CMFRI
bulletin 42
Part Two

DECEMBER 1988

NATIONAL SEMINAR ON SHELLFISH RESOURCES AND FARMING

TUTICORIN

19-21 January, 1987

Sessions II-VI

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
P. B. No. 2704, E. R. G. Road, Cochin-682 031, India

54. ON SOME ASPECTS OF TRANSPORTATION OF SEED OF PEARL OYSTER *PINCTADA FUCATA* (GOULD)

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ABSTRACT

The object of mass production of pearl oyster seed in the hatchery at Tuticorin Research Centre of Central Marine Fisheries Research Institute (CMFRI) is to ensure adequate supply of seed needed by the culture indutry and also to meet the demands of the future requirement of different maritime states and other establishments. To ensure adequate supply of healthy seeds, experiments were conducted to perfect the technique of transport of seed oysters. The paper highlights some significant results which will facilitate transport of pearl oyster seed over long distances.

INTRODUCTION

Seed oysters produced at Miyagi and Kumamoto Prefectures in Japan are exported to Hong Kong and North America in ships (Imai 1971). History shows that oysters were introduced to new environs when there was total mortality and destruction of the local species due to epidemics. Chidambaram in 1950 had attempted transportation of pearl oyster by air from Persian Gulf and introduced them to the Tuticorin oyster beds and Krusadai farm, Gulf of Mannar (Devanesen and Chacko 1958). In Japan, the pearl oysters are taken in large vessels from place where the conditions are unfavourable to places where suitable environmental conditions exist (Alagarswami 1970).

Vast fluctuations exist in the production of pearl oyster in the pearl oyster beds of the Gulf of Mannar (Alagarswami et. al 1987) and hence dependance on the natural population for the commercial pearl culture operations becomes a nonguaranteed venture. By the recent success in the production of pearl oyster (Alagarswami et. al 1983), required quantity of pearl oyster seed can be produced by hatchery method. To ascertain the suitability of the spat for tranpsorting them to the culture sites, cheapest and efficient means of transportation methods are to be evolved and hence these experiments.

MATERIAL AND METHODS

Hatchery produced pearl oyster spat belonging to different batches were reared in the farm at Tuticorin Harbour. The spat of different size groups were taken for the experiment from the above batches. They were divided into 5 mm size groups, viz 5-10, 10-15 and so on upto 35-40 mm. Prior to the experiment, the spat were conditioned for 24 h in the laboratory by keeping them in filtered seawater under aeration, No food was supplied to the spat during conditioning.

Tolerance limit of the spat in room condition, controlled temperature condition and refrigerated condition are found out. For this, each group was arranged separately in trays. The time of exposure to various conditions varied from 3 to 24 h in the size groups 20-25 mm, 25-30 mm, 30-35 mm and 35-40 mm. The experiment commenced at 10.00 h and continued upto the the next day. The room temperature was recorded regularly. After the stipulated time, 10 spat from each size group were removed and placed in filtered and well aerated seawater in tanks. survival rate of spat was estimated at the end of 24 h of immersion in water.

The survival rate of the different size groups of the spat in wet condition was also studied. The experiment was conducted in room temperature. The gunny bag, prior to the experiment was washed thoroughly in fresh water and finally soaked in seawater. The gunny bag was spread inside a plastic basin of 50 cm dia and the spat were placed over it, covered by another piece of gunny bag. To keep the spat in wet condition, seawater was sprinkled over

it as and when required. Care was taken not to accumulate seawater at the bottom of the basin. The time for this experiment varied from 5 to 25 h in the size groups 5-10, 10-15 and 15-20 mm and from 10 to 35 h in the other size groups (20-25, 25-30, 30 35 and 35-40 mm). At 5 h interval, 10 spat from the size groups 5-10, 10-15 15-20 mm and 25 spat from 20-25, 25-30, 30-35 and 35-40 mm size groups were removed and put in filtered and aerated seawater to find out their survival. The room temperature was recorded at every two hours.

