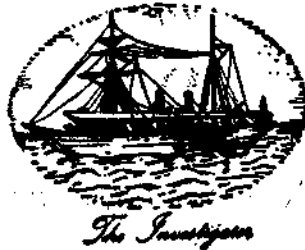


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SETTLEMENT AND GROWTH OF BARNACLE AND ASSOCIATED FOULING ORGANISMS IN PEARL CULTURE FARM IN THE GULF OF MANNAR

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ABSTRACT

The settlement of fouling organisms on the pearl oysters, pearl oyster shells and wooden test panels was compared. The barnacle *Balanus amphitrite variegatus* was the major fouling organism observed and the polychaete *Polydora ciliata* and the sponge (*Cliona vastifica*) were the main boring organisms. The intensity of settlement at different depths and the period of abundance of these organisms were studied. The successive settlement and fast growth of barnacles resulted in heavy loading on the oysters within a short period. The fouling load and the rate of growth of barnacles were higher on the shells than on live oysters. The settlement was more at the top rows of the sandwich-type frame net.

INTRODUCTION

A DETAILED study on the fouling and boring organisms in the pearl culture farm at Veppalodai has been made by Alagarwami and Chellam (1976). Kuriyan (1950) and Ananthanarayanan (1967) have given a list of fouling organisms on the pearl oyster cages at Krusadai Island, Gulf of Mannar. The pearl oysters reared in the farm at Veppalodai are affected by fouling throughout the year. Besides elucidating the problems of biofouling with emphasis on barnacles, the study, reported here, aimed at comparing settlement and growth of barnacles on wooden panels and pearl oysters on one hand and on pearl oyster shells and live oysters on the other.

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MATERIAL AND METHODS

Three series of experiments were conducted to study the fouling and boring aspects in the pearl culture farm at Veppalodai using the following material as the substratum: (i) wooden test panels, (ii) live oysters and (iii) shells of pearl oysters. Each wooden panel unit consisted of three square planks, each of 20 cm × 20 cm × 2.5 cm, which were suspended vertically from the raft in a manner that the top-most one was at 0.5 m, the middle one at 1.4 m and the bottom one at 2.0 m from the surface of the sea water and the depth of water below raft was 2.0 m. The panel of three planks was terminated at the end of days and a fresh one was introduced. The barnacles were counted irrespective of their size. Height of the barnacles was taken as the standard measurement as Crisp and Patel (1965) have done. The study covered a period of 12 months from January to December, 1975. Another set of wooden panels suspended simultaneously gave

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the data on cumulative fouling load and growth of barnacles for a period of 1, 2, 3, 4, 5, and 6 months. Beyond that period the panels could not be kept in the sea due to heavy damage by the pholad mollusc *Martesia* sp. Hence a fresh set was introduced for the second 6 months of the year.

In the second and third series of experiments, commencing March 1977, live pearl oysters and shells (both valves) were arranged in separate sandwich-type frame nets and

first, third and fifth rows of the net were recorded.

RESULTS

Monthly panels

Balanus amphitrite variegatus was dominant fouling organism on the panels throughout the year. *B. a. communis* and *B. a. venustus* were few. The settlement of barnacles on the panels at different depths was found to differ from month to month. From January to middle of June the settlement was less. During

