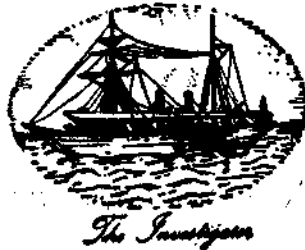


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Held at Cochin
From January 12 to 18, 1980

PART 2 : MOLLUSCAN CULTURE

(Issued on 31st December 1983)



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CULTURE OF THE BROWN MUSSEL *PERNA INDICA* AT VIZHINJAM, SOUTHWEST COAST OF INDIA

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ABSTRACT

The brown mussel *Perna indica* is found to be abundant in the intertidal rocky area from Vizhinjam to Cape Comorin on the southwest coast of India. Results of culture experiments conducted at Vizhinjam during 1976-1979 period is summarised with details on environmental features of mussel farm, method of brown mussel culture on rope, seeding seasons, growth rate, spawning periodicity, production rate and animal association. The average growth rate of cultured mussels in the bay was 2.92 mm/month. Experiments on culture in the open sea have shown a faster growth rate of 5 mm/month. Spawning of *P. indica* begins by May and lasts till September with peak during July to August. Natural settlement of spat was noticed from July and the peak period of settlement was September-October. Production rate was estimated as 150 tonnes per hectare area for brown mussel. The average yield per metre length of rope was 12 kg.

INTRODUCTION

IN INDIA the green mussel *Perna viridis* and brown mussel *Perna indica* are found in abundance in the intertidal zone of the coastal areas attached to rock, pilings and other hard stratas. *P. indica* has a very restricted distribution from Pondicherry to cape comorin on the east coast and from Quilon to cape comorin on the west coast. From Vizhinjam to Muttom this species is found in greater abundance. Jones and Alagarwami (1969) while describing the molluscan fishery resources of India have pointed out the possibilities of mussel cultivation in India. Davies (1970) mentioned mussels as a potential resource which can be cultivated along Indian Coast. In India experiments on rope culture of mussel were initiated at Vizhinjam in 1971 (Anon., 1978) with a view to developing techniques suitable for the Indian Coast. Important works on mussel culture in India are by Achari (1975), Rao *et al.* (1960), Qasim *et al.* (1977), Appukuttan *et al.* (1980),

Kuriakose (1980), Kuriakose and Appukuttan (1980), Rangarajan and Narasimham (1980) and Rajan (1980). In the present communication the results of experiments on brown mussel culture at Vizhinjam from 1976 to 1979 are given.

The authors wish to acknowledge with thanks the keen interest and advice of Dr. E. G. Silas, Director, Central Marine Fisheries Research Institute, Mr. K. Nagappan Nayar and Mr. S. Mahadevan. The help received from Dr. P. A. Thomas of Vizhinjam Research Centre of Central Marine Fisheries Research Institute in identifying the sponges and from Mr. P. Radhakrishnan, Mr. Mathew Joseph and Mr. K. T. Thomas for the assistance in analysing the data is gratefully acknowledged.

RESULTS

Rope culture experiments during 1976 to 1979 at Vizhinjam

The environmental features of mussel culture site in Vizhinjam Bay where the present experiments were conducted have been described in

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detail by Appukuttan *et al.* (1980). The bay is protected and has a depth range of 10-15 m. There is good settlement of *Perna indica* seed in the natural bed in and around Vizhinjam in all the years. The site selected for open sea mussel culture experiments was 1-2 km away from the shore. The depth here ranged from 15 to 25 m. The sea is calm from December to the end of May but is subject to severe monsoon conditions there after making it impossible to keep floating rafts in the sea. The environmental features of the open sea farming site were similar to those of the bay.

