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DIVERSITY OF THE GENERA OF CHLOROPHYTA IN FRESH WATERS OF DISTRICT SWAT N.W.F.P PAKISTAN

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Abstract

Fifty six genera of green algae were collected from ten different localities of District Swat, belonging to 25 families and 9 genera of Chlorophyta from December 2006 August 2008. Family Oocystaceae with 39 species was most commonly found, next to it were families Scenedesmaceae with18 species and Desmidiaceae with 14 species. The genera Oocystis and Tetraedron were represented by 10 species and Cosmarium with 7 species occurred most commonly. Among the recorded genera 13 (23.2%) were Unicellular, 25 (44.6%) were Colonial, 9 (16.7%) were Unbranched filamentous, 4 (7.1%) were branched filamentous, 1 (1.7%) was Pseudofilamentous, 1 (1.7%) was Mesh-like, 2 (3.5%) were Heterotrichous and 1 (1.7%) was with Irregular amorphous thallus. Highest proportion of Chlorophycean members was recorded from Kanju area 89 and lowest was recorded from Kalam 69.

Introduction

The Valley of Swat a part of Malakand Division covers 5737 square kilometers (estimated). 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. Faridi (1971) recorded some genera of fresh water algae from Pakistan and Azad Kashmir. Leghari *et al.,* (2001) reported 46 species of Chlorophycean members belonging to order Chlorococcales from Sindh. Reshmi (2004) conducted a detailed study on Chlorophycean biodiversity in Wet lands on Satna (M.P.) India. The study revieled 32 genera and 52 species belonging to 18 families and 7 orders of Chlorophyceae, which were recorded from different wet lands of Satna. Kumar & Rai (2005) recorded 13 taxa of Chlorophyceae from Namchi, Sikkim-Himalayas. Misra *et al.,* (2005) worked on some fresh water algae of Eastern Uttar Pradesh, India. Their communication deals with morpho-taxonomic description of 11 fresh water algae belonging to class Chlorophyceae and Bacillariophyceae. Sarim and 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. Zarina *et al*., (2005) worked on Green algae and made large collections from various Districts of Punjab. Tiwari and Chauhan (2006) studied the seasonal phytoplanktonic diversity of Kitham Lake, Agra. There collections were dominated with Chlorophycean members. Zarina *et al*., (2009) described 22 genera and 127 species of Green algae from Punjab and neighboring areas of Pakistan. The recent report of algal species diversity was reported in Swat by Ali *et al*., 2010 and 2010a.

Materials and Methods

Algal collections were made during December 2006 to August 2008 from various localities of District Swat. The specimens were identified with the help of authentic literature (Smith, 1950; Prescott, 1961; Siddiqi & Faridi, 1964; Tiffany & Britton, 1971; Akiyama & Yamagishi, 1981).

Results and Discussion

Fifty six genera containing 138 species belonging to 25 families and 9 orders have been collected from various fresh water habitats. Collected algal members were identified up to species level. (Tables 1-2).

1. Taxonomic diversity: Chlorophyta was represented by 9 orders, 25 families, 56 genera and 138 species. Family Oocystaceae was represented by 12 genera, Palmallaceae and Volvocaceae by 5 genera each, Scenedesmaceae, Cladophoraceae and Zygnemataceae by 3 genera each, Dictyosphaeriaceae, Hydrodictyaceae, Oedogoniaceae, Tetrasporaceae, Ulotrichaceae and Cosmarieae by 2 genera each, while Chlorococcaceae, Characiaceae, Chaetophoraceae, Chaetosphaeridiaceae, Coleochaetaceae, Sphaeropleaceae, Cocomaxaceae, Microsporaceae, Cylindrocapsaceae, Haematococcaceae and Desmidiaceae/Closterieae were represented by 1 genera each.

2. Thallus diversity: Among the recorded 56 Chlorophycean genera 13 (23.21%) were Unicellular forms, 25 (44.64%) were belonging to Colonial types, 9 (16.07%) were Unbranched Filamentous forms, 4 (7.14%) were Branched Filamentous thalli, 2 (3.57%) were those belonging to Heterotrichous thalli, while Pseudofilamentous, Mesh-Like thallus and Anastomosing thallus were recorded as 1 (1.78%) genera each.