Seaweeds, in the place of gunny bags, were used in another experiment. The seaweeds collected freshly were washed well in seawater before use. Seawater was sprinkled to keep them moist throughout the experiment. The results were recorded.

The time limit to which the spat of the size groups 5-10, 10-15 and 15-20 mm remain in a limited quantity of water was determined. 50 spat in each size group were placed separately in polythene bags of 55x30 cm size which contained 1 l of filtered seawater. Tne bags were tied on both ends. These bags with the spat were kept in the room away from light. The duration of the experiment ranged from 12 to 72 h. The dissolved O_2, pH, salinity and temperature of the water were recorded prior to and after the experiment. The bags with the spat were removed at the intervals of 12 h, 24 h, 36 h etc. upto 72 h of immersion. The survival rate of these spat was determined as in the earlier cases.

In order to find out the effect of oxygenation in spat survival under packed condition, a similar experiment as in the previous one was conducted. Oxygen was filled to the capacity of the polythene bag The duration of the experiment was from 24 to 108 h. The bags were lifted at the interval of 24 h upto 72 h, 12h upto 84 h and 6 h upto 108 h The resuts were recorded.

The optimum number of spat that can be transported safely in a known quantity of water was tried in another experiment. The size groups of spat experimented were 10-15, 15-20, 25-30 and 30-35 mm. In 10-15 mm size group, 500 spat were kept in 2.5 l of water and 1000 spat in 5 l. The experiment was terminated after 122h. 250 spat (15-20 mm) were kept in 2.5 l of water and 750 in 5 l and were dismantled after 99.5 h. 250 spat (25-30 mm) and 500 spat of the same group were kept in 2.5 l and 5.0 l of water respectively, the former was terminated after 66 h and the latter after 75.55 h. 100 spat and 200 spat of the 30-35 mm group were kept in 2.5 l and 5 l respectively and were removed after 72 h and 96 h. The survival of the spat was estimated after 24 h of immersion in normal seawater under aeration. The water used for the experiment was analysed for its hydrological parameters prior to and after the experiment.

RESULTS

Exposure to room temperature

Fifty per cent mortality occurred in spat of the size group 5-10 mm between 15 and 18 h. In 18 h exposure, this group suffered 80% mortality (Table 1). The tolerance limit for the size group 10-50 mm was 21 h. The size group 15-20 mm withstood 24 h exposure suffering only 10% mortality. During the experiment, the room temperature ranged from 26.7 to 30 5°C with an average of 28.4°C. The size groups 25-30, 30-35 and 35-40 mm survived 21 h of exposure beyond which heavy mortality exceeded 64% in the 20-25 mm group in 21 h which was quite abnormal when compared to the other groups During the second phase of experiment, the ambient temperature ranged from 27.2 to 32.3°C with an average of 29.2°C.

Exposure to controlled temperature conditions

The size group 5-10 mm showed mortality upto 80% whereas in the size group 10-15mm, it was 50% in 18 h of exposure. The larger size groups (15-20mm to 35-40 mm) withstood exposure for 24 h causing negligible mortality. In the size group 20-25mm, 29.2% mortality was seen which seemed abnormal (Table 2). The range in temperature when the 5-10 and 10-15 mm group experimented was from 24.0 to 27.6 °C (average 25.2 °C) and when the higher size groups were experimented, it was from 19.0 to 24.9°C (average 22.6°C).

