

COMPARATIVE STUDY OF THE ABIOTIC AND BIOTIC COMPONENTS OF AN
AQUACULTURE POND AND ITS ADJACENT THANE CREEK AREA,
MAHARASHTRA,
INDIA

Prakash G. Virkar, R.P. Athalye*, P.N. Kurve*, M.U.Borkar*, Goldin Quadros*,
Asst. Fisheries development officer,
Commissioner of Fisheries office, New Administrative building,
Bandra (E) Mumbai - 400 051 (Maharashtra).

* B.N. Bhandodkar College of science, Chendani Koliwada, Thane (West), 400
601.

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Abstract :

Fishery of Thane creek has significantly declined due to heavy pollution. Fishermen grow fish in aquaculture ponds along the banks of the creek. They collect creek water in the ponds during the spring tide of monsoon when the pollutant is diluted and the water contains fishes. In the following months adding fresh water to the ponds compensates the evaporative water loss and additional fertilizers are added. The ponds give an annual average fish yield of 600 kg/hectare (approx), while the adjacent creek area has uncertain and negligible fish yield, which makes fishing in that area uneconomical. The fishermen obtain Mugil, Tilapia, *Lateus calcarifer* and prawns from the pond. A comparison of the abiotic and biotic components of an aquaculture pond near Thane city and the adjacent creek area showed better dissolved oxygen and lower average salinity in the pond water than the creek. The other parameters did not vary significantly. Among the biotic components phytoplankton and the macrobenthos had comparable densities in both the pond and the creek. However average density of zooplankton was higher in pond and the meiobenthos was significantly high in the creek. It is inferred that the aquaculture pond gave better fish yield than the creek, mainly due to better water quality in terms of dissolved oxygen; as it did not receive, organic sewage load and there was intermittent addition of fresh water keeping the salinity moderate.

Introduction :

Thane creek (long. 72.55' to 73.00' E and lat. 19.00' to 19.15' N) is known to receive heavy loads of industrial effluents and domestic sewage from the highly industrialized and

urbanized Thane-Mumbai complex. Gokhale and Athalye (1995) have reported 67% decline in the fishery near Thane city. Presently due to pollution and siltation in the creek the fishery

has further declined. The fishermen along the banks report that they do not get any fish in the creek waters near Thane city for a major part of the year, and have to go to the mouth of the creek for fishing purpose. However during rainy season fish is obtained in the creek near Thane city. Some of the fishermen have therefore made aquaculture ponds along the banks of the creek. In these ponds they collect creek water during spring high tide of monsoon season. This water is of better quality and contains fish. When a pond is full, the gates are closed and the trapped fish is allowed to grow in the pond. Fresh water is added to the pond from time to time to make up the loss due to evaporation. Sometimes the fishermen release fish seed (Tilapia) or prawn seed in the aquaculture pond to grow them. The creek water being nutrient rich, fertilizer is not added to the pond water and the maintenance cost is negligible. These types of extensive aquaculture practices are known as

Bhasabandh fisheries or Bheries in west Bengal, Pakrasi (1965) has described the yield in range 324-2323 kg/Ha./year to be optimum in the brackish water impoundments in West Bengal whereas Pillay (1954) reported optimum yield in a brackish water bheri to be in the range 113.5 to 170.2 kg/Ha/Yr. In the present paper the abiotic and biotic components of an aquaculture pond near Thane are compared with the adjacent area of Thane creek ecosystem.

Materials and Methods :

Sample collection sites.

Site 1

Aquaculture pond: located near Thane railway bridge on its north. The pond has an area 0.6 ha. In the pond, water is taken from the creek during spring high tide in monsoon season. The

Table 1. Ranges and averages of different water parameters of aquaculture pond and the nearby region of Thane creek.

