

Zooplankton in Nearshore Waters off Tarapur Near. the Atomic Power Plant

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Data were collected on the hydrographical and biological parameters in the nearshore waters of the Tarapur Atomic Power Plant to study the standing crop of zooplankton of the water and the effect of effluent if any. Variations in the temperature and dissolved oxygen content in the intake and discharge canal regions were very insignificant. Zooplankton peaks were observed in December and March, dominated by siphonophores, copepods and decapod larvae. No appreciable difference was noticed between the faunistic composition of the intake and discharge water.

STUDIES on some hydrographical and biological parameters in the near-shore waters at Tarapur, central west coast of India, are initiated with a view to determining the effect of heated effluents on inshore waters. Tarapur Power Station with a capacity to generate 420 MWe requires about 650 million gallons of water a day for its cooling process. This cooling water is pumped in through the intake canal from the adjacent sea and is released back through the discharge canals. The temperature of the outgoing water is raised by about 7° to 10°C as compared to the incoming water, and when released back into the sea may affect the environment. In the immediate area of impact the high temperature of water will cause oxygen deficiency by increasing the oxidation rate of organic matter, and also by lowering the solubility of oxygen in water. The present studies are taken up with a view to estimating the effect of elevation of water temperature, if any, on the zooplankton community of the inshore waters. Since the intake and discharge canals are long and semiclosed channels of the power plant, the work has been undertaken only at the discharge point and beyond in the inshore waters where the impact of heated effluents, if any, would make any influence on the planktonic biomass.

Although considerable work, both qualitative and quantitative, has been done on the plankton of Indian coastal waters in recent years, this has been mainly confined to the south-west and south-east coasts of India. Except for the investigations of Bal and Pradhan¹, and Pillai² very little information is available on the zooplankton distribution on the west coast north of Bombay. The impact of heated water on receiving water has been discussed³⁻⁹. However, no such account is available for the tropical seas on the Indian coast.

In the present study, therefore, distribution and abundance of zooplankton in inshore waters near the Tarapur Atomic Power Plant has been discussed and the results reveal that there is no effect on the zooplankton by the coolant water discharged into the sea.

Materials and Methods

Samples collected from December 1972 to May 1973 from 9 stations along 3 transects off the Tarapur Atomic Power Station in the 3, 7 and 9 fm areas (Fig. 1) were studied. These transects, southern, central and northern, were almost parallel to each other; stations along the central transect being in the path of the intake canal and the other two transects in the path of the discharge canals. Stations in the 3 fm area were situated at c. $\frac{1}{2}$ mile away from the plant. Stations in each transect were set at c. $\frac{1}{2}$ mile apart from each other and the distance between each transect was $1\frac{1}{2}$ mile. Zooplankton samples were taken with a net of mouth area 0.25 m^2 and mesh size of 0.2 mm (Heron Tranter net) set with a flow meter. Horizontal (surface) hauls of 10 min duration were taken on all occasions. After fixing the samples in 5% formalin, the total volume of each haul was determined by displacement method. Samples were fractioned by Folsom plankton splitter and the total number of organisms in the subsample were counted. Hydrological factors studied along with plankton investigations were temperature, salinity, oxygen, phosphate-phosphorus and nitrate-nitrogen content.

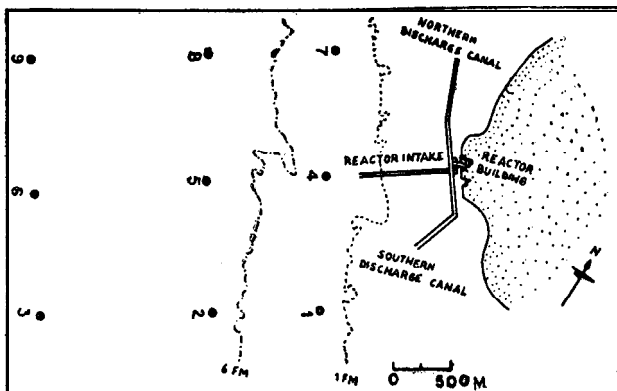


Fig. 1 -Location of stations

Results

Hydrography

Salinity — Since there is no influx of fresh or brackish water, the salinity of the area remained more or less constant throughout the period of sampling ranging from 35.77 to 36.85‰.