TABLE 1. *Percentage mortality of spat - exposure to air at room temperature*

Size group (mm)	Exposure (h) 9	12	15	18	21	24
5-10*	11.1	20.0	25.0	80.0		
10-15*	—	10.0	20.0	30.0	50.0	70 0
15-20*	—	—	—	—	10.0	10.0
20-25@	—	—	—	20.00	64.0	83 0
25-30@	—	—	—	—	4.2	37.5
30-35@	—	—	—	—	10.0	66.7
35-40@	—	—	—	—	5.0	52.6

* : Temperature range : 26.7 - 30.5°C (Average 28.4°C)
@ : Temperature range : 27.2 - 32.3°C (Average 29.2°C)

TABLE 2. *Precentage mortality of spat - exposure to air at controlled temperature condition*

Size group (mm)	Exposure (h) 9	12	15	18	21	24
5-10*	10.00	20.00	20.00	80.00	—	—
10-25*	—	—	44.4	50.0	—	—
15-20*	—	—	—	—	—	Nil
20-25@	—	—	—	—	—	29.2
25-30@	—	—	—	—	—	4.4
30-35@	—	—	—	—	—	11.1
35-40@	—	—	—	—	—	Nil

* : Temperature range : 24.0 - 27.6°C (Average 25.2°C)
@ : Temperature range : 19.0 - 24.9°C (Average 22.6°C)

TABLE 3. *Precentage mortality of spat—gunny bag soaked in seawater.*

Size range (mm)	Exposure (h) 10	15	20	25	30	35
5-10*	—	—	—	11.1	No	No
10-15*	—	—	—	10.0	No	No
15-20*	—	—	—	—	No	No
20-25@	—	—	12.0	84.0	92.3	96.3
25-30@	—	—	12.0	13.3	79.0	84.2
30-35@	—	—	—	30.0	100.0	100.0
35-40@	—	—	—	66.7	73.3	80.0

* : Temperature range 26.3 - 28.3°C (Avdrage 27.1°C)
@ : Temperature range 29.0 - 30.6°C (Average 29.9°C)
No Not Observed

TABLE 4. *Percentage mortality of spat - seaweed soaked in seawater*

Size range (mm)	Exposure (h) 10	15	20	25	30	35
5-10*	—	—	10.0	8.3	No	No
10-15*	—	—	—	10.0	No	No
15-20*	—	—	—	—	No	No
20-25@	—	4.6	15.4	85.7	100.0	100.0
25 30@	—	—	—	35.0	90.9	95.7
30-35@	—	—	—	16.7	50.0	75.0
35-40@	—	—	33.3	25.3	50.0	58.8

* : Temperature range : 28.4 - 30.0°C Average 29.1°C)
@ : Temperature range : 25.9 - 28.5°C (Average 26.7°C)
No Not Observed

TABLE 5. *Percentage mortality of spat - 50 spat in 1 litre seawater*

Size range (mm)	Exposure (h) 36	42	48	54	60	66	72	Final pH
5-10	—	—	—	—	—	—	6.4	7.54
10-15	2.0	—	—	26.0	100.0	—	—	7.34
15-20	4.2	92.0	100.0	—	—	—	—	6.88

Mean temperature : I day : 28.2°C
II day : 28.3°C
III day . 27.9°C
Initial pH of the medium : 8.0

TABLE 6. *Percentage mortality of spat - 50 spat in 1 litre seawater with oxygen*

Size range (mm)	Exposure (h) 24	48	72	84	90	96	102	108
5-10	—	—	2.0	4.0	—	—	—	—
10 15	—	2.0	—	2.0	—	—	4.0	—
15-20	—	2.0	—	2.0	—	—	4.0	—

Mean temperature of the days : 28.9°C, 28.5°C, 28.8°, 29.0°C, 28.7°C

Tolerance limit in refrigerated condition

The size groups 20-25, 25-30, 30-35 and 35-40 mm subjected for refrigerated condition resulted in heavy mortality ranging from 62 to 100%, even in 6 h of exposure. The temperature varied from 7 to 20°C (average 15.3°C)

Survival of spat in wet condition

The spat kept covered in wet gunny bag tolerated exposure to a maximum of 24 h wherein only 10% to 11% mortality could be seen in the size groups 5-10 and 10-15 mm. No mortality occurred in 15-20 mm group during the period. The ambient temperature ranged between 26.3 to 28.8°C with an average of 27.1°C during the experiment. In the larger size groups higher rates of mortality occurred between 25-30 h (Table 3).

