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INDEXING THE CYANOBACTERIAL COMMUNITIES OF DIFFERENT ECOLOGICAL HABITATS OF MALAKAND PAKISTAN

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ABSTRACT

The fresh water habitat studied were river, streams, ponds, stagnant water and waste water. Among this stagnant water, ponds were found to be most favorable for the growth of most of the species. Similarly, slow running water was also found to favor algae growth. Algae species were reported from all water bodies. There is a great variety of algae existing in the water bodies of District Malakand. It is evident that among the seasons the best growth season for almost all genera of cyanobacteria was summer. Apart from summer some of the species were common for all the seasons and some were common to summer with early winter or spring. A total of 68 blue-green algal species belonging to 29 genera were recorded from the various habitats in five major regions of district Malakand. The genera identified were: Anabaena (4 spp.), Anacystis (1 sp.), Aphanocapsa (3 spp.), Aphanothece (2 spp.), Arthrospira (3 spp.), Calothrix (4 spp.), Chroococcus (4 spp.), Cyanobacterium (1 sp), Cylindrospermum (3 sp.), Geitlerinema (2 spp.), Gloeocapsa (4 spp.), Gloeothece (1 sp.), Gloeotrichia (2 spp.), Lyngbya (3 spp.), Merismopedia (6 spp.), Microchaete (1 sp.), Microcoleus (1 sp.), Microcystis (4 spp.), Nodularia (1 sp.), Nostoc (2 spp.), Oscillatoria (4 spp.), Pleurococcus (1 sp.), Phormidium (1 sp.), Planktothrix (1 sp.), Plectonema (1 sp.), Rivularia (1 sp.), Scytonema (2 spp.), Spirulina (2 spp.) and Synechococcus (2 spp.). The present study showed that District Malakand is rich in algal diversity and needs firther investigations.

Key words: Algae, Cyanobacteria, diversity, habitat, Malakand Pakistan.

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INTRODUCTION

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This part of the present research work is related to the identification of algae from different habitats of district Malakand. Algae are a very important group of organisms and can affect human life both positively and negatively. Algae are a good source of food and energy. Among them the unicellular algae has a major contribution as food source (Geoghegan, 1951). Chlorella is the rich source of nutrients for the chick (Combs, 1952) and the most useful organism to fix atmospheric nitrogen especially the blue green algae (Allison and Morris, 1930). Nitrogen fixing blue-green algae has a positive effect on the growth of rice (Watanabe *et al.*, 1951). Certain algae help in utilization of nitrogenous organic compounds and sodium salts of organic acids like some of the soil inhabiting algae (Skinner and Gardner, 1930), amino acids (Fowden, 1951) like lysine and threonine (Hundley *et al.*, 1956) and a new amino acid Gigartinien(Ito and Hashimoto, 1966), citric acids (Creac'H, 1952), Ascorbic acids (Creac'H and Baraud, 1954) and Arginine in free and combined form (Dokhan, 1953). Enzymes like oxidase, transoxidase(Yamafuji *et al.*, 1954) and aldolase (Van Baalen, 1965) can be obtained from different kinds of algae. Both freshwater and marine water algae are a rich source of vitamins like vitamin B12 (Hashimoto, 1954), B-complex vitamins (Teeri and Bieber, 1958).

MATERIALS AND METHODS

To investigate algae species and the various growth parameters in the research area,various sites were selected from District Malakand on the basis of adequate water bodies present. These sampling sites were based on the kind of water i.e. stagnant/running, number of water bodies, profundity of water bodies, seasonality, contamination and turbidity of water bodies. The main sites selected for current work were Thana, Batkhela, Malakand, Dargai and Shergarh areas of district Malakand. Sample collection was done from various water bodies of these seven major areas.

Regular monthly algal samplings were made (January 2012-January 2013) using planktonic net, hand picking, scratching of various materials in water, and taking water in bottles from the surface and at the depth of 2-3 meters below for the study of physico-chemical characteristics of water and identification of phytoplankton. Duplicate samples were also collected from each sampling spot at 10:00 am and 2:00 pm with a phytoplankton net of mesh size for the microalgae

For the taxonomic studies of algal flora samples were collected and preserved in 4% formalin. Algal identification was made using inverted electric microscope (BH-2 Olympus, Japan). Photomicrographs were taken with camera LetizWetzlarand

identification was made with the help of Prescott (1941), Tiffany and Briton (1952), Faridi (1977, 1978), Shah (1984, 1999, 2000, 2001), and Shameel (2003). The collection has been deposited at the Department of Botany, Islamia College Peshawar (A public sector university).