The data on salinity and temperature from 1976 to 1979 are given in Fig. 1. Water temperature ranged between 20.75° C and 30.05° C, the lowest during monsoon period and highest during January/February. The minimum salinity observed was during May-June and

TABLE 1. The percentage of silt by volume observed at different depths in Vizhinjam Bay during 1976-79 (Average of three year data)

Months	0-1 m	1-2 m	2-3 m	3-4 m
July	1.00	28.20	42.33	57.33
August	1.58	21.88	22.40	34.33
September	1.17	5.75	14.45	16.18
October	1.50	6.27	8.03	15.10
November	1.42	3.02	5.87	10.47
December	1.78	2.63	2.83	4.56
January	2.05	2.71	4.25	7.17
February	1.70	3.48	3.87	6.17
March	1.75	3.07	2.75	5.45
April	1.47	3.30	4.19	7.52
May	0.66	3.95	10.70	11.28
June	1.68	14.38	13.80	32.63

water was highly turbid during monsoon months. The percentage of silt was calculated from the volume of silt bound in fixed quantity

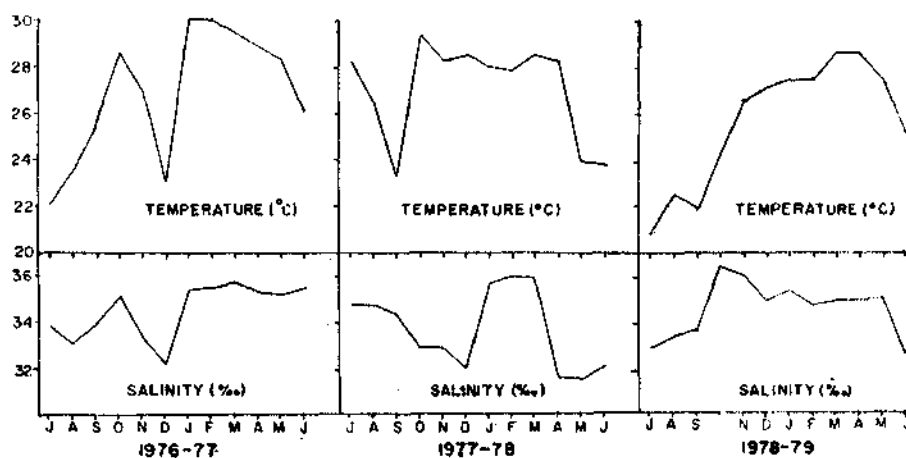


FIG. 1. Seasonal variation in salinity and temperature in Vizhinjam Bay during 1976-1979.

maximum during summer (March). Salinity was about 33‰ in most of the months in all the three years at Vizhinjam. The decline in salinity and temperature coincided with the monsoon season. Average percentage of silt observed at different depths for three years (Table 1) showed that at 0-1 m silting was insignificant. At 2-4 m silting was more and

of water collected from different depths at equal intervals.

Method of rope culture of brown mussel

Floating rafts of area range 30-100 m² were used in all the experiments at Vizhinjam (Pl. I A). Achari (1975), Appukuttan (1980 a) and Appukuttan *et al.* (1980) have described

the methods of rope culture for various experiments at Vizhinjam. Kuriakose and Appukuttan (1980) have given the details of rope culture techniques adopted at Calicut and Vizhinjam.

Seeds for mussel culture were available along the intertidal rocky area in the Vizhinjam Coast and good settlement of mussel seed is observed all along the coast (Pl. I B). Using iron chisel the mussel seed are collected from the rocks. The seed are cleaned and spread over a piece of old cotton net or mosquito net and the nylon rope is kept over the net. The net is wrapped over the rope securing the seed intact and both the ends of net were stitched using cotton twine (Pl. I C). Apart from the seed collected from the natural bed, artificial spat settlers such as roofing tiles, split nylon rope, strings of coconut shells, split bamboo poles and 1×1 m iron cages covered with nylon screen were used in the farm to collect mussel seed. Split nylon rope, roofing tiles (Pl. I D) and iron cages gave encouraging results. During 1978, 402 kg of mussel seed were collected from spat settlers released in the bay. This was used for seeding the ropes in December.