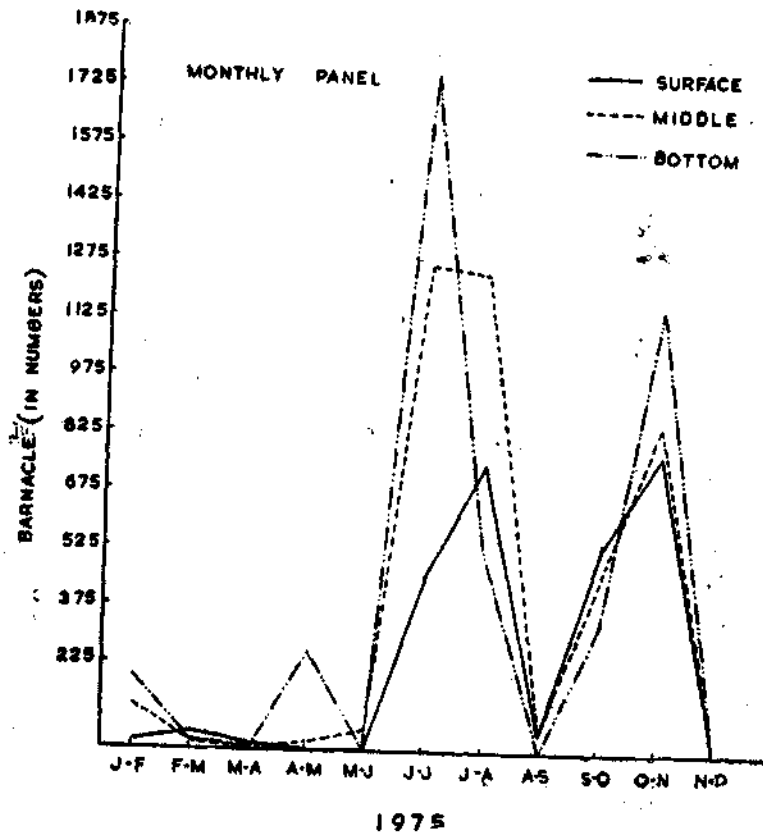


Fig. 1. Settlement of barnacles on the wooden panels in the pearl culture farm at Veppalodai during 1975.

suspended simultaneously from the rafts after recording the measurements and weight of individual oyster and shell. These were examined on completion of one month. The number and size of barnacles which have settled on both valves of oyster and shell in the

this period the total number of barnacles settled on all the three panels (at different depths) ranged from 26 (in March) to 268 (in April). Two peaks of heavy settlement were recorded, one was from middle of June to August and the other from September to November (Fig. 1),

A minimum of 2,500 barnacles (July) to a maximum 3,460 barnacles (June) were noted during the first peak and in the second peak it ranged from 1,290 (September) to 2,710 (November). When the total number of barnacles settled was taken into account for the whole period, the bottom panels showed higher settlement rate (39.3%) and the surface panels had less (23.8%).

For the period from January to December the size of the barnacles settled ranged from 0.1 to 9.0 mm in height. In the first half the maximum size of barnacle recorded was 6.0 mm and it was 9.0 mm in the second half. The size 0.1-1.5 mm dominated on the panels during February to June and December. From July onwards the dominant size group was found to be 1.6-3.0 mm. It was 4.6-6.0 mm in November and 3.1-4.5 mm in January.

Cumulative fouling

Fluctuation in settlement of barnacles on the longterm panels at different depths was noted. In the first half of the year, the settlement was more on the bottom panels in the first 2 months but it was not the case in the 3rd, 4th, 5th and 6th months in which the high settlement was on the surface panels. The total number of barnacles on the three panels at different depths for 1, 2, 3, 4, 5 and 6 months was 313, 99, 65, 6280, 5140 and 2730 respectively. When the total settlement of barnacles for the 6 months was considered, it was 47.0% on the surface panel, 35.6% on the middle panel and 17.3% on the bottom panel. Barnacles of size 1.5mm and less in height were present in all months. The barnacles which settled on panels kept in January 1975 grew to 6.2 mm in July 1975 and 26.9 mm by January 1976.

The weight of fouling on the surface panels had a uniform increase from 1 to 6 months. In the first month, it was merely 8 g but in the sixth month it had increased to 268.5 g. On the middle panels the increase in weight of

fouling was from 15 to 89.5 g. On the bottom panels the weight of fouling ranged from 20.5 to 103 g. For the first 6 months the surface panel had 45.5% of fouling weight, the middle one 28.3% and the bottom ones 26.2%. It was also noticed that the volume of total fouling on the surface panels increased uniformly from 3.5 ml to 179 ml for the first to sixth month. In the case of middle and bottom panels, the total fouling volume was not uniform and was less compared to the surface panels.