When the seaweeds were used in the place of wet gunny the mortality was negligible for the spat of the size groups 5-10, 10-15 and 15-20 mm upto a period of 25 h. In the size groups 20-25, 25-30, 30-35 and 35-40 mm, substantial mortality was observed in 30 h. The temperature range was from 28.4 to 30.0°C (average 29.1 °C) when the size groups 5-20mm were experimented and 25.9 to 28.5°C (average 26.7°C) when the size groups 20-40 mm were experimented (Table 4).

Survival of spat in aqueous condition

The smaller size group (5-10 mm) survived with negligible mortality of 6.4% in 72 h. 100% mortality occurred for the size group 10-15 mm in 60 h whereas it was 92% in 42 h in the 15-20 mm size group (Table 5). From the initial pH of 8.0, it had gone down to 7.54 for the 5-10 mm size group, 7.34 for the 10-15 mm size group and 6.85 for the 15-20 mm size groups in a period of 72 h. The average temperature for the first through third day was 28.2, 28.3 and 27.9°C respectively (Table 5).

Under the influence of oxygen, the spat of the size groups 5-10, 10-15 and 15-20 mm could withstand very well for a period of 108 h till the observation was made (Table 6). The pH of the water at the end was 7.65, 7.50 and 7.50 in the three size groups from the initial value of 7.95. The dissolved oxygen was 3.6 ml/l in the smaller size group and it came down to 1.35 and 1.92 ml/l for the immediate larger size groups. The initial oxygen content of the water was 3.6 ml/l. The temperature of the experimental water increased to 31.2°C, 31.8°C and 29.4°C from the initial temperature of 27.0°C. The averages of the atmospheric temperature during the period of experiment (108 h) ranged from 28.5 to 29°C.

Spat density vs volume of water

The size group 10-15 mm at a density of 500 spat in 2.5 l of water showed no mortality upto 122 h of immersion whereas at a density of 1000 in 5 l of water, a mortality of 37.5% had occurred. The pH in this experiment decreased from 8.2 to 7.91 in the first case and 6 74 in the second one and the dissolved oxygen from 3.60 to 3.39 ml/l and 2 88ml/l in the above two densities.

The size group 15-20 mm in a density of 250 spat in 2.5 l of water suffered 28.8% mortality in 99.5 h. In the size group 25-30mm a negligible mortality (0.8 and 1.0%) in concentrations of 250 and 500 spat in 5 l of water in a period of 68 h and 75.5 h had occurred. In size group 30-35 mm, 100 spat in 2.5l of water and 200 spat in 5 l of water kept for 72 h and 96 h gave similar rates of mortality (Table 7).

DISCUSSION

Chidambaram in his experiments at the Krusadai farm, found that pearl oyster can remain out of water for 36 h. He had succeeded in keeping *Pinctada margaritifiera* out of water for 60 h at Bahrain. The air-lifting of different sizes of 600 *P. margaritifera* from Bahrain to Tiruchirappally in 16 h 45 m was accomplished by him in 1950 (Devanesen and Chacko 1958). According to him, the mortality

TABLE 7. *Spat survival vs volume of water and oxygen*

Size range (mm)	No of spat	Quantity of water (l)	pH final	Oxygen (ml/l) final	Observation time (h)	Mortality %
10-15	500	2.5	7.91	3.39	122.0	Nil
10-15	1000	5.0	6.74	2.88	122.0	37.5
15-20	250	2.5	6.81	3 95	99.30	28.8
25-30	250	5.0	6.83	1.13	66.0	0.8
25-30	500	5.0	6.82	—	75.30	1.0
30-35	100	2.5	6.85	3.05	72.0	2.0
30-35	200	5.0	6.80	1.07	96.0	2.6

Initial pH : 8.2
O_2 : 3.60 ml/l

set in only subsequently and out of 124 oysters introduced to Krusadai farm 79 could survive and out of 179 oysters kept at Tholayiram paar only 38 could survive.

