PHYSICO-CHEMICAL STATUS OF WATER AT THE VICINITY OF ST. MARTIN’S ISLAND, BAY OF BENGAL, BANGLADESH

M.Y. Mehedi\textsuperscript{a}\textsuperscript{*}, S. Islam\textsuperscript{b}, K. Azam\textsuperscript{a} and D. Kamal\textsuperscript{a}

\textsuperscript{a} Fisheries and Marine Resource Technology Discipline, Khulna University, Khulna 9208, Bangladesh
\textsuperscript{b} Institute of Marine Sciences, University of Chittagong, Chittagong 4331, Bangladesh

Manuscript received: November 11, 1999; Accepted: March 14, 2000

Abstract: Surface water around two stations of the St. Martin’s Island stretching 12 km south from southern most part of main land located in Ukhia and Teknaf were collected monthly during low tide and were analyzed for different hydrological parameters. The maximum and minimum values of water temperature, salinity, dissolved oxygen (DO), pH, water transparency, phosphate-phosphorous (PO$_4$-P), nitrate-nitrogen (NO$_3$-N), nitrite-nitrogen (NO$_2$-N), ammonia-nitrogen (NH$_3$-N) were noted as 27.9 and 25.6\textdegree{}C, 34.93 and 31.40 ppt., 8.71 and 6.35 mg l\textsuperscript{-1}, pH 9.39 and 7.2, 74.86 and 52.40 cm, 18.02 and 7.28 mg l\textsuperscript{-1}, 3.61 and 0.72 mg l\textsuperscript{-1}, 1.88 and 0.07 mg l\textsuperscript{-1}, and 1.92 and 0.08 mg l\textsuperscript{-1} respectively. During the period of investigation, the values of DO showed inverse relationship with salinity and water temperature. Nutrient contents in the investigated areas were much higher.

Key words: Physico-chemical parameter; Nutrients; St. Martin’s Island; Bay of Bengal

Introduction

Quality of water generally refers to the component of water, which is to be present at optimum level for suitable growth of plants and animals. Various factors like water temperature, turbidity, salinity, and nutrients play a considerable role for the growth of plants and animals in a water body. Each factor has its individual role, which has great significance. Protection of aquatic life is sort by assessment of all available toxicity data from both acute and chronic exposure tests. Values are usually set on the basis of habits of an average member of the most critically exposed group of the population (Hunt \textit{et al.}, 1982). GESAMP (1974) took initiatives to find out criteria related to water pollution control for protection of marine living resources and human health. IMCO (1973) considered water quality criteria in preparation for the International Convention for the prevention of pollution from ships.

St. Martin’s Island, though a small area, present a variety of physiographic feature \textit{viz.}...
rocky platform, sandy beach, sand dunes, a lagoon, marshes, a tumble, crenulated shoreline and coral clusters. The rocks of the island are made of argillaceous limestone, calcareous sandstone, fossiliferous conglomerates and coralline limestone. These lie in the form of a thin sheet and also in the shape of big rough boulders (Islam, 1970). Sarker (1992) reported 1500 MT red seaweed biomass available around the St. Martin’s Island. There are also rich aquatic fauna inhabiting in water dominating the island. However, scanty information is available on the water quality in this area. The present investigation is undertaken to assess hydrological parameters so as to find out the ecological status of the studied area as well as the contribution of each factor on the growth and distribution of aquatic weeds.

Materials and Methods

St. Martin's Island is situated in between 92°18’–92°21’ E and 20°34’–20°38’ N and is about 12 km south from southern most part of the mainland. It is stretched North to South. To the East of this island Myanmar boundary line is about 5km away while to the West and South-west it faces the open sea. It is a group of several small and big islets but broadly three or four of this are recognized at high tide. Two stations, namely Dakshin para and Jingira, were selected around the St. Martin’s Island and the stations were treated as station 1 and station 2 respectively. Station 1 is situated at the southern part of the western coast. The shore slope of this station area is gradually slanting. The coast is made up of compactly stacked boulders of different shapes and sizes. Station 2 is situated at the Northern part of the western coast. The shore slope of area is gradually slanting. The coast is composed of large rock boulders.

