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An initiative to Conserve Pearl oyster (*Pinctada fucata*) population in the Gulf of Kachchh through Sea ranching of Hatchery produced spat

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Abstract

Pearl oyster population in Gulf of Kachchh has declined considerably in the last two-three decades due to industrialization, mining activity, illegal fishing and effect of climate change and need some serious attempt to conserve them in their natural bed. Study aims conservation of pearl oyster through hatchery production and sea ranching of spat at selected sites. Standard methods were used for hatchery culture and selection of potential sites for sea ranching. Out of three induced spawning attempts two were successful to produce fertilized eggs. Spat production was achieved at average survival rate of 42.5%. The key element of present study was sea ranching of 1, 50,000 spats (2.1 to 3.2 mm) sea ranched in suitable habitat at eight selected sites of study area. The rate of spat release was 5-10/ m^2.

Keywords: Pearl oyster, *Pinctada fucata*, Sea ranching, Gulf of Kachchh, conservation.

Introduction

In India, *Pinctada fucata* is found in Gulf of Kachchh and Gulf of Mannar. *P. fucata* occurs in extensive beds in the Gulf of Mannar and to a much less extent in the Gulf of Kachchh[1]. However, it has been reported that the Gulf of Kachchh pearls were costlier and their pearl yielding capacity was more than those of the Gulf of Mannar[2]. The pearl oyster reefs of the Gulf of Kutch-locally known as 'Khaddas' are found all along the southern side, bordering the coastline of the Jamnagar District. These reefs are not continuous but separated by sandy patches, mudflats and mangrove forests. A typical bed consists of a hard bottom of coral and rocky frame work, with an admixture of mud and sand.

Before independence, the pearl fishery of the Gulf of Kachchh was under the control of the Jam Saheb of Nawanagar and the fishery was conducted under certain unique rules[3]. In 1926, a separate department called 'Moti Khata' was organized to manage the fisheries and finally, with the merger of the Nawanagar State with the Indian Union in 1948, the pearl fishery came under the control of the Government of Gujarat. The Department of Fisheries organized the fishery by engaging fishermen who were paid according to the number of oysters they collected. The fishery used to be held almost every year or on alternate years from 1913 to 1939. Subsequently after 1939, it was held after every 3-4 years till 1967; but after 1967 there has been no fishery at all, as the oyster population became depleted[2]. According to Dept. of Fisheries, Govt. of Gujarat, average harvested pearl oysters was 30840 individuals per fishery, while it was highest in 1916-17 (76658 individuals). After 1966-67 due to overfishing and mining, pearl oyster population depleted to 6-17 numbers /km in 1992-93. Since 1993 continuous depletion of pearl oyster is observed due to anthropogenic activities like industrialization, ship traffic and oil spilling.

Devanesan and Chidambaram had commented that the proximity of the two sexes is essential for the oysters to spawn and only when the oysters live in dense patches spawning will be successful and result in abundant spat-fall[4]. Hence the chance of reproduction and spat-fall in the case of the Gulf of Kachchh oysters is little since the individual oysters are far apart from each other. The tidal levels fluctuate greatly in the littoral zone in the Gulf where the oyster beds are located, hence, during successful natural breeding larvae are either destroyed when the reefs become exposed during low tides, or carried away by the outgoing tides to the deeper waters, where they may settle[2]. Till date the number of pearl oysters in nature is very less and there are very fewer chances to find individuals of opposite sex phase nearby so that they can successfully spawn. To overcome this problem and to support the replenishment of pearl oysters of Gulf of Kachchh, there is need to develop the technique of induced spawning of pearl oysters, rearing of the larvae and sea ranching of pearl oyster. Earlier hatchery production of pearl oyster spat was successfully carried out at Central Marine Fisheries Research Institute and experimental sea ranching of laboratory hatched larvae was successfully carried out at Gulf of Mannar by Dharmaraj S. et al[5] and Chellam A. et al[6]. Sea-ranching of captive reared organisms is a method which aims at rebuilding the wild population from its destruction by manmade and natural causes[5]. Establishment of hatcheries at strategic locations and production of seed on a large scale for subsequent release in natural habitats would go a long way in enhancing production of sea ranched resources from the coastal waters[7].