Temperature-Variation of about 10°C was encountered in this area largely due to the changes in atmospheric temperature. During winter (January and February) surface water temperature remained low, fluctuating between 21° and 22°C. In March, temperature became moderately high ranging from 28.2° to 29°C, after which it increased steadily to a maximum value of 31.5°C in May.

Temperature changes within the stations of both the intake and discharge canals were very insignificant; greatest difference noticed was 0.7°C. Temperature values in different stations during the period of investigation are shown in Table 1.

Dissolved oxygen — Oxygen values ranged from 3.02 to 5 and 2.85 to 4.8 ml/litre at the surface and bottom respectively. In general the surface concentrations were slightly higher than the bottom concentrations. Levels of oxygen concentration were higher during January to March (3.85-5 ml/litre) than April to May (3.02-3.6 ml/litre) indicating that dissolved oxygen changes are inversely proportional to temperature. Here also, the stationwise

difference in the oxygen content of the 3 transects was insignificant. Variations in dissolved oxygen for different months are shown in Table 1.

Nutrients — Nitrate-nitrogen concentration ranged from 1 to 9.25 and 1 to 11.5 µg-at/litre for the surface and bottom respectively.

Phosphate-phosphorus values ranged from 0.1 to 1.55 and 0.1 to 1.9 µg-at/litre for the surface and bottom respectively.

Zooplankton

Zooplankton in the vicinity of the Tarapur Atomic Power Plant was quite rich in its fauna, the forms present being mainly marine, some having a definite maximal period while a few forms did not show much variation in numbers during the period of observation.

Total zooplankton biomass was estimated by displacement method. The results (Fig. 2) show that the major zooplankton peaks were during December and March. The maximum value (28 ml/100 m³) obtained during December was owing to the siphonophore swarms, and in March (9.5 ml/100 m³) the major components of the plankton were copepods and decapod larvae. Pillai² has also observed 2 peaks of the zooplankton biomass, one in March/April and the other in October-November, in the offshore region of Bombay. He reported

TABLE 1 -TEMPERATURE AND DISSOLVED OXYGEN VALUES OF SEA WATER AT DIFFERENT STATIONS DURING DIFFERENT MONTHS

Month	South			Central			North			
	Stations : 1	2	3	4	5	6	7	8	9	
TEMPERATURE (°C)										
January	S	21.7	21.2	21.2	21.5	21.4	20.9	21.2	21.2	21.0
	B	21.0	21.0	20.8	21.2	21.1	21.0	20.8	20.9	20.8
February	S	21.9	22.0	22.0	21.9	22.5	22.2	21.9	21.9	22.0
	B	21.7	21.5	21.5	22.0	21.6	22.0	22.2	22.2	21.4
March	S	28.5	28.5	28.5	29.0	29.0	28.5	28.7	28.2	29.0
	B	28.4	26.5	28.3	28.8	28.2	27.9	28.5	28.0	28.9
April	S	28.8	28.9	28.9	29.6	29.1	29.0	29.2	29.1	29.1
	B	28.6	28.7	28.6	28.8	28.9	28.9	28.8	28.9	28.9
May	S	30.5	30.7	31.5	31.0	31.5	31.1	30.9	31.1	31.1
	B	30.1	30.6	31.2	31.1	31.3	30.8	30.8	30.9	30.6
DISSOLVED OXYGEN (ml/litre)										
January	S	4.2	4.0	4.2	3.8	3.9	4.1	4.0	4.3	4.1
	B	4.1	4.0	4.0	3.9	4.0	4.2	3.8	4.2	--
February	S	5.0	4.89	4.85	4.89	5.0	4.9	4.89	4.52	4.71
	B	4.8	4.71	4.8	4.8	4.8	4.8	4.65	4.52	4.71
March	S	4.05	4.15	3.95	4.15	3.95	4.05	4.05	3.95	3.85
	B	3.95	3.95	3.75	3.45	3.75	3.85	3.95	3.65	3.75
April	S	3.57	3.48	3.3	3.57	3.67	3.67	3.52	3.48	3.67
	B	3.3	3.21	3.21	3.3	3.21	3.3	3.48	3.11	3.48
May	S	3.21	3.02	3.02	3.02	3.3	3.02	3.02	3.2	3.11
	B	3.11	2.92	2.85	2.85	3.11	2.92	2.92	3.11	3.02

S = surface; B = bottom.