In 1976, seeding work commenced by June but could not be continued in August due to rough weather; it could be resumed only during September-December. In 1977, seeding was done during September-December. In 1978 seeding could commence only by November. Generally September to December period was found ideal for seed collection and seeding. In 1976, four rafts with 13 coir ropes and 110 nylon ropes of 1 to 6 m long were set inside the bay. In 1977, two rafts were launched in the open sea and maintained for 3 months with 36 seeded nylon ropes of 10 m length; 81 seeded nylon ropes were set in the bay in the corresponding period. In 1978, three rafts with 114 seeded nylon ropes with average length of 5.5 m were kept in the open sea for 5 months. 144 seeded nylon ropes of average length of 6 m were suspended in 6 rafts inside the bay.

Growth rate

Samples were taken every 15th day from numbered ropes which had been seeded and suspended in the same period. The mean length of mussels of each sample was taken into consideration for calculating the growth rate. Fig. 2 depicts the growth of *P. indica* under culture conditions in the bay and Fig. 3 gives its growth in the open sea farm. Analysis of samples show that the average growth rate for all the three years inside the bay have shown similar trends. In 1976-77 the growth increment per year was 35 mm, 35.6 mm in 1977-78 and 36.3 mm in 1978-79. The average monthly growth rate was 2.92 mm. The growth rate of open sea mussels in 5 months was 25 mm *i.e.*, 5 mm/month. In open sea conditions the mussels grow faster and attain marketable size.

Increase in total weight and meat weight of cultured mussels

Fortnightly samples were used for finding out increase in total weight and meat weight from bay and open sea. In 1976-77 the increase in total weight observed was 10.75 g for 12 months, 9.24 g in 1977-78 and 8.9 g in 1978-79 in the bay (Fig. 2). The average total weight increase was 0.77 g per month. The increase in meat weight for 1976-77 was 4.9 g, in 1977-78 3.49 g and 3.52 g in 1978-79. The calculated meat weight increase per month was 0.32 g. In the open sea samples the increment in total weight and meat weight was greater than that of bay (Fig. 3). The increase in total weight in 5 months was 9.72 g with 1.94 g/month and that of meat weight for the same period observed was 4.5 g with 0.9 g/month. The meat weight — total weight relationship is given in Table 2.

Spawning periodicity

The maturity stages of gonad were classified as follows:

Stage I — Ova have not attained regular shape, sperms non-motile; Stage II — Granulation in the ovary observed, ovary with-

