J. Mar. Biol. Ass. India, **51** (2) : 173 - 177, July - December 2009

Incidence of fish mortality in Tuticorin Bay, Gulf of Mannar

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Abstract

A study was conducted to assess the possible cause for fish mortality during 14-15th February 2008 in Tuticorin Bay. Analysis showed normal values of sea surface temperature, pH, dissolved oxygen and nutrient concentrations. The mean salinity (30.8 ppt) was lower than the normal (35.5 ppt). Though the concentration of chlorophyll was slightly higher than normal, no visible colour change was noticed in the Bay water. The possible entry of land drainage along with freshwater influx might have caused lower salinity and higher algal concentration. Analysis of water and dead fish tissue samples were carried out for metal load. The concentration of trace metals within safe limits ruled out the possibilities of fish mortality due to metal pollution. The estimated mean value of ammonia (1.09 mg. L^{-1}) in water was very much higher than the toxic limit of 0.1 mg. L^{-1}, indicating the possibility of ammonia as the major cause of fish mortality in the Bay.

Keywords: Fish mortality, Tuticorin Bay, ammonia

Introduction

Tuticorin Bay (08^{0} 45' N lat; 08^{0} 12' E long.), situated in the Gulf of Mannar, is at present exposed to pollutants from industrial and sewage effluents. The effluent discharge mainly the fly ash containing slurry is filling up the Bay along with the heated water effluent posing serious threat to the flora and fauna (Easterson *et al*., 2000; Asha, 2002).

The anthropogenic effects on biological processes result in mass mortality of marine organisms. An incidence of fish mortality was observed in the Tuticorin Bay in the evening along the seaward side of the port area on 14-02-08, followed by mass mortality of fishes on 15-02-08. The mortality continued for four days up to 19-02-08. Fishes in the Bay were noticed as lethargic, slow moving and surfacing with breathing difficulties. Many fishermen caught the fishes in bulk quantities. Women collected fishes by hand. Upon enquiry it was learned that mortalities did not occur in the open sea, indicating that the main source of pollution causing fish mortality prevailed only in the Bay water. Fish mortality due to ecological changes has been reported previously from Mandapam area (Badrudeen *et al*., 1987), but such incidences were seldom reported from Tuticorin Bay. This paper presents the results of the studies carried out in the Bay during the fish mortality to assess its major causes.

Material and Methods

Six stations were selected along the Bay (08^{0} 45' N lat; 8^{0} 12' E long.) and the locations are given in Fig. 1. Station 1 (St. 1): the hot water effluent discharge point of Tuticorin Thermal Power station (TTPS), where no mortality was observed. St. 2 : 500 m away from the discharge point where the water was turbid with one or two dead fishes; St. 3 : open sea towards the western side of TTPS, where there was no fish mortality; St. 4 : two km south off CMFRI office, where large number of dead fishes occurred; St. 5: the Karapad Bay near the seawater intake point of CMFRI; and St. 6: nearer to the Rosche park area, one km north off CMFRI, with more number of dead fishes. Physical examination of water did not show any changes except for the presence of oil scum and greasy smell along shore areas at St. 4 on 14-02-08.

Water samples from two stations on 14-02-08, six stations on 15-02-08 and three stations on 19-02-

