

Studies on the Physico-Chemical Parameters and Pollution Indicator Algal Flora of Main Nara Valley Drain Water Entering Manchhar Lake (Distt. Dadu) Sindh, Pakistan

M. A. Mahar, S. I. H. Jafri, S. M. Leghari and M.Y. Khuhawar*

Department of Fresh Water Biology and Fisheries, University of Sindh, Jamshoro, 76080 Sindh, Pakistan.

Abstract

Main Nara Valley Drain (MNVD) is a distributary of Indus river which was constructed in (1932) in Sukkur barrage command area. It connects Hamal lake with Manchhar lake through regulator. Water samples of Main Nara Valley Drain entering Manchhar lake were collected at monthly intervals between January to December 2001. These samples were analyzed for temperature, Secchi disc depth, conductivity, total dissolved solids, chemical oxygen demand, total nitrogen and orthophosphate contents.

The results indicated that the salinity (1.2 - 6.4 g/l), conductivity (2.35 - 11.34 mS/cm), total dissolved solids (890 - 6200 mg/l), hardness (710 - 994 mg/l) and chemical oxygen demand (60 - 284 mg/l) values were far beyond the permissible limits of WHO standards for drinking water.

Sixty one algal species belonging to Cyanophyta (23), Chlorophyta (21), Euglenophyta (16) and Rhodophyta (1) were identified. The algal genera *Anabaena*, *Microcystis*, *Merismopedia*, *Oscillatoria*, *Euglena* and *Scenedesmus* were considered as indicators of eutrophication as well as organic 'Pollution Index' species. The water quality of Main Nara Valley Drain is drastically degrading the quality of Manchhar lake along with the biotic components.

Keywords: Limnology, Pollution indicators, Manchhar lake, Algae.

Introduction

The Main Nara Valley Drain (MNVD) is an old natural distributary of river Indus called Eastern Nara. It was an inundation canal on the right bank of the river. Before the construction of Sukkur Barrage, its overflow used to find its way towards Manchhar lake, later it was modified into a regular canal named as Main Nara Valley Drain. At the time of construction of the first barrage of Sindh in (1932), taking this old path of the natural flow of water into consideration, two permanent regular canals namely Rice canal and Dadu canal were constructed to supply water to the cultivable lands of Dadu District. Later on Main Nara Valley Drain was also used to carry surplus water of Rice canal area and spillage of Hamal lake to Manchhar lake. Hamal lake is a natural depression in Larkana district which also receives water

from hill torrents of Khirthar range. This freshwater also used to reach Manchhar lake from Hamal lake via MNVD.

Right Bank Outfall Drainage Project (RBOD) started in (1970). Since then, various drains are pouring their effluent, agricultural runoff and domestic sewage into Hamal lake and Main Nara Valley Drain and finally this water falls into the Manchhar lake.

Relationship of physico-chemical factors and algal growth has been studied by various workers (Gonzalves and Joshi, 1946; Kumarvoskey, 1953; Rao, 1955; Philipose, 1959; Munawar, 1970; Singh and Swarup, 1979; Parmisvam and Sreenivasan, 1981; Leghari *et al.*, 2001).

Such man made changes affect the physico-chemical characteristics of water. Water quality influences the biotic

* Dr. M. A. Kazi, Institute of Chemistry, University of Sindh, Jamshoro.

components of ecosystem. Present study provides information about the influence of environmental parameters on the algal flora of Main Nara Valley Drain (MNVD) at the point where it enters in Manchhar lake.

Materials and Methods

Water samples were collected at monthly intervals during (2000-2001). Selected parameters of water were analyzed according to the methods of APHA (1992). The conductivity, salinity and TDS were recorded in the field with the help of WTW 320 Conductivity meter; pH was measured with the help of Orion 420 A pH meter. For taxonomic studies filamentous and planktonic algal samples were collected by plankton net (mesh 55 μ). Samples were preserved in 3-4% formalin and brought to the laboratory. Taxonomic identification was carried out with the help of taxonomic keys (Desikachary, 1959; Prescott, 1961).

Results

The temperature of water ranged between 15 and 36 °C; the transparency (secchi disc depth) of water fluctuated between 35 and 64 cm. pH of water was from 6.91 to 8.1; Alkalinity (CaCO₃) and Hardness values ranged as 240 -314 mg/l and 710 - 994 mg/l respectively. Salinity, conductivity and total dissolved solids (TDS) were in the range of 1.2 - 6.4 g/l; 2.35 - 11.34 mS/cm and 890 - 6200 mg/l respectively. Orthophosphate and Total Nitrogen varied as 0.36 - 0.52; 1.98 - 3.24 mg/l and Chemical Oxygen Demand (COD) fluctuated between 60 and 284 mg/l respectively. N/P ratio ranged from 3.9 to 9 Table 1.

