Mollusk Research in Asia

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FEASIBILITY OF INTEGRATED BIVALVE FARMING IN AN ESTUARINE SYSTEM OF CENTRAL KERALA, INDIA

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INTRODUCTION

Kerala State (between Lat. 8° 18' and 12°48' N; Long. 74°52' and 77°22' E) located along the southern coast of India has extensive estuaries which open to the Arabian Sea. These estuaries are subjected to wide variations in hydrographic condition due to the southwest monsoon during June to September and a less intense northeast monsoon from October to November. The mean annual rainy days in Kerala has been estimated as 130 days, of this 66% is during June to September, 19% during October to December and 15% during January to March. Based on the hydrographic condition in most estuaries two phases, *viz.*, a marine phase during December to May, and a brackish water phase during June to November have been observed. It is during the marine phase that the ecosystem becomes conducive for mussel and oyster culture.

The coastal zones are rich in bivalve fauna especially mussels, oysters and clams. Among the commercially important bivalves, mussels of the genus *Perna* are abundant in the rocky sea shores where they are exploited by the fishermen and marketed locally. Annually, about 2000 t of mussels are harvested from Kerala. There are two species of mussels which contribute to the fishery, the green mussel *Perna viridis* and the brown mussel *Perna indica*. The distribution of these two species is unique as they form single species populations in two different regions, the former along the northern region and the latter along the southern region. In the central region of Kerala both the species co-exist. Though the mussels are mainly distributed in the coastal region where typical marine conditions prevail they occur in the estuaries also. In Ashtamudi Lake (Estuary) of southern Kerala the green mussel is found in the subtidal region where they are fished along with other bivalves .

Oysters have a much wider distribution than mussels. Being euryhaline they inhabit the intertidal region from the coastline to the upper reaches of the estuary where the salinity does not fall below 10 ppt. *Crassostrea madrasensis* and *Saccostrea cucullata* are the major species and they coexist forming heterogeneous populations. Though the standing stock of oyster resource amounts to thousands of tons, the fishery is at a subsistence level mainly due to lack of awareness about the quality of oyster meat.

Mussel and oyster culture technologies were developed at the Central Marine Fisheries Research Institute (CMFRI) during the late 70's. However due to the low market price and lack of awareness about the feasibility of these technologies they were not easily adopted by the end users. With the objective

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of popularising the technology it was decided to set up demonstration farms in different parts of coastal Kerala. Since the coastal zones of Kerala are sites of intense fishing activity the estuarine system was selected for bivalve farming.

Among the different farming systems developed for bivalve culture, oyster culture by the rack and ren method was first tested at Ashtamudi Lake estuarine system of Kerala (Velayudhan, *et al,* 1995). The success achieved in the demonstration trials underlined the fact that the estuarine ecosystem is highly conducive for oyster culture. With this background information it was decided to test the feasibility of integrated bivalve culture, *i.e.* culturing oysters and mussels at the same site from a common grow out structure during December 1996 to June 1997 .

FARM SITE

The demonstration farm was set up in Chettuva estuary in Thrissur district of Central Kerala. Keecheri and Puzhakkal are the main rivers which open into this estuary. The main bivalve resource in the estuary and coastal zones are: the clam *Meretrix casta,* the black clam *Villorita cyprinoides*, the green mussel *Perna viridis* and the oyster *Crassostrea_madrasensis*. The farm was setup at a site about 2 km from the barmouth on the eastern side of Chettuva bridge. The average depth in the region was 3 m. The annual variation in salinity was between 2 and 35 ppt. However during the culture period the salinity of the estuary ranged between 22 and 35 ppt. The dissolved oxygen content of the water was between 4.2 and 5.1 $ml.l^{-1}$.

FARM STRUCTURE

Two different structures were used for bivalve culture, a wooden rack and a small long line unit. The rack of 15x 3 m (45 m^2) was fabricated using bamboo poles. Three rows of vertical poles of 3 m length were erected at intervals of 1.5 m and these rows were connected by horizontal poles. For the construction of rack, 22 bamboo poles of 6 m length were used. An experimental triple roped longline unit of 12 m length made of 12 mm dia nylon rope was moored near the rack. Empty plastic drums were used as floats while large cement blocks (ca 200 kg) were used to anchor the unit. The floats were placed at intervals of 2 m. Along the Indian coast, long lines have been used mainly in the offshore region for pearl and mussel culture. In the present study it was decided to test the utility of long lines in the estuarine ecosystem for farming mussel and oyster.