Water samples were collected from the two stations around the St. Martin’s Island during the period of November to April at low tide. The samples were collected in clean plastic buckets of one-liter capacity each for measuring all the physico-chemical parameters except DO and water transparency. For measuring DO, samples were collected in BOD bottles (300 ml) and treated with 2 ml of alkali-iodide azide reagents in the field. The bottles were turned upside down several times to allow thorough mixing. The bottles were closed with stopper in such a way so that no air bubbles were formed.

All the bottles with samples were placed in wooden boxes to avoid direct sunlight. Samples were then transferred to the laboratory and preserved at 4°C before analysis (WHO, 1982). Water temperature was measured by thermometer (centigrade) by dipping in the water for three minutes. The value of pH was determined with the help of digital pH meter (Model PW 9409 Philips). Salinity was determined by following Mohr’s titration method (Strickland and Parson, 1965). DO, Phosphate-phosphorous, Nitrate-nitrogen, Nitrite-nitrogen, Ammonia-nitrogen were measured according to the procedure of APHA (1976). To obtain transparency, a secchi disc was lowered in to the water, in the shade until it disappeared and a depth measurement at this point was taken. Then the disc was raised until it reappeared and another depth measurement was taken. This process was repeated three times and the over all average was considered as the proper secchi disc reading or value of water transparency.
Results and Discussion

Different water temperature ranges were observed in two stations during the period of investigation. Between the two stations, the highest water temperature was recorded as 27.9°C in station 2 and the lowest was recorded as 25.6°C in station 1. Interpretation (Table 1 and 2)) reveals that water temperatures were higher in November, February and March than those of December and January. Such higher values of water temperature in those months occurred probably due to the air temperature of the surrounding influence air. Similar inferences were observed by Quasim and Gopinathan (1969) in Cochin back water and Dehadri (1970) in Mormugua Bay. In the present study, the water temperature suddenly dropped from a peak high (March) to a peak low (April). It might be attributed to heavy rainfall. In the present study, the range of water temperature was within the limit stated by Luning (1990).

Table 1. Hydrological parameters of station 1 in different months (1994-1995).

| Parameter                  | Nov. 1994 | Dec. 1994 | Jan. 1995 | Feb. 1995 | Mar. 1995 | Apr. 1995 | Mean 1995 |
|----------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Water temp. (°C)           | 27        | 25.8      | 25.7      | 26.4      | 27.82     | 25.8      | 26.39     |
| Salinity (ppt.)            | 33.82     | 32.7      | 32.25     | 33.71     | 34.7      | 31.8      | 33.11     |
| DO (mg l⁻¹)                | 7.93      | 8.12      | 8.71      | 7.51      | 6.82      | 8.21      | 7.88      |
| pH                         | 7.2       | 7.35      | 8.11      | 9.13      | 8.2       | 7.41      | 7.9       |
| Water transparency (cm)    | 52.4      | 55.9      | 67.18     | 73.42     | 67.98     | 55.83     | 62.12     |
| PO₄-P (mg l⁻¹)             | 9.13      | 18.02     | 16.25     | 10.52     | 9.02      | 8.56      | 11.92     |
| NO₃-N (mg l⁻¹)             | 2.78      | 2.43      | 1.82      | 1.0       | 0.95      | 0.91      | 1.65      |
| NH₃-N (mg l⁻¹)             | 1.82      | 1.8       | 1.32      | 0.6       | 0.07      | 0.46      | 1.01      |

The maximum (34.93 ppt.) and the minimum (31.40 ppt.) values of salinity were recorded in station 2 between the two stations (Table 2). The maximum salinity was observed in March, 1995 and the minimum salinity was observed in April, 1995. Variations in salinity during the present investigation were related to seasons with an exception in April, 1995. Similar seasonal variations were observed by Hossain (1980). In April, 1995, salinity suddenly dropped from the maximum value to the minimum value probably due to heavy rainfall and discharge of terrestrial and river runoff. Similar fluctuations were also reported Rao and Sastry (1980). Zafar (1992) observed that the
values of salinity were proportional to the values of water temperature in coastal waters of Bangladesh.