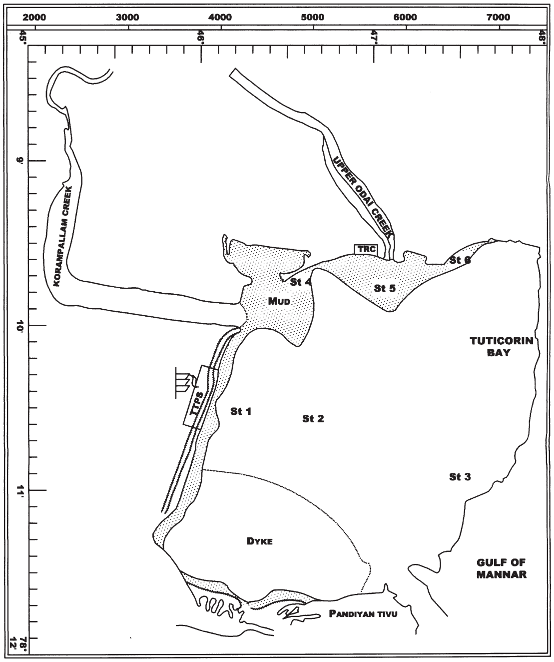

Fig. 1. Map showing location of sampling stations in the Tuticorin Bay

08 were collected to estimate hydrological parameters. Dead fish specimens at random from various stations and water samples from six stations were collected on 15-02-08 for metal analysis. *In-situ* observation on temperature was made with a precision thermometer of 0.5^0 C accuracy. Standard procedures (Strickland and Parsons 1968) were followed to estimate the hydrological parameters like salinity, carbon dioxide, dissolved oxygen, pH, inorganic nutrients and chlorophyll. Ammonia was estimated by following phenol hypochlorite method (Solarzano, 1969). Tissue samples from dorsal side of dead fishes namely, *Mugil cephalus, Siganus lineatus, Carangoides armatus, Nematalosa nasus, Gerres filamentosus, Strongylura leiura, Arius thalassinus, Scolopsis bimaculatus, Stolephorus indicus* and *Platycephalus indicus* were removed and washed in distilled water and dried in an oven at $80 \pm^0$ C. The metals were extracted from dried fish tissue samples (5 g) in duplicate by following acid digestion procedure (Dalziel and Baker, 1984). Calcium, magnesium, manganese, strontium and zinc from both water and digested fish tissue samples were detected in an Atomic Absorption Spectrophotometer (GBC-932 plus) in an air acetylene flame. The mean values of the estimated parameters were used for discussion. For comparison of various parameters, earlier estimates made by Asha (unpublished) in Tuticorin Bay in 2007 were used.

Results and Discussion

The list of dead fishes is given in Table 1. The analysis of water samples collected on 14^{th} February 2008 from two stations (St. 4 and St. 5) indicated no significant variation in the mean values of sea surface temperature (SST) (28.1^0 C), pH (8.22), dissolved oxygen (2.4 ml. L^{-1}), nitrites (8.37 µg. L^{-1}), phosphate (0.71 µg. L^{-1}) and silicate (0.0683 µg. L^{-1}) from their normal range (Asha *et al.*, unpublished). Low salinity (28 ppt), high chlorophyll-a (37.56 µg. ml^{-1}) and high ammonia (2.124 mg. L^{-1}) indicated the entry of freshwater with some pollutants into the Bay.

Table 1. List of dead finfish

No.	Species
1.	*Plotosus canius*
2.	*Plotosus lineatus*
3.	*Eleutheronema tetradactylum*
4.	*Mugil cephalus*
5.	*Liza parsia*
6.	*Monodactylus argenteus*
7.	*Platycephalus indicus*
8.	*Siganus javus*
9.	*Siganus lineatus*
10.	*Epinephelus malabaricus*
11.	*Epinephelus merra*
12.	*Sillago sihama*
13.	*Solea elongata*
14.	*Therapon jarbua*
15.	*Therapon theraps*
16.	*Nibea maculata*
17.	*Gerres filamentosus*
18.	*Megalops cyprinoides*
19.	*Elops saurus*
20.	*Caranx ignobilis*
21.	*Odonus niger*
22.	*Nematalosa nasus*
23.	*Acanthurus strigosus*
24.	*Chanos chanos*
25.	*Strongylura leiura*
26.	*Leiognathus brevirostris*
27.	*Scatophagus argus*
28.	*Lutjanus argentimaculatus*
29.	*Psettodes erumei*
30.	*Pentaprion longimanus*
31.	*Carangoides armatus*
32.	*Arius thalassinus*
33.	*Scolopsis bimaculatus*
34.	*Stolephorus indicus*
35.	*Diodon hystrix*

