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Composition of Algal Flora from Mahasheer National Park AJK, Pakistan

Saeed Khalil* Mubahshrah Munir Sajid Safeer Rizwan Sarwar Ahmed Faraz
Deoartment of Botany, PMAS Arid Agriculture University Rawalpindi, Pakistan

Abstract
The present study was objectively conducted to analyze the physico-chemical and biological characteristics of the water in the Mahasheer National Park Azad Jammu & Kashmir (AJK). For this study the water samples were collected from five sampling stations; Tetrinote (S1) Jawara (S2), Mainder (S3), Tatapani (S4) and Kotli (S5) during the January 2013 to December 2013; the algal species were identified for the first time from study area. The physico-chemical parameters observed were air temperature, water temperature, turbidity, light transparency, humidity, pH, total dissolved solids (T.D.S), phosphate (PO_4), nitrate, (NO_3), sulphate (SO_4) magnecium (Mg) , calcium (Ca), zinc (Zn) , lead (Pb) iron (Fe) and copper (Cu) during the study. Most of the parameters were in normal range and indicated better quality of lake water. The species of algae identified in the water samples belong to the groups of *Cyanophyta*, *Volvocophyta*, *Bacillariophyta; Euglenophyta, Chlorophyta, Ochrophyta*, *Dinophyta.*
Keywords: Physical / Chemical indicators, algal taxons, Mahasheer National Park.

1.1 Introduction

Water is crucial to life on earth. It is essential for the survival of plants, animals and human beings. Water is very important for all forms of lives, from micro-organisms to man. It has become a serious problem today because all water resources have reached to a point of crisis due to urbanization and industrialization Singh et al., (2002).

Physio-chemical factors of water are very important in estimating the level of contaminants present in it. Contaminated water is the major cause for the spread of many epidemics and some serious diseases like cholera, tuberculosis, typhoid, diarrhea etc. Although number of researchers (Harrison, 1958; Lenat and Crawford, 1994; Biggs, 1995; Gergel et al., 1999; Caraco et al., 2003; Donohue *et al.,* 2006) studied various aspects of water quality and the factors responsible for its degradation in order to formulate an impressive control strategy all over the world yet the problem is on rise.

Phytoplankton play very important role in aquatic food chain. They are primary producers and act as a direct food source for other aquatic organisms. The physico- chemical and biological characteristics of water leads to the production of phytoplanktons. Their composition, distribution, diversity, and abundance is also influenced by these factors. Algae are bio indicators to the quality of water. (Kalyoncu *et al*., 2009; O'Farell *et al.,* 2002; Barinosa *et al.,* 2010). Algae along with phytoplankton present rapid and reliable answers to a varied range of polluting substances (Rishi and Awasthi, 2012). They provide intimation regarding the deterioration of water quality and its possible causes. According to the Water Frame Directive 60 ⁄2000 ⁄ E, the algae are used to estimate the ecological state of the water bodies.

The Poonch River, its tributaries and their beds have been designated as Mahasheer National Park since December, 2010 (Fig.1). The 62 Km length of Poonch River from Madarpur where it enters the AJK territory from occupied Kashmir to Dadyal, where it drains into Mangla dam is Mahasheer's protected area. The name of the park is after the name of fish, the Golden Mahasheer, scientifically known as "*Tor Putitora"* which is the largest freshwater fish on earth found in many of the rivers originating from Himalayas (www.dawn.com/.../ajk-s-poonch-river-is-now-mahasheer-national-park/).

1.2 Materials and methods

Water samples were collected in sterilized bottles from all the sampling stations for the analysis of physico-chemical properties. Air temperature, water temperature, light transparency, Humidity, pH and T.D.S were recorded on the spot. While phosphate (PO_4), nitrate, (NO_3), sulphate (SO_4), magnecium (Mg), calcium (Ca), Zinc (Zn), Lead (pb) iron (Fe) and Copper (Cu) were analyzed at Soil and Water testing Department Rawalpindi, Pakistan. The chemical analysis of water was carried out in accordance with the standard methods mentioned in APHA (2005).