SEED COLLECTION AND SEEDING

It has been observed during the past two decades that mussels spawn during the monsoon season and the spat settles in the intertidal rocky coast during July to January (James and Narasimham 1991). For the demonstration of mussel culture, mussel seed which had settled on the seawall in the coastal zone near Chettuva barmouth was utilised. The seed were collected manually and cleaned to remove foulers and silt. Then they were placed in loose bags of old fish net and suspended in the estuary to avoid mortality and stress. During seeding ,the mussel spat were secured around 12 mm diameter nylon ropes using 3 to 5 mm diameter biodegradable cotton net. Since the depth at the culture site was 3m, the length of the seeded rope was 1 to 1.5 m. The average length of the seed was 20.8 mm with a shell-on weight of 0.93 g. For seeding about 1.5 kg of seed was used per meter length of rope. A total of 110 seeded ropes were hung from the raft and the longline unit.

Oyster spat for the present experiment was collected from the estuary. In an earlier experiment in 1995 oyster spat on rens were transferred from the demonstration farm at Ashtamudi Lake to study the suitability of the estuary for culture. The transplanted oyster spat grew to harvestable size by the end of May 1996. The incessant rains during the southwest monsoon lowered the salinity to 2 ppt which resulted in complete mortality of the oysters cultured. However these rens were not removed, instead they were kept on the rack itself. On these rens (120 no.) fresh settlement of oyster spat was observed during December 1996 and these spat were cultured at the same site. The oyster rens were suspended from the same rack and longline units.

The monthly growth and survival of oysters and mussels were monitored by analysing one mussel rope and oyster ren each. The length of all the mussels and oysters in the rope/ren were measured to the nearest 0.01mm using vernier calipers and the shellon and wet meat weights were recorded to the nearest 0.1g.

GROWTH AND PRODUCTION

Mussel farming in the estuarine ecosystem by the rack and longline method was highly

successful. The mussel spat exhibited fast growth and reached an average length of 65.6 mm; shellon weight of 16.6 g and meat weight of 5.2 g in 158 days (Table.1). Fouling by barnacles and polychaetes was completely absent. It was also observed that the mussel seed which had slipped initially did not perish, instead, it showed fast growth and good survival by attaching to the clams on the estuarine substratum. Survival of mussel and oyster was high throughout the grow out period. Earlier studies on mussel culture in Indian estuarine ecosystems have indicated reduced growth than that observed in the open sea (Table 2, for comparison of growth). This could be attributed to the stability of environmental parameters like salinity in the open sea as compared to that in estuaries. The growth rate obtained in Chettuva estuary is comparable to that obtained in open sea off Mangalore and Goa. The rate of monthly length increments showed a declining trend after 2 months of culture, while the weight increment was high during the 3rd and 4th months of culture (Fig. 1). The tissue build-up during the later months may be because of gonadal development as most mussels sampled during the last two months were in mature condition.

The oysters were grown for a period of 178 days during which the average length of the oysters increased to 54.1 mm. The average total weight of the ren increased from 11 g to 1696 g, and average wet meat weight increased from 13 to 219 g (Table 3). The average length of oysters was less than 55 mm at the time of harvest. However, the oysters on the periphery of the ren were larger, their length ranging between 75 and 85 mm. The growth of oysters is similar to that observed in other estuaries of Kerala (Velayudhan *et al* 1998). However the study showed that the culture period in Chettuva estuary cannot be extended to the brackish water phase since the salinity drops to below 5 ppt. The monthly incremental growth of oysters is shown in Fig. 2. Rate of growth in length was high during the first two months, while growth in weight peaked during the second month. During the third month there was a decrease in weight due to spawning and this was reflected by fresh settlement of spat during fourth month (see Table 2 decrease in minimum length during fourth month.

The production per meter length of mussel rope ranged between 10 and 12 kg. From the demonstration unit about 5 tonnes of shell-on mussel was harvested. From the same farm about 0.2 tonnes of shell-on oysters were obtained.