Parameters and units	Ranges and averages ()	
	Pond	Creek
Temperature 0c	25 to 38 (30.36)	26 to 36 (29.45)
Light penetration cms.	12 to 39 (26.7)	13 to 48 (29.5)
Suspended solids g/l	01 to 1 (.197)	01 to 1.19 (.250)
pH	8.04 to 9.76 (8.73)	6.58 to 8.16 (7.67)
Salinity ppt.	2.4 to 32.06 (10.7)	2.1 to 31.7 (20.06)
Dissolved oxygen mg/l	6.2 to 14.2 (8.34)	9 to 9.3 (4.3)
PO ₄ -P µg/l	2 to 309 (31)	1.1 to 31 (9.3)
NO ₃ -N µg/l	2 to 6.7 (3.34)	5 to 13 (5.5)
SiO ₂ -Si µg/l	2.5 to 485 (216.5)	11.5 to 998.75 (292.55)

Table : 2 Average phytoplankton density (No. / ml) increek and pond.

	Phytoplankton/ml.	
	Pond	Creek
<i>BACILLARIOPHYCEAE</i>		
<i>CYCLOTELLA SPP.</i>	0	1547
<i>NAVICULA DELICATULA</i>	0	859
<i>NAVICULA PYGMIE</i>	119	409
<i>NAVICULA TUMIDA</i>	0	6818
<i>NITZSCHIA ACICULARIS</i>	1485	928
<i>NITZSCHIA SPP.</i>	119	0
<i>PLEUROSIGMA SPP.</i>	0	881
<i>THALASSIOSIRA SPP.</i>	4350	16722
<i>CHLOROPHYEAE</i>		
<i>Chlorogonium spp.</i>	7875	0
<i>Cosmarium spp.</i>	773	0
<i>Crucigenia spp.</i>	546	3676
<i>Flagellate spp.</i>	4603	0
<i>Gloeocapsa spp.</i>	9900	0
<i>Golenkinia spp.</i>	80	773
<i>Scenedesmus spp.</i>	597	2557
<i>unicellular forms</i>	3581	0
<i>CYANOPHYCEAE</i>		
<i>Anabaena spiroides</i>	0	1393
<i>Lyngbya spp.</i>	0	619
<i>Total</i>	34029	37182

water is then retained in the pond with irregular intermittent addition of fresh water to compensate evaporative water loss. Fertilizer was not added to the pond. The owner of the pond had experimented growing Rohu, Catla and Mrigal but was not successful, owing to high salinity. However he had successfully

Table 3. Zooplankton average density (No./ m³) in pond and creek.

Type	Pond	Creek
Medusae	0	3
Oligochaete	0	12
Insect larvae	0	12
Mosquito Larvae	0	6
Cyclops	243	177
Prawn juvenile	780	7
Crab	0	4
Gastropod	27	0
Total	1050	221

Table 4. Meiobenthos average density (No./ m²) in pond and creek.

Type	Pond	Creek
Oligochaete	3564	75356
Polychaete tubes	1018	0
Polychaete	594	1528
Gastropod	933	0
Turritella spp.	976	170
Assaminia spp.	254	0
Bivalve	0	0
Total	7339	77054

Table 5. Macroenthos average density (No./ m²) in pond and creek.

Type	Pond	Creek
Oligochaete	0	1098
Polychaete	60	418
Polychaete tube	40	13
Crab	0	331
Balanus	0	1
Gammarus	0	1
Maggot	0	7
Turritella	1659	147
Assaminia	123	102
Bivalve unidentified	141	0
Total	2023	2118

grown prawns, Mugil and Lateus calcarifer in the earlier ears. But during the present study period he had maintained only Tilapia.

Site 2

The Thane creek near the aquaculture pond; the creek region 20 meters away from where water is taken into the pond.

Sample Collection :

The Sample for abiotic and biotic component analysis were collected every month during spring high tide from March 2001 to February 2002. Data has been compiled and collated for the following seasons Premonsoon (March, April, May); Monsoon (June to September),

early postmonsoon (October - November) and late post monsoon (December, January, February)

The surface water samples were collected in clean PVC containers and different parameters were analyzed using Standard Methods (APHA, AWWA, WPCF, 1981). To observe phytoplankton water samples were collected of known quantity (500ml), which were fixed immediately using Lugol's iodine. The phytoplankton types were observed under trinocular light microscope and the density count was done using Lackey's drop method (Trivedy and Goel, 1984). The zooplankton were collected using a net of mesh size 60 mm through which known volume of water was filtered and the organisms collected were preserved in known quantity of 10% formalin made in filtered creek water.