A total of 61 species of algae were identified (Table 1). Large number of phytoplanktonic species belonged to Cyanophyta (23), Chlorophyta (21), Euglenophyta were found in slightly less number (16). One species of red algae, *Compsopogon coeruleus* was also recorded from MNVD water.

48 species of algae as indicated in table 2, are considered as, "Pollution Index" species.

Discussion

The physico-chemical variables of Main Nara Valley Drain (MNVD) water represented freshwater environment. The values of salinity, TDS and conductivity were beyond the permissible limits of WHO (1984). pH values were similar to the range found in Hub dam lake, 6.8-7.5 (Iqbal, 1988), Keenjhar lake, 7.9-8.7 (Khuhawar *et al.*, 1999), Hamal lake, 7.9-8.7 (Khuhawar *et al.*, 1999), Manchhar lake, 7.44-8.74 (Mahar *et al.*, 2000) and Chotiari lakes, 7.8-8.1 (Jafri, 1997). Salinity was the only factor which shows the highest value of 6.4 ppt in March and June. An earlier report (WAPDA, 1990) indicated the salinity of MNVD as 1.2-1.5 ppt. Such abnormally high values of chemical factors of water of MNVD can be explained to some extent due to the fact that Hamal lake is receiving the water of various drains that enter MNVD, which at present releases water into the Manchhar lake. On its way the MNVD also receives agricultural runoff, so that characteristics of water have completely changed due to addition of various polluted waters. The same water enters Manchhar lake, so its ecology has also drastically changed (Mahar *et al.*, 2000).

Table 1: Physico-chemical parameters of Main Nara Valley Drain (MNVD) entering in Manchhar lake 2000-2001.

Parameters	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Mean	S.D±
Temperature (°C)	30	30	30	29	25	23	18	15	17	23	25	25	24.16	5.25
Transparency (cm)	35	48	47	55	52	58	64	36	42	57	54	46	49.5	8.86
pH	7.36	8.1	7.96	7.75	7.94	8	7.99	7.88	7.75	6.92	6.91	7.8	7.696	0.41
Alkalinity (mg/l)	268	290	290	276	297	286	289	260	314	302	240	304	284.6	20.7
Hardness (mg/l)	921	994	920	892	820	738	710	867	911	874	888	914	870	80.02
Orthophosphate (mg/l)	0.52	0.51	0.5	0.498	0.5	0.421	0.49	0.36	0.39	0.48	0.495	0.5	0.472	0.05
Nitrogen (mg/l)	2.17	2.45	1.98	2.07	2.62	3.1	2.18	3.24	2.75	2.69	2.8	2.34	2.53	0.40
Dissolved Oxygen (mg/l)	6.6	5.5	5	6.2	6.7	8	7.9	7.8	8.8	8	7.2	7.1	7	1.12
COD (mg/l)	284	148	208	296	83	92	60	96	120	204	144	272	167	83.48
Salinity (g/l)	6.4	4	2.3	2.38	1.2	2.6	3	6.3	3	6.4	6.1	5.4	4.09	1.91
Conductivity (mS/cm)	11.34	0.18	4.31	4.63	2.35	4.28	6.12	11.19	5.54	11.21	10.84	9.72	6.80917	3.89
TDS (mg/l)	6020	890	2190	3076	1160	2960	2870	6150	2870	6200	5980	5230	3799.67	1999.9
N/P ratio	4.17	4.8	3.9	4.1	5.24	7.3	4.4	9	7	5.6	5.9	4.6	5.4	1.56

Table 2: List of algal flora of Main Nara Valley Drain water

Division: Cyanophyta

1. *Anabaena variabilis**
2. *A. limnetica**
3. *Anabaenopsis raciborskii**
4. *Lyngbya contorta**
5. *L. limnetica**
6. *Merismopedia minima**
7. *M. marssonii**
8. *M. tenuissima**
9. *Microcystis aeruginosa**
10. *M. pulverea**
11. *M. Flax-aquae**
12. *Synechocystis salina**
13. *Chroococcus limneticus**
14. *C. turgidus**
15. *C. minimus**
16. *Spirulina laxissima**
17. *Oscillatoria amoena**
18. *O. simplicissima**
19. *O. claricentrosa**
20. *O. sancta**
21. *O. jasorvensis**
22. *O. vizagapatensis**
23. *O. limosa**