Algal samples were collected from Mahasheer National Park during the period of January 2013 to December 2013. Field trips were made to collect the algal samples with the help of suckers, pipette, forceps, toothbrush, knife and hand picking. The collected samples were transferred into collection bottles and were labeled accordingly at the spot (Munir *et al.,* 2014). Unicellular algae were kept in 2 to 3 % formalin (Munir *et al.,* 2013) while macro algae were preserved in the 4% formalin (Zarina *et al.,* 2009). One drop from each algal sample was taken through pipette and were placed on slide for identification. A cover slip was kept on the slide and examined under the light microscope (BH-2 Olympus, Japan). Photomicrographs of species were taken with the help of camera fitted with the microscope. The specimens were identified with the help of authentic literature

(Tilden, 1910; Hustedt, 1930; Majeed, 1935; Smith, 1950; Prescot, 1962; Patrick and Reimer, 1966; Philopse, 1967; Tiffny and Britton, 1971; Vinyard, 1979).

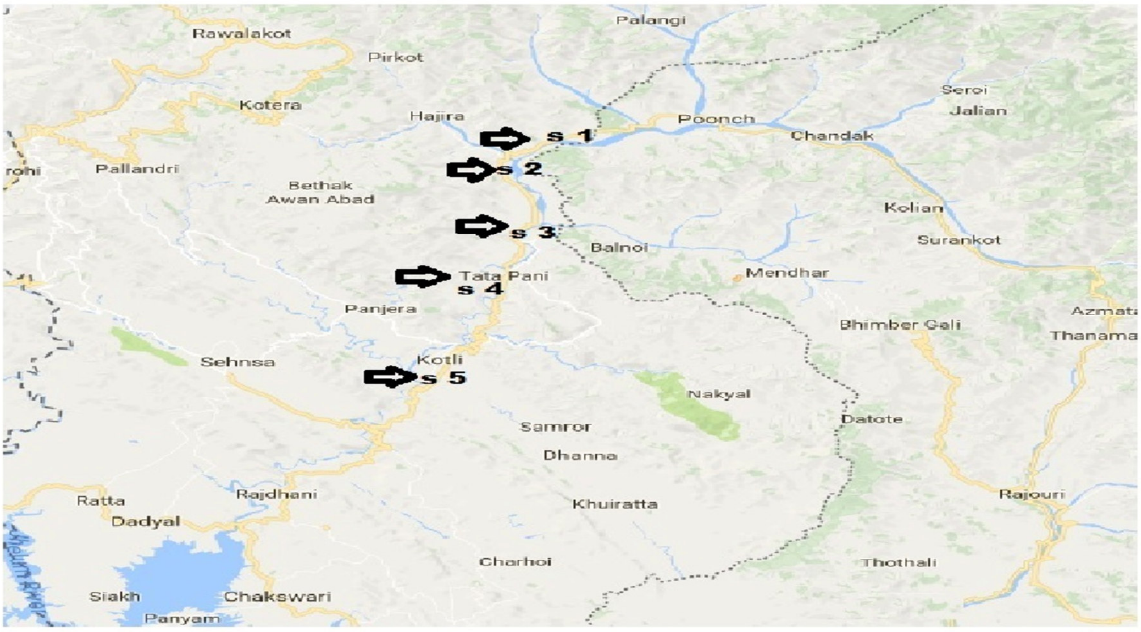

Figure 1. Map of Mahasheer National Park, AJK

1.3 Results and discussions

Algae are of great importance to life on earth. They play a vital role in aquatic food chains as producers. Algae are regularly providing fresh oxygen to aquatic and terrestrial organisms. They are source of food for fish and other aquatic animals important to man. Their luxuriant growth change 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 other organisms in aquatic ecosystems. Physico -chemical properties of water of the Mahasheer National Park showed spatial and temporal variations.

