

## TOXIC EFFECTS OF DOMESTIC SEWAGE ON ZOOPLANKTON

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### ABSTRACT

The toxic effects of raw domestic sewage on different groups of zooplankton was tested in the laboratory for evaluating acute toxicity. 24 hr., LC-50 values for larvae of stomatopods, gastropods and chaetognaths (2-7% concentration) indicated that they are very sensitive to the sewage. Copepods, *Lucifer* and decapod larvae (20-30% concentration) were moderately tolerant. *Acetes*, medusae, ctenophores and mysids were the most resistant groups (42-49% concentration).

*Key-words:* toxicity, domestic sewage, zooplankton.

The discharge of industrial and sewage effluent into the coastal environment has created an awareness on the hazards of pollution to aquatic life. Often, a quantitative evaluation of fish in the marine environment is taken as a biological index to evaluate the degree of pollution. More recently biological assessment of water quality has been considered as a part of pollution monitoring studies.

In Bombay approximately 1500 mld of sewage is being generated and the present treatment capacity in the plant is only about 340 mld (Metcalf and Eddy/EEC, 1979). Obviously most of the sewage is being discharged without treatment into coastal waters. Recent studies on zooplankton from the sewage polluted creek area around Bombay substantiate the adverse effects of pollution on these organisms (Gajbhiye 1979, 82; Gajbhiye and Desai, 1981; Nair, Gajbhiye and Sayed, 1983). Such field observations need to be supplemented by laboratory studies giving details on the acute toxicity of pollutants. Hence, a series of experiments were conducted to find the toxic effects of raw sewage on different groups of zooplankton.

Zooplankton were collected from offshore waters of Bombay during February to May 1981. In the laboratory they were acclimatised for a period of 24 hours and according to the requirement, different groups were carefully taken out from the mother tank. Loading was done at the rate of 40 organisms per

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litre for copepods and gastropod larvae while for remaining groups it was 10 organisms per litre. Continuous aeration was maintained throughout the experiment.

Sea water was collected Off Bombay, kept for about 7 days in carboys and filtered before use. Static bioassays were conducted as per standard procedure (APHA, 1971 and FAO 1977). Raw sewage from Versova treatment plant was brought to the laboratory for the experiment. The sewage showed DO concentration of 0 mg/l, 7.0 pH, 170 mg/l of BOD, 4510 mg/l of total dissolved solid, 99 mg/l sulphate and 1885 mg/l chloride (data obtained from Bombay Municipal Corporation). Different dilutions were tried and experiments were repeated till comparable results were obtained. Each experiment was run in duplicate along with a control.

Relevant parameters like salinity, DO, pH were monitored during the experiment. Dead organisms were recorded and removed periodically. The cumulative number of dead organisms after 24 hour was plotted against the concentration and regression line fitted. By interpolating the graph at 50% survival levels the expected lethal concentration (LC 50) of the sewage for concerned organisms was obtained.

Variations in salinity, dissolved oxygen and pH for different concentrations of sewage just after making various concentrations are given in Table I. Salinity of the raw sewage was 4.21‰. DO values decreased when the concentrations of sewage was more. The pH value also gradually decreased when concentration of effluents increased and for 100% sewage the value was 6.87. The Biochemical Oxygen Demand (BOD) of sea water and effluent was 1.80 and 170. mg/l respectively. Ranges in salinity, DO and pH of the sea water used for

Table I - Salinity, dissolved oxygen and pH for the different concentrations of sewage

Concentration (%)	Salinity (‰)	DO (mg/l)	pH
5	34.84	5.67	7.80
10	32.92	5.38	7.73
20	30.46	3.95	7.61
30	27.10	3.46	7.41
40	23.85	2.33	7.20
50	20.59	0.44	7.20
70	11.94	0.0	7.10
100	4.21	0.0	6.87

the experiment were 35.5 to 36.2‰, 5.9 to 6.3 mg/l and 7.9 to 8.1 respectively.

### *Medusae and Ctenophores*

Two species of medusae namely *Blackfordia virginica*, and *Eirene ceylonensis* were selected for the experiments. The ctenophores *Pleurobrachia* sp. was used for the test. Mortality rate increased, from 60% concentrations and none survived in 80% concentration. *Blackfordia virginica* was more tolerant than *Eirene ceylonensis* and *Pleurobrachia* sp. The estimated LC 50 values for three species were 49%, 42% and 45.5% respectively.

