

BIOLOGY OF THE GREEN MUSSEL, *PERNA VIRIDIS* (LINNAEUS) CULTURED IN MUTTUKADU LAGOON, MADRAS

P.V. SREENIVASAN, R. THANGAVELU AND P. POOVANNAN

Central Marine Fisheries Research Institute, Cochin - 682 031, India

ABSTRACT

This paper deals with the biology of the green mussel, *Perna viridis* (Linnaeus), cultured by pole and bag methods in the Mariculture Farm of C.M. F.R. I., located in the Muttukadu lagoon, near Madras. In the culture system, the mussel showed a growth of 79.8 mm in 11 months. The growth was better in the cultured population than that of the natural bed mussels. The growth was not uniform, but varied with active and slow phases in different months.

Spent and spent resorbitive gonads were predominant among both males and females. Ripe and spawning mussels were found in good numbers from January to April. Sexes were evenly distributed in the cultured mussels. A significant feature was that, inspite of the occurrence of ripe and spawning mussels, there was scanty settlement of spat, suggesting unfavourable conditions in the area for the establishment of mussel populations.

INTRODUCTION

The green mussel, *Perna viridis* (Linnaeus), is one of the most important species which could be used in molluscan culture practices in India and elsewhere (Nayar, 1980). With the achievement of good production in the culture of brown mussel, *Perna indica* Kuriakose and Nair, at Vizhinjam, the mussel culture was attempted at many centres along both the coasts of India (Qasim *et al.*, 1977; Appukuttan, 1980; Appukuttan *et al.*, 1980; Kuriakose, 1980; Nayar, 1980; Parulekar, 1980; Rajan, 1980; Rangarajan and Narasimham, 1980; Pai and Kuriakose, 1981; Chatterji *et al.*, 1984). The Central Marine Fisheries Research Institute, which pioneered the experiments on mussel culture has drawn up project to extend the work to saltwater

lagoons, which lie unused at present. As a part of this programme, in Muttukadu lagoon, experiments were conducted in 1986-'87 to culture the green mussel on poles and bags (Sreenivasan *et al.*, 1987).

There was paucity of information on the biology of the green mussel grown in saltwater lagoons. The present account embodies the results of the biological observations made during the above experimental culture in Muttukadu lagoon.

MATERIAL AND METHODS

Topography and other general features of the Muttukadu lagoon and Mariculture Farm of C.M.F.R.I., were earlier described by Rajagopalan *et al.*, (1983). In this farm pole culture for mussels was carried out

at the northern point, while two racks for bag culture were fixed opposite the Mariculture Centre.

A detailed account of the pole and bag culture experiments carried out in the saltwater lagoon at Muttukadu was given by Sreenivasan *et al.* (1987). Samples for biological observations were collected twice in a month. In the case of pole culture, sampling was from August '1986 to March '87 and in the bag culture, from August '86 to July '87. About 100 specimens were measured for length (measured in antero-posterior direction) in each sample. Simultaneously, total weight of the sample, individual weight, shell weight and meat weight were also recorded for 50 specimens. Length was measured with a vernier calipers upto 0.1mm precision and weight with an electronic balance upto 0.01g.

The gonads of 50 specimens were examined in each sample for maturity studies and data from poles and bags were pooled and analysed. Male and female gonads could be easily recognised by the colour, the former being creamy white and the latter, bright orange. Based on the distension of the gonads and microscopical examination, the following four stages of maturity were distinguished (Narasimham, 1980).

Stage I (Developing) : The gonad is moderately developed and has attained 2/3 of the final size of the gonad. Gametogenesis begin and follicles contain developing gametes.

Stage II (Ripe): The gonad is fully distended. In Females, the ripe ova fill practically the entire follicular space. In males, the follicles are full with ripe sperms.

Stage III (Spawning) : With emission of gametes, the gonads become flabby and a

reduction in the density of ripe gametes is evident.