3. Diversity of localities: Collections were made from 10 different localities of Swat District. During present study highest proportion of Chlorophycean members was recorded from Kanju 89 (64.49%). It was followed by Kabal 86 (62.31%), Aligrama 85 (61.59%), Matta 74 (53.62%), Khwaza Khela 73 (52.89%), Madian and Bahrain 70 (50.72%) each. Lowest number was that of Kalam 69 (50.00%).

4. Seasonal variation: Collections were made during all seasons, i.e., summer, autumn, winter and spring. Highest number of Chlorophycean members was recorded during summers and autumn. Winters displayed comparatively low Chlorophycean diversity. As we know that winters are a bit harsh in upper Swat region and are accompanied with heavy snowfall and hail storms so most of the Green algal members form resistant spores and parenting bodies to tide over the winters.

Table 1. Thallus Diversity exhibited by Chlorophycean Genera from fresh waters of District Swat.

S.No.	Algal taxa	1Uni		2Colo		3UBF		4BF		5PsF		6ML		7HT		8IRR	
		No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
	Division Chlorophyta																
	Class Chlorophyceae	138															
	Order Chlorococcales																
	Family Oocystaceae																
1.	Ankistrodesmus Corda	5	3.6														
2.	Chlorella Beyerinck	2	1.4														
3.	Dactylococcus Naegeli									1	0.7						
4.	Gloetaenium Hansgirg			1	0.7												
5.	Kirchneriella Schmidle									2	1.4						
6.	Nephrocytium Naegeli			2	1.4												
7.	Oocystis Naegeli *in* A. Braun			10	7.2												
8.	Quadrrigula Printz			1	0.7												
9.	Selenastrum Reinsch			1	0.7												
10.	Tetraedron Kuetzing	10	7.2														
11.	Trochiscia Kuetzing	3	2.2														
12.	Westella de Wildemann			1	0.7												
	Family Chlorococcaceae																
13.	Chlorococcum Fries	1	0.7														
14.	Dictyosphaerium Naegeli			2	1.4												
15.	Dimorphococcus A. Braun			1	0.7												
	Family Characiaceae																
16.	Characium A. Braun *in* Kuetzing	3	2.2														
	Family Coelastraceae																
17.	Coelastrum Naegeli *in* Kuetzing			4	2.9												
	Family **Hydrodictyaceae**																
18.	Hydrodictyon Roth											1	0.7				
19.	Pediastrum Meyen			5	3.6												
	Family Scenedesmaceae																
20.	Actinastrum Lagerheim			1	0.7												
21.	Crucigenia Morren			7	5												
22.	Scenedesmus Meyen			10	7.2												
	Order Cladophorales																
	Family Cladophoraceae																
23.	23. Basicladia Hoffman & Tilden							1	0.7								
24.	Cladophora Kuetzing							1	0.7								
25.	Pithophora Wittrock							2	1.4								
	Order Chaetophorales																
	Family Chaetophoraceae																
26.	Chaetophora Schrank							1	0.7								
	Family Chaetosphaeridiaceae																
27.	Chaetospharidium Klebahn	1	0.7														
	Family Coleochaetaceae																
28.	Coleochaete de Brebisson													1	0.7		
	Order Sphaeropleales																
	Family Sphaeropleaceae																
29.	Sphaeroplea C. A. Agardh					1	0.7										

Table 1. (Cont'd.).