Mean values of water temperature and salinity in station 1 were comparatively lower than that of station 2 (Tables 1 and 2). These lower values of water temperature and salinity at station 1 occurred probably due to higher wave action at station 1 compared to station 2. The highest values of dissolved oxygen (8.81 mg l\(^{-1}\)) was observed at station 1 in January, 1995 and lowest (6.35 mg l\(^{-1}\)) was observed in station 2 in March, 1995. The mean values of DO at station 1 and 2 were 7.88 and 7.59 mg l\(^{-1}\) respectively (Tables 1 and 2). The standard value of DO for the coastal water of Bangladesh is 6.0 mg l\(^{-1}\) (EQS, 1991). However, the values of DO in the present investigation were higher than the EQS value. This was probably due to heavy wave action and high algal production. An inverse relationship of DO with salinity and temperature was observed during the present study. Similar relationship was also made by Benakappa et al. (1980) from the fishing ground of Mukka-kaup. As suggested by Redfield (1948), this was perhaps due to the greater solubility of oxygen in water at lower temperature and lower salinity.

The maximum (9.39) and the minimum (7.20) pH were recorded in station 2 and station 1 respectively (Tables 2 and 1). The mean values of pH at station 1 and station 2 were 7.90 and 8.38 whereas the standard value of pH of the coastal water of Bangladesh is pH 6 to 9 (EQS, 1991). The values of pH of the present investigation were found higher during, January-March, 1995, when the algal vegetation was maximum and lower in November, 1992 and April, 1993. There higher values of pH might be due to utilization of carbon-di-oxide by primary producers (e.g. seaweed) in their photosynthetic activities. Similar higher values of pH were reported by Benackappa et al. (1980). The lower values of pH might be attributed to the dilution of waters by river runoff.

Different values of water transparency were observed in two stations during the period of investigation. In the present study, the maximum (74.86 cm) and the minimum (52.40 cm) values of water transparency were recorded in station 2 and 1, respectively (Tables 2 and 1). The values of water transparency were found higher during, January, February, and March, 1995. It could be due to low wave action and absence of rainfall. Comparatively lower values of water transparency were found in November, 1994. The low values of water transparency occurred due to rainfall.

The maximum (18.02 mg l\(^{-1}\)) and the minimum (7.28 mg l\(^{-1}\)) PO\(_4\)-P contents were recorded in station 1 and station 2 respectively during the period of investigation (Tables 1 and 2). The higher PO\(_4\)-P contents were observed during December 1994, January and February, 1995. While the lower PO\(_4\)-P contents were observed during November, 1994, March and April, 1995. This variation in PO\(_4\)-P content might be due to utilization of PO\(_4\)-P by seaweeds, and absorption and desorption of PO\(_4\)-P by phytoplankton. Besides, buffering action of sediment under varying environmental condition may also cause the variation in PO\(_4\)-P content. Uddin (1993) found the range of PO\(_4\)-P between 7.3 and 12.2 mg l\(^{-1}\) in the Karnafully River. Nair et al. (1984) reported the concentration of PO\(_4\)-P between 3.4 µg l\(^{-1}\) and 6.02 µg l\(^{-1}\) from Ashtamudi estuary. Abidi et al. (1983) found the values of PO\(_4\)-P from 1.1 to 10 µg l\(^{-1}\). The range of PO\(_4\)-P content (7.28-18.02 mg l\(^{-1}\)) in
the present investigation is nearly similar to the contents (7.30-12.2 mg l$^{-1}$) reported by Uddin (1993). However, it does not agree with the ranges reported by Nair et al. (1984) and Abidi et al. (1983).

Between the two stations, both the maximum (3.61 mg l$^{-1}$) and the minimum (0.72 mg l$^{-1}$) NO$_3$-N contents were recorded in station 2 (Table 2). The NO$_3$-N concentration was high during the months of November and December, 1994 and January, 1995 and low concentration during the months of March and April, 1995. It was also observed that from the highest concentration in November, 1994, NO$_3$-N concentration gradually decreased. This gradual depletion occurred probably due to utilization of NO$_3$-N by seaweeds and phytoplankton. Uddin (1993) found the values of NO$_3$-N ranged from 8.2 mg l$^{-1}$ to 11.40 mg l$^{-1}$ in the Karnafully River. Abidi et al. (1983) found the values of NO$_3$-N ranged between 0.57 µg l$^{-1}$ and 7.6 µg l$^{-1}$ in the west coast of India. Whereas in the present investigation the NO$_3$-N content ranged between 0.72 mg l$^{-1}$ and 3.6 mg l$^{-1}$.