Fifty pearl oysters (25 *P. fucata* and 25 *P. sugillata)* taken by train by one of us (A. Chellam) during December 1976 and again in January 1977 had withstood the transportation from Tuticorin to Bhubaneshwar for about 43 h. In this transportation, the oysters were packed in gunny bag sprinkled with seawater for most part of the transport. In between they were kept in seawater in plastic basins for a while. After keeping the oysters in seawater under aeration for 3 days, they were packed as before and taken back to Tuticorin without mortality. The time taken for this trip was 52 h. In his experiments, Dharmaraj (1983) could keep exposed the *P. fucata* upto 21 h.

The present observations indicate that when the ambient temperature remains around 29°C the spat ranging in size from 15-40 mm can tolerate upto 24 h of exposure and if the temperature is less than 25°C (controlled) they can tolerate the conditions for more than 24 h with negligible mortality (Table 1 & 2). But spat of 5-15 mm were safe only for 12 h in the above temperatures (Table 1 & 2).

Under wet conditions both gunny bag and seaweed are equally good in the transportation of pearl oyster seed (Table 3 & 4) about 24 h. Spat of 5-10 mm size group are suitable for transportaion in seawater for about 72 h whereas the size group 10-15 mm and 15-20 mm can tolerate upto 48 h and 36 h respectively (Table 5) in water. The suitable way of transportation of spat upto 20 mm is by keeping them in seawater with oxygen (Table 6). During the experiments, the mean atmosphere temperature never exceeded 29°C.

Chidambaram Devanesen and Chacko (1958) opined that the high rate of mortality to the *P. margaritifera* transplanted from the Persian Gulf to the Gulf of Mannar may be due to the low salinity and their inability to stand the change in conditions. Dharmarj (1983) observed that the pearl oyster could withstand exposure upto 21 h whereas in anaerobic condition (in water) the mortality set in from 19th hour. This, he said may be due to the organic products excreted by the oyster into the water. The excretory products and carbondioxide released in the water medium may decrease the pH (Taylor 1976). A noted decrease in the pH was found to have resulted in the mortality of spat (Table 5).

The survival time after exposure differs for the bivalves. At room temperature (30°C), *Donax cuneatus* could survive 69 h after exposure

and *D. faba* 94 h (Rao and Kutty 1968). *Ostrea edulis* could withstand upto 24 days of exposure and complete recovery after 18 days of exposure at low temperature (Korringa 1952). To transport seed oysters from Japan to Hongkong and North America, they are loaded in ships, covered with straw mats to prevent drying during transportation. To prevent mass mortality, the straw mats are sprayed with seawater two or three times daily during the 10 day voyage to North America where the seed oysters are then released into the growing beds and reared (Imai 1971). Hardened seed oysters of *Crassostrea madrasensis* withstood transportation in semiarid condition upto 120 h with 76% survival whereas the survival rate of non-hardened seed for the same period was 22% (Muthiah 1987). Jones (1987) in his preliminary experiments found that the brown mussel seed can be kept in viable condition for several days in the lower shelves of a domestic refrigerator.

The pearl oyster seed which settle and grow in deeper water, could tolerate exposure to air only for a limited time (20-24 h). Under wet condition, this could be extended a little more (25-30 h). In water, spat upto 15 mm could be safely kept for about 48-54 h and if oxygen was supplied spat upto a size of 30-35 mm could withstand the condition upto 72 h (observed) with negligible mortality.

ACKNOWLEDGEMENTS

The authors wish to acknowledge with gratitude the encouragements given by Dr. P.S.B.R. James, Director and Dr. K. Alagarswami Joint Director, Central Marine Fisheries Research Institute, Cochin and Shri S. Mahadevan, officer-in-charge, Tuticorin Research Centre of Central Marine Fisheries Research Institute, Tuticorin in the preparation of this paper. They also wish to record with thanks the help extended at the laboratory by S/Shri K. Shanmugasundaram and K. Srinivasagan, Assistants in conducting the experiments.

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