For meiobenthos surface soil samples were collected with a 10cm. x 10cm. metal scoop. They were fixed in 1:500 Rose Bengal formalin (Teitjen, 1969) and preserved in plastic container (Holme and McIntyre, 1971) In the laboratory, the samples were passed through two sieves, first through 0.5mm to separate macrobenthos and then through 62 mm sieve to collect meiobenthos. The collected meiobenthos were preserved in 10% formalin and then

studied under microscope. The types of meiobenthos and their abundance (no/m²) were calculated. To study the macrobenthos 10cm surface soil samples were collected using 10 cm. x 10cm. metal scoop. 5 scoops were randomly collected and pooled together. To the sample 15 ml of 10% MgCl₂ was added and mixed to narcotize the macrofaunal organisms so as to prevent their fragmentation while sieving. The samples were then passed through a metal sieve of mesh size 0.425mm (Bachelet, 1990) The fauna collected on the sieve was preserved in 10% formalin prepared in filtered creek water. The preserved samples were then analysed to record the types of organisms and their densities per m².

Results and Discussions :

Results of different abiotic and biotic components studied are presented in Tables 1-6.

Water parameters : Comparison of the averages indicates that, the aquaculture pond had in general warmer water temperature, lower suspended solids, alkaline pH, lower salinity, significantly high dissolved oxygen, higher PO₄-P and lower NO₃-N, SiO₃-Si and light penetration. The dissolved oxygen contents were significantly better in the pond water than the creek water.

Table 6 Season wise densities of different biotic components in aquaculture pond and creek.

Types ↓ Seasons →	Pre monsoon	Monsoon	Early Post monsoon	Late Post monsoon	Average
	< Pond >				
Phytoplankton No./ml	53007	3076	32468	47567	34029
Zooplankton No./m ³	3147	1533	621	1188	1050
Meiobenthos No./m ²	2716	8654	15275	2716	7339
Macro benthos No./m ²	6510	1310	255	20	2023
	< Creek >				
Phytoplankton No./ml.	47062	50023	14703	36940	37182
Zooplankton No./m ³	28	748	14	99	221
Meiobenthos No./m ²	4074	211813	69246	23082	77054
Macrobenthos No./m ²	370	325	5260	2526	2118

Phytoplankton :

The phytoplankton included different types belonging to families Bacillariophyceae, Chlorophyceae and Cyanophyceae. In general family Chlorophyceae was more dominant in aquaculture pond whereas Bacillariophyceae types dominated in the creek waters. Both the systems showed comparable average total phytoplankton densities (marginally higher in the creek). In the creek, the peak of phytoplankton was observed during monsoon. In pond, peak densities were observed in late postmonsoon and the premonsoon. A total of 12 types of phytoplankton were recorded in the aquaculture pond namely *Navicula pygmaea*, *Nitzschia* spp., *Nitzschia acicularis*, *Thalassiosira* spp., *Chlorogonium* spp., *Cosmarium* spp., *Crucigenia* spp. Flagellate types, *Gloeocapsa* spp., *Golenkinia* spp., *Scenedesmus* spp. and unicellular unidentified forms. The dominant types being *Gloeocapsa* spp., *Chlorogonium* spp. and *Thalassiosira* spp. Similarly in the creek waters also 12 different types were recorded that included *Cyclotella* spp., *Navicula delicatula*, *Navicula pygmaea*, *Navicula tumida*, *Nitzschia acicularis*, *Pleurosigma* spp., *Thalassiosira* spp., *Crucigenia* spp., *Golenkinia* spp., *Scenedesmus* spp., *Anabaena spiroides* and *Lyngbya* spp. The most dominant species were *Thalassiosira* spp., *Navicula tumida* and *Crucigenia* spp.

Zooplankton :

The total zooplankton types observed included medusae, oligochaetes, insect and mosquito larvae, cyclops, prawn juveniles, a small crab, and a gastropod. The prawn juveniles and cyclops were most dominant in pond water where the medusae, oligochaetes and insect larvae were absent. The remaining types had sporadic occurrence. In the creek, cyclopoid

copepods were most dominant while the other zooplankton had lower density. The creek water in general showed much lower zooplankton density than the aquaculture pond. In aquaculture pond the highest zooplankton density was recorded in pre monsoon, which declined in monsoon and early post monsoon, whereas the creek waters showed the highest density during monsoon.