Earlier studies of pearl oyster in Gulf of Kachchh mostly include growth rate and breeding ecology[8,9,10] but no attempt has been made for sea ranching. To fulfill this research gap initially in 2007-08, FRS-Sikka had identified feasible sites for monitoring of sea ranched pearl oyster; (1) Vador, (2) GSFC Jetty (Sikka) and (3) Goose Island. Site- 1, 2 lie near industrial zone and under high fishing pressure. The study was continued in 2008-2010 and the sea ranched spat were monitored. Successful survival of spat was observed at site- 3, in 2011. On the basis of this encouraging result, present study has been carried out to extend the sea ranching program to seven other different suitable sites in Marine National Park and Sanctuary. By introducing this program in Gulf of Kachchh replenishment of pearl oyster population is expected.

Material and Methods

Study Area: Hatchery production of *Pinctada fucata* was carried out at FRS campus – Sikka and reared spats were sea ranched in southern part of Gulf of Kachchh (figure 1). All potential sites selected for sea ranching were located inside Marine National Park and Sanctuary.

Hatchery Production: Hatchery operations were carried out from July to October, 2011 using standard methods developed by Central Marine Fisheries Research Institute[5,11].

Broodstock maintenance and conditioning: A brood stock of mature oysters was maintained in cages at Vador. A week before breeding experiment, brooders in the hatchery were kept in the conditioning room. Pearl oysters were provided mixed algal food dominated by *Chaetoceros sp*.

Induced spawning: Pearl oysters were induced to spawn by thermal stimulation in a glass aquarium. The water temperature was increased gradually from room temperature to 35.0°C.

Fertilization: Invariably male pearl oysters spawn first which triggered the female pearl oysters to spawn in about 20-25 minutes. Soon after the eggs were released, they were fertilized by the sperms. The fertilized eggs measured 45-48 µm in diameter and settled at the bottom of the vessel. The water with the fertilized eggs was filtered gently through sieve of 28 µm and the collected eggs were transferred to circular tank (capacity 300 L).

Larval estimation and stocking: Within 24 hours, fertilized eggs developed as veliger. The larvae were counted and estimated using plankton counting chamber and transferred to rearing tank at a density of 2 larvae/ ml.

Feeding schedule: From veliger to spat stage larvae were fed with unicellular flagellate *Isochrysis galbana*. The detailed schedule of feeding is given in table 1.

Water change: Seawater in the tanks was changed regularly on alternate days by gently siphoning out through appropriate sieves. At every water change, the larvae were collected in the sieve and transferred to clean tank filled with filtered seawater and covered with black cloth.

Table-1
Feeding schedule of *Pinctada fucata* larvae

Developmental Stage	*Isochrysis galbana* (cells/larva/day)
Trochophore	Nil
Veliger (D stage)	5000
Umbo	10000
Eyed stage	15000
Pediveliger	20000
Plantigrade	20000
Spat	25000

Spatfall: Spatfall normally occurs between 20th and 24th day rarely extended up to 28th day. After settlement spats were transferred to FRP tank (capacity 1000 L) filled with filtered seawater.

Spat Rearing: Spat were reared in the hatchery. *Isochrysis galbana* was given as feed for one month after setting of the spat and gradually this was changed to mixed algae. The spat reached the size of 3 mm in 60 days and was ready for sea ranching.

Sea-Ranching: Site selection: Sites which were at lower tidal level with at least 2 m depth and salinity above 27 ppt with low levels of pollutant and presence of sandy or rocky patches with dead or live coral reef and past records of *Pinctada fucata* were selected.

Spat Release: Spat were sea ranched at selected sites during October – November, 2011. The spat were transferred to a plastic container (capacity 100 L) filled with filtered seawater. With the help of mechanical speed boat the spat were transported to the selected sites during low tide. The spat were released on the substratum at the rate of 5-10 spat/ m^2. The GPS coordinates for the same was taken for each site.