PROCESSING AND MARKETING

The entire process of harvesting and shucking was manual (Fig. 3, flow chart). The harvested mussel ropes and oyster rens were jet washed and then mussels were declumped by placing the ropes on thick rexine sheets followed by application of mild pressure through stamping. The declumped mussels were placed in an old fish net and lowered into a wide mouthed cooking utensil by holding both the ends of the net bag. The steaming of mussels for 5 minutes was sufficient to loosen the adductor muscle for easy shucking. More than 200 kg of mussel meat was obtained from 1.5 t. Oysters were also heat shucked, however the time taken for opening the valves of the oysters was slightly more. The yield of oyster meat was 26 kg from 0.2 t.

The heat shucked meat were packed in half and one kg polythene bags and iced. They were transported to the processing plant of Integrated Fisheries Project, Cochin on the same day by insulated vans. The mussel meat was sold as frozen product in the domestic market at a per kg price of Rs. 40 (1 US$ = Rs.40), while the oyster meat which fetched the same price was processed into value added products (canned /smoked/ pickled products) and then marketed. Some part of the mussel meat was sold at the demonstration site for Rs 80/kg due to unexpected local demand.

ECONOMICS

Total expenses incurred upto harvest was Rs. 5800. Labour charges for construction of rack and longline, harvesting and shucking together accounted for 40% of the expense (Table 4). This can be an considerably reduced if the farmers are directly involved in doing labour. Similarly the cost of seed also can be reduced if the farmers collect the seed themselves from the natural beds. The bamboo poles and nylon ropes can used for more than three crops. This will bring down the expense in the subsequent two years. Shucked oyster and mussel meat fetched a price of Rs. 40/kg which yielded a profit of Rs.3240. This indicates 56 % profit for the money invested within 5 months.

PROSPECTS

By setting up the demonstration unit it was possible to impress the fishermen about the feasibility of integrated bivalve culture. The transfer of technology programmes have indicated that the estuaries of Kerala are suitable for mussel and oyster

culture during the marine phase when the salinity is above 25 ppt. The growth and production of oysters and mussels observed in the integrated system are comparable to that attained in single species culture. From the present study the following results can be summarised.

- Mussels and oysters can be cultured together from a common structure in an estuary.
- Reasonably fast growth rate of mussel and oyster.
- Negligible fouling, boring and disease of farmed bivalves.
- Intact farm structure throughout the growout period.
- Moderate market demand (the market for bivalve meat is generally very low in India).
- Considerable prospects for on-bottom mussel culture along with clams.

However to make bivalve culture popular the following aspects also should be given importance.

- Adequate financial support in the form of loans at concessional rates and subsidies should be made available to farmers as incentives.
- For the development of quality and maintenance of hygene suitable depuration units should be set up by governmental agencies/entrepreneurs.
- Bivalve products suitable for domestic as well as export market should be developed and simultaneously product awareness among consumers should be created through publicity.
- Framing the legal aspects of farming bivalves in open access areas.

Bivalve mariculture is suitable for rural development programmes since the different culture activities like seed collection, seeding, farm construction, harvesting, shucking and marketing provide employment opportunities. Farming of bivalves in the estuaries is less expensive and provides scope for effective utilisation of the water resources.

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Table 1. Growth details of the mussel grown in Chettuva estuary.

Month of culture	Average length (mm)	Average weight (g)	Average meat weight (g)
01	20.3	2.61	0.7
44	34.3	3.64	1.3
122	60.3	11.19	3.2
138	63.9	14.4	4.5
158	65.6	16.6	5.2

Table 2. Comparison of growth rates of the green mussel (*Perna viridis*) cultured in India.

No.	Location	Ecosystem	Method of culture	Growth Rate mm/month	Reference
1	Kakinada, East coast	Natural bed	-	7.5	Rengarajan & Narasimham (1980)
2	Kakinada, East coast	Estuary	Raft/cage	8.98	"
3	Ennore, East coast	Estuary	Raft/rope	7.99	"
4	Kovalam, East coast	Open sea	Raft/rope	12.79	"
5	Muttukadu, East coast	Lagoon	Pole	4.13	Sreenivasn et al, 1988
6	Muttukadu, East coast	Lagoon	Rack/net bag	3.55	"
7	Calicut, West coast	Natural bed	-	8.66	Kuriakose, 1980
8	Calicut, West coast	Open sea	Raft/rope	12.92	Kuriakose, 1980
9	Karwar, West coast	Open sea	Raft/rope	10.52	Pai & Kuriakose, 1981
10	Goa, West coast	Natural bed	-	5.0	Qasim et al., 1977
11	Goa, West coast	Open sea	Raft/rope	8.0	Qasim et al., 1977
12	Mangalore, West coast	Open sea	Longline/rope	8.6	Mohamed et al., 1998
13	Mangalore, West coast	Estuary	Rack/rope	7.3	"
14	Mangalore, West coast	Estuary	Rack/net bag	7.4	"
15	Andakaranazhi, West coast	Open sea	Longline/rope	6.8	Laxmilatha et al., 1996
16	Chettuva, West coast	Estuary	Rack/rope	8.5	Present study