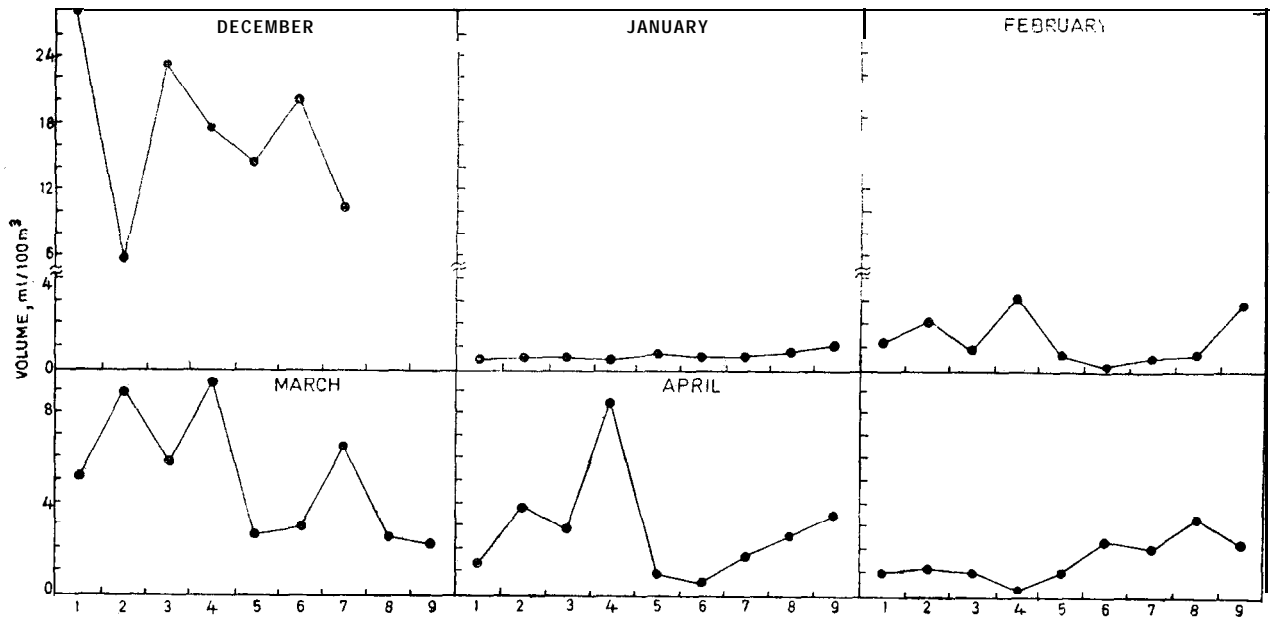


Fig. 2 -Total zooplankton values at different stations during different months

abundance of copepods, *Lucifer* sp., diatoms and fish eggs and larvae during October/November and siphonophores and salps in March/April. However, observations at Tarapur differed in the constituents of the peaks, i.e. copepods and decapod larvae dominated the community in March whereas siphonophores controlled the total composition in December. Plankton production for the month of January was very low, the highest value obtained being 1.1 ml/100 m³, and in February, although there was a remarkable increase in the number of almost all the groups, the plankton volume remained low (varying between 0.2 and 3.3 ml/100 m³) from which it is clear that large number of small adults or developmental stages ranked high in the counts. In April also the plankton volume continued to be moderately high (following the peak in March), but by May a reduction in the total volume was noticed. The faunistic composition is shown in Fig. 3.

Siphonophores — These appeared in swarms in November and December forming the major component (35-85%) of the plankton. During January and February their number was considerably reduced constituting only 6% of the total number. In the following months they completely disappeared from the plankton except for the presence of some stray individuals in May.