Results and Discussion

Hatchery Production: Induced spawning: Three attempts of induced spawning were made; among them two attempts succeeded to produce fertilized eggs. In attempt-1 the count of fertilized eggs was 5,00,000 from them 3,00,000 larvae were sea ranched at early developmental stage and 2,00,000 were kept for rearing. No response was found in case of attempt- 2. In attempt- 3, the count of fertilized eggs was 2, 00,000 and all were kept for rearing (table 2).

Embryonic and larval development of *Pinctada fucata* was similar to that reported by previous studies[12,13].

Larval rearing: The fertilized eggs (45-48 µm) were spherical. First cell division occurred in 40-50 minutes of spawning and reached to morula stage in 3-4 hours. The trochophore larvae were developed in 10-12 hours and started to move by lashing the terminal flagellum. The larvae developed to D-shaped hinge stage (Size 67.5 µm x 56.5 µm) with a well developed ciliated velum after 19-22 hours. At this stage larvae were transferred to a circular tank at 2 larvae/ ml density and fed with *Isochrysis galbana* at 5,000 cells/ larva/day. The larvae developed to the umbo stage (size135µm x 130 µm) after 12- 14 days and the feeding was increased to 10,000 cells / larva/day. The pediveliger stage (size 200 x 190 µm) was observed after 18-22 days and the feeding was increased to 20,000 cells / larva/day. The plantigrade stage (size 220 x 200 µm) was observed after 21-25 days and the byssal threads were produced for attachment, which metamorphosed into a spat (size 300 µm) by the formation of a straight hinge line and anterior and posterior ears. The spat was observed on 25^{th} day of spawning and feeding was increased to 25,000 cells/ larva/day and by 30^{th} day all the larvae metamorphosed into spats.

Table-2
Details of survival rate of larvae

No.	Fertilized eggs	Sea ranched larvae	Trochophore larvae	Spats	Survival Rate
1	5,00,000	3,00,000	1,35,000	75,000	37.5%
3	2,00,000	-	1,40,000	95,000	47.5%

In attempt-3 the larval development was almost similar to that of the attempt-1 but the settlement of spats began on 25^{th} day and completed by 31^{st} day. The survival rate of larvae was 37.5 % in attempt-1 and 47.5 % in attempt-3 (table 3).

Spat rearing and growth: Spat were transferred into a FRP tank at a density of 2 larvae/ml and fed with 50,000 cells/spat/day at the rate of 20% *Chaetoceros sp.* and 80% *Isochrysis galbana*. The percentage of *Chaetoceros sp.* and feeding was increased with the growth of the spat. On 60^{th} day the spat had grown to 2.1-3.2 mm and were ready for sea ranching.

Table-3
Detail of sea ranching at selected sites

Sr. No.	Release Site	GPS Coordinates	No. of spat (Approx)
1	Narara Reef	22°29'2.81"N 69°43'5.07"E	20,000
2	Dholiyo Pir Island	22°23'22.36" N 69°12'12.26"E	20,000
3	Bhaidar Island	22°27'24.17"N 69°17'09.13"E	15,000
4	Laku-San Point	22°25'30.27"N 69°11'11.02"E	5,000
5	Goose Island	22°29'08.38"N 69°47'44.74"E	20,000
6	Kalubhar Island	22°27'53.30"N 69°39'15.78"E	20,000
7	Pirotan Island	22°35'25.96"N 69°57'28.90"E	10,000
		22°36'49.42"N 69°57'40.44"E	25,000
8	Jindra Island	22°35'46.59"N 70°01'13.40"E	15,000
		22°35'11.02"N 70°01'54.84"E	