Division: Chlorophyta

24. *Ankistrodesmus falcatus*
25. *A. convolutus*
26. *Oocystis parva*
27. *O. crassa*
28. *Pediastrum tetras*
29. *Crucigenia quadrata*
30. *Tetraedron minimum*
31. *T. muticum*
32. *T. caudatum*

33. *Scenedesmus arcuatus**
34. *S. acutus**
35. *S. acuminatus**
36. *S. quadricauda**
37. *Cosmarium granatum**
38. *C. leave**
39. *Closterium acerosum**
40. *C. ehrenbergii**
41. *Spirogyra micropunctata*
42. *S. subsalsa*
43. *Cladophora glomerata*
44. *Oedogonium sp.*

Division: Euglenophyta

45. *Euglena acus**
46. *E. polymorpha**
47. *E. intermedia**
48. *E. spathirhyncha**
49. *E. granulate**
50. *E. hyaline**
51. *E. charkomiensis**
52. *E. eleukinii**
53. *Lepocinclis salina**
54. *L. ovum**
55. *Phacus curvicauda**
56. *P. acutua**
57. *P. meson**
58. *P. acuminatus**
59. *P. tortus**
60. *P. pleuronectes**

Division: Rhodophyta

61. *Compsopogon coeruleus*

*Pollution indicator species

When any water body changes from freshwater to polluted water, its biotic components are also disturbed. In an earlier study Javed and Hayat (1995) stated that decrease in pH of water in river Ravi resulted into elevated levels of heavy metals. In another study Javed and Hayat (1996) found that due to heavy metal pollution various planktonic genera exhibited variable tolerance. Some showed decrease in number while the others were totally eliminated. The planktonic species which tolerate the polluted waters are termed as "Pollution Indices". The phytoplanktonic genera of MNVD water have shown the same type of variation of tolerance. Among these *Spirulina*, *Aphanocapsa*, *Anabaena*, *Merismopedia*, *Microcystis* and *Euglena* showed their status as 'Pollution Index' organisms.

Physico-chemical factors of water play an important role in promotion of algal growth. The N/P ratio in MNVD ranged from 3.9 to 9, with a mean value of 5.5. Sigee (2005) stated that if the "Redfield Ratio" (N/P) is >10:1, then phosphorus can become a limiting factor for algal growth. Phytoplankton and algal flora also indicated the quality of water. Singh and Swarup (1979) stated that higher temperature, nitrate, phosphate, dissolved oxygen and pH favour the growth of Cyanophycean algae. Palmer (1980) listed 60 species under the category of pollution tolerant algae and suggested the term 'Pollution Index Algae' for those species which were common in organically enriched waters. In the present study 48 algal species recorded from MNV Drain are included in the above mentioned list.

Round (1979) stated that in general, eutrophication involves the increase in growth promoting substances. He concluded that first major source of

artificial eutrophication is the flow of excessive fertilizers off the agricultural land (the main source of nitrogen) and second is the addition of sewage (the main source of phosphate). Another source of eutrophication are the detergents, a large proportion of which rapidly flows into the aquatic system and enhance the production of algae in the water. Horn (1978) has reviewed nitrogen fixation in eutrophic lakes and stated that nitrogen fixation in eutrophic lakes is frequently a dominant feature of phytoplankton blooms.

Only three species of *Anabaena* were found, the source being the higher nitrogen contents in MNVD water. Genus *Oscillatoria* has been found to be tolerant to pollution and frequently grow in the polluted waters (Rai and Kumar, 1976). In MNVD 7 species of *Oscillatoria* were found in the form of mats and attached with other aquatic plants. Kumar *et al.*, (1974) observed that blue green algae, dinoflagellates and euglenoids are most intimately associated with organically rich effluents and green algae are the dominant forms found in waters rich in nitrogenous compounds. One species of red algae (Rhodophyta) was also recorded. Fresh water red algae are found in a wide range of pH (Reis, 1974). Sheath *et al.* (1987) also discussed the presence of *Compsopogon* sp. in alkaline water bodies. Present findings confirm the above study. Palmer (1980) concluded that the species of *Euglena* and *Oscillatoria* are more likely to be present than any other species when organic pollution exists.

The water of MNVD was highly polluted as evident from the water quality and the presence of many pollution indicator algal species recorded during this study.