Coelenterata — Among the coelenterates, hydro-medusae were more common. They appeared in all months, though not in all stations, and were only nominally represented. They were more abundant in May, the highest number being 47/100 m³.

Pleurobrachia sp. was caught in small numbers in November and December, but was not represented in the following months.

Annelida — In the plankton, annelids consisted almost exclusively of larval polychaetes. However, stray specimens of such adult forms as *Tomopteris*

were also encountered. On the whole polychaetes were very few in the collection (max. No. 190/100 m³ in December) and their occurrence was very erratic throughout the period of sampling.

Chaetognatha — These were present at all times of the year in varying numbers. Month-to-month variation showed that they were more numerous in November, December and March and comparatively fewer in the other months. The highest number 2887/100 m³ was recorded in March. Following this there was decimation in their number and they remained at a low level but with occasional minor variation.

Crustacea — The bulk of the zooplankton was contributed almost throughout the year except when siphonophores were abundant by adults and larvae belonging to this group; and of this, copepods ranked first. The crustacean plankton was also characterized by a number of larvae and the cirripeds and stomatopods were represented by their larval stages. Amphipods, Ostracods and Mysids were not very common and occurred sporadically.

Copepoda formed the major component of the plankton. They were present in considerable numbers throughout the year. Numerically they remained low in November and December forming about 4-26% of the total number. By January the number reached the lowest ebb but still they accounted for about 23-53% of the plankton. Following this, there was an increase in the population number in February reaching the peak period in March when they constituted 30-83% of the plankton. In the following months (April and May) though steadily declining, appreciable numbers continued to be present. Even though there was great variation in their numbers the copepod contributed the bulk of the population.

Decapoda were present in appreciable numbers throughout the period of sampling and was similar to copepoda in their numerical abundance. The