RESULTS AND DISCUSSION

The blue green algae dominated almost all habitat and seasons of the year. They were found in collection from stagnant, running and waste water bodies of the research area. Among the different seasons and water body's nature, a variety of blue-green algae was observed in summer seasons and stagnant water was found to be especially more suitable for their growth. The high temperature has a positive effect on the growth of both freshwater and marine algae. The growth can double in temperature up to 40C (Goldman and Carpenter, 1974). Growth environment for blue-green algae are suitable even in terrestrial habitat of the research area. BARKATULLAH *et al.* (2013) described 30 lithophytic species of blue-green algae from research site Batkhela.

Anabaena with four different species was recorded in almost all seasons of the year from different localities (Table-1). This genus was previously recorded by (Naz *et al.*, 2011) who observed 16 species from different parts of the country including one species from Kalam, Malakand. Similarly, (Zarina *et al.*, 2010) recorded nine species of Anabaena from northeastern part of the country which also includes Kalam and Bahrin. The Genus Anacytis was represented by single species only which was observed in the early summer collection only. Anacystis may grow well in slightly hot seasons (Tassaduqe *et al.*, 2003) observed the members of Anacystis from Indus river in the month of April which shows closeness to our results.

The genus Aphanothece was represented by two species in our collection which was *A. castagnei* and *A. pallida*. Three species of Aphanothece, including A.castagnei, were recorded from the collection of Leghari *et al.* (2004) from Wah garden, Attock. Similarly a single species of Aphanothece i.e.,A.stignina were also recorded by Jahangir *et al.* (2001) from ManghoPir geothermal springs Karachi, Sindh. Arthrospira, a genus, with three species were recorded from different spots of the district. This genus was frequent in all the seasons especially summer and spring. This genus was found commonly in stagnant water and those areas which were affected by the domestic drainages. Three species of the said genus were reported by *Mahar et al.* (2000) from Mancher lake Dadu as poisonous species.

The genus Calothrix was represented by four species in our results from different habitat of the district. The members of the genus were common in stagnant or very slow running water and were present in all seasons of the year. Sarim and Afzal (2008) reported a single species of

Calothrix i.e. *C. paritina* from their collection of Tarbella Dam. Our results showed different species (Table-1) from their work. Chroococcus was also represented by four species from the collection. It was common in waste water, stagnant water and slow running water. The average observance for this genus was the same for almost all seasons. Two species of Chroococcus were recorded by Naveed *et al.* (2012) in a vegetative form from district Karrak. While four species of the said genus were observed by Jahangir *et al.* (2001) from Karachi.

A single species of Cyanobacterium was identified from the bloomy stagnant water collection of the district in the spring season and early summer. The same species was also reported by Zarina *et al.* (2010) from different parts of the country among other species of the same genus. During collection we also found the members of genus Cylindrospermum. This genus was represented by the three species from different regions. This was also commonly found in the stagnant and slow running water. The collection from the river Swat also showed the members of this genus in winter time. Geitlerinema, a genus with two species, were found from our collection*. G. amphibium* was present only in one spot of the whole district i.e., Batkhela. While the second species *G. claricentrosa* was observed from two regions i.e. Thana and Dargai.

Gleocapsa was represented by four species in almost all the seasons of the year from the research area. Zaman *et al.* (2009) observed single species of Gloeocapsa in their collection from Peshawar valley. Similarly (Leghari *et al.*, 2001) observed a single species G. montona from river Kunhar Pakistan. The species is common in both running and stagnant water. A single species of Gleoethece (*G. samoensis*) was observed from two locations in the collection fromBatkhela and Dargai regions of the area. Same species of Gleoethece was collected by (Naz, 2004) from the collection of Shekhapura district. The species was found somewhat adherent to stone and walls or bottom of the running water in the said locations.

rom the collection two species of Gleoetrichia was identified. *G. natans* was identified from area of Thana, Batkhela and Dargai while the *G. pisum* was observed only in Thana and Dargai region of the research area. Members of the same genus was also observed by (Janjua *et al.*, 2009) from Shahpur dam reservoirs Pakistan. The

members of the species were dominant in the stagnant water. They were also observed in slow running water.

The genus Lyngbya was common to all major areas of the present research having three different species (table 1). The species was commonly found in running streams and stagnant water. Four species of the same genus was also reported by Leghari (2000) from different part of the Gilgit region of Pakistan.

