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Traditional bivalve culture practices along the Ratnagiri coast of Maharashtra, India

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ABSTRACT

Clams have high nutritive value and are important in the economy of coastal fishing villages. Due to the development of export market for the frozen clam meat, research had been undertaken for culturing the clams along the estuaries and creeks. Clams such as *Paphia malbarica* (False clam), *Meretrix casta* (Backwater clam), *Katelysia opima* (Inflated clam), *Villorita cyprinoids* (Black clam), *Meretrix meretrix* (Great clam), *Donax cuneatus* (Wedge clam) an other bivalves belonging to the family Veneridae form vast beds in estuaries and backwaters of the Ratnagiri coast. Though practice of clam culture has not become widespread as oyster and mussel culture, some of the clam species are being cultured traditionally along the Ratnagiri coast. Study of the culture sites along the Kalbadevi and Kajali estuaries was done during the present work. Stocking density of the transplanted clams at randomly selected pits, environmental and soil parameters were recorded. The largest pit was 2.25 m^3 while the smallest pit was of 0.50 m^3, where the stocking density was 1700 and 350 respectively. The clams are kept in the pits for a period of 15 days to 3 months, after which they are harvested for sale. During the study, dead clams with blackening of sand due to formation of hydrogen sulphide were recorded in the pits with higher stocking density.

Keywords: Veneridae, clams, Ratnagiri, *Paphia, Meretrix, Katelysia*

1. INTRODUCTION

Among the exploited bivalve resources of India, clams are by far the most widely distributed and abundant. India has rich molluscan resources all along the coast, in inshore waters, bays, backwaters and estuaries. Among the exploited molluscan resources, bivalves contribute to bulk of the catch and clams are most important in abundance and occurrence in both east and west coast of India. Edible bivalves form a cheap but important source of nutrition along

Table 1

Avg. annual parameters measured at the 10 culture locations

Location No.	Size of the pit (cubic.m.)	Stocking density (No. of clams)	Salinity ‰	pH	DO (mg.L-1)	Temp (0C)	Sulphide (mg/l)
1	1.5	1000	34	8.25	5.2	26	1.32
2	0.75	500	34.5	8.31	6.1	25.5	1.28
3	1.5	950	34.5	8.35	6	26	1.35
4	2.25	1700	35	8.64	5.3	27.5	1.55
5	0.75	450	34	8.32	6.1	25	1.28
6	1.0	850	34	7.56	6	26	1.30
7	1.875	1250	35.5	8.32	5.2	25.6	1.32
8	1.125	850	35.5	7.70	5.2	25	1.34
9	0.50	350	35.5	7.70	6.3	25	1.28
10	0.75	500	34.5	8.3	6.1	26	1.28

Table 2

Avg. Monthly ecological parameters of the Kalbadevi estuary

Sr. No	Avg. Water parameter	May 2011	June 2011	July 2011	Aug. 2011	Sept. 2011	Oct. 2011	Nov. 2011	Dec. 2011	Jan. 2012	Feb. 2012	March 2012
1	Temp (^{0}C)	26	26	27	26	26.6	27	27.5	27	24	24	26
2	DO (mg.L^{-1})	6.0	6.7	6.7	6.9	6.8	6.1	5.3	5.7	6.1	6.2	5.2
3	pH	7.7	7.1	6.5	6.5	6.6	7.0	7.2	7.6	7.6	7.8	7.8
4	Salinity ‰	36	10	9.5	8.5	10	30	31	32	34	34	34

the coastal areas of Ratnagiri district of Maharashtra. Clams belonging to Family Veneridae have formed vast beds in the Kalbadevi estuary (Shirgaon creek) and Kajali estuary (Bhatye creek), Ratnagiri. They are exploited on commercial basis throughout the year. From here, the clams are exploited for local as well as for external markets due to the heavy demand. Traditionally, the exploited live clams are kept in the sand pits of varying sizes along the Kalbadevi estuary, when there is no demand. The traditional clam culture methods were studied from May 2009 to April 2012 to find out the best stocking density and growth of the clams during the culture period.