Table 3. Growth details of oysters grown in Chettuva estuary.

No. of days	Total no. of oyster per bag	Average length (mm)	Minimum length (mm)	Maximum length (mm)	[illegible]	Total meat weight (g)
42	27	32.0	14.2	55	[illegible]	13
88	52	49.9	24.3	67	[illegible]	178
116	53	52.6	33.2	81	[illegible]	175
178	63	54.1	29.1	81	[illegible]	219

Table 4. Expenditure incurred under different heads as percentage of the total expense.

LABOUR	ROPE	BAMBOO POLES	[illegible]	PROCESSING & MARKETING
rack / longline fabrication harvesting cleaning heat shucking	ren longline seeding rack fabrication	rack fabrication	mussel [illegible] cloth for [illegible]	fuel for heat shucking polythene covers
40%	24%	23%	10%	3%

Fig.1
Incremental growth in Mussel

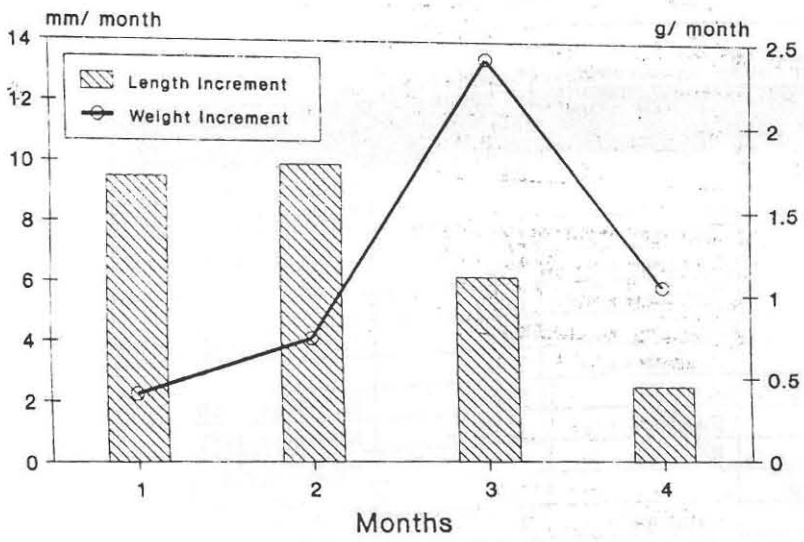

Figure 1. Incremental growth in Mussel.

Fig.2
Incremental growth in Oyster

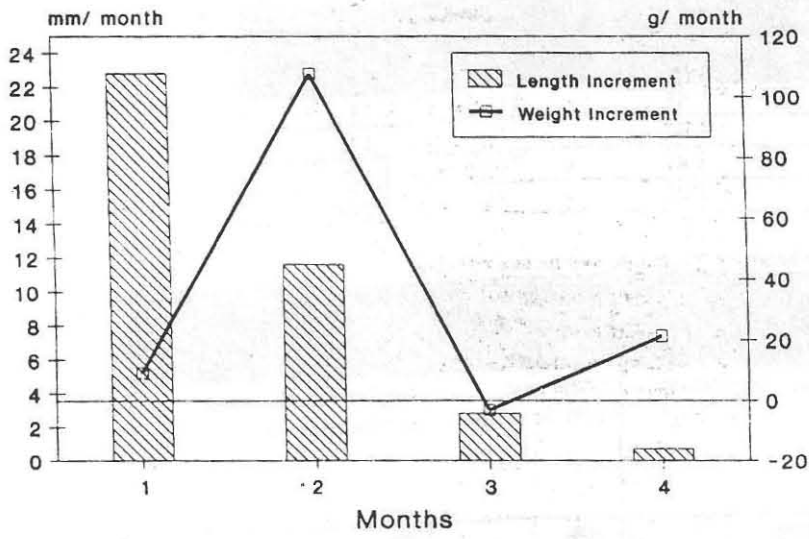

Figure 2. Incremental growth in Oyster.