Meiobenthos :

The meiobenthos included a few types namely oligochaetes, tube polychaetes, polychaetes and gastropods *Turritella* spp., *Assiminea* spp., and an unidentified bivalve. In general in both the ecosystems there was dominance of oligochaetes followed by polychaetes. However the tube dwelling polychaetes were not recorded in the creek. Gastropods were also better represented in aquaculture pond as compared to the creek. Though the average number per m² of the meiobenthos was significantly high in the creek sediments, significantly high in the creek sediments, it was mainly due to the high number of oligochaetes. The pond sediments on the other hand showed more types of meiobenthos and their relatively uniform distribution. High meiobenthic density in the creek can be attributed to high organic enrichment caused by domestic sewage constantly added to the creek. On the contrary, the aquaculture pond ecosystem did not experience renewal of sewage load. Further the lower density of meiobenthos in pond could be due their utilization as food by the fish and prawns in the pond. The creek water did not attract fish due to high pollution level, thus probably leaving the meiobenthos unutilized.

Macrobenthos :

The macrobenthos included total 11 types of which only 5 types namely polychaetes, tube dwelling polychaetes, the gastropods Turitella spp. and Assimina spp. and a type of bivalve occurred in aquaculture pond, whereas the creek sediments had nine types including the above and oligochaetes; the arthropods crab, Balanus, gammarus, insect maggot. In the creek, oligochaetes formed the most dominant type followed by polychaetes and Turitella spp. (the highest dominant type in the aquaculture pond), The seasonal trend of macrobenthos differed in the two ecosystems. In aquaculture pond the maxima of density occurred in pre-monsoon which then declined in the following seasons, as compared to this, the creek showed the maxima in early post monsoon followed by a decreasing trend. The overall average of macrobenthos density was marginally and insignificantly higher in the creek ecosystem.

Conclusion :

Thus, comparison of the biotic components of the aquaculture pond and the creek ecosystem adjacent to the pond showed that only the zooplankton component was significantly high in the aquaculture pond, whereas all the other components such as phytoplankton, meiobenthos, macrobenthos were higher in the creek waters. In spite of this, the creek in this region did not have fishes through out the year except monsoon. This could be due to high pollution and low dissolved oxygen in the creek, which also adversely affected the zooplankton density. The dilution of pollutants in monsoon attracted the fishes to the creek, which the aquaculture pond owners trapped and allowed to grow. The aquaculture pond did not receive organic load of sewage so also intermittent addition of fresh water kept its salinity lower.

These conditions improved the dissolved oxygen in the pond favouring the fish growth.

References :

APHA AWWA and WPCF, (1981) American Public Health Association, American Water Works Association and Water

Pollution Control Federation for International Standard Methods for the examination of water and waste water 18th edition, Washington D.C., 874 pp.

Bachelet, Guy (1990) The choice of sieving mesh size in the quantitative assessment of marine macrobenthos: a necessary compromise between aims and constraints. Marine Environmental research, 30: 21-35.

Gokhale, K.S. and R.P. Athalye (1995) Study of impact of pollution on mangrove fauna of Thane creek near Thane city. Report submitted to the Ministry of Environment and Forests, New Delhi.

Holme and McIntyre (1971) (eds) Methods for the studies of marine meiobenthos. IBP hand book No. 16 (Blackwell Scientific Publication, Oxford and Edinburgh]

Pakrasi B.B. (1965) A report on the preliminary survey of brackish water impoundments in West Bengal. Sur. Rep. Cent. Int. Fish. Res. Inst. (3) : 34 pp.

Pillay, T.V.R. (1954) The ecology of a brackish water bheri, with special reference to the fish culture practices and the biotic interactions. Proc. Nat. Inst. Sci. India, 20 (4) : 399-427.

Tietjen, J.H. (1969) The ecology of shallow water meiofauna in two New England estuaries
Oecologia, 2: 201-291

Trivedi, R. K. and P.K. Goel (1984) Chemical and biological Methods for water pollution studies.
Environmental Publications, Karad (India), 340 pp.