
30. <i>T. regulare</i> Kuetzing		+	+	+	+			+		
31. <i>T. regulare</i> var. <i>incus</i> Teiling				+			+	+		
32. <i>T. regulare</i> var. <i>torsum</i> (Turner) Braun.	+	+						+	+	
33. <i>T. trigonum</i> (Naegeli) Hansgirg	+	+	+			+		+	+	
34. <i>T. tumidulum</i> (Reinsch) Hansgirg		+	+			+		+	+	
35. <i>T. victoriae</i> Wloozynska						+	+	+		
36. <i>Trochiscia granulata</i> (Reinsch) Hansgirg		+					+			
37. <i>T. obtusa</i> (Reinsch) Hansgirg.		+				+			+	
38. <i>T. reticularis</i> (Reinsch) Hansgirg		+							+	
39. <i>Westella botryoides</i> (W. & W.) de Wild					+	+	+		+	
Family: Chlorococcaceae										
40. <i>Chlorococcum humicola</i> (Naeg.) Rab.	+	+	+	+	+	+			+	
Family: Dictyosphaeriaceae										
41. <i>Dictyosphaerium ehrenbergianum</i> Naegali	+	+	+				+			
42. <i>D. pulchellum</i> Wood	+	+	+				+		+	+
43. <i>Dimorphococcus lunatus</i> A. Braun	+	+	+		+	+			+	+
Family: Characiaceae										
44. <i>Characium obtusum</i> A. Braun.			+	+	+	+	+		+	
45. <i>C. curvatum</i> G. M. Smith	+	+	+	+	+			+	+	+
46. <i>C. rabenhorsti</i> De Toni		+	+							
Family: Coelastraceae										
47. <i>Coelastrum cambricum</i> Archer.	+			+	+			+	+	+
48. <i>C. microporum</i> Naegeli in A. Braun	+	+	+		+				+	
49. <i>C. scabrum</i> Reinsch		+	+	+			+			+
50. <i>C. sphaericum</i> Naegeli	+						+			+

(Cont'd.). A Checklist of Chlorophycean members recorded from District Swat.

	Saidu Sharif	Kanju	Aligrama	Kabal	Ningoli	Matta	Khwaza Khela	Madian	Bahrain	Kalam
Family: Hydrodictyaceae										
51.	+	+	+	+	+	+	+	+	+	+
52.	+	+	+	+	+	+	+	+	+	+
53.		+	+	+	+	+		+	+	+
54.	+	+	+	+	+	+	+	+	+	+
55.	+	+	+	+	+		+	+	+	+
56.	+	+				+	+	+	+	+
Family: Scenedesmeceae										
57.					+	+	+	+		
58.	+	+	+		+	+	+			
59.	+	+	+	+	+	+	+			
60.	+	+	+	+	+	+				
61.	+	+			+	+				
62.	+	+	+	+	+	+		+		
63.	+		+	+			+			+
64.			+	+						+
65.	+	+	+	+	+					
66.	+	+	+	+	+				+	
67.	+	+	+	+	+				+	
68.	+	+	+	+					+	
69.	+	+	+	+	+				+	
70.	+	+	+	+	+				+	+
71.	+	+		+	+	+			+	
72.	+	+	+		+				+	
73.	+	+	+					+	+	+
74.	+	+	+	+					+	+

(Cont'd.). A Checklist of Chlorophycean members recorded from District Swat.

	Saidu Sharif	Kanju	Aligrama	Kabal	Ningoli	Matta	Khwaza Khela	Madian	Bahrain	Kalam
Order: Cladophorales										
Family: Cladophoraceae										
75.							+	+		
76.	+	+	+	+	+	+	+	+	+	+
77.	+	+	+	+		+	+	+	+	
78.	+	+	+	+	+	+	+	+	+	+
Order: Chaetophorales										
Family: Chaetophoraceae										
79.							+	+	+	+
Family: Chaetosphaeridiaceae										
80.				+	+	+	+			
Family: Coleochaetaceae										
81.	+	+	+	+	+	+	+	+		
Order: Sphaeropleales										
Family: Sphaeropleaceae										
82.	+			+	+	+				
Order: Oedogoniales										
Family: Oedogoniaceae										
83.	+	+	+	+	+	+	+	+	+	+
84.	+	+	+	+	+	+	+			
Order: Tetrasporales										
Family: Palmellaceae										
85.			+	+	+	+	+	+	+	+
86.		+	+				+	+	+	+
87.		+	+	+	+	+	+			
88.		+	+	+			+			
89.				+	+	+		+		
90.	+	+	+	+						
91.				+	+	+				

(Cont'd.). A Checklist of Chlorophycean members recorded from District Swat.