The results of the present investigation did not coincide with the results of Uddin (1993) and Abidi et al. (1983).

The maximum (1.88 mg l$^{-1}$) and the minimum (0.07 mg l$^{-1}$) NO$_2$-N concentrations were recorded in station 2 and station 1 respectively during the period of investigation (Tables 2 and 1). The values of NO$_2$-N were found lower than those of NO$_3$-N values. This less values of NO$_2$-N might be caused by the rapid alternation from NO$_2$-N to NO$_3$-N. Uddin (1993) found NO$_2$-N concentrations ranged from 0.70 to 1.52 mg l$^{-1}$ in the Karnafully River. Sarma et al. (1982) reported maximum concentration (1 mg l$^{-1}$) of NO$_2$-N from the Visakhapatnam harbour. Results of the present investigation coincided with the results of Uddin (1993) and Sarma et al (1982) with little differences. In the present investigation the highest NO$_2$-N concentration was found in November, 1994. It gradually decreased in April, 1995 and reached to the lowest value. Higher concentrations occurred during the months of November, December, 1994 and January, 1995, which might be due to the production of extracellular nitrite produced by phytoplankton population as reported by Carlucci et al. (1970). Further it was also assumed that excretion by phytoplankton, oxidation of ammonia and reduction of nitrate had contributed higher concentration of nitrite in the studied water bodies. Monthly variations in NO$_2$-N contents were observed during the period of investigation. This was probably due to the predominance of any one of the above processes.

The maximum (1.92 mg l$^{-1}$) and the minimum (0.078 mg l$^{-1}$) NH$_3$-N contents were recorded at station 2 and station 1 respectively during the period of investigation (Tables 2 and 1). The values of NH$_3$-N were found lower than the values of NO$_3$-N. Uddin (1993) found NH$_3$-N that ranged between 0.25 mg l$^{-1}$ and 0.50 mg l$^{-1}$ in the Karnafully River. Sarma et al. (1982) reported maximum concentration (12 ng l$^{-1}$) in the Visakhapatnam Harbour. Results of the present investigation show similarity with the results of Uddin (1993) but disagree with the results of Sharma et al. (1982). Highest values of NH$_3$-N were found in November 1994 and gradually decreased till February 1995. No remarkable fluctuations of NH$_3$-N were observed from November 1994 to February 1995 but it suddenly dropped to the minimum value in March 1995. It happened probably due to the utilization of NH$_3$-N by seaweeds and phytoplankton. In April 1995, the value of
NH$_3$-N increased but did not reach the highest value. The increasing trend of NH$_3$-N probably occurred due to the metabolic activities of plants, animals and bacteria. Severdrup et al. (1970) reported that the metabolic activities of the plants, animals and bacteria returned the elements to inorganic forms. The present work is in well agreement with the findings of Severdrup et al. (1970).

Generally, nutrients contents remain lower in the open ocean than coastal water or adjacent to the locality. Higher values in the coastal water were usually due to the addition of river run off, terrestrial run off, organic wastes etc. In the present work the concentrations of nutrients were much higher than the normal range. This higher range of nutrients occurred probably due to the addition of river run off, terrestrial run off, organic wastes etc. Moreover, certain bacteria played a vital role for such higher values of nutrients during the present investigation around St. Martin’s island by decomposing various organic substances such phytoplankton, seaweeds and other aquatic plants and animals.

**Conclusion**

The values of pH during the studied period were within the limit of EQS (6-9) for coastal water that was also responsible for the growth of seaweeds with an exception in February 1995. Nutrients (PO$_4$-P, NO$_3$-N, NO$_2$-N, NH$_3$-N) content around the St. Martin's Island water very high, which were essential for the growth of seaweeds. The findings of the present investigation will add to our understanding about the ecological status of St. Martin’s Island.

**References**

Abidi, S.A.H., Desai, B.N. and Ram, J., 1983. Studies on the hydrography and plankton of waters off Akarpati near Navapur, West coast of India during February-March. *Mahasagar*, 16 (1): 91-94.

APHA (American Public Health Association), 1976. *Standard Methods for the Examinations of Water and Waste Water*. 13$^{th}$ edition, Broadway, New York, 10019 pp.