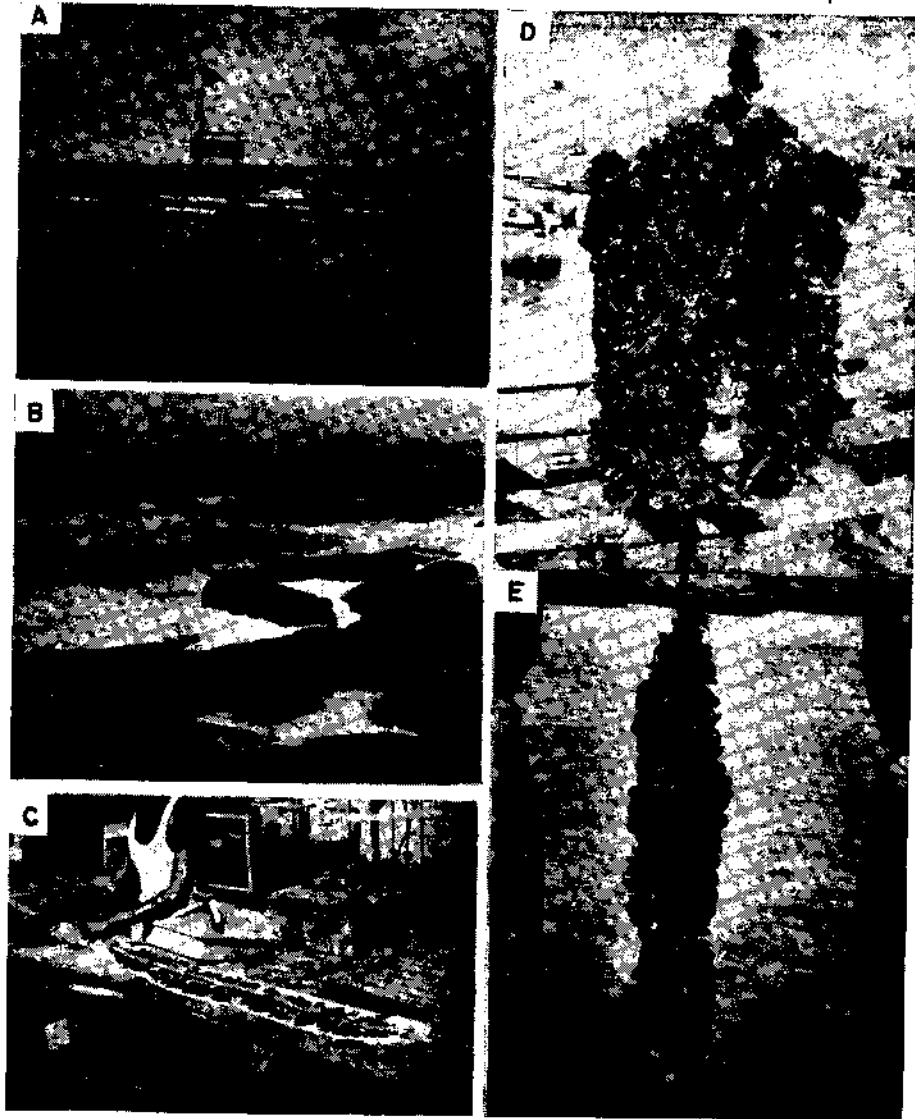


PLATE J A. Floating rafts for rope culture of mussel, B. Natural mussel bed at Vizhinjam, C. Seeding of mussels on rope, D. Spat settlers with mussel spat and E. Brown mussels grown to harvestable size on rope.

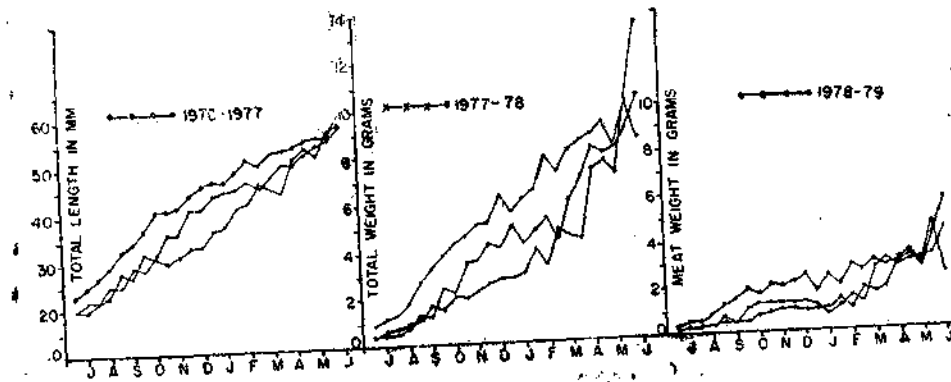


FIG. 2. Growth rate and increase in total weight and meat weight of mussel inside the bay from 1976-1979.