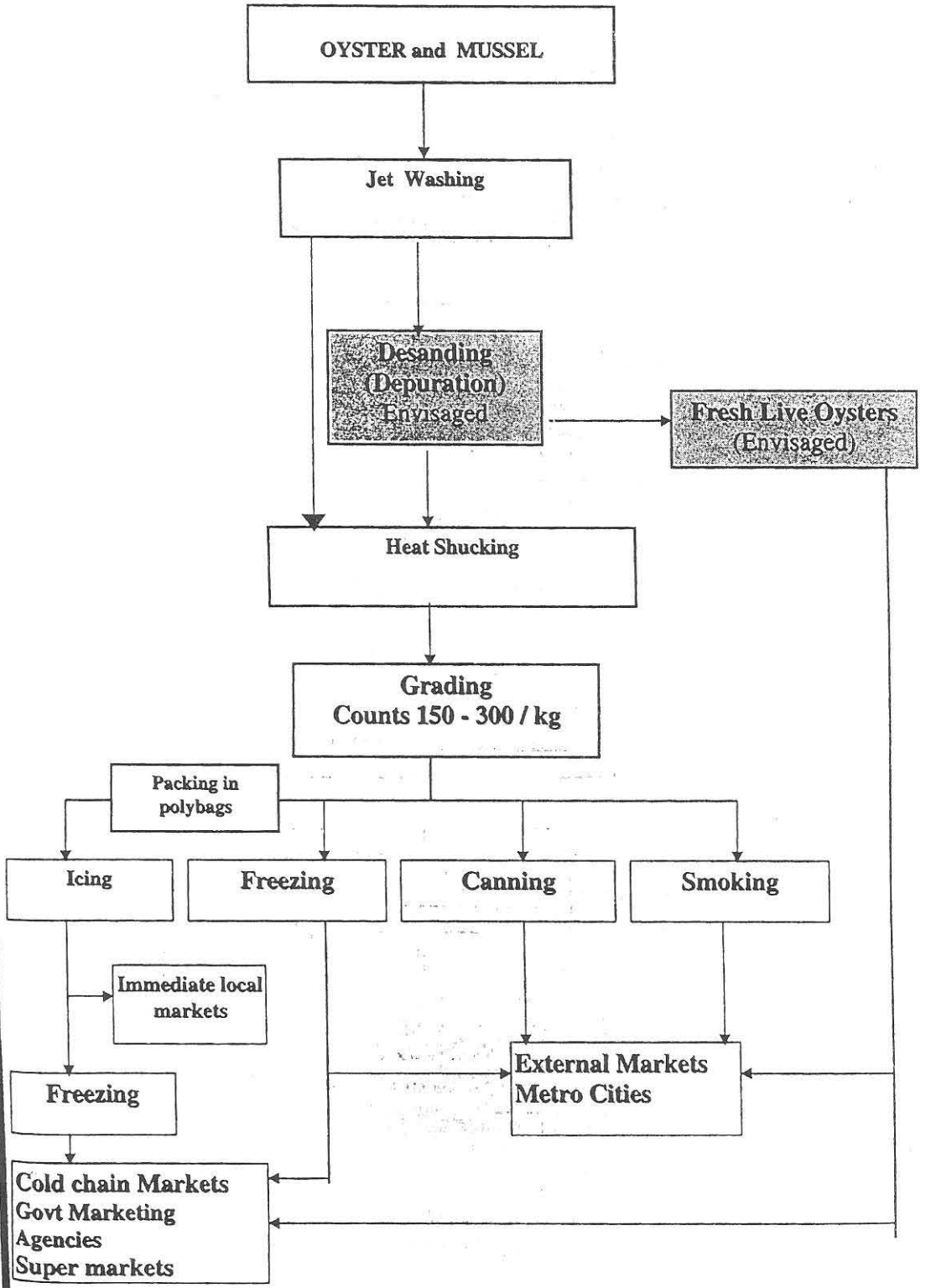

Figure 3. Post-Harvest Flowchart.