### *Chaetognaths*

*Sagitta bedoti* and *S. enflata* were used as the test species and the concentrations tried varied from 2-100%. The estimated LC 50 values were 2.5 and 7.0% respectively for *S. enflata* and *S. bedoti*. All the organisms died at a range of 30-50% of sewage.

### *Gastropod larvae*

All the gastropod larvae died when the concentration exceeded 30-35%. LC 50 value was observed at 2.5%.

### *Mysids*

The selected species of mysid was *Mesopodopsis zeylanica*. Compared to other species mortality rate for *M. zeylanica* was very low. The calculated 24hr LC 50 was observed at 42.5%.

### *Copepods*

The species selected for the experiments were *Acartia spinicauda*, *A. centrura*, *Paracalanus crassirostris*, *P. aculeatus* and *Eucalanus* sp. LC 50 for different species of copepods were obtained within a range of 20 to 30% concentration of sewage. The recorded maximum tolerant limit was observed for *Acartia spinicauda* and minimum was recorded for *P. crassirostris*. All the copepods died within 3 hours at 50% concentration. At 30 and 40% levels mortality rate increased after six hours of exposure attaining maximum after 20 hours of exposure.

### *Decapods*

24 hr LC 50 for *Acetes indicus* was 46%. All the test organisms died at a concentration of 70% and above.

### *Lucifer*

The LC 50 for *Lucifer hanseni* was found to be at 23% concentration. Initially the mortality rate was very low at different concentrations but later it increased after 12 hours of exposure and all the organisms were found dead at 50% concentration.

### *Brachyuran zoea*

50% survival for zoea was observed around a concentration of 27%. All the specimens died at 50% concentration and above within 3-4 hours of exposure.

### *Stomatopod larvae*

These larvae were very sensitive to sewage. The estimated 24 hr LC 50 value was at 3.5%.

In the present bioassay test the effect of a number of important environmental variables like salinity, dissolved oxygen and pH (Table 1) were found to influence the survival of organisms. At different concentrations of the sewage, salinity and dissolved oxygen values showed significant variation. In 100% concentration, salinity, DO and pH lowered down up to 4.21‰, 0.0 mg/l and 6.87 respectively. The effect of lowering of pH on zooplankton showed that even a pH of 6.0 can be tolerated by zooplankton (Gajbhiye, 1982). Sewage or other oxygen demanding waste can lead to the depletion of the DO and septic conditions are created when the DO level is very low (Hodges, 1977) and lower levels of DO act as a limiting factor for the survival of organisms. The low salinity also indicated a pronounced effect on the survival of zooplankton. The results for salinity tolerance in the present investigations indicated that none of the tested zooplankton could tolerate salinity less than 20.6‰. The reports on salinity tolerance of different species of copepods and hydromedusae gave a range of 20-57‰ of sea water (Bhattacharya & Kewalramani 1973, 1976). The lower range of salinity tolerance in the present experiments may be attributed to the synergistic effect of salinity, DO, pH and nutrients on zooplankton.

The various groups of zooplankton exhibited a wide range of tolerance (2-49%) to the different concentration of sewage. Among the different zooplankton tested, stomatopod larvae, gastropod larvae and chaetognath were found to be the most sensitive. Copepods, *Lucifer hanseni* and brachyuran zoea were moderately tolerant. The most resistant groups were medusae, ctenophores, mysids and *Acetes indicus*.

Among copepod species *Acartia spinicauda* was most resistant. The hydromedusae *Blackfordia virginica* was relatively more resistant than *Eirene*

*ceylonensis*. Between the two species of chaetognaths *S. bedoti* was more tolerant as compared to *S. enflata*.

The present study gives some basic information on the toxicity of sewage to marine/estuarine zooplankton. However, in such laboratory tests simulation of the complex environmental conditions similar to sewage dumping ground is not possible. The chemical composition of the sewage and the characteristics of the receiving water body supported by results of monitoring experiments provide a better basis for evaluating the toxicity of a pollutant to marine life.

#### ACKNOWLEDGEMENT

The authors are grateful to the Director of NIO for the facilities provided.

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