S.No.	Algal taxa	1Uni		2Colo		3UBF		4BF		5PsF		6ML		7HT		8IRR	
		No	%	No	%	No	%	No	%	No	%	No	%	No	%	No	%
	Order Oedogoniales																
	Family Oedogoniaceae																
30.	Oedogonium Link					1	0.7										
31.	Bulbochaete C. A. Agardh							1	0.7								
	Order Tetrasporales																
	Family Palmellaceae																
32.	Asterococcus Scherffel	1	0.7														
33.	Gloeocystis Naegeli			3	2.2												
34.	Palmella Lyngbye															1	0.7
35.	Palmodictyon Kuetzing															1	0.7
36.	Sphaerocystis Chodat			1	0.7												
	Family Cocomaxaceae																
37.	Elakatothrix Wille			2	1.4												
	Family Tetrasporaceae																
38.	Tetrospora Link															3	2.2
39.	Schizochlamys Braun *in* Kuetzing															2	1.4
	Order Ulotrichales																
	Family Ulotrichaceae																
40.	Geminella Turpin					2	1.4										
41.	Ulothrix Kuetzing					4	2.1										
	Family Microsporaceae																
42.	Microspora Thuret					1	0.7										
	Family Cylindrocapsaceae																
43.	Cylindrocapsa Reinsch					1	0.7										
	Order Volvocales																
	Family Chlamydomonadaceae																
44.	Chlamydomonas Ehrenberg	4	2.1														
	Family Haematococcaceae																
45.	Haematococcus C.A.Agardh Icon Algar	1	0.7														
	Family Volvocaceae																
46.	Gonium Mueller, Silva %Wade			1	0.7												
47.	Eudorina Ehrenberg			1	0.7												
48.	Pandorina Bory			1	0.7												
49.	Pleodorina Shaw			1	0.7												
50.	Volvox Linnaeus			2	1.4												
	Order Zygnematales																
	Family Desmidiaceae/Closterieae																
51.	Closterium Nitzsch	5	3.6														
	Sub-family Cosmarieae																
52.	Cosmarium Corda	7	5														
53.	Staurastrum Meyen	2	1.4														
	Family Zygnemataceae																
54.	Spirogyra Link					2	1.4										
55.	Mougeotia (C.A. Agardh) Wittrock					4	2.1										
56.	Zygnema C. A. Agardh					1	0.7										

(**Uni-** Unicellular **Colo-** Colonial **UBF-** Unbranched Filamentous **BF-** Branched Filamentous **PsF-** Pseudofilamentous **ML-** Mesh like thallus **HT-** Heterotrichous **IRR-** Irregular thallus)

Table 2. Diversity of Chlorophycean Genera from different localities of Swat.