Stage IV (Spent): In the spent/spent resorbitive stage, majority of the follicles are either empty with few residual gametes or with resorbed gametes of irregular shape and size.

OBSERVATIONS

Length composition and growth

At the time of seeding, the total length ranged from 15.6 mm to 40.2 mm in August with a mean size of 23.7 mm and SD of only 4.4 mm (Fig.1). Since there was no settlement of new broods, the progression in the length range and mean size in the succeeding months was steady. The length range of the mussel population on the poles was 15.0 - 53.0 mm, 29.0 - 59.4mm, 21.7 - 70.0mm, 32.0 - 70.0 mm, 47.0 - 89.0mm, 51.0 - 85.0 mm, 52.4 - 109.4 mm

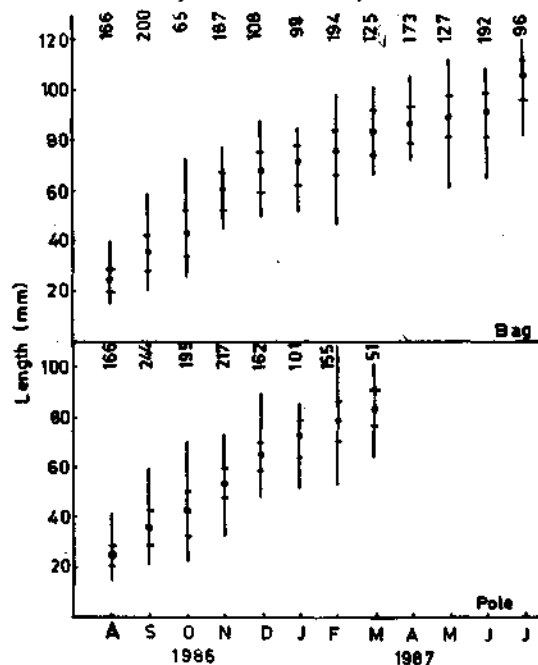


FIG. 1. Length composition of *P. viridis*, cultured by poles and bags method (Length range, mean value and SD are indicated. Numbers indicate the sample size).

and 64.0 - 101.0mm from August '86 through March '87 and the corresponding mean sizes were 23.7, 34.7, 41.1, 53.4, 63.4, 71.0, 77.9 and 83.3 mm. In bag culture, the length range recorded was 15.0 - 53.0 mm, 29.0 - 59.2 mm, 26.3 - 73.5 mm, 45.0 - 77.0mm, 50.0 - 87.0 mm, 51.0 - 85.0 mm, 46.0 - 98.4 mm, 65.7 - 112.5 mm, 72.0 - 107.0mm, 60.7 - 107.4 mm, 65.0 - 109.0 mm and 82.0 - 120.4 mm from August '86 to July '87 and the respective mean sizes were 23.7, 34.7, 42.3, 60.3, 67.0, 71.0, 74.6, 83.1, 86.1, 88.6, 90.0 and 103.5 mm.

The net growth in length by bag culture during the period was 79.8 mm in 11 months, which gives an average of 7.2 mm per month (Fig. 2). The monthly growth rate was highly variable during the period. It was 11 mm in September and as high as 18 mm in November. In the succeeding three months, the growth rate was poor being 6.7 to 3.6 mm. In March, the rate of growth was better (8.5 mm), followed by poor growth of 3.0 to 1.4 mm, during the warmer months of April-June. In July, a sharp increase in growth rate was observed i.e., 13.5 mm. A comparison of the growth of *P. viridis*, in successive months and the environmental parameters recorded during the above period, did not indicate any well-defined relationship.

