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OCCURRENCE OF ALGAE IN INDUSTRIAL WASTE WATER AROUND KARACHI

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Abstract

Waste water samples of Korangi industrial and SITE areas showed the occurrence of 43 algal species belonging to 39 genera and 4 divisions, in which *Microcystis flos-aquae, Phormidium purpurascens* and *Chlamydomonas oblonga* were dominant. This is the first report of the occurrence of Chrysophyta from Pakistan.

Introduction

Karachi is an industrial city of Pakistan where pollution is a big problem. Algae can play an important role in minimizing hazards of industrial pollution by utilizing industrial waste water for their propagation. Algae growing in the sewage waters of Pakistan have been reported (Ahmed, 1974; Parvaiz & Ahmed, 1981) but there does not appear to be any report on the growth of algae in the waste waters of different industries.

Material and Methods

Water samples were collected in plastic bottles from Nabi Qasim, Hoechst, Progressive Laboratories Ltd., Paramount Hosiery Ltd., and from the Korangi industrial and SITE areas at monthly interval. The temperature, pH and colour of the samples were recorded on the spot. The samples were centrifuged, supernatant discarded and the concentrate observed under the microscope. The algae were identified after reference to Desikachary (1959), Prescott (1962) and Pentecost (1984). *Chlamydomonas acidiophila* and *C. oblonga* were cultured at room temperature under fluorescent light (800 ft. candles) by syn-culture method in Modified Bristol's Solution (inorganic medium) and Volvox Solution (organic medium) as described by Brunel *et al.* (1950).

Results and Discussion

A total of 43 algal species, belonging to 39 genera and 4 divisions were recorded from waste water samples during summer and winter months (Table 1). Not much difference was observed regarding the ocurrence of species during summer and winter. Species like *Microcystis flos-aquae* (Wittr.) Kirchn., *Phormidium purpurascens* (Kütz.) Gom. and *Chlamydomonas oblonga* Pringsh., were dominant in the algal flora in both the seasons. Such similar results were found in the sewage water (Par-

Table 1. List of algal species found in waste water of different factories and companies.

ALGAL SPECIES	JULY				AUGUST											OCTOBER				NOVEMBER					DECEMBER				JANUARY		
	1	2	4	5	1	2	3	4	6	7	8	9	10	11		1	2	3	4	1	2	3	4	6		1	2	3	4		1	2	3
CYANOPHYTA																																	
Anabaenopsis arnoldii var. *indica* Ram.	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-		-	-	-	-		-	+	-
Anabaina fertilissima Rao.	-	-	-	-	-	-	-	+	-	+	+	-	-	-		-	+	-	+	-	-	-	-	-		-	-	-	+		-	-	-
Aphanozomenon sp.	-	-	-	+	-	-	-	-	-	-	-	-	-	+		-	-	-	-	-	-	-	-	-		-	-	-	-		-	-	-
Arthrospira jenneri (Kütz.) Stizenb.	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-		-	-	-	-		-	+	-
Aulosira bombayensis Gonz.	+	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-		-	-	-	-		-	-	-
Chroococcus dispersus (Keissl.) Lem.	-	-	-	+	-	-	-	+	-	-	-	-	-	-		+	+	+	-	+	-	-	+	-		+	+	-	+		-	-	-
Gloeocapsa nigressens Näg.	-	-	-	-	-	-	-	-	+	-	-	-	-	-		-	-	-	-	-	+	-	+	-		-	-	-	+		-	+	-
Lyngbya epiphytica Hieron.	-	-	-	-	-	-	-	-	-	+	-	-	-	+		-	-	-	-	-	-	-	-	-		-	-	-	-		-	-	-
Merismopedia glauca (Ehrenb.) Näg.	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-		-	+	+	-		-	-	-
Merismopedia punctata Meyen.	-	+	+	-	-	-	-	+	-	-	-	-	-	-		-	-	-	+	-	-	-	-	-		-	-	-	-		-	-	-
Microcystis flos-aquae (Wittr.) Kirchn.	+	-	-	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+		+	+	+	+		-	+	
Nostoc punctiforme (Kütz.) Hariot.	-	-	-	-	-	+	-	-	-	-	+	-	-	-		-	-	+	+	-	-	-	-	-		-	-	-	-		-	-	-
Oscillatoria princeps Vauch.	+	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	+	-	-	-	-		-	+	-	-		-	-	-
Phormidium autumnale (Ag.) Gom.	-	-	-	-	-	-	-	-	-	-	+	-	-	-		-	-	-	-	-	-	-	-	+		+	+	-	-		-	-	-
Phormidium purpurascens (Kütz.) Gom.	-	-	-	-	-	+	+	+	-	-	+	+	-	-		+	+	-	+	-	-	-	+	+		-	-	-	-		-	-	-
Scytonema coactile Mont.	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	+	-	-	-		-	-	-	-		-	-	-
Spirulina laxa Smith	-	+	-	-	+	-	-	-	-	+	-	+	-	-		-	-	-	-	-	-	-	-	-		-	-	-	-		-	-	-
CHLOROPHYTA																																	
Aphanochaete sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-		+	-	-	-	-	-	-	-	-		-	-	-	-		-	-	-
Asterococcus spinosis Prescott.	-	-	-	+	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-		-	-	-	-		-	-	-
Chlamydomonas acidiophila Negore.	-	-	-	-	-	-	-	+	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-		-	-	-	-		-	-	-
Chlamydomonas oblonga Pringsh.	-	-	-	-	+	+	-	+	-	+	+	-	-	-		-	-	+	-	-	-	-	-	-		-	+	-	+		-	+	-
Chlorococcum humicola (Näg.) Raben.	-	-	+	+	-	-	+	-	-	-	+	-	+	-		-	-	+	-	-	-	+	-	-		-	-	-	-		-	-	-
Chlorohormidium flaccidum (Kütz.) Fott	-	-	-	-	-	-	-	-	-	-	-	-	-	+		-	-	-	-	-	-	-	-	-		-	-	-	-		-	-	-