2. MATERIAL AND METHOD

The river Kalbadevi flows east – west and turns to the south by a small peninsular land, locally known as Kalbadevi land, before emptying into the sea. Kalbadevi estuary joined by the Shirgaon creek stretches wide for about one km. in east – west direction and is very shallow. At high tides the depth of water generally is about one fathom at a point of about 1 km. from the river mouth. At low tides, the entire region is exposed. This area is rich with mangrove vegetation. The sandy muddy shore of this creek has various types of flora and fauna, including green filamentous algae, gastropods and molluscs. Among molluscs, clams belonging to genus *Paphia, Meretrix, Katelysia* are found in large numbers (Plate 2.1- 2.4). On the other side, the Kajali estuary is joined by the Bhatye creek has sandy shore. Culture pits were selected randomly from the Shirgaon and Bhatye stations. They were sampled for the venerid clams on monthly basis at low tide periods. Samples were collected at randomly selected 10 locations from the exposed intertidal zones of Kalbadevi (Sakhartar - Shirgaon) and Kajali estuaries (Bhatye), by adopting quadrant method (measuring 1 sq. m). After fixing the quadrants, the sand and mud were scooped out and the molluscan species found in the scooped out material were separated. The clams were identified (genus level) and their numbers were recorded. The data for each station was pooled together and the average density of the population of each species was estimated. Month wise species density of the stations was recorded. The study of water temperature, atmospheric temperature, salinity, pH, dissolved oxygen, total dissolved solids was done during the period of one year. The samples were measured weekly by adopting the standard methods given in APHA (1998) and by Strickland and Parsons (1968). Monthly rainfall data was collected from the Office of Meteorological Department, Ratnagiri. Sediment parameters such as pH and sulphide were also measured using the standard methods given by Jackson (1967). Organic carbon was estimated by the method given by Walkley and Black (1934).

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Plate 2.1. Clam collection from the estuary

Plate 2.2. Clams culture site

Plate 2.3. Collection of clams using "Kurund" net

Plate 2.4. Clams collected for culture / transplantation

2.1. Test Animals

The term "clam" is generally applied to a subset of molluscs, belonging to class Bivalvia (= Pelecypoda). These are bilaterally symmetrical, untorted molluscs with a shell of two dorsally hinged lateral valves enclosing a laterally compressed body with a bilobed mantle, without a head or tentacles, but with paired gills i.e. ctenidia and gonads. The culture of clams viz. *Paphia malabarica, Meretrix meretrix* and *M. casta* is practised along the Shirgaon creek.

3. RESULT AND DISCUSSION

The Shirgaon creek is characterised by course sand, Fine sand and silt while the Bhatye creek is characterised by hard rocks and semi-hard mud. The venerid clams have been established at both the places and thrive well in the estuarine conditions. The calms are found along the periphery of these creeks, buried in the sandy mud upto the depth of one meter. But alternate abundance of genus *Paphia* and *Meretrix* was found during the study. Varying stocking densities were found at different culture sites. The local fishermen harvest the clams from the creeks and estuaries using the traditional "kurund" net. Clams of minimum size ranging between 25 – 35 mm are selected for transplantation at the prepared sites. Since there was no restriction on the sizes of the pits and stocking densities, samples were collected at randomly selected 10 locations from the exposed intertidal zones. Using quadrant method, the stocking densities of these locations was calculated (Table 1). Ecological parameters were also measured for the locations (Table 2), (Plate 3.1 to 3.8).

Location no. 1, 3, 4, 7 and 8 were larger with higher number of clams stocked at these areas. Corresponding higher values of salinity, pH, temperature and sulphide were recorded at these locations. Mortality recorded at these locations was 80, 78, 82, 86 and 76% respectively. The Shirgaon creek is characterised by course sand, Fine sand and silt while the Bhatye creek is characterised by hard rocks and semi-hard mud. It has been observed that the ecological parameters like temperature and salinity affect the physiological activities of many bivalves. Rao (1951) observed that

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Plate 3.1. Smaller pits with 100clams.sq.m^{-1}. stocking density

Plate 3.2. Larger pits with more than 300 clams. sq.m^{-1} stocking density

Plate 3.3. Harvesting of clams after a period of 3 months

Plate 3.4. Harvesting of clams after the short culture period

Plate 3.5. *Katelysia opima*

Plate 3.6. *Meretrix casta*

Plate 3.7. *Meretrix meretrix*

Plate 3.8. *Paphia malabarica*

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the growth rate of *K. opima* was rapid when the salinity was higher and decrease in salinity resulted in the cessation of growth. Baker et al., (2002) reported that optimum growth in clams occurs at about 20 to 30‰ salinity. Growth is reduced above or below this range and below 18‰, the growth ceases. Epifanio et al., (1975) observed that production of carbon dioxide by the cultured organisms is converted into acid in water. Therefore organisms in cultured provide a continuous input of acid in the culture system, thereby affecting its pH. This acid has deleterious effects on the cultured organisms.