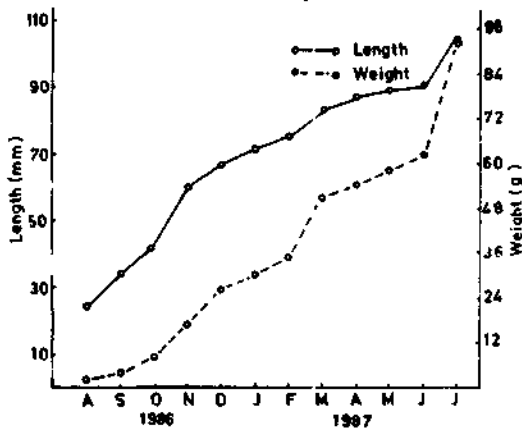


FIG. 2. Growth in length and weight of *P. viridis*

TABLE 1. Salinity, surface temperature and dissolved oxygen at Muttukadu lagoon during 1986 - '87 (monthly average values)

Month	Salinity (%)	Temperature (°C)	Dissolved Oxygen (ml/l)
Aug. '86	35.47	29.4	3.85
Sep.	39.32	30.4	3.43
Oct.	36.61	29.3	3.59
Nov.	22.67	28.3	5.30
Dec.	26.06	27.2	5.34
Jan. '87	31.16	26.8	4.92
Feb.	33.74	31.0	3.87
Mar.	33.62	30.7	3.54
Apr.	37.40	31.3	3.10
May	43.50	31.9	3.10
Jun.	48.40	31.8	4.50
Jul.	45.60	32.9	2.90

Corresponding with the growth in length of the mussel, the weight increase was, from an initial of 1.78 g in August to 93.03 g in July, which gives an average increase of 8.28 g per month (Fig. 2). The actual increase was 2.0, 3.96, 9.08, 9.51, 3.85, 3.55, 17.19, 3.0, 3.99, 3.25 and 31.79 g in successive months from August onwards.

Environmental conditions

During the period of study, the salinity showed a slight increase from August to September and October, but declined in November due to monsoon rains (Table 1). From December onwards, the increase was gradual but reached a very high saline condition by June (48.50‰). Similarly water temperature also showed a declining trend from September to January, and rose gradually to reach a high value of 32.9°C by

July. In the case of dissolved oxygen, comparatively higher values were recorded in cooler months of November-December and lower during summer months. As mentioned earlier, growth of the mussel and environmental parameters prevailed did not indicate any significant relationship.

Maturity and spawning

For maturity studies, data from poles and bags were pooled and analysed. From the examinations, it was observed that the gonads in *P. viridis*, appeared in specimens from 15 mm onwards and more than 50% of the mussel of both the sexes were mature by

25 mm, which can be considered as the size of the maturity for this species. Similar observations were made by Rao (1980) in this species. Indeterminates were not common in the samples and only to the extent of 15% in August and 7% in October.

The percentage composition of different stages of maturity of males and females of *P. viridis* are given in Fig. 3. In the case of males and females in August and September, developing gonads (Stage I), were encountered. Ripe gonads were in good numbers from January to April, while spent and spent resorbitive individuals were predominant in almost all the months. Partially spawned (Stage III) males were found in good numbers from October to January and again in July, while spawning females were recorded from October to April and again in July.

Occurrence of spawning and partially spent specimens of both the sexes recorded from October to April indicate that spawning took place during a prolonged period of time. Though there was a drop in salinity and temperature during November-December, ripe and spawning individuals were continued to be present. This indicates that *P. viridis* could spawn in salinities less than 30‰ also. An important factor noted during the course of the study was that there was only stray spatfall within the lagoon. Though there is spawning of the green mussel in the lagoon, no appreciable spatfall takes place to establish a natural population within the area.