Table 1. (Cont'd.)

ALGAL SPECIES	JULY				AUGUST										OCTOBER				NOVEMBER				DECEMBER				JANUARY		
	1	2	4	5	1	2	3	4	6	7	8	9	10	11	1	2	3	4	1	2	3	4	6	1	2	3	4	1	2	3
Closterium acerosum (Schrank) Ehrenb.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-
Coleochaete irregularis Pringsh.	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	+	+	-	-	-	-	-	-	+	-	-	-
Cosmarium melanosporum Arch.	-	+	-	-	-	+	-	-	-	-	-	-	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
Eudorina elegans Ehrenb.	-	-	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-
Gemiella interrupta (Turp.) Lagerh.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-
Mougetia windermere	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-
Pandorina morum (Mull.) Bory.	-	+	+	-	-	+	-	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Stigeoclonium nanum (Dill.) Kutz.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	+	-	-	-	-	-	-
Ulothrix subtilissima Raben.	-	-	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Volvox aurens Ehrenb.	-	-	-	-	-	+	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BACILLARIOPHYTA																														
Amphora ovalis Kutz.	-	-	-	-	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cymbella tumida (Breb.) Heurck.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Melosira ambiqua (Grun.) Mull.	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meridion sp.	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Navicula gastrum Ehrenb.	-	-	-	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Navicula tuscula (Ehrenb.) Grun.	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nedium productum (Smith) Cleve.	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Synedra berolinensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
CHRYSOPHYTA																														
Ophiocytum arbuscule (Braun) Raben.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Raphidionema tetrae Kol.	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

1: Hoechst Korangi Industrial area, 2: Nabi Qasim Korangi Industrial area, 3: Paramount Hosiery Limited Korangi Industrial area, 4 : Progressive Laboratory Limited Korangi Industrial area, 5: Jaquard's Industry Korangi Industrial area, 6: International Meiji Biscuits Hab Industrial area, 7: Dada Bhoy Silk Mills S.I.T.E. area, 8: Pak Dying and Printing Works S.I.T.E. area, 9 : Shamsi Cloth Mills S.I.T.E. area, 10: Sabir Textile Printing Works S.I.T.E. area, 11 : Paper Mills Industry S.I.T.E. area, + : Present, - : Absent.

Table 2. Temperature, colour (c) and pH of waste water samples of different factories and companies