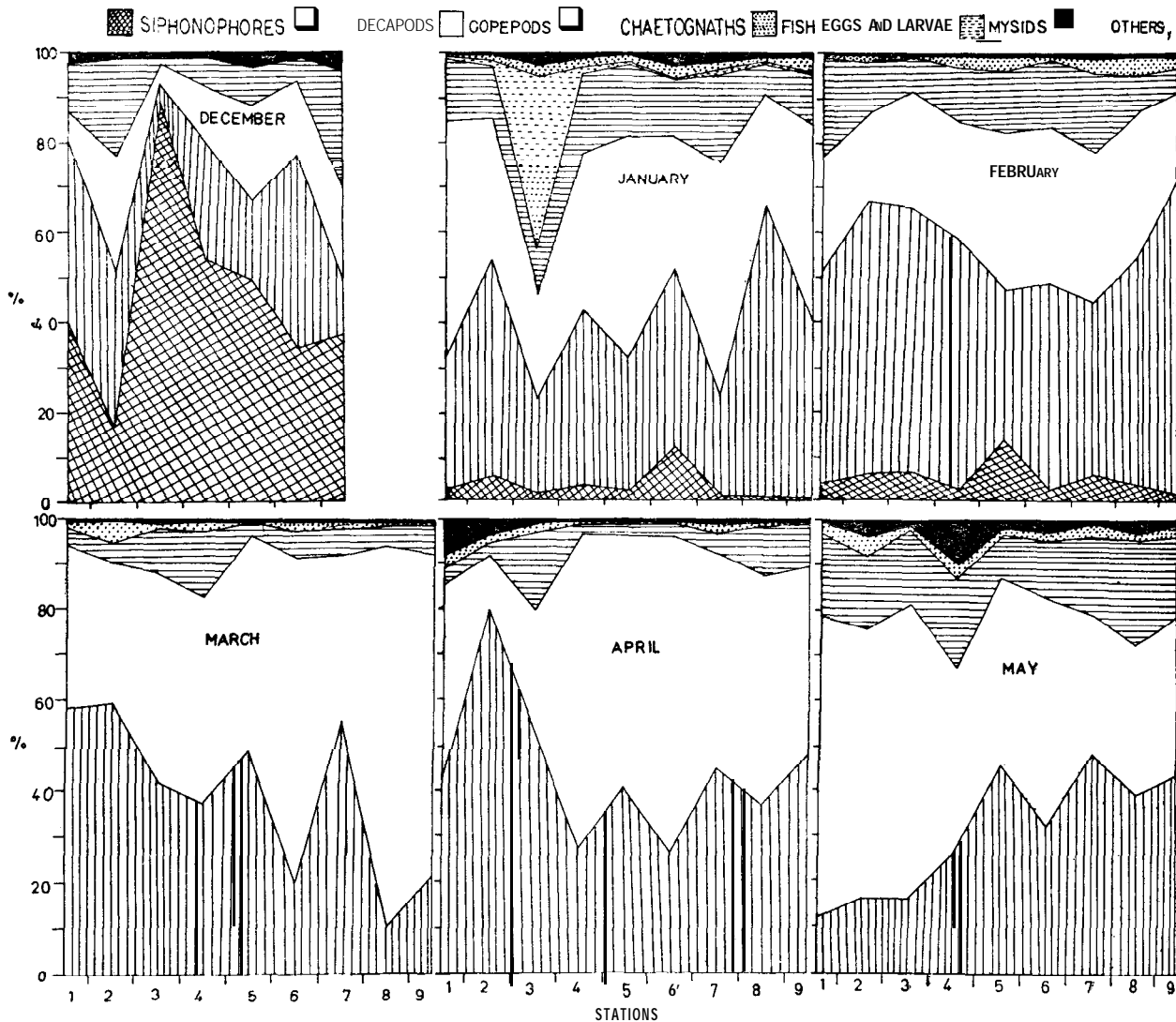


Fig. 3 -Per cent faunistic composition during different months

bulk was represented by larval forms particularly zoea and mysis stages belonging to several families. The peak period was reached in February when they dominated the whole plankton constituting 33-69%. In March also they continued to be present in large numbers reaching the highest value of 18000/10 m³. In the following months their numbers were reduced. Stray individuals of *Alima* stage of *Squilla* were also encountered. The only adult planktonic decapod present was the sergestid *Lucifer* sp. which appeared in very small numbers from November to January and altogether disappeared from the plankton in the following months.

In November and January Mysidacea dominated the plankton forming 63 and 39% of the total number respectively. They were not present in February to April, and again in May they were caught in small numbers.

On the whole the ostracoda were absent in the plankton except in December to February when they were only nominally represented.

Presence of Amphipoda in the plankton was very insignificant. From November to February their occurrence generally appeared to be sporadic. In March and April they were not recorded. They were more commonly present in May.

Mollusca — Stray specimens of this group were caught in February represented by larval bivalves and gastropods.

Echinodermata — Larvae of this group occurred in very small numbers in April and May.

Fish eggs and larvae—These were caught on all occasions and were present in varying numbers. On the whole the larvae were caught more abundantly than the eggs. From November to January the number of larvae remained low. From February onwards there was a gradual increase reaching maximum in March. Thereafter the trend was once again reversed. No marked fluctuation in the number of fish eggs had been noticed except for a slight increase during February. The data

available do not indicate any distinct maximum or minimum.

Discussion

Large volume of water is drawn in from the sea near Tarapur for cooling the reactors of the Tarapur Atomic Power Plant and is discharged back into the sea through the discharge canals. Although there is an appreciable rise in the water temperature within the plant, the water when discharged into the discharge canals, rapidly loses the heat, and because of considerable length of the canals, the temperature of the water when it meets the sea does not show any appreciable difference from that of the sea water. As a result of this, apart from the seasonal fluctuation in the surface temperature no other deviation is noticed. The dissolved oxygen concentration in this area also gives the same value as in the surrounding water.

The studies on the zooplankton have revealed a rich population and no difference is observed between the faunistic composition near the intake and discharge canals. Siphonophores, copepods and decapod larvae are the most dominant organisms. The other faunal groups are represented both by larval and adult stages.

Fox and Moyer³, who have discussed the impact of heated water on the receiving system, have shown that only in the cooling coils because of heat transfer there is any appreciable difference in the biota

such as phytoplankton, etc. They have concluded that heat did not appreciably affect the biota. The present studies have also shown that a very slight rise in water temperature does not make any appreciable impact on the receiving waters.

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