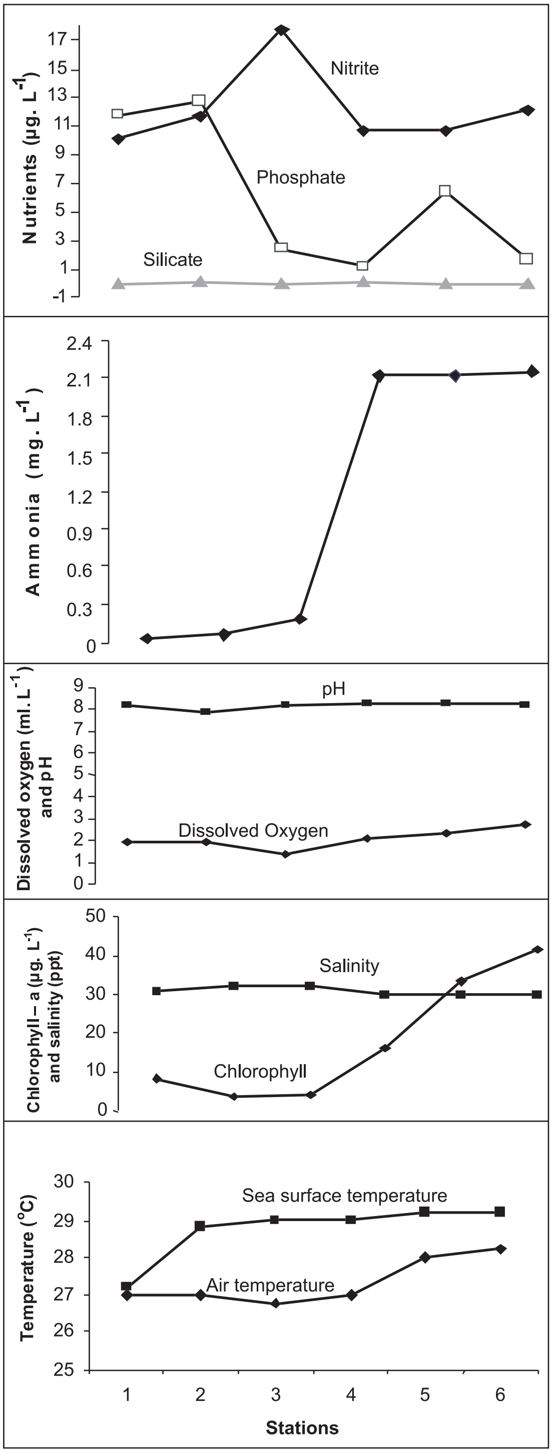

Fig. 2. Variations in the hydrological parameters of the bay water on 15-02-2009

***Temperature and pH*:** On 15th February 2008, no significant variation was observed in the sea surface temperature (SST) among the stations and the values ranged from a minimum of 27.2 ^{0}C at St.1 to 29.2 ^{0}C at St. 5 and 6. The SST was found to be within the normal range (29.5^0 C) confirming the absence of thermal pollution in the Bay. The pH varied between 7.89 at St. 2 to 8.28 at St. 4 with a mean of 8.1 within its normal range of 7.9 (Fig. 2).

***Dissolved oxygen content*:** The dissolved oxygen content ranged between 1.38 ml. L^{-1} at St. 3 and 2.76 ml. L^{-1} at St. 6 with a mean of 2.07 ml. L^{-1}. It was also close to the normal content of 2.5 ml. L^{-1} in the Bay water. This ruled out anoxic conditions in the Bay. The absence of carbon dioxide estimated at all stations confirmed it.

***Salinity*:** The salinity ranged between 30 ppt at Sts. 4, 5 and 6 and 32 ppt at St. 2 and 3 with a mean of 30.8 ppt which is found to be lower than the normal value of 35.5 ppt indicating the entry of freshwater into the Bay. However, this marginally low salinity might not be a major problem to cause fish mortality in the Bay, since low salinity during the northeast monsoon due to freshwater influx is a common phenomenon in the Tuticorin Bay water. The salinity lowered to a minimum of 14 ppt in 2007, but did not cause any fish mortality.

***Nutrients*:** The values of nutrient concentrations ranged between 10.13µg. L^{-1} at St. 1 to 17.8 µg. L^{-1} at St. 3 with a mean of 12.2 µg. L^{-1} for nitrite ; 1.22 µg. L^{-1} at St. 4 to 12.8 µg. L^{-1} at St. 2 with a mean of 6.05 µg. L^{-1} for phosphate and 0.003 µg. L^{-1} at St. 6 to 0.06 µg. L^{-1} at St. 2 with a mean of 0.0269 µg. L^{-1} for silicate (Fig. 2). The nutrient concentrations were found to be within the normal range of 10.7 µg. L^{-1} for nitrite, 6.8 µg. L^{-1} for phosphate and 0.69 µg. L^{-1} for silicate respectively which also ruled out the possibilities of nutrient enrichment in the water.

***Chlorophyll and ammonia*:** The chlorophyll-*a* concentration ranged from 3.90 µg. L^{-1} at St. 2 to 41.6 µg. L^{-1} at St. 6 with a mean of 18.01 µg. L^{-1}, which is much higher than the normal value of 3.02 µg. L^{-1}. The free ammonia concentration was found to vary between 0.028 mg. L^{-1} at St. 1

to 2.16 mg. L^{-1} at St. 6 with a mean of 1.099 mg. L^{-1} which was much higher than the usual value of 0.0684 mg. L^{-1} recorded in the Bay water. There was a pattern in the concentration of ammonia observed among the stations with the maximum observed towards the shoreward side of the Bay.