Air Temperature (A.T.) was ranged from 16°C and 35°C (Avg. 25.5 °C). A.T. was highest at Tatapani in August and lowest in February at Tetrinote. Water temperature was ranged from 15°C and 34°C (Avg. 24.5°C). Water temperature was maximum in the month of August at Tatapani and minimum in the month of February at Tetrinote. Temperature is one of the most important ecological factor, which control the physiological behavior and distribution of organisms. It controls various metabolic processes of organisms. According to Welch (1952), the dissolved-oxygen content decreases as temperature rises. During our studies average temperature recoded was 24.5 which is an ideal temperature for the growth of phytoplankton. Physico-chemical parameters such as water temperature, air temperature, turbidity, T.D.S and biological parameters of the water in the Bistrita River in the sector Piatra Neamt-Podoleni were studied and it has been found that that all the parameters were in permissible range and water is not polluted (Surubaru *et al.,* 2012).

pH is an important parameter in the determination of water quality. Maximum and minimum pH Values were ranged from 6.1-8.7 (Avg. 7.4). The maximum pH was recorded in August at Tetrinote and minimum in December at Tatapani. According to Umavathi *et al.,* (2007) pH ranged from 5 to 8.5 is best for plankton growth.

Highest humidity value 88% have been recorded in the month of February at Tatapani while lowest value 49% have been recorded in August at Mainder (Avg. 68.5%). Khan *et al.,* 2012 found similar results.

Turbidity measures the relative clarity of a liquid. Material that causes turbidity is composed of clay, silt, inorganic and organic matter etc. These particles also provide attachment places for other pollutants, metals and bacteria. In this way turbidity values can be used as an indicator of pollution in a water body. Turbidity was ranged from 10-35 NTU respectively. It was highest in June at Kotli and lowest in December at Jawara. Maximum value of turbidity was recorded in June and minimum in December (Avg. 22.5). Similar studies were carried out in Harsool-savingi Dam, India (Shinde *et al.,* 2011).

The light environment of the phytoplankton is an important ecological factor which has a great influence on formation of phytoplankton communities. Light Transparency (L.T.) was ranged from 1.5-3.1 (Avg.2.3) meter in the month of June and December respectively. The highest value was noted at Jawara and lowest value has been recorded at Mainder. L.T. was greater during April while smallest during December. Markku *et al.,* 1999 found almost similar results.

Total dissolved solids (T.D.S) is an important parameter which measures all the dissolved substances, both organic and inorganic in water. The dissolved salts are composed mainly of carbonates, bicarbonates, chloride, sulphate, calcium, magnesium, phosphate, nitrate, sodium and potassium (Trivedy and Goel, 1986. In such a way these solids play an important role in the distribution of phytoplankton. TDS showed significant differences with respect to their concentration among different sampling stations. The highest T.D.S. 302 mg/l and lowest 73 mg/l (Avg. 186.5 mg/l) were found during the months of June and February respectively. T.D.S was highest at Tatapani and lowest at Tetrinote. These results are comparable with average T.D.S value made by Thirupathaiah *et al.,* 2012.

Phosphate (PO_4) is one of the key elements necessary for the growth of plants and animals and in lake ecosystems it tends to be the growth-limiting nutrient. Variations were found in the concentrations of PO_4 which was ranged from 0.2-2 mg/l (Avg. 1.1). The highest value was recorded in June at Tatapani and lowest in October at Jawara. Considerable variations have been observed in the case of SO_4 with a range of 0.10-1.8 (Avg.0.95 mg/l). The highest value was observed in December at Tatapani while the lowest value was observed in June at Mainder. These results are nearly similar with Xhelal *et al.,* 2013.

Nitrate-nitrogen is basic mineral nutrient, which determine the productivity of lake. High yield coefficients, low crude protein contents and low productivities have been observed at low supplies of nitrogen in algae. Nitrogen is present in porphyrin ring of chlorophyll. The highest NO_3 value (1.87 mg/l) have been observed in June at Jawara while its minimum value (0.4 mg/l) was found in February at Mainder (Avg.1. 1). Xhelal *et al.,* 2013 observed similar results.

Calcium is essential for all the organisms. It is required as micronutrient for algae and very important for the metabolism of plants. Highest value for calcium15 mg/l was recorded in June at Jawara and the lowest 8 mg/l in September at Mainder (Avg.11.5). Magnecium has strong effect on the growth of algal species as it is an integral part of chlorophyll. Highest value for magnesium 6mg/l have been recorded in the month of August at Tatapani while lowest value 2 mg/l have been recorded in October at Mainder. (Avg. 4 mg/l). Similar studies were carried out by (Khan *et al.,* 2012).