During the second half, the total number of barnacles settled on all the panels was 2500, 5540, 2760, 2720, and 1680 for the 1, 2, 3, 4, and 5 months respectively. More number of barnacles settled on the middle panels (36.7%) followed by the bottom panels (33.4%). The surface panels had less barnacles (29.8%). In this half year the maximum size ranged from 7.4 mm to 26.9 mm.

There was no definite pattern in the settlement of other fouling organisms at different depths on monthly and long-term panels. Of the five foraminiferans observed on these panels, *Discorbis* sp., *Quinqueloculina* sp. and *Orbulina* sp. occurred in the three levels throughout the year 1975. The presence of amphipods (from May to December) bivalve molluscs (from March to November) and nematode worms (from June to October) was recorded. Other organisms such as *Nymphon* sp., *Cryptophallus* sp., *Sphaeroma* sp., Gastropods (*Oliva* sp.), *Modiolus* sp., *Avicula* sp. and simple ascidians were found in lesser numbers during certain months of the year.

Fouling on oysters

The average surface area of both the valves of the oyster used for the experiment ranged from 42.6 to 59.1 sq.cm. The number of barnacles per unit area of 10 sq. cm on an oyster in the first, third and fifth row of the frame net is given in Table 1. The settlement per unit area per oyster ranged from 3.4 (in May) to 62.2

TABLE 1. Settlement of barnacles and fouling load on pearl oysters and shells in sandwich-type nets in the pearl culture farm at Veppalodai in 1977

Period	No. of days	Materials	No. of barnacles per 10 sq. cm			Fouling load per oyster/shell (pair) (g)			Fouling load on net (gm)
			I row	III row	V row	I row	III row	V row	
March	.. 30	O	11.6	5.7	5.8	..	..	..	..
		S	14.5	13.4	10.2	..	..	..	..
Mar.-Apr.	.. 29	O	25.2	7.5	8.2	..	..	..	..
		S	62.9	39.6	35.7	..	..	..	..
April-June	.. 39	O	0.4	3.0	3.2	..	..	..	..
		S	3.4	2.6	1.8	..	..	..	..
June	.. 21	O	15.3	12.4	14.0	..	..	..	..
		S	18.0	20.6	16.4	..	..	..	..
June-July	.. 31	O	21.6	9.2	9.9	9.1	7.4	7.5	400
		S	28.7	23.9	21.2	17.5	12.9	13.3	500
July-Aug.	.. 32	O	21.8	15.3	11.8	6.8	10.1	11.7	500
		S	24.9	25.2	35.7	25.5	16.8	13.6	750
Aug.-Sept.	.. 32	O	29.4	29.4	20.6	2.4	4.3	1.7	300
		S	53.2	32.5	25.1	6.5	5.3	6.6	910
Oct.-Nov.	.. 34	O	24.5	19.4	15.0	14.0	11.2	7.4	1300
		S	16.3	..	37.0	19.4	32.2	40.0	1500
Nov.-Dec.	.. 35	O	65.5	..	57.4	34.3	32.0	..	2240
		S	107.2	..	120.7	48.0	63.9	..	2490

O = Oyster ; S = shell (pair).

barnacles (in November). The settlement of barnacles on the unit area was 8.2 in March to May ; 14.0 in June to August and 36.1 in September to November. The maximum size of barnacles on oysters was found to be 8.9 mm in August. The total number of barnacles on oysters of each row of the frame net showed variation. In the first row it was high and the intensity decreased towards the bottom rows. The average number of barnacles on unit area for the period from March to November was 23.9 in the first row and 16.2 in the fifth row. In November a maximum fouling load of 33.1g/oyster was recorded. The accumulation of

fouling organisms and other suspended detritus on the frame net holding oysters increased in weight from 400 g in July to 2,240 g in November.

Bryozoans and hydrozoans occurred on all the oysters throughout the period of observations. Other organisms observed in good quantity were amphipods and *Hydroides* sp.