LOCALITIES	JULY			AUGUST			OCTOBER			NOVEMBER			DECEMBER			JANUARY		
	Temp °C	C	pH	Temp °C	C	pH	Temp °C	C	pH	Temp °C	C	pH	Temp °C	C	pH	Temp °C	C	p
1. Hoechst (Korangi Industrial Area)	32	T	6	32-33	W	6	22-29	T	5-6	20-25	W	6-6.5	22-29	W	4.5-6	24	W	6
2. Nabi Qasim (Korangi Industrial Area)	32	T	6	30-32	DW	6-10	25-28	T	6	20-35	D	6-6.5	21-25	DW	6-6.5	20	D	7
3. Paramount Hosiery Limited (Korangi Industrial Area)	-	-	-	33-34	Bl	9	26-30	G	6-8	21-29	Y	10	28	Y	9	60	G	5
4. Progressive Hosiery Limited (Korangi Industrial Area)	31	B	B	31-34	B	6-7	21-24	B	7	21-22	B	6	20-39	B	6-10	20	DG	7
5. Jaquard's Industry (Korangi Industrial Area)	31	B	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6. International Meiji Biscuits (Hab Industrial Area)	-	-	-	30	W	B	-	-	-	22-27	W	6.5-8	-	-	-	-	-	-
7. Dada Bhoy Silk Mills (S.I.T.E. Area)	-	-	-	32	DW	6	-	-	-	-	-	-	-	-	-	-	-	-
8. Pak Dying and Printing Works (S.I.T.E. Area)	-	-	-	30	DW	6-5	-	-	-	-	-	-	-	-	-	-	-	-
9. Shamsi Cloth Mills (S.I.T.E. Area)	-	-	-	40	0	8	-	-	-	-	-	-	-	-	-	-	-	-
10. Sabir Textile Printing Works (S.I.T.E. Area)	-	-	-	43	DW	9	-	-	-	-	-	-	-	-	-	-	-	-
11. Papers Mills Industry (S.I.T.E. Area)	-	-	-	30-34	T	6-9	-	-	-	-	-	-	-	-	-	-	-	-

B = Black, Bl = Blue, D = Dirty, DG = Dirty Grey, DW = Dirty White, G = Green, O = Orange, T = Transparent, W = White, Y = Yellow, - = No observation.

vaiz & Ahmed, 1981) and in the freshwater ponds of Karachi (Shameel & Butt, 1984).

Members of Cyanophyta were predominant followed by Chlorophyta. The algae have been reported to grow abundantly in the fresh water ponds and lakes (Ahmed *et al.*, 1983; Hussain *et al.*, 1984). Members of Bacillariophyta and Chrysophyta occurred occasionally. Although Diatoms have been reported from different parts (Hussain *et al.*, 1984), but this is the first report of the occurrence of Chrysophytes from Pakistan.

The temperature ranged between 21-43oC during summer and 20-39 ^{o}C during winter months, while pH fluctuated between 5-10 during summer and 4.5-10.0 in winter (Table 2). Change in temperature and pH did not seem to effect the growth of algae since 32 species were found to occur in summer and 21 species in winter.

Table 1 gives the distribution of algae in industrial waste waters, and also gives an idea of their cultivation. On two or three occasions water samples from Progressive Laboratories Ltd., showed the occurence of either *Chlamydomonas acidiophila* Negoro or *C. oblonga* indicating the presence of uni-algal cultures. The samples of *C. acidiophila* and *C. oblonga* were cultivated in the Laboratory using waste water for mass cultivation and it was confirmed that they were unialgal cultures. The waste water of factories might have some chemical constituents, which supports the growth of algae. A complete chemical analysis of the waste water is therefore necessary.

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References

Ahmed, J., M. Begum and S. Begum. 1983. Survey and cultivation of freshwater algae from Karachi and its suburbs. *Biblio. Phycol.*, 66: 389-445.

Ahmed, K. 1974. A preliminary survey of algae in sewage oxidation ponds of Lahore. *Pak. J. Bot.*, 6: 85-86.

Brunel, J., G.W. Prescott and L.H. Tiffany. 1950. *The Culturing of Algae: A Symposium.* The C.F. Kettering Foundation, Yellow Springs, Ohio, USA. 114 pp.

Desikachary, T.V. 1959. *Cyanophyta.* Indian Council of Agricultural Research, New Delhi., 686 pp.

Hussain, F., G. Anjum, M.I. Zaidi and M.A.F. Faridi. 1984. Freshwater algae of Hanna Urak valley Quetta. *Pak. J. Bot.*, 16: 81-84.

Pentecost, A. 1984. *Introduction to Freshwater Algae.* Richmond Publ. Co. Ltd., Richmond, Surrey, England, 247 pp.

Parvaiz, K. and J. Ahmed. 1981. A preliminary survey of sewage algae from Karachi. *Pak. J. Bot.*, 13: 221-223.

Prescott, G.W. 1962. *Algae of the Western Great Lake Area.* Wm. C. Brown Co., Dubuque, Iowa.

Shameel, M. and N.I. Butt. 1984. On the occurrence of Cyanophyta from Karachi, Pakistan. *Pak. J. Bot.*, 16: 75-79.

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