Heavy metals are essential for the growth and development of organisms in required amount and regarded as harmful if their concentration exceeds the required amount. These are released by anthropogenic activities like; burning fossil fuels and discharging industrial, agriculture and domestic wastes. Phytoplankton absorb heavy metals from the water and can accumulate its high amounts within their bodies. In this way, they are indicators to the toxicity of the water environment. Maximum and minimum values for Zn were 3.7 mg/l and 1.6 mg/l (Avg. 2.65) in the months of June and February respectively. Maximum values were recorded from Tatapani site while minimum values have been found from Mainder. Temporal change has been recorded in the concentration of lead metal. Maximum and minimum values for lead were 0.35 mg/l and 0.08 mg/l (Avg.0.21) in the months of October and August respectively. Maximum values were recorded from Mainder site while minimum values have been found from Kotli. Similarly iron metal showed differences in concentration among sampling stations. Maximum and minimum values for iron were 2.0mg/l and 0.5 mg/l (Avg.1.25) in the months of August and February respectively. Maximum values were recorded from Tatapani site while minimum values have been found from Tetrinote. Maximum and minimum values for Cu were 1.5mg/l and 0.2 mg/l (Avg.0.85) in the months of October and February respectively. Maximum values were recorded from Mainder site while minimum values have been found at Kotli. Similar studies were carried out on Zinc, Lead, Iron and Copper by Abdou KA *et al.,* 2016.

A total of 105 species belonging to 37 genera and 25 families have been recorded from the Mahsheer National Park (Table 1). The identified genera include *Achananthes*, *Amphora*, *Ankistrodesmus*, *Aphanocapsa*, *Chaetophora*, *Chlorella*, *Cladophora*, *Coelastrum*, *Cosmarium*, *Cymbella*, *Cystodinium*, *Diatoma*, *Euglena*, *Fragilaria*, *Geminella*, *Gomphonema*, *Gyrosigma*, *Lyngbya*, *Micrispora*, *Navicula*, *Nitzschia*, *Oedogonium*, *Oocystis*, *Oscillatoria*, *Pandorina*, *Scenedesmus, Spirogyra, Stipitococcus, Surirella, Synedra, Tetraedron*, *Trochiscia, Tetraspora, Ulothrix, Volvox* and *Zygnema.*

Algae are of great importance to life on earth. They play a vital role in aquatic food chains as producers. Algae are regularly providing fresh oxygen to aquatic and terrestrial organisms. They are source of food for fish and other aquatic animals important to man. Algae are mostly aquatic and are present both in fresh and marine environments. They are reported from various fresh water bodies of Pakistan and Azad Kashmir. One hundred and two species of Chlorococcales from fresh water bodies of Peshawar Valley and Azad Kashmir are reported. (Siddiqui and Faridi, 1994 Faridi, 1971, 1972). Khan *et al.,* (2012) described 15 species of the diatom genus Navicula from different fresh water bodies of Bannu of the Khyber Pakhtunkhwa province of Pakistan. They found almost all the species during winter and spring. Ten species of diatoms genus Cymbella were described from fresh water bodies at Kasur, Lahore and Sialkot districts of the Punjab Chenari and Neelum Valley of Azad Kashmir. These species were identified and taxonomically described (Ali *et al.,* 2006). Hussain *et al.,* (2011) described thirty nine algal species from fresh water of Gulbahar, district Peshawar Pakistan. These species included Cyanophyceae (12 species), Navicula (4 species), Nitzchia (4 species), Pinnularia (3 species) while other recorded species showed less distribution. Various studies have been carried out on the algae of fresh water bodies of Punjab, N.W.F.P. and Azad Kashmir and were taxonomically described (Hassan and Batool, 1987; Hassan and Yunus, 1989; Leghari *et al.,* 1991, 1995, 2002, 2003; Leghari and Sultana, 1993). Shakeel *et al.,* (2010) found phytoplankton composition as a response of water quality in the Salam canal Hadous drain and Demietta branch of river Nile Egypt. They observed considerable variations in water quality which in turn affected the phytoplankton at the study area. Khuhawar *et al.,* (2009) carried out limnological studies of Baghsar Lake District Bhimber Azad Kashmir. They recorded a total of 122 algal species with 35 of *Volvocophyta*, 23 Chlorophyta; 38 Cyanophyta; 14 Euglenophyta; and 11 Bacillarophyta. Fifteen species of grass green algae belonging to the genera *Aphanochaete, Chaetophora, Coleochaete, Cylindrocapsa, Microspora* and *Stigeoclonium* were collected from various fresh water habitats of province Punjab Pakistan and taxonomically determined (Zarina *et al.,* 2010). Our results are nearly similar with the observations made by Leghari et al., (1999), Khan *et al.,* (2012), Khuhawar *et al.,* (2009) Shakeel *et al.,* (2010) and Ali *et al.,* 2006).