	Algal taxa	Saidu Sharif		Kalam		Aligrama		Kabal		Ningolai		Matta		Khwaza Khela		Madian		Bahrain		Kalam	
		No:	%	No:	%	No:	%	No:	%	No:	%	No:	%	No:	%	No:	%	No:	%	No:	%
	Division Chlorophyta																				
	Class Chlorophyceae	73		89		85		86		71		74		73		70		70		69	
	Order Chlorococcales																				
	Family Oocystaceae																				
1.	Ankistrodesmus Corda	4	5.4	-	-	5	5.8	5		-	-	5		-	-	4		3		3	
2.	Chlorella Beyerinck	2	2.7	2	2.2	2	2.3	2		2		2		1		1		-	-	-	-
3.	Dactylococcus Naegeli	-	-	1	1.1	1	1.1	-	-	-	-	1		-	-	-	-	-	-	-	-
4.	Gloetaenium Hansgirg	-	-	1	1.1	1	1.1	-	-	-	-	-	-	1		-	-	-	-	-	-
5.	Kirchneriella Schmidle	1	1.3	2	2.2	2	2.3	1		1		1		-	-	2		1		1	
6.	Nephrocytium Naegeli	2	2.7	2	2.2	2	2.3	1		-	-	1		2		-	-	-	-	-	-
7.	Oocystis Naegeli in A. Braun	6	8.2	5	5.6	3	3.5	8		5		3		-	-	5		4		3	
8.	Quadrrigula Printz	-	-	-	-	-	-	-	-	1		1		1		-	-	-	-	-	-
9.	Selenastrum Reinsch	-	-	1	1.1	1	1.1	1		1		1		1		-	-	1		-	-
10.	Tetraedron Kuetzing	2	2.7	3	3.3	4	4.7	5		3		7		6		9		8		3	
11.	Trochiscia Kuetzing	-	-	3	3.3	-	-	-	-	-	-	1		1		-	-	-	-	-	-
12.	Westella de Wildemann	-	-	-	-	-	-	-	-	1		1		1		-	-	-	-	-	-
	Family Chlorococcaceae	1	1.3	1	1.1	1	1.1	1		1		1		-	-	-	-	1		-	-
13.	Chlorococcum Fries																				
14.	Dictyosphaerium Naegeli	2	2.7	2	2.2	2	2.3	-	-	-	-	-	-	2		-	-	1		1	
15.	Dimorphococcus A. Braun	1	1.3	1	1.1	1	1.1	-	-	1		1		-	-	-	-	1		1	
	Family Characiaceae																				
16.	Characium A. Braun in Kuetzing	1	1.3	2	2.2	3	3.5	2		2		1		1		1		2		1	
	Family Coelastraceae																				
17.	Coelastrum Naegeli in Kuetzing	3	4.1	2	2.2	2	2.3	2		2		-	-	2		1		2		2	
	Family **Hydrodictyaceae**																				
18.	Hydrodictyon Roth	1	1.3	1	1.1	1	1.1	1		1		1		1		1		1		1	
19.	Pediastrum Meyen	4	5.4	5	5.6	4	4.7	4		4		4		4		5		4		4	
	Family Scenedesmaceae																				
20.	Actinastrum Lagerheim	-	-	-	-	-	-	-	-	1		1		1		1		-	-	-	-
21.	Crucigenia Morren	6	8.2	5	5.6	5	5.8	4		-	-	4		4		1		-	-	2	
22.	Scenedesmus Meyen	1	1.3	10	11.2	3	3.5	8		7		1		-	-	-	-	9		1	
	Order Cladophorales																				
	Family Cladophoraceae																				
23.	Basicladia Hoffman & Tilden	-	-	-	-	-	-	-	-	-	-	-	-	1		1		-	-	-	-
24.	Cladophora Kuetzing	1	1.3	1	1.1	1	1.1	1		1		1		1		1		1		1	
25.	Pithophora Wittrock	1	1.3	2	2.2	2	2.3	2		-	-	2		2		2		2		1	
	Order Chaetophorales																				
	Family Chaetophoraceae																				
26.	Chaetophora Schrank	-	-	-	-	-	-	-	-	-	-	-	-	1		1		1		1	
	Family Chaetosphaeridiaceae																				
27.	Chaetospharidium Klebahn	-	-	-	-	-	-	1		1		1		1		-	-	-	-	-	-
	Family Coleochaetaceae																				
28.	Coleochaete de Brebisson	1	1.3	1	1.1	1	1.1	-	-	1		1		1		1		-	-	-	-
	Order Sphaeropleales																				
	Family Sphaeropleaceae																				
29.	Sphaeroplea C. A. Agardh	1	1.3	-	-	-	-	1		1		1		-	-	-	-	-	-	-	-

Table 2. (Cont'd.).