Benakappa, S., Reddy, M.P.M. and Hariharan, V., 1980. Hydrographic conditions in the fishing group off Mukka-kaup, South Kanara. *Mahasagar*, 13(1): 1-7.

Carlucci, A.P., Hartwig, E.O. and Bowcs, P.M., 1970. Biological production of Nutrient in seawater. *Marine Biology*, 7:161-166.

Dehadri, P.V., 1970. Observations on certain environmental features at the Dona Paula Point in Mormugao Bay, Goa. Proceedings of the Indian Academy of Sciences, 72B: 56-67.

EQS (Environmental Quality Standards), 1991. Environmental Quality Standards for Bangladesh. Department of Environment, Governments of People's Republic of Bangladesh.

GESAMP (Joint Group [IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP] Experts on the Scientific Aspects of Marine Pollution), 1974. Review of Harmful Substances. Supplement to the Report of Sixth Session, 22-28 March 1974, Geneva.

Hossain, M.M., 1980. Pollution as revealed by macrobenthic organisms in the Karnafully River Estuary. M.Sc. Thesis, Institute of Marine Sciences, University of Chittagong.
Hunt, G.J., Hewith, L.J. and Shepherd, J.G., 1982. The identification of critical groups and its application to fish and shell fish consumers in the coastal area of the North-east Irish Sea. *Health Physics*, 13(6): 875-889.

IMCO, 1973. International convention for the prevention of pollution from ships, IMCO, London, 1973.

Islam, A.K.M.N., 1970. Preliminary ecological report on the marine algal flora of the St. Martin’s Island, East Pakistan. *Journal of the Asiatic Society of Pakistan*, 15(3): 283.

Luming, K., 1990. *Seaweeds: Their Environment, Biogeography and Ecophysiology*. Willey- Interscience Publication, N.Y., pp. 3-370.

Nair, N.B., Dharmaraj, B., Aziz, P.K.A., Arunachalam, M., Krishnakumar, K. and Balasubramnian, N.K., 1984. Ecology of Indian estuaries: VIII. Inorganic nutrients in the Ashtamudi estuary. *Mahasagar*, 17(1): 19-32.

Quasim, S.Z. and Gopinathan, C.K., 1969. Tidal cycle and environmental features of Cochin Backwater (a tropical estuary). *Proceeding of the Indian Academy of Science*, 69B: 336-348.

Rao, D.P. and Sastry, J.S., 1981. Circulation and distribution of some hydrological properties during the late winter in the Bay of Bengal. *Mahasagar*, 14(1): 1-15.

Redfield, A.C., 1948. The exchange of oxygen across the sea surface. *Journal of Marine Research*, 7: 347-361.

Sarker, M.N., 1992. Status of the red seaweeds in Bangladesh. Paper presented at the Regional Workshop and Study on the Taxonomy, Ecology and Processing of Commercially Important Red Seaweeds. 21-28 April, 1992, Karetsoe University, Bangkok, Thailand. Organized by FAO, NACA and France Government.

Sarma, V.V., Raju, G.P.K. and Babu, T.B., 1982. Pollution characteristics and water quality in the Visakhapatnam harbour. *Mahasagar*, 15(2): 15-22.

Severdrup, H.U., Johnson, M.W. and Fleming, R.H., 1970. *The Oceans*. Prentice-Hall Inc., Englewood Cliffs, N.J., pp. 165-263.

Strickland, J.D.H. and Parson, J.R., 1985. *A Manual of Seawater Analysis*. Fish Research Board of Canada Bulletin No. 125, Ottawa, 525 pp.

Uddin, S.M.J., 1993. Environmental impact assessment (EIA) of the municipal sewage discharge through Majhirghat canal on the Karnafully river water, Chittagong. M.Sc. Thesis, Institute of Marine Sciences, University of Chittagong, pp. 22-58.

WHO, 1982. *Examination of Water for Pollution Control: A Reference Hand Book*, Vol. 1 and 2, Rome, Italy.

Zafar, M., 1992. Study on some hydrological aspects of the South-eastern part of Bangladesh coastal waters in the Bay of Bengal. M.S. Thesis, Marine Ecology, Vrije University of Brussels, Belgium, 258 pp.