All the identified species belongs to 25 famalies. The family Naviculaceae was the leading one which contributed 19 algal species (18 %) followed by Cymbellacea (13 spp., 12.3%), Fragilaraiceae (7 spp., 6.6%), Zygnemataceae (7 spp., 6.6%), Desmidiaceae, Nitzschiaceae (5 spp., 4.7% each), Oscillatoriaceae, Gomphonemaceae, Euglenaceae, Cladophoraceae (4 spp., 3.8 % each), while rest of families shared 1-3 species (Table 2). Similar studies were carried out by Aliya *et al.,* 2009. They identified 214 species of algae belonging to 86 genera of 33 families 15 orders, 10 classes and 6 phyla were reported from various fresh water habitats in three towns of Karachi city. It was found that Cyanophyta (38.32%) and Volvophycota (36.45%) were most prevalent and those of Euglenophycota and Crysophycota poorly represented (2.8%) among various phyla.

Considerable variations have been found in frequency (%) of algal flora of different sites of study area (Table 1). *Tetraspora lacustris, Tetraspora cylindrical* and *Cymbella normanii* have been found in all the sites with 100% frequency. *Cymbella parva, Cymbella tumidula, Cymbella ventricosa, Ankistrodesmus falcatus Cymbella leptoceros, Oscillatoria chlorina* and *Pandorina morum* showed 80% frequency, while *Cymbella brehmii, Cymbella laevis, Gomphonema constrictum, Gomphonema acuminatum var. linearis, Navicula meniscula, Navicula crucicula, Synedra tenera, Surirella linearis, Cladophora glomerata* and *Spirogyra tetrapla* have been found with 60% frequency. Some of the species showed 40% frequency including *Troschiscia asper, Tetraedron regulare, Ulothrix gemilata, spirogyra subsalsa, Oedogonium reinschii, Cladophora elegans, Euglena gracilis, Surirella elegans, Synedra affinis and Navicula citrus.* Some species were rare regarding research sites of study area with only 20% frequency including *Euglena polymorpha, Zygnema sterli, and Zygnema insigne.*

Rishi and Awasthi, (2012) demonstrated that the genera *Oscilatoria, Merispopedia, Chroococcus*, *Euglena, Navicula, Cyclotella, Closterium, Gomphonema*, etc. are main species indicating the pollution. During our studies a larger number of algal species belonging to the genera *Oscilatoria, Euglena, Navicula, Cyclotella, Closterium, Gomphonema*, etc. have been identified which indicated the existence of organic and inorganic nutrients, hence conditions of water pollution. The species of algae especially members of *Cyanophyta* indicated the existence of human impacts on the Mahasheer National Park water. It was more obvious in the City Kotli where industrial activities and household activities influence the quality of the water.

Table 1: The taxons of algae identified from different stations of Mahasheer National Park.