Kurian and Sebastian (1976) reported a pH in the range of 6.00 to 9.00 as the best for the growth in molluscs. Seasonal periods of oxygen deficiency or depleting oxygen levels have been observed during the culture of molluscs (Malouf and Bricelj, 1989). They have reported that low dissolved oxygen levels not only affect the survival of bivalves, but also exert sub-lethal effects, which may reduce the energy available for production and cause indirect or direct mortalities.

Temperature is one of the important environmental factors, which affects the rate of metabolism and the level of activity in marine organisms. It was reported by many workers that under tropical conditions of Indian coast, the water temperature does not decrease as in temperate waters and the temperature remains comparatively high throughout the year except for a few degrees decrease during November to January. In temperate regions, the gonad development and reproduction in marine bivalves have been correlated with the wide range of fluctuations in temperature. Temperature seems to have only a limited role in the ecology of clams. Kurian (1972) concluded that temperature is not an important factor affecting the distribution of fauna in Cochin backwaters.

Sulphide is found in the sediments due to the interactions of the pollutants and rotting organic matter. Increasing production of hydrogen sulphide due to the rotting of seaweeds and dead clam meat results in the blackening of the sediments and affects the survival of clams. It is well known that sulphide affects the survival, growth as well as recruitment of freshwater fishes, salt marsh plants, mangroves and various invertebrates. Gopakumar and Kuttyamma (1999) found hydrogen sulphide as the regulating factor, affecting the distribution and abundance of bivalves in the Kayamkulam estuary. Girkar (2003) reported the value of sulphide in the sediment at Kalbadevi estuary, Ratnagiri as 1.26 mg /l in July at stocking density of 50 no./sq.m. to maximum 2.86 mg / l at stocking density of 1000 no./ sq.m. in January in case of *P. malabarica* and *K. opima*.

The average initial shell length was 25 – 35 mm. During the culture period of 3 months, the clams attained an average final length of 27 – 38 mm, indicating an increase of 2-3 mm. The average initial weight of the clams was 7 - 8.10 g. The final weight for the duration of three months was recorded as 10.2 – 10.9 g indicating an increase of 3 g. Abraham (1953) observed a very rapid rate of growth in *M. casta* in Adyar backwaters. Length gain of 29.5 mm was recorded in seven months. Sreenivasan (1983) reported the average length gain of 34 mm in *M. casta* in thirteen months of culture period. Narasimham (1983) observed better length increment at stocking densities of 30 to 140 no. / sq.m. for *Anadara granosa* in seven months. Kripa et al., (1996) reported an average length increment of 13.3 mm in five months in the black clam, *Villorita cyprinoides* in Vembanad Lake, Kerala at the stocking density of 500 no. / sq.m. Patil (2002) reported the maximum shell length gain of 4.30 mm in *P. malabarica* at stocking density of 200 no./ sq.m. Durve (1970) reported the total increase in weight of 23.09 g in *M. casta* reared for twenty-two months and an average increase per month was observed as 1.19 g. In the traditional culture of clams practised at Ratnagiri coast, there is no limit on the stocking density, which has resulted in the mortality of clams due to increase in temperature, pH and reduction in dissolved oxygen. This has further led to the formation of hydrogen sulphide due to the rotting of dead clams. Optimum stocking density of 100 clams/ sq.m. had shown better survival in similar experiment along the same estuary (Mohite, 2010).

4. CONCLUSION

1) Locations with lower stocking density showed high rate (80 – 85%) of survivl.
2) Locations with high stocking density showed high mortality due to formation of hydrogen sulphide.
3) Growth of 2-3 mm was recorded during the culture period of 3 months.
4) No feeding was done during the traditional culture practice.
5) The salinity showed wide fluctuation but that didnot affect the clams stocked.
6) In the traditional culture system, there was no limit on the stocking density of clams, which had a direct effect on the survival of clams.
7) High values of sulphide were recorded at the locations having highest stocking densities.
8) The traditional culture system acted as “live godowns” for storing and culturing the clams till their supply in the markets.

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