Sex ratio

Males were dominant in 8 of 12 months observed in the mussel population (Fig. 4). However, 'chi' square test indicates that at 5% level, there is no significant deviation from the normal distribution ($\chi^2 = 2.0083$). Sex composition in different length groups (Fig. 5), indicates that both males and females are

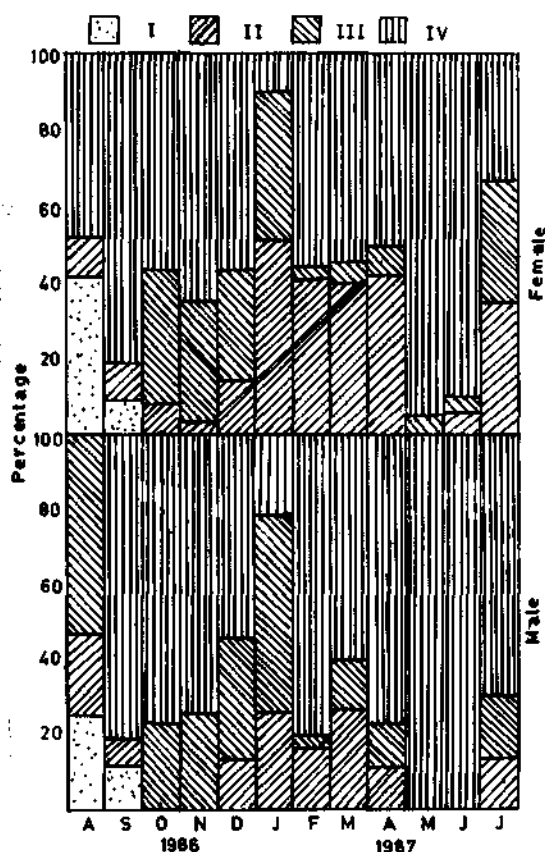


FIG. 3. Stages of maturity among males and females of *P. viridis*.

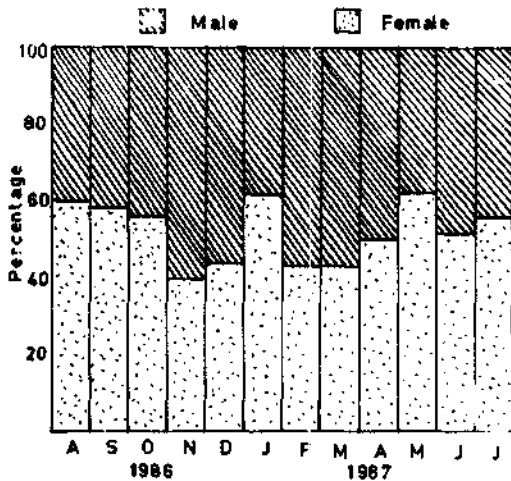


FIG. 4. Sex ratio of *P. viridis*, during 1986-87.

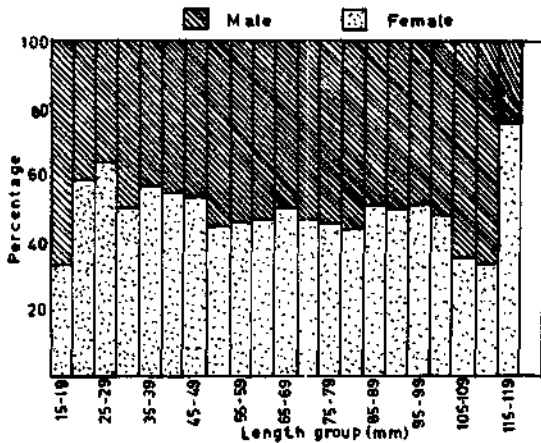


FIG. 5. Length-wise sex ratio of *P. viridis*.

equally distributed in all the size groups except in the large groups of 115 - 119 mm and 120 - 124 mm. Again, the statistical approach by 'chi' square test indicates that $\chi^2 = 2.4890$, and is not significant at 5% level.

Index of condition

Variations in the value of index of condition (termed IC) was studied by two methods; percentage of meat weight in total weight of the mussel and meat weight in shell weight. Highest index was recorded in

September and the lowest in May in the former method (Fig. 6). In the case of the latter also, the highest index was recorded in September and lowest values in January and March. The index values were low, when more number of spent and spent resorbitive specimens occurred in considerable numbers in the population.