References

- APHA (1992) *Standard methods for the examination of water and waste water*. Amer. Public Health Assoc. Washington D.C. Approx. p.1500.
- Desikachary, T. V. (1959) *Cyanophyta*. Ind. Agr. Res. Council New Delhi, pp. 686.
- Gonzalaves, E.A. and V. Joshi (1946) Algae near Bombay. The seasonal succession of algae in a tank of Bandra. *Bomb. Nat. Hist. Soc.*, **46**: 154-176.
- Horn, A. J. (1978) Nitrogen fixation in eutrophic lakes. In. *Water Pollution Microbiology*, Vol.2 (Ed. R. Mitchell) John Wiley and Sons, N. Y. pp.1-30.
- Iqbal, M. (1988) Ecology of limnetic crustacean zooplankton in Hub lake. *M.Phil Thesis Deptt. of Zoology, Uni. Karachi*, p. 117.
- Jafri, S. I. H. (1997) Final report on fisheries survey of Chotiari reservoir (Sanghar) and Tidal link lakes (Badin). *Final report of LBOD Fishery survey project*, pp.12-61.
- Javed, M. and S. Hayat (1995) Effect of waste disposal on the water quality of river Ravi from Lahore to Head Baloki, Pakistan. *Proc. Pak. cong. Zool.*, **15**: 41-51.
- Javed, M. and S. Hayat (1996) Planktonic productivity of river water as bio-indicator of fresh water contamination by metals. *Proc. Pak. Congr. Zool.*, **16**: 283-298.
- Khuhawar M.Y., G. M. Mastoi, T. M. Jehangir and M. Kombhar, (1999) Studies on some wetlands of Sindh, P.12-17 *Proc. Impact of Envir. Pollution on lakes of Sindh (MUET) Jamshoro, Sindh, Pakistan*.
- Kumar, H. D. and G. P. Bisaria, L. M. Bhandari, B.G. Rana and V. Sharma (1974) Ecological studies on algae isolated from effluents of an oil refinery, fertilizer factory and brewery, *Indian J. Environ. Hlth.*, **16**: pp.247-255.
- Kumarvoskey, B. (1953) A comparative study of the phytoplankton of several fish ponds in relation to some of the essential chemical constituents of the water. *Bull. of res. Council of Israel*, **2** (4): pp 379-410.
- Leghari, S. M, S. N. Arbani and T. M. Jahangir (2001) Chlorococcales (chlorophyta) of Sindh, Pakistan. *Pakistan J. Biol. Sci.*, **1** (6): 451-455.
- Mahar, M. A., Jafri, S. I. H., S. M. Leghari and M. Y Khuhawar (2000) Studies on water chemistry and fish production of Manchhar lake, Dadu, Sindh. Pakistan. *Pakistan J. Biol. Sci.*, **3** (12): 2151-2153.
- Munawar, M. (1970) Limnological studies on ponds of Hyderabad, India I. The biotope. *Hydrobiology.*, **35** (1): 127-162.
- Palmer, C. M. (1980) *Algae and Water Pollution*. Castle House Publications Ltd., England, P. 123.
- Parmisivam, M. and A. Sreenivasan (1981) Change in algal flora due to pollution in Cauvery river. *Indian J. Environ. Hlth.*, **23** (3): pp. 222-238.
- Philipose, M. T. (1959) Phytoplankton of inland fisheries. *Proc. Symp. Algal. (Ed. P. Kachroo) I. C. A. R., New Delhi*, pp. 272-291.
- Prescott, G. W. (1948) Objectionable algae with reference to the killing of fish and other animals. *Hydrobiol.*, **1**: 1-13.

Prescott, G.W. (1961) *Algae of western great lake area*. W.M.C.Brown Company, Iowa, U. S. A. pp. 977.

Rai, L. C. and M. D. Kumar (1976) Systematic and ecological studies on algae of some habitats near Sahupuri varabasum. *India. Nova.. Medcoigia.*, **27**: 805-812.

Rao, C. B. (1955) On the distribution of algae in a group of six small ponds. II. Algal periodicity. *J. Ecol.*, **43** (1): 291-307.

Round, F. E. (1979) *The Ecology of algae*, Cambridge, P. 653.

Sigee, D. C. (2005) *Fresh water microbiology*. John Willey, U. K. p. 265.

Singh, S. R. and K. Swaarup, (1979) Limnological studies of Suraha lake (Ballia). II. The periodicity of phytoplankton in Suraha lake. *Phykos.*, **20**: 34 -43.

WAPDA (1990) Indus Region Study of Right bank Master Plan: Fisheries Studies. Working paper. No. 27 ODA, London, U. K. P.51.

W. H. O. (1984) Guidelines for drinking water quality Vol. II and III, Geneva.