Metal concentration: The concentration of metals like Ca, Mg, Mn, Sr and Zn observed in the water samples and in the body tissues of dead fishes are given in Fig. 3 and 4 respectively. Except for Ca and Mg, the concentrations of other metals were found to be below the detectable limit in the muscle tissues. The levels of Ca and Mg ranged between 2 – 2.5 µg. g^{-1} and 1.52 – 3.78 µg. g^{-1} respectively. *Gerres filamentosus* was found to have accumulated the lowest amount of Ca and Mg. In the water samples, the concentration of Ca varied between 2.002 and 2.454 µg. ml^{-1}; Mg 9.05 – 32.2 µg. ml^{-1}; Mn 0.047 – 0.109 µg. ml^{-1}; Sr 3.72 – 5.89 µg. ml^{-1} and Zn 0.0887 – 0.1078 µg. ml^{-1}. The concentrations of these metals were found to be within safe limits of 75 µg.

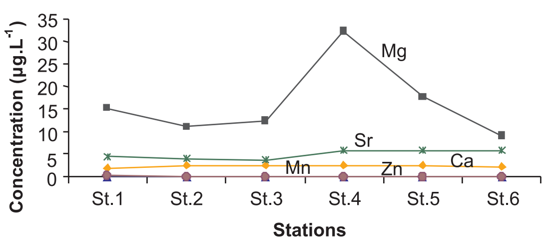

Fig. 3. Metal concentrations in water samples collected on 15-02-2009

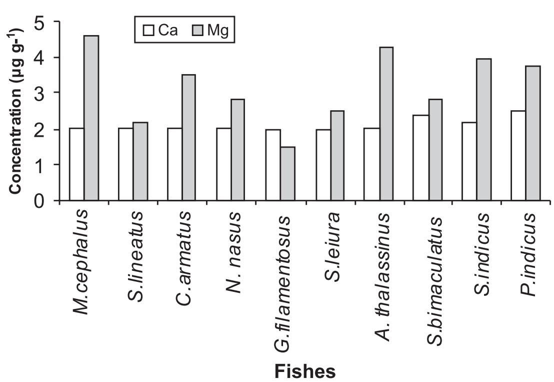

Fig. 4. Metal concentrations in dead fishes collected on 15-02-2009

ml^{-1} for Ca; 30 µg. ml^{-1} for Mg; 0.1 µg. ml^{-1} for Mn; 20 µg. ml^{-1} for Sr and 0.1 µg. ml^{-1} for Zn which has been mentioned by Palanisamy *et al.* (2007) in their studies. Thus the possibility of fish mortality due to metal pollution is ruled out.

A sampling was carried out four days after the incidence of mortality *i.e.*, on 19.2.2008 at St. 4, 5 and 6 in the Bay water. It revealed normal values of pH, dissolved oxygen, salinity and nutrients. The increased salinity (32 ppt) and decreased chlorophyll-*a* (7.4 µg. L^{-1}) and ammonia (0.952 mg. L^{-1}) in this analysis indicated the buffering capacity of seawater through tidal effects.

The present investigation indicates that high concentration of ammonia in the Bay water may be the major cause of fish mortality. Though concentration of chlorophyll was higher at St. 4, no visible changes in water colour were noticed in the study areas. The possible entry of land drainage along with freshwater influx due to monsoon might have caused increased algal concentration in the Bay. Ammonia has been described as one of the most significant limiting factors for growth and survival of aquatic living resources among the water quality criteria. It is produced from different nitrogenous organic matters and inorganic compounds by bacterial decomposition as well as chemical transformation (Boyd and Pillai, 1984). Un-ionized ammonia concentration above 0.1 mg. L^{-1} is reported to be toxic to cultured marine animals (Costelo and Gamble, 1992). According to Ana De la Torre *et al*. (2004), increased ammonia concentration reduces the oxygen absorption capacity of the animal from the outside medium causing stress in the animal. Tarazona *et al*. (1987) reported that short-term (<3h) exposure to extreme ammonia causes gill hyperplasia, which decreases fish respiratory efficiency. In the present work, the mean value of ammonia concentration in the Bay water was 1.099 mg. L^{-1}, which was very much higher than the lethal limit of 0.1 mg. L^{-1}. Such high values were never encountered previously in the Bay water and the mean normal value estimated in the Bay was around 0.0684 mg. L^{-1}. In the present study, high chlorophyll indicated that algal bloom might have been due to increased land drainage associated with freshwater influx, which in turn resulted in excess free nitrogenous compounds.

Acknowledgement

The authors are thankful to the Director, CMFRI, Kochi, and the Scientist-in-Charge, Tuticorin Research Centre of CMFRI for providing facilities. The first author is grateful to the anonymous reviewers for their constructive comments.

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Received : 27/03/09
Accepted : 03/08/09