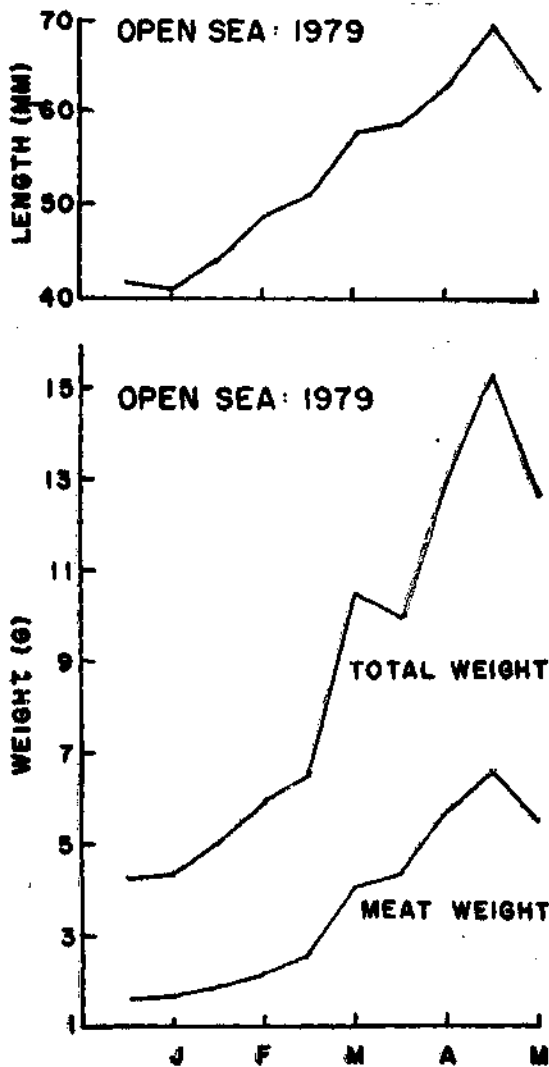


FIG. 3. Growth rate and increase in total weight and meat weight of mussel in the open sea in 1979.

out regular shape, sperms non-motile; Stage III — Ova spherical, sperms motile and Stage IV — Spent. For determining the stages of maturity in each month 50-300 mussels were examined from the ropes. Maturity stages were observed in different months in the bay for 3 years (Fig. 4). Since mussels above 20 mm in size were examined in the present study, indeterminate stages were not found in the samples. In 1976-77, Stage I was observed from July to March, Stage II from December to April and Stage III from April to June and Stage IV in July and August. In 1977-78 Stage I was observed from September to March, Stage II from November to March, Stage III in July, November, December and from March to June and Stage IV from August to November. In 1978-79 Stage I was present from October to March, Stage II from November to December and in March, Stage III in July to August and April to May period and Stage IV in September and in June. In the open sea samples Stage I to III alone were observed from January to March in 1978 and from January to May in 1979. Stage I was present in January to February and from March onwards Stage II and III were present. In April and May all specimens were in Stage III.

Spawning of *P. indica* commences by May and lasts till September with peak during July-August. Natural settlement of spat in mussel beds was noticed from July and peak period of