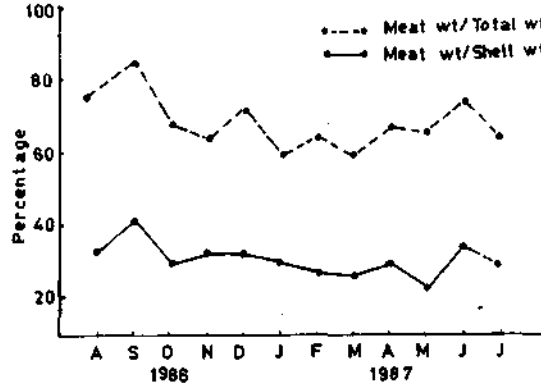


FIG. 6. Index of condition of *P. viridis*, during 1986-87.

DISCUSSION

As evidenced by the above observations, growth of *P. viridis*, in the culture experiment was 79.8 mm in 11 months i.e., from 23.7 mm in August to 103.5 mm in July, with a mean monthly growth rate of 7.2 mm. On the otherhand, the growth of the population at the natural bed at Ennore from where the seed was collected, was 67 mm in 12 months in the first year and 26 mm in the second year at a monthly average of 5.6 and 2.2 mm respectively (Sarvesan *et al.*, 1988). This clearly evidences that the growth of the green mussel is faster at the culture site, though the latter is located in a lagoon. Kuriakose (1980) observed an average monthly growth of 10.6 to 13.5 mm for the species in the culture experiments in the open rafts, while the growth in the natural bed was only 6.9 to 8.5 mm. Qasim *et al.*, (1977) observed 85 mm growth for *P. viridis* in 11 months in a raft culture experiment at Goa,

registering an average growth of 7.7 mm in a month. In the natural bed, the growth rate was only 5 mm/month. At Kakinada, Rangarajan and Narasimham (1980), recorded 9 mm growth per month in the cultured mussels, while it was only 7 mm in the natural bed in the first 12 months. They further stated that the growth of *P. viridis*, in the culture experiments at Ennore was 8 mm per month and 13 mm when grown in the rafts suspended in open sea, off Kovalam. All the above observations indicate that in culture experiments, better growth was observed. It is possible that the faster growth was due to less competition for food and space among the mussels in the off-bottom culture system than in the natural bed. Additional advantages are the periodical maintenance works such as cleaning of silt deposited on the mussel, removal of predators and foulers and thinning of the mussels population. These factors also accelerate growth among the cultured mussels.

Another interesting point is the occurrence of various stages of maturity in the cultured population. Ripe and spawning individuals of both the sexes were recorded from September to July, with more numbers from January to April. This indicates that there was spawning among cultured mussels during these months. In the natural bed also, peak spawning was recorded during these months. But as mentioned earlier, there was a mild spatfall in the lagoon, during the entire period of observations. It means that the gametes were released from the mussel, but development could not take place to attain the spat stage. It may be mentioned here that the cultured mussels used for spawning experiments in Mussel Hatchery at Kovalam Field Laboratory released viable gametes which were successfully reared to spat stage. This clearly indicates that the gametes in the

mussels were in good condition and can develop into larvae and spat. In spite of this, if spat settlement could not occur in the lagoon, it means only that the conditions were not favourable to the larvae to settle. Therefore, it can be inferred that while the conditions are favourable for the growth of the adult population, they were adverse for the larval development.

ACKNOWLEDGEMENTS

We gratefully acknowledge Dr. P.S.B.R. James, Director, Central Marine Fisheries Research Institute, for his kind encouragement. We also thank Dr. S. Ramamurthi, Officer-in-Charge, Madras Research Centre of C.M.F.R.I., for his keen interest in the progress of the work. Our thanks are due to Shri S. Mahadevan, Head of Molluscan Fisheries Division and Dr. K. Satyanarayana Rao, Scientist for critically reading the manuscript, to Shri M. Rajagopalan, Scientist for providing the environmental data and to Shri M. Kathirvel, Scientist for the help rendered during the observations.