The highest number of species in present work was six for any specific genus. Genus Merismopodiahad six species from different parts of the research area. Merismopodia was common in all most all habitats, especially in stagnant water. The species were dominate in summer seasons and were commonly found in early winter and early spring. The number was reduced to very low in a collection from mid-winter. Mahar *et al.* (2000) observed four species of

Merismopodia from Mancher lake Dadu Sindh. He suggested it is one of the common algae which deteriorate the common drinking water making it unfit for use. Microchaete was observed from three parts of district (Table 1) with a single species only. The species *M. aequalis* was present in slow running water and sometime in stagnant water during summer season. Two species of Microchaete were observed by Aliya *et al.* (2009) from freshwater habitat of Karachi Pakistan. They reported the species to be very common in fresh water bodies of Gulshan e Iqbal town Karachi among their research areas.

A single species of Microcoleus was also reported in the present research work i.e. *M. vaginatus*. Shahnaz *et al.* (2009)obsereved*M. accutissimus* for the first time from Pakistan. They observed it in their collection from different freshwater habitats of Lahore Pakistan. The species was reported from Thana region of the research area only and was found in the small stagnant water bodies of the area.

The genus Microcystis was reported with 4 species from the research area. The species were found to be common in all freshwater habitats including waste water. They were common in all seasons of the year and were most abundant in summer season. 3 members of this genus were reported by Mahar *et al.* (2010) while working on fish ponds in Tattha Karachi. The presence of Microcystis in water bodies does not affect their quality for fish life (Mahar *et al.*, 2010).

The next genus Nodularia has a single speciesreported in this work. The species was found only in highly bloomy stagnant water in the area of Shergarh. The previous studies showed the existence of Nodularia from different regions of the country. The same species was also reported by Zarina *et al.* (2010) from northeastern part of the country. The species was present in summer season only. Nostoc with 2 species was reported from three regions of the district. The *N.calcicola* was found in Batkhela and Malakand regions while the *N.*

carneum was restricted to Thana region. They were common in all seasons and all water bodies' especially slow running water. The members of the species was also reported by Janjua *et al.* (2009) from Shahpur dam reservoir and by (Mahar *et al.*, 2000) from Sindh. The species were the inhabitant of bloomy environment but were also found in clear water.

The genus Oscillitoria was common to all habitats of the district and was found in almost all seasons of the year. Members of the genus were reported from all major areas of the district except Malakand. It was represented by four species (table 1). Oscillitoria has also been reported by other researchers with a lot of variation in their species number, type and habitat. Some new species were reported by Faridi and Khalil (1974) for the first time in the country. Similarly single species of *Oscillitoria* was reported by Naveed *et al.* (2012) from district Karrak.

Phormidium was reported with a single species *P.bohneri* from only one spot of the district i.e., Malakand. The species was found in the hot summer season from a small pond. This species may be the inhabitant of somewhat hot conditions. Five members of the same genus was identified by (Jahangir *et al.*, 2001) from Mangopir geothermal spring where the temperature remains between 45-47 C. In this study Palnktothrix was identified with a single species *P. peronata* from a single region Shergarh. The members of this genus were also reported by (Bano and Siddiqui, 2003) from near Karachi city of the country. The species reported in present work was common in bloomy pond which was also found to be toxic and unfit for use. The members of this genus are common to toxic and bloomy habitat (přehled rodů Planktothrix, 2004).

Plectonema was reported from two regions i.e. Thana and Shergarh with a single species *P. terebrans.* The species was found in mid summer in running streams and stagnant water. A single member of this genus was also reported by Sarim and Afzal (2008) from Tarbella dam. Similarly, in the present study, the genus Pleurococcus was also represented by a single species only i.e., P. minor. This species was reported from two areas i.e. Thana and Shergarh. This genus is previously reported by Khan *et al.* (2011) with a single species *P. tomasinianum* from Mardan.

The genus Synechococus was represented by a single species *S. elongatus*. The species was commonly found in spring and summer seasons and in almost all habitat of the district. Similarly, the same species were collected from Kalam region of upper Malakand by Zarina *et al.* (2010). The last genus among blue-green algae was Synechocystis which was represented by two species (Table-1). These species were found in all the five major areas of the present research.

Members of the same genus were reported by Hussain *et al.* (2011) from Katlang region of district Mardan which is located very close to the present research area Shergarh. The collection spot was characterized by blooms and the water was unfit for human and animal use.

Table-1. Distribution of the recorded blue-green algal species in the area.