Group/ Families	Taxa	Spp. No	S1	S2	S3	S4	S5	Freq. %
Kingdom: Monera								
Phylum: **Cyanophyta**								
Class: Chroococophyceae								
Order: Chrococcales								
Family:Chrococcaceae								
	Aphanocapsa spp. West and West	1.	-	+	+	-	+	60
Class: Nostocophyceae								
Order: Nostoccales								
Family: Oscillatoriaceae	*Lyngbya heieronymusii* Menegh. ex Gomont	2.	+	-	+	-	+	60
	Oscillatoria chlorina (Kuetz.,) Gomont	3.	+	-	+	+	+	80
	Oscillatoria acutissima Kufferath	4.	-	-	+	-	+	40
	Oscillatoria perronata Skuja	5.	-	+	+	+	+	80
Kingdom: Protista								
Phylum: **Volvocophyta**								
Class: Chlorophyceae								
Order: Chlorococcales								
Family: Oocystaceae	*Ankistrodesmus falcatus* (Corda) Ralfs	6.	-	+	+	+	+	80
	Ankistrodesmus falcatus var. radiatus (Chod.) Lemmermann	7.	+	+	-	-	+	60
	Tetraedron regulare Reinsch	8.	-	-	-	+	+	40
	Oocystis borgei Snow.	9.	+	+	-	-	+	60

	Tetraedron muticum (Yendo) Fensholt	10.	-	-	+	+	+	60
	Trochiscia asper Reinsch	11.	-	-	+	+	-	40
	Trochiscia reticularis Reinsch) Hansg	12.	+	+	+	-	-	60
Family: Scenedesmaceae								
	Scenedesmus abundans (O.Kirchner) Chodat	13.	-	-	-	-	+	20
	Scenedesmus arcuatus var.palydisca Proshkina-Lavrenko	14.	+	+	-	-	-	40
Family: Volvocaceaea								
	Pandorina morum (O.F.Müller)	15.	-	+	+	+	+	80
	Volvox aurus Ehrenberg	16.	-	-	+	+	+	60
Family: Coelastraceae								
	Coelastrum microporum Naegeli	17.	-	-	-	+	+	40
	Coelastrum cambricum (W.Archer)	18.	+	+	-	-	+	60
Order: Tetrasporal								
Family: Palmellaceae								
	Tetraspora cylindrical (Wahlenberg) C.Agardh	19.	+	+	+	+	+	100
	Tetraspora lacustris Hariot) Lagerheim	20.	+	+	+	+	+	100
Order: Chlorellales								
Family: Chlorallaceae								
	Chlorella ellipsoidea Gerneck	21.	+	-	-	+	+	60
Class: Desmidiophyseae								
Order: Desmidiales								
Family: Desmidaceae								
	Cosmarium formosulum Corda ex Ralfs	22.	+	+	-	-	+	60
	Cosmarium punctulatum Brébisson	23.	-	-	+	+	-	40
	Cosmarium impressulum var. Esremulatum Elfving	24.	+	+	-	-	+	60
	Cosmarium dydowskii Corda ex Ralfs	25.	+	+	-	+	-	60
	Closterium littorale M.Chihara	26.	+	+	-	-	-	40
Phylum: **Bacillariophyta**								
Class: Bacillariophyceae								
Order: Bacillaiales								
Family: Achananthaceae								
	Achananthes minutissima (Kuetzing) Cleve	27.	-	+	-	+	-	40
	Achananthes lineris W.Smith	28.	-	-	+	+	+	60
Family: Fragilariaceae								
	Diatoma anceps (Ehrenberg) Grunow	29.	+	-	+	-	-	40
	Diatoma vulgare (Fricke) Hust.	30.	-	-	+	+	-	40
	Fragilaria intermedia (Grunow) Grunow	31.	+	-	-	-	+	40
	Fragilaria pinnota Ehrenberg	32.	+	-	-	-	+	40
	Fragilaria virescens Ralfs	33.	+	+	-	-	-	40
	Fragilaria capucina Desmazières	34.	+	-	-	+	-	40
	Fragilaria construens Grun.	35.	+	-	-	+	+	60
Family: Cymbellaceae								
	Amphora holsatiaca Hustedt	36.	-	-	+	-	+	40
	Amphora commutate Grun.	37.	-	+	-	-	+	40
	Amphora coffeaeformis (Kützing) Kützing	38.	+	-	-	+	-	40
	Cymbella turgida W. Gregory	39.	-	-	+	-	+	40
	Cymbella cesati Rabenhorst) Grunow	40.	+	+	-	-	-	40
	Cymbella parva (W.Smith) Kirchne	41.	+	+	+	-	+	80
	Cymbella tumidula Grunow	42.	-	+	+	+	+	80
	Cymbella normani Ehrenberg	43.	+	+	+	+	+	100
	Cymbella brehmii Hustedt	44.	+	-	-	+	+	60
	Cymbella leptoceros (Ehrenberg) Kützing	45.	+	+	+	+	-	80
	Cymbella laevis (Nägeli) Rabenhorst	46.	-	+	-	+	+	60
	Cymbella tumida (Brebisson) Van Heurck	47.	+	+	-	+	+	80
	Cymbella ventricosa C.Agardh) C.Agardh	48.	+	+	+	-	+	80
Family: Gomphonemaceae								
	Gomphonema ventricosum Gregory	49.	-	-	+	+	+	60
	Gomphonema constictum (Lyngbye)	50.	-	-	+	+	+	60