REFERENCES

- APPUKUTTAN, K.K. 1980. Brown mussel production and economics at Vizhinjam. *Workshop on Mussel Farming*, Madras, 8 pp.
- APPUKUTTAN, K.K., K. PRABHAKARAN NAIR, MATHEW JOSEPH AND K.T. THOMAS 1980. Culture of brown mussel at Vizhinjam. In: *Mussel Farming - Progress and Prospects*. *Bull. Cent. Mar. Fish. Res. Inst.*, 29 : 30 - 32.
- CHATTERJI, A., Z. A. ANSARI, S. S. INGOLE AND A.H. PARULEKAR 1984. Growth of the green mussel, *Perna viridis* L, in seawater circulating system. *Aquaculture*, 40: 47 - 55.
- KURIAKOSE, P.S. 1980. Open sea raft culture of green mussel at Calicut. In: *Mussel Farming - Progress and Prospects*. *Bull. Cent. Mar. Fish. Res. Inst.*, 29: 33 - 38.
- NAYAR, K. NAGAPPAN 1980. Present status of mussel culture in India. *Workshop on Mussel Farming*, Madras, 10 pp.

BIOLOGY OF GREEN MUSSEL

- NARASIMHAM, K.A. 1980. Fishery and biology of the green mussel *Perna viridis* (Linnaeus). In : *Mussel Farming - Progress and Prospects*. Bull. Cent. Mar. Fish. Res. Inst., 29 : 10 - 17.
- PAI, M.V. AND P.S. KURIAKOSE 1981. Mussel culture at Karwar, Karnataka State. *Mar. Fish. Infor. Serv.*, T & E Ser., 33: 13 - 16.
- PARULEKAR, A.H. 1980. Production and economics of mussels in Goa. *Workshop on Mussel Farming*, Madras, 12 pp.
- QASIM, S.Z., A.H. PARULEKAR, S.N. HARKANTRA, Z.A. ANSARI AND A. NAIR 1977. Aquaculture of green mussel *Mytilus viridis* L : cultivation on ropes from floating rafts. *Indian J. mar. Sci.*, 6 : 18 - 25.
- RAJAN, S.J. 1980. Mussel production and economics at Kovalam (Tamil Nadu). *Workshop on Mussel Farming*, Madras, 5pp.
- RAJAGOPALAN, M, K.G. GIRIJAVALLABHAN, GEETA BHARTHAN, M. KATHIRVEL, P. NAMMALWAR AND T. DHANDAPANI 1985. An instance of mass mortality in the Muttukadu farm near Madras during April 1983. *Mar. Fish. Infor. Serv.*, T & E Ser., 61 : 8 - 12.
- RANGARAJAN, K. AND K. A. NARASIMHAM 1980. Mussel farming in the east coast of India. *Mussel Farming - Progress and Prospects*. Bull. Cent. Mar. Fish. Res. Inst., 29 : 39 - 41.
- RAO, K. VIRABHADRA 1980. Life history studies on Indian sea mussels. *Workshop on Mussel Farming*, Madras, 13 pp.
- SARVESAN, R., P.V. SREENIVASAN, R. THANGAVELU AND P. POOVANNAN 1988. Green mussel resources of Ennore estuary and Muttukadu backwaters, Madras. *Symp. Tropical Marine Living Resources*. Mar. Biol. Ass. India, cochin. Abst. No. 13.
- SREENIVASAN, P. V., R. THANGAVELU AND P. POOVANNAN 1987. Potentialities of Muttukadu Mariculture Farm for green mussel culture. *Mar. Fish. Infor. Serv.*, T & E Ser., 81 : 10 - 12.