Algal taxa	Saidu Sharif		Kalam		Aligrama		Kabal		Ningolai		Matta		Khwaza Khela		Madian		Bahrain		Kalam	
	No:	%	No:	%	No:	%	No:	%	No:	%	No:	%	No:	%	No:	%	No:	%	No:	%
Order Oedogoniales																				
Family Oedogoniaceae																				
30. Oedogonium Link	1	1.3	1	1.1	1	1.1	1		1		1		1		1		1		1	
31. Bulbochaete C. A. Agardh	1	1.3	1	1.1	1	1.1	1		1		1		1		-	-	-	-	-	-
Order Tetrasporales																				
Family Palmellaceae																				
32. Asterococcus Scherffel	-	-	-	-	1	1.1	1		1		1		1		1		1		1	
33. Gloeocystis Naegeli	-	-	3	3.3	3	3.5	2		1		1		3		1		1		1	
34. Palmella Lyngbye	-	-	-	-	-	-	-	-	1		1		-	-	1		-	-	1	
35. Palmodictyon Kuetzing	-	-	1	1.1	1	1.1	1		-	-	-	-	-	-	-	-	-	-	-	-
36. Sphaerocystis Chodat	-	-	-	-	-	-	1		1		1		-	-	-	-	-	-	-	-
Family Cocomaxaceae																				
37. Elakatothrix Wille	2	2.7	1	1.1	2	2.3	2		1		-	-	-	-	2		-	-	-	-
Family Tetrasporaceae																				
38. Tetrospora Link	2	2.7	3	3.3	2	2.3	-	-	2		-	-	3		2		2		1	
39. Schizochlamys Braun in Kuetzing	2	2.7	2	2.2	2	2.3	-	-	-	-	-	-	2		1		-	-	-	-
Order Ulotrichales																				
Family Ulotrichaceae																				
40. Geminella Turpin	2	2.7	-	-	-	-	2		-	-	-	-	-	-	-	-	-	-	-	-
41. Ulothrix Kuetzing	4	5.4	4	4.4	4	4.7	3		3		4		3		3		4		4	
Family Microsporaceae																				
42. Microspora Thuret	-	-	1	1.1	1	1.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Family Cylindrocapsaceae																				
43. Cylindrocapsa Reinsch	-	-	-	-	-	-	-	-	-	-	1		1		1		1		-	-
Order Volvocales																				
Family Chlamydomonadaceae																				
44. Chlamydomonas Ehrenberg	3	4.1	4	4.4	3	3.5	2		2		4		4		3		1		2	
Family Haematococcaceae																				
45. Haematococcus C.A.Agardh Icon Algar	-	-	-	-	-	-	-	-	1		1		-	-	-	-	-	-	-	-
Family Volvocaceae																				
46. Gonium Mueller, Silva %Wade	1	1.3	-	-	1	1.1	1		1		1		1		1		1		-	-
47. Eudorina Ehrenberg	-	-	1	1.1	1	1.1	1		1		1		-	-	-	-	-	-	-	-
48. Pandorina Bory	1	1.3	-	-	-	-	-	-	1		-	-	1		1		-	-	-	-
49. Pleodorina Shaw	1	1.3	-	-	1	1.1	1		-	-	1		1		1		1		1	
50. Volvox Linnaeus	2	2.7	2	2.2	2	2.3	2		2		-	-	2		2		2		2	
Order Zygnematales																				
Family Desmidiaceae/Closterieae																				
51. Closterium Nitzsch	2	2.7	4	4.4	3	3.5	3		4		3		3		3		4		4	
Sub-family Cosmarieae																				
52. Cosmarium Corda	4	5.4	5	5.6	2	2.3	5		3		4		5		6		5		5	
53. Staurastrum Meyen	-	-	-	-	-	-	-	-	-	-	-	-	2		-	-	-	-	2	
Family Zygnemataceae																				
54. Spirogyra Link	2	2.7	2	2.2	2	2.3	2		2		2		2		2		2		2	
55. Mougeotia (C.A. Agardh) Wittrock	1	1.3	-	-	4	4.7	4		4		1		-	-	-	-	-	-	-	-
56. Zygnema C. A. Agardh	1	1.3	1	1.1	1	1.1	1		1		1		1		1		1		1	

Simpson's Diversity Index (D): The Simpson's Index (D) measures the probability that two individual randomly selected from a sample will belong to the same species. The Simpson's Index (D) is defined as:

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

where n = Total number of organism of a particular species and N = total number of organism of all species
The value D will always lie between 0 and 1
0 represent infinite diversity & 1 represent no diversity
The larger the value of D the lower will be diversity

Table: Diversity index for families of Chlorophyta in District Swat.