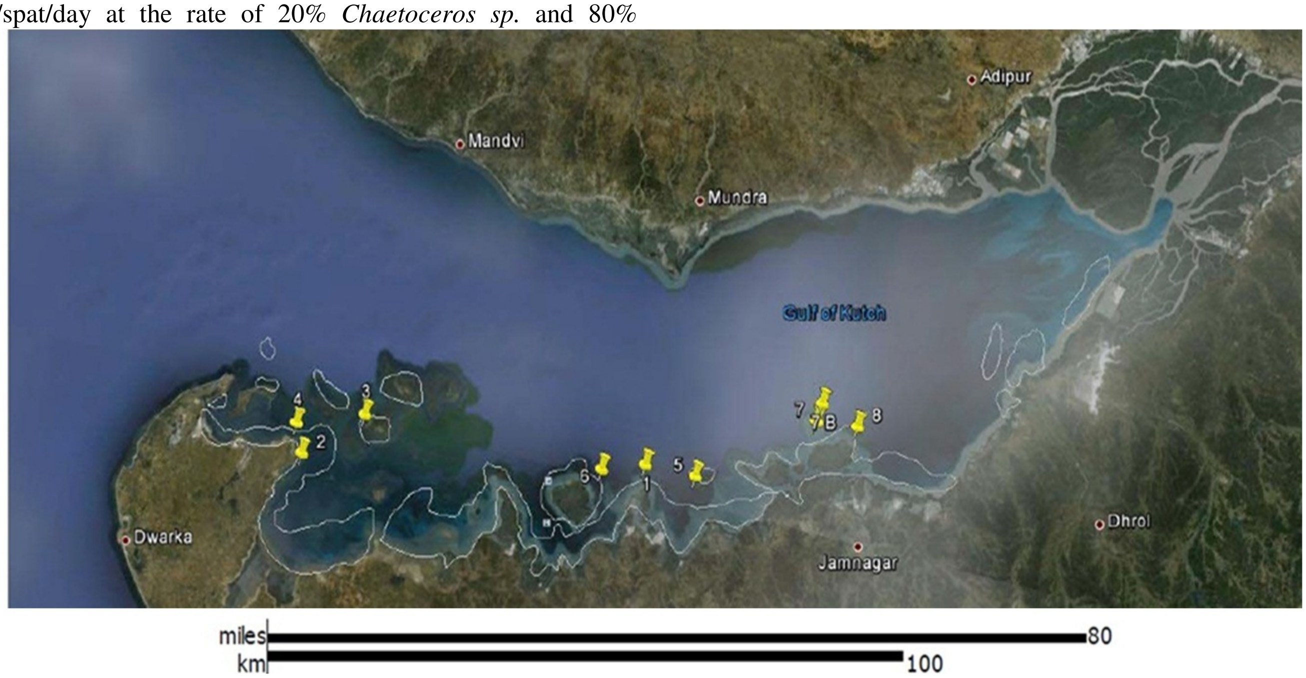

Figure-1
Sea ranching sites of *Pinctada fucata* spat

Sea ranching: Eight sites were selected for sea ranching of *P. fucata* among them three sites was situated towards the mouth of Gulf and five sites were in the middle part of the Gulf (figure 1). The larvae were released on suitable substratum at an approx. rate of 5-10 larvae/ m^2. The details of larval release are given in table 3. Spats were also kept in 5 cages (45×45×15 cm^3) with initial density of 100 spats/cage at Narara reef and Goose Island (site-1 and 5). Each cage was covered with velon screen and additionally enclosed with old fish net for better protection. Cages were tied with synthetic ropes and kept in sub tidal area at depth of 0.5 to 1 meter. The cages were regularly cleaned and monitored.

Conclusion

Millions of trochophore larvae and thousands of spat were sea ranched at selected sites. Though water current plays a vital role in the dispersal of pearl oyster larvae not much could be predicted regarding larval movement due to less information available on the pattern of water current at release site. Regarding this phenomenon Victor *et. al.* has commented that unless a scientific method is devised to locate the site, it would be impossible to make further observations on the survival and growth of ranched spat[14]. Goose Island (site-3) is one of the suitable releasing sites of pearl oyster spats in our study area and regularly sea ranching of spats is done since 2008. During our regular visits at this site, we have noticed that pearl oyster population has been increased. It is difficult to study the rate of increase of natural population by sea ranching but observations on relative density of pearl oyster indicates that sea ranching had helped to replenish the population at Tuticorin during 1985-1990[15].

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