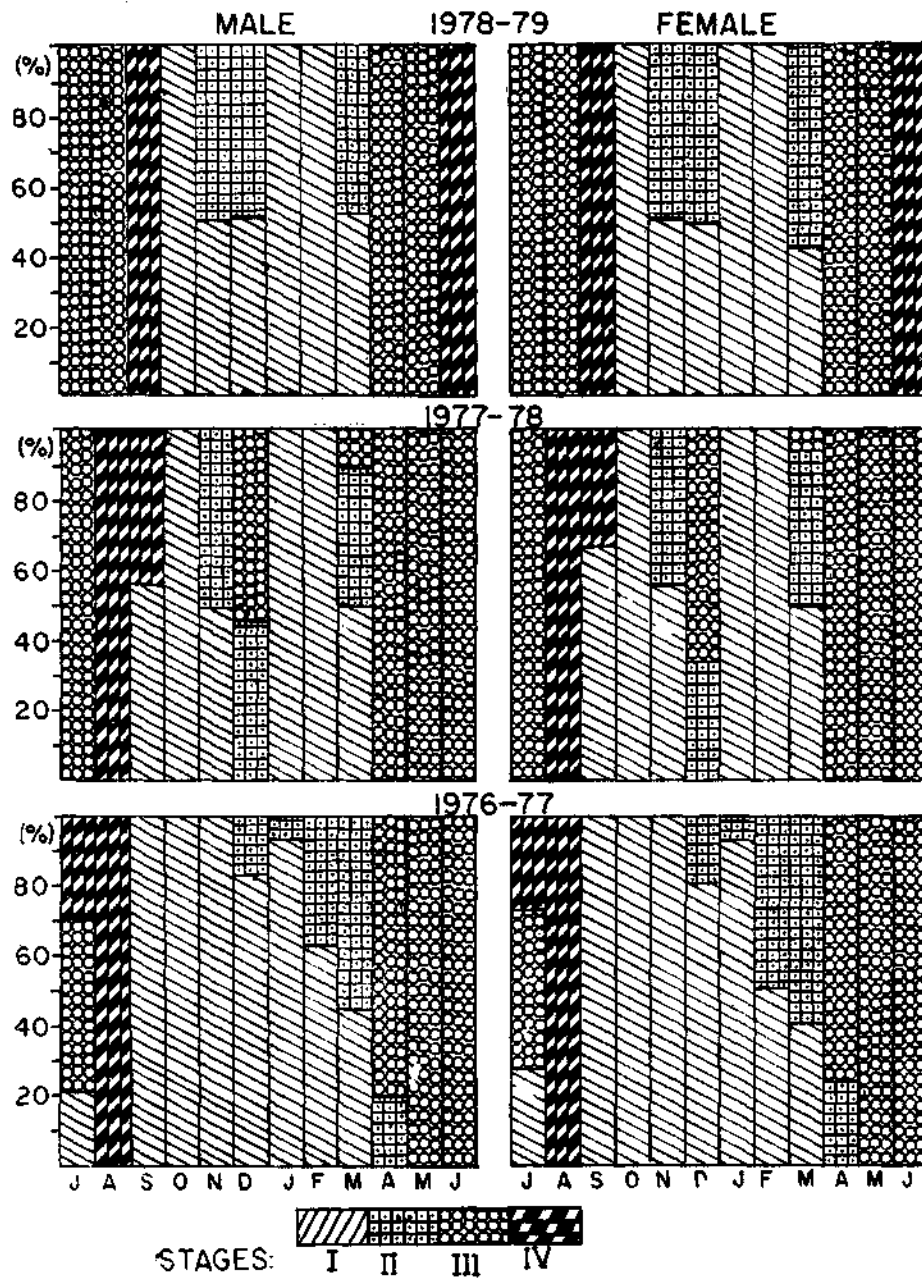


FIG. 4. Maturity stages of *P. Indica* in different months in the bay from 1976 to 1979.

TABLE 2. The average values of meat weight expressed as percentage of total weight of mussels of Vizhinjam Bay and open sea in successive months

Month	Bay 1976-77	Bay 1977-78	Bay 1978-79	Open sea 1978	Open sea 1979
July	38.20	47.58	38.24	..	..
August	38.40	31.45	37.04	..	..
September	38.30	37.90	37.85	..	..
October	37.95	38.78	41.73	..	..
November	39.60	35.92	40.97	..	..
December	37.95	36.72	42.26	..	..
January	34.80	21.31	35.38	27.31	36.37
February	33.58	26.17	35.29	28.18	36.31
March	34.94	26.24	32.88	30.98	38.44
April	33.15	37.44	40.69	..	43.58
May	32.62	37.28	41.31	..	43.33
June	40.53	33.78	39.19	..	..

settlement was in September and October. Clutches were kept in the farm and settlement of mussel spat was observed from June to September.

Production rate

In Vizhinjam Bay *P. indica* reaches marketable size (55-59 mm) in 8 months from October to May (Pl. I E). In the open sea marketable size of 60-65 mm is reached in five months. Harvesting of mussel could be done in May. Experiments in the bay have shown that the average production per metre length of rope is 10-12 kg. In a single raft of 6 × 5 m size, 30 ropes of 5 m length could be accommodated. The production per raft is 3 tonnes and in a hectare area 50 such rafts can be launched giving an estimated production rate of 150 tonnes/ha. Open sea experiments showed that within 5 months (January to May) the mussel production per metre length of rope is 15 kg and the estimated production rate per hectare is between 180-200 tonnes. The production rate is high in the upper two metres of ropes, moderate between 2-4 metres and below that there is a sharp decline in production.