Order	Family	D
Chlorococcales	Oocystaceae	0.0420
	Chlorococcaceae	0. 0022
	Dictyosphariaceae	0.0044
	Characiaceae	0.0047
	Coelastraceace	0.0038
	Hydrodictyaceae	0.021
	Scenedesmaceae	0.014
Cladophorales	Cladophoraceae	0.011
Chaetophorales	Chaetophoraceae	0.0006
	Chaetosphaeridiaceae	0.0006
	Coleochaetaceae	0.0022
Sphaeropleales	Sphaeropleaceae	0.0006
Oedogonialles	Oedogoniaceae	0.0077
Tetrasporales	Palmellaceae	0.008
	Cocomaxaceae	0.0022
	Tetrasporaceae	0.0066
Ulotrichales	Ulotrichaceae	0.0157
	Microsporaceae	0.0001
	Cylindrocapsaceae	0.0006
Volvocales	Chlamydomonadaceae	0.0090
	Haematococcaceae	0.0001
	Volvocaceae	0.0081
Zygnematales	Desmidiaceae/ Closterieae	0.0122
	Cosmarieae	0.0145
	Zygnemataceae	0.0161

CONVOLVULUS SCINDICUS: CONSERVATION ASSESSMENT AVOIDING EXTIRPATION

References

Akiyama, M. and T. Yamagishi. 1981. Illustrations of the Japanese Fresh water algae published by Uchidarokokuho Publishing Co. Ltd. 1-2-1 Kudankita Chiyoda ker, Tokyo, Japan U.R. No. 200-2 p. 1-933.

Ali, A., Z.K. Shinwari and F.M. Sarim 2010. Contribution to the algal flora (Chlorophyta) of fresh waters of district Swat. NWFP, Pakistan. *Pak. J. Bot*., 42(5): 3457-3462

Ali, A., Z.K. Shinwari and F.M. Sarim. 2010a. Confidence limits for Chlorophycean members recorded from fresh waters of district Swat N.W.F.P. Pakistan. *Pak. J. Bot*., 42(6): 4157-4167

Faridi, M.A.F. 1971. The genera of fresh water algae of Pakistan and Kashmir. *Biologia*, 17: 123-142.

Kumar, S. and S.K. Rai. 2005. Contribution to the algal flora (Chlorophyceae) of Namchi, Sikkim-Himalayas. *Our Nature.* 3: 50-55.

Leghari, S.M., S.N. Arbani and T.M. Jehangir. 2001. Chlorococcales (Chlorophyta) of Sindh, Pakistan. *OnLine Journal of Biological Sciences* 1 (6): 451-455, 2001© Asian Network for Scientific Information 2001, 451-455.

Misra, P.K., A.K. Srivastava, J. Prakash, D.K. Asthana and S.K. Rai. 2005. Some fresh water algae of eastern Uttar Pradesh, India. *Our Nature* 3: 77-80.

Prescott, G.W. 1961. Algae of the western great lake area monograph. Michigan State University, 1-975.

Reshmi, S. 2004. Chlorophycean biodiversity in Wet lands of Satna (M.P.) India. *Biodiversity and Environment*, 171-190.

Sarim, F.M. and A. Zaman. 2005. Some freshwater algae of District Charsadda NWFP, Pakistan. *Peshawar University Teacher`s Association Journal, (PUTAJ).,* 12: 5-10.

Siddiqi, I.I. and M.A.F. Faridi. 1964. The Chlorococcales of Peshawar valley. *Biologia.,* 10: 1-88.

Smith, G.M. 1950. Fresh water algae of United State of America. Mc Graw Hill, New York.

Tiffany, L.H. and M.E. Britton, 1971. *The Algae of Illinois*: 395 Hapner P. Comp.

Tiwari, A. and S.V. Chauhan. 2006. Seasonal phytoplanktonic diversity of Kitham lake, Agra. *J. Environ Biol.,* Jan; 27(1): 35-38.

Zarina, A., Masud-ul-Hasan and M. Shameel. 2005. Taxonomic study of order Ulotrichales (Chlorophyta) from North-Eastern areas of Pakistan. *Pak. J. Bot*., 37(4): 797-806.

Zarina, A., Masud-ul-Hasan and M. Shameel. 2009. Diversity of freshwater green macro-algae in the Punjab and neighbouring areas of Pakistan. *Pak. J. Bot.,* 41: 277-291.

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