S. No.	Species	1	2	3	4	5
	Anabaena					
1	*A. inaequalis*	+	-	-	-	-
2	*A. orientalis*	-	+	-	-	+
3	*A. sphaerica*	-	-	-	-	+
4	*A. spiroides*	-	+	-	-	-
	Anacystis					
5	*A. montana*	+	-	-	-	-
	Aphanocapsa					
6	*A. crassa*	-	+	-	-	+
7	*A. pulchra*	-	+	-	+	-
8	*A. virescens*	+	-	-	-	+
	Aphanothece					
9	*A. castagnei*	+	-	-	-	-
10	*A. pallid*	+	-	+	+	-
	Arthrospira					
11	*A. jenneri*	+	-	-	-	-
12	*A. khannae*	-	+	-	+	-
13	*A. major*	+	-	-	-	+
	Calothrix					
14	*C. castellii*	-	+	-	+	-
15	*C. clavata*	-	-	-	-	+
16	*C. contarenii*	+	-	+	-	-
17	*C. minima*	-	-	-	+	-
	Chroococcus					
18	*C. hansgirgii*	+	+	-	+	-
19	*C. minutus*	+	-	+	-	+
20	*C. tenax*	+	+	-	+	+
21	*C. turgidus*	+	-	-	+	-
	Cyanobacterium					
22	*C. cedrorum*	-	-	-	+	+
	Cylindrospermum					
23	*C. majus*	-	-	-	-	+
24	*C. michailovskoense*	+	-	+	-	-
25	*C.musicola*	+	-	-	+	+

	Geitlerinema					
26	*G. amphibium*	-	+	-	-	-
27	*G. claricentrosa*	+	-	-	+	-
	Gloeocapsa					
28	*G. aeruginosa*	+	+	-	-	-
29	*G. calcarea*	+	-	-	-	-
30	*G. gelatinosa*	-	+	-	+	-
31	*G. livida*	+	-	-	-	+
	Gloeothece					
32	*G. samoensis*	-	+	-	+	-
	Gloeotrichia					
33	*G. natans*	+	+	-	+	-
34	*G. pisum*	+	-	-	+	-
	Lyngbya					
35	*L. birgei*	-	+	-	-	+
36	*L. fragilis*	+	-	+	+	-
37	*L. majuscule*	+	-	+	-	-
	Merismopedia					
38	*M. convoluta*	+	-	+	-	-
39	*M. glauca*	-	-	+	+	-
40	*M. haumanii*	+	-	+	-	+
41	*M. marssonii*	-	-	-	-	+
42	*M. minima*	+	-	+	-	-
43	*M. punctata*	+	-	-	+	+
	Microchaete					
44	*M. aequalis*	+	-	+	-	+
	Microcoleus					
45	*M. vaginatus*	+	-	-	-	-
	Microcystis					
46	*M. pulverea*	+	-	-	-	-
47	*M. robusta*	+	-	-	+	-
48	*M. roseana*	-	+	-	-	+
49	*M. viridis*	+	+	-	+	-
	Nodularia					
50	*N. spumigena*	-	-	-	-	+
	Nostoc					
51	*N. calcicola*	-	+	+	-	-
52	*N. carneum*	+	-	-	-	-
	Oscillatoria					
53	*O. acuta*	+	-	-	-	+
54	*O. angusta*	+	-	-	+	+
55	*O. anuguina*	-	+	-	+	-
56	*O. fracta*	-	-	-	-	+
	Phormidium					
57	*P. bohneri*	-	-	-	+	-
	Planktothrix					

58	*P. peronata*	-	-	-	-	+
	Plectonema					
59	*P. terebrans*	+	-	-	-	+
	Pleurococcus					
60	*P. minor*	+	-	-	-	+
	Rivularia					
61	*R. hansgirgii*	-	+	-	-	-
	Scytonema					
62	*S. myochrous*	-	+	+	-	+
63	*S. simplex*	+	+	-	-	+
	Spirulina					
64	*S. laxissima*	-	+	-	+	-
65	*S. platensis*	+	+	-	-	+
	Synechococcus					
66	*S. elongatus*	+	-	+	+	-
	Synechocystis					
67	*S. aquatilis*	+	+	-	+	-
68	*S. pevalekii*	+	-	+	-	+

Sites 1, 2, 3, 4 and 5 representing the area of Thana, Butkhela, Malakand, Dargai and Shergarh district Malakand respectively; while positive and negative signs indicate the presence or absence of a species in particular area.

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