	Kuetzing							
	Gomphonema acuminatum var. linearis Ehrenberg.	51.	+	+	-	-	+	60
	Gomphonema constrictum var. capitates	52.	-	+	-	+	-	40
Family: Naviculaceae	*Navicula citrus* Krasske	53.	-	-	+	+	-	40
	Navicula dicephala var. neglecta Ehrenberg	54.	+	+	-	-	+	60
	Navicula meniscula J. Schumann	55.	+	+	+	-	-	60
	Navicula exigua Gregory	56.	-	-	-	+	+	40
	Navicula crucicula (W.Smith) Donkin	57.	+	+	+	-	-	60
	Navicula leptoceros Krasske	58.	+	-	+	-	-	40
	Navicula simplex Krasske	59.	-	-	+	+	-	40
	Navicula gregaria Donkin	60.	+	+	-	-	+	60
	Navicula grimmei Krasske	61.	-	+	+	-	+	60
	Navicula falaisiensis Greory	62.	+	+	-	+	-	60
	Navicula graciloives Gregory	63.	+	+	+	-	-	60
	Navicula costulata Grunow	64.	+	+	+	-	-	60
	Synedra amphicephala Kützing	65.	-	-	+	+	-	40
	Synedra tenera Rabenhorst	66.	+	+	-	-	+	60
	Synedra affinis Kuetz.	67.	+	-	-	-	+	40
	Synedra acus W.Smith	68.	-	-	+	+	+	60
	Synedra ulna (Nitzsch) Ehrenbeg	69.	-	+	-	-	+	40
	Gyrosigma scalproides Rabenhorst	70.	+	+	-	+	-	60
	*Gyrosigma eximium (*Thwaites) Boye	71.	+	-	+	+	-	60
Family: Nitzschiaceae								
	Nitzschia spp.	72.	+	-	-	-	-	20
	Nitzschia obtuse W.Smith	73.						
	Nitzschia grandersheimiensis W.Smith	74.	+	-	-	+	-	40
	Nitzschia linearis W.Smith	75.	+	-	-	+	+	60
	Nitzschia sublinearis Hustedt	76.	-	-	+	+	-	40
Order: Surirellales								
Famly: Surirellaceae								
	Surirella linearis W.Smith	77.	+	+	-	-	+	60
	Surirella elegans Ehrenberg 200X	78.	-	-	+	-	+	40
	Surirella ovata Kützing	79.	+	+	+	-	-	60
Phylum: **Euglenophyta**								
Class: Euglenophyceae								
Order: Euglenales								
Family: Euglenaceae								
	Euglena polymorpha P.A.Dangeard	80.	-	-	+	-	-	20
	Euglena gracilis Klebs	81.	-	+	+	-	-	40
	Euglena oblanga F.Schmitz	82.	-	-	-	+	-	20
	Euglena acutissima Lemmermann	83.	+	+	-	-	+	60
Phylum: **Chlorophyta**								
Class: siphonocladophyceae								
Family: Cladophoraceae								
	Cladophora spp.	84.	-	-	+	-	-	20
	Cladophora crispate (Roth) Kützing	85.	+	-	-	+	-	40
	Cladophora glomerata (L.) Kuetzing	86.	+	+	-	-	+	60
	Cladophora elegans Linnaeus) Hoek	87.	-	-	+	-	+	40
Order: Chaetophorales								
Family: Chaetophoraceae								
	Chaetophora spp.	88.	-	-	+	+	-	40
	Chaetophora elegans (Roth) C.A. Agardh	89.	+	+	-	-	-	40
	Chaetophora pisiformis (Roth) C.Agardh	90.	-	-	+	+	-	40
Class: Ulbophyceae								
Order: Microsporales								
Family: Micrisporaceae								
	*Micrispora stagnorum (*Kützing) Lagerheim	91.	+	+	-	-	+	60
Class: Zygnemophyceae								