	Saidu Sharif	Kanju	Aligrama	Kabal	Ningoli	Matta	Khwaza Khela	Madian	Bahrain	Kalam
Family: Cocomaxaceae										
92. <i>Elakatothrix gelatinosa</i> Wille	+	+	+	+	+		+	+		
93. <i>E. viridis</i> (Snow) Printz.	+		+	+				+		
Family: Tetrasporaceae										
94. <i>Tetraspora cylindrical</i> (Wahl.) Agardh.	+	+			+		+	+	+	
95. <i>T. lacustris</i> Lemm.	+	+	+		+		+	+		+
96. <i>T. lubrica</i> (Roth.) Agardh.	+	+	+				+			
97. <i>Schizochlamys compacta</i> Prescott.	+	+	+				+			
98. <i>S. gelatinosa</i> A. Braun. in Kuetzing	+	+	+				+			
Order: Ulotrichales										
Family: Ulotrichaceae										
99. <i>Geminella crenulatoollis</i> Prescott	+			+						
100. <i>G. ordinata</i> (W. & West) Heering.	+			+						
101. <i>Ulothrix aequalis</i> Kuetz.	+	+	+	+	+	+	+	+	+	+
102. <i>U. subconstricta</i> West.	+	+	+			+	+	+	+	+
103. <i>U. tenuissima</i> Kuetz.	+	+	+	+	+	+		+	+	+
104. <i>U. zonata</i> (Web. & Mohr.) Kuetz.	+	+	+	+	+	+	+	+	+	+
Family: Microsporaceae										
105. <i>Microspora tumidula</i> Hazen.		+								
Family: Cyliandrocapsaceae										
106. <i>Cyliandrocapsa geminella</i> Wolle var. <i>minor</i> Hansgirg.						+	+	+		
Order: Volvocales										
Family: Chlamydomonadaceae										
107. <i>Chlamydomonas epiphytica</i> Smith	+	+	+			+	+	+		+
108. <i>C. globosa</i> Snow	+	+	+			+	+	+		
109. <i>C. pseudopertyi</i> Pascher.		+	+	+	+	+	+	+	+	+
110. <i>C. polypyrenoides</i> Prescott	+	+		+	+	+	+			
Family: Haematococcaceae										
111. <i>Haematococcus lacustris</i> (Girod) Rostaf.					+	+				

Table 1. Proportion and 95 % confidence limits for order Chlorococcales.

Order	Family	Proportion	Confidence limits
Chlorococcales	Oocystaceae	0.47	(0.4195, 0.5185)
	Chlorococcaceae	0.70	(0.46, 0.984)
	Dictyosphaeriaceae	0.57	(0.393, 0.747)
	Characiaceae	0.53	(0.351, 0.709)
	Coelastraceae	0.45	(0.296, 0.604)
	Hydrodictyaceae	0.87	(0.785, 0.955)
	Scenedesmaceae	0.43	(0.358, 0.502)

1. The Confidence Interval estimate of Oocystaceae (Family) was found to be (0.4195, 0.5185)
2. The Confidence Interval estimate of Chlorococcaceae (Family) was found to be (0.46, 0.984)
3. The Confidence Interval estimate of Dictyosphaeriaceae (Family) was found to be (0.393, 0.747)
4. The Confidence Interval estimate of Characiaceae (Family) was found to be (0.296, 0.604)
5. The Confidence Interval estimate of Coelastraceae (Family) was found to be (0.296, 0.604)
6. The Confidence Interval estimate of Hydrodictyaceae (Family) was found to be (0.785, 0.955)
7. The Confidence Interval estimate of Scenedesmaceae (Family) was found to be (0.358, 0.502)

Table 2. Proportion and 95% confidence limits for order Cladophorales.