Animal associations

Among the fouling organisms noticed in the mussel farm, the barnacle *Balanus amphitrite* was the most important and next to that was *Crassostrea cucullata*. An interesting observation found during 1977 onwards in the farm area and in the natural bed was the unusual heavy spatfall of *Modiolus* sp. The settlement of *Modiolus* starts by May onwards, which almost coincides with the settlement of brown mussel in natural beds and on spat collectors kept inside the bay. One of the reasons for poor settlement of *P. indica* in natural bed during 1977-78 and 1978-79 period was the heavy spatfall of *Modiolus* sp. before the settlement of brown mussels commenced. During March-April *Avicula vexillum* was found attached to rope and spat collectors in large quantities. Simple ascidians *Ascidia* sp. were commonly found on mussel ropes throughout the year. Crabs of the genera *Thalamita*, *Porcellana* and *Pinnotheres* were found on the ropes. *Pinnotheres* sp. was found inside the mussels but no incidence of damage was noticed. Encrusting tubicolous polychaetes, nematodes, crinoids, flat worms and algae were also found over the mussel

ropes. The species of sponges found encrusting over the mussel shells were *Haliclona tenuiramosa* (Burton), *Callyspongia diffusa* (Ridley), *C. fibrosa* (Ridley and Dendy), *Mycala mytilorum* (Annandale). Occasionally coral growths over the mussel shells was observed. Appukuttan (1980 b) has described the details of production of mussels by fish *Rhabdosargus sarba* in the Vizhinjam Bay.

Remarks

Various experiments conducted at Vizhinjam have shown that rope culture of *P. indica* in protected areas and also in open sea yields high production and this technique can be utilised for commercial scale production of mussels along this coast. The present investigation at Vizhinjam has shown that salinity and temperature, which are most important factors determining the spawning activities of mussels have not shown much differences in the bay and open sea. During monsoon period there was change in salinity and temperature. Qasim *et al.* (1977) have made similar observations in the green mussel culture in Goa Coast. Silting percentage was found higher in depths beyond 2 metres and this was high from May to October. The main reason for poor settlement of mussel seed at Vizhinjam was the indiscriminate exploitation of adult mussels from the mussel beds by the fishermen and also due to heavy settlement of *Modiolus* sp. in this area. Experiments have shown that the ideal length of mussel seed for seeding work is between 20 and 35 mm. Among the spat collectors used, roofing tiles, iron cages and split nylon ropes give good results. The peak season for mussel seeding is September to December. Open sea culture experiments have shown that rafts can be positioned only in December and will have to be taken back to the bay by the end of May, since mussel rafts cannot be kept in permanently due to heavy wave action in the sea. The growth per year in bay was 35 mm and that

per month 2.92 mm, whereas in the open sea growth in 5 months was observed to be 25 mm with 5 mm growth per month, thus showing a faster growth in open sea conditions. Qasim *et al.* (1977) have recorded 8 mm/month growth on ropes at Goa in *P. viridis*. Kuriakose (1980) recorded 10.6 mm to 13.5 mm growth per month for *P. viridis* from Calicut Coast. The average increment of total weight of *P. indica* inside the bay was 0.77 g per month and meat weight increment was 0.32 g per month. In the open sea the increase of total weight per month was 1.94 g and that of meat weight 0.9 g/month. Meat weight ratio was high from May to December and hence it is felt that cultured mussels could be harvested from May onwards. Spawning of *P. indica* commences by May and lasts till September with peak during July to August. Rao *et al.* (1976) have reported that *P. viridis* breeds along the Goa coast almost throughout the year with two peaks of spawning — one from September to November and another during February-March.

The estimated production per hectare in the bay is 150 tonnes and in the open sea it is between 180 and 200 tonnes. An annual yield of 480 tonnes per hectare of green mussel has been reported by Qasim *et al.* (1977). The present study has shown that settlement of *modiolus* sp. spat from May onwards has an adverse effect on the natural settlement of brown mussel at Vizhinjam. The effect of other fouling organisms on cultured mussels is negligible.

Davies (1970) has pointed out mussels as a potential food resources and Jones and Alagar-swami (1969), Achari (1975), Rao *et al.* (1976), Qasim *et al.* (1977) and Silas (1980) have emphasised the need for culture of mussels to increase the production. Present observations show that mariculture of *P. indica* on commercial scale operation is feasible along our coasts.

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