Order: Oedogoniales								
Family: Oedogoniaceae								
	Oedogonium reinschii J.Roy ex Hirn	92.	-	-	+	+	-	40
	Oedogonium macrandrium Wittrock ex Hirn	93.	+	+	+	-	-	60
Order: Zygnematales								
Family: Zygnemataceae								
	Spirogyra spp.	94.	-	-	-	+	-	20
	Spirogyra tetrapla Transeau	95.	+	+	-	-	+	60
	Spirogyra subsalsa Kutzing	96.	-	-	+	+	-	40
	Spirogyra rhizobrachialis C-C Jao	97.	+	+	-	-	-	40
	Zygnema insigne Hassall) Kützing	98.	-	-	-	+	-	20
	Zygnema tenue Kutzing	99.	+	-	-	-	+	40
	Zygnema strile Transeau.	100.	-	-	-	-	+	20
Order: Ulotrichales								
Family: Ulotrichaceae								
	Geminella intrepta Kutzing	101.	+	-	-	-	+	40
	Ulothrix spp (F.Weber & Mohr) Kützing)	102.	-	-	-	+	-	20
	Ulothrix gemilata Kutzing	103.	-	-	-	+	+	40
Phylum: **Ochrophyta**								
Class: Xanthophyceae								
Order: Rhizochloridales								
Family: Stipitococcaceae								
	Stipitococcus capensis Prescott.	104.	-	-	-	+	-	20
Phylum: **Dinophyta**								
Class: Dinophyceae								
Order: Phytodiniales								
Family: phytodinaceae	*Cystodinium spp.* Transeau	105.	-	+	-	-	-	20

Table 2: Contribution of different algal families in terms of flora from Mahasheer National Park AJK

Sr. No	**Family**	**No. of spp.**	**Percentage (%)**
1	Chrococcaceae	1	0.95
2	Oscillatoriaceae	4	3.8
3	Oocystaceae	7	6.6
4	Scenedesmaceae	2	1.9
5	Volvocaceaea	2	1.9
6	Coelastraceae	2	1.9
7	Palmellaceae	2	1.9
8	Chlorallaceae	1	0.95
9	Desmidaceae	5	4.7
10	Achananthaceae	2	1.9
11	Fragilariaceae	7	6.6
12	Cymbellaceae	13	12.3
13	Gomphonemaceae	4	3.8
14	Naviculaceae	19	18
15	Nitzschiaceae	5	4.7
16	Surirellaceae	3	2.8
17	Euglenaceae	4	3.8
18	Cladophoraceae	4	3.8
19	Chaetophoraceae	3	2.8
20	Micrisporaceae	1	0.95
21	Oedogoniaceae	2	1.9
22	Zygnemataceae	7	6.6
23	Ulotrichaceae	3	2.8
24	Stipitococcaceae	1	0.95
25	Phytodinaceae	1	0.95
26	**Total**	**105**	**100.00**

1.4 Conclusion

It has been concluded through the present study that physico-chemical and phytoplankton characteristics of

Mahasheer National Park showed spatial and temporal variations. The water samples taken from station 4 (Tata Pani) showed high value of temperature and T.D.S. while high values of pH have been recorded from station 1 (Tetrinote) other indicators also showed spatial and temporal variations. However most of the physico-chemical parameters were within normal range which indicated better quality of water for the growth and survival of phytoplanktons. The family Naviculaceae was the dominant one which contributed 19 algal species (18 %) followed by Cymbellacea (13 spp., 12.3%), while family Ulotrichaceae, stipitococcaceae and Chloraceae showed minimum number of species (1-3%). The species of algae especially members of *Cyanophyta* indicated the existence of human impacts on the Mahasheer National Park water. It was more obvious in the City Kotli where industrial activities and household activities influence the quality of the water.

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