Order	Family	Proportion	Confidence limits
Cladophorales	Cladophoraceae	0.70	0.558, 0.842

1. The Confidence Interval estimate of Cladophoraceae (Family) was found to be (0.558, 0.842)

Table 3. Proportion and 95% confidence limits for order Chaetophorales.

Order	Family	Proportion	Confidence Limits
Chaetophorales	Chaetophoraceae	0.40	(0.096, 0.704)
	Chaetosphaeridiaceae	0.40	(0.096, 0.704)
	Coleochaetaceae	0.70	(0.416, 0.984)

1. The Confidence Interval estimate of Chaetophoraceae (Family) was found to be (0.096, 0.704)
2. The Confidence Interval estimate of Chaetosphaeridiaceae (Family) was found to be (0.096, 0.704)
3. The Confidence Interval estimate of Coleochaetaceae (Family) was found to be (0.416, 0.984)

Table 4. Proportion and 95% confidence limits for order Sphaeropleales.

Order	Family	Proportion	Confidence limits
Sphaeropleales	Sphaeropleaceae	0.40	(0.096, 0.704)

1. The Confidence limits for Sphaeropleaceae (Family) was found to be (0.096, 0.704)

Table 5. Proportion and 95% confidence limits for order Oedogoniales.

Order	Family	Proportion	Confidence limits
Oedogoniales	Oedogonioceae	0.85	(0.694, 1.006)

1. The Confidence limits for Oedogonioceae (Family) was found to be (0.694, 1.006)

Table 6. Proportion and 95% confidence limits for order Tetrasporales.

Order	Family	Proportion	Confidence limits
Tetrasporales	Palmellaceae	0.49	(0.369, 0.603)
	Cocomaxaceae	0.50	(0.281, 0.719)
	Tetrasporaceae	0.52	(0.382, 0.658)

1. The Confidence Interval estimate of Palmellaceae (Family) was found to be (0.369, 0.603)
2. The Confidence Interval estimate of Cocomaxaceae (Family) was found to be (0.281, 0.719)
3. The Confidence Interval estimate of Tetrasporaceae (Family) was found to be (0.382, 0.658)

Table 7. Proportion and 95% confidence limits for order Ulotrichales.

Order	Family	Proportion	Confidence limits
Ulotrichales	Ulotrichaceae	0.67	(0.551, 0.789)
	Microsporaceae	0.20	(-0.048, 0.448)
	Cylindrocapsaceae	0.40	(0.096, 0.704)

1. The Confidence Interval estimate of Ulotrichaceae (Family) was found to be (0.551, 0.789)
2. The Confidence Interval estimate of Microsporaceae (Family) was found to be (-0.048, 0.448)
3. The Confidence Interval estimate of Cylindrocapsaceae (Family) was found to be (0.096, 0.704)

Table 8. Proportion and 95% confidence limits for order Volvocales.

Order	Family	Proportion	Confidence limits
Volvocales	Chamydomonadaceae	0.70	(0.558, 0.842)
	Haematococcaceae	0.10	(0.031, 0.231)
	Volvocaceae	0.43	(0.304, 0.555)

1. The Confidence Interval estimate of Chamydomonadoceae (Family) was found to be (0.558, 0.842)
2. The Confidence Interval estimate of Haematococcaceae (Family) was found to be (0.031, 0.231)
3. The Confidence Interval estimate of Volvocaceae (Family) was found to be (0.304, 0.555)

Table 9. Proportion and 95% confidence limits for order Zygnematales.

Order	Family	Proportion	Confidence limits
Zygnematales	Desmidiaceae/Closterieae	0.66	(0.510, 0.809)
	Cosmarieae	0.52	(0.417, 0.623)
	Zygnemataceae	0.63	(0.517, 0.743)

1. The Confidence Interval estimate of Desmidiaceae/Closterieae (Family) was found to be (0.510, 0.809)
2. The Confidence Interval estimate of Cosmarieae (Family) was found to be (0.417, 0.623)
3. The Confidence Interval estimate of Zygnemataceae (Family) was found to be (0.517, 0.743)

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