Fouling on shells

The shells used in the experiments had an average surface area of 54.7 to 63.6 sq.cm. The settlement of barnacles per unit area of

10 sq. cm of shell was 2.6 barnacles in May and 113.9 in November. The number of barnacles in the unit area of the shells was 19.6 (March to May); 23.8 (June to August) and 59.1 (September to November). The maximum size of barnacle recorded on the shells was 15.7 mm (August). The variation in settlement on different rows of shells in frame net also existed in each month (Table 1). The average number of barnacles per unit area for the whole period of observations was 36.7 on the first row and 33.6 on the fifth row. The weight of fouling organisms and detritus on the net holding the shells ranged from 500 g (March) to 2490 g (November). A maximum fouling load of 55.9 g per shell was recorded in November.

The settlement of bryozoans on the shells was rare compared to oysters where each oyster was fouled by it. A sparse settlement of hydrozoans was noted. Amphipods were also observed in lesser numbers on the shells.

Boring organisms

The intensity of boring by the polychaete *Polydora ciliata* and by the sponge *Cliona vastifica* was found to differ from place to place. *P. ciliata* was more in the sheltered bay farm at Tuticorin Harbour than at the shallow farm at Veppalodai. Oysters from the natural pearl banks showed very less boring. Blisters caused by the boring polychaetes were practically few in the oysters of 40 mm in DVM and less. It was also noticed that farm oysters were subject to boring, whereas oysters collected from the south breakwater of the Tuticorin Harbour (depth 0.5 - 1.0 m) showed negligible instances. The maximum infection by *C. vastifica* was on the Vappalodai farm oysters and the intensity was less in harbour farm and negligible in pearl banks.

The pholad mollusc *Martesia* sp. was not a common borer on the oysters of the farms. There were a few instances of boring by the

mollusc on oysters kept for a prolonged period in the farm. Its destructive nature was noted on the test panels which could not be retained in the sea for more than six months. The intensity of attack was high on the surface panels and less on the bottom panels.

REMARKS

The settlement of barnacles on the panels at different depths varied from month to month. The bottom panels showed a higher settlement (39.3%) during the year 1975. Depth may influence the settlement of barnacles and *B. a. variegatus* was found to prefer 5 feet level for maximum settlement in Madras Harbour (Antony Raja, 1959). Barnes (1956) found that most liberations of cirripede larvae occurred when temperature was high and minimum plankton and less silt were observed. However, the turbid nature of water in the shallow farm at Veppalodai probably afforded ideal conditions for the settlement and growth of numerous fouling organisms (Alagarwami and Chellam, 1976). Skerman (1956) found in Auckland Harbour that silt or other suspended detritus in sheltered regions can get incorporated on the slime films that develop on panels and these granular films can promote barnacle settlement on these surfaces.

Disparities in the occurrence of barnacles on the long-term panels are not uncommon. Nair (1965) observed that the number of barnacles remaining over the blocks after prolonged periods of exposure (1 to 6 months) need not give correct indication of the number that actually settled over the blocks. From January to June the maximum growth of barnacles on monthly panels was found to be 6.0 mm in height and from July to November it was 9.0 mm. On long-term panels the best grown barnacles were 6.4 mm in height in the first half and 26.9 mm in the second half. This clearly indicates that the period from July to November was better for good growth.

The intensity of boring was high in oysters of size 40 mm and above. Herdman (1905) also had reported the destructive nature of boring by *Cliona margaritiferae* on the Cheval paar oysters of Sri Lanka pearl banks. A high intensity of boring by the sponge *Cliona vastifica* has been observed on the oysters at Veppalodai farm. The infestation of *Martesia* sp. was

mostly confined to shallow inshore waters of the seas and estuaries and at depths ranging from 0.5 to 6.0 m attack of the borer is quite predominant (Balasubramanyan, 1968). Of the test panels suspended at depths ranging from 0.5-2.0 m, the surface ones were damaged more and the intensity decreased towards bottom.

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