Blue barred parrot fish (*Scarus ghobban* Forsskal, 1775) culture in sea cages at Rameshwaram Island, Southeast coast of India

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Two square HDPE cages of 2 x 2 x 2.5 m (10 m³) size were deployed at 6 m depth in the sea at a distance of 600 m from the shore at Olaikuda fishing village. Live parrot fishes of <450 g procured from the trap fishermen were sorted out into two size groups viz. 200-245 g (X 214.00 ± 16.63 g) and 375-450 g (X 425.00 ± 20.64 g) and stocked @ 8.5 kg/m³ separately in these cages. Low value shrimp head waste was fed @ 8-10% of total biomass stocked. The fishes were reared for two months and the culture was terminated due to severe blooming of the blue green alga, *Lyngbya* sp. Average weight gain during this 2 month culture varied between 44 g (GR 0.73 g/day) in the smaller group (200-245 g) and 98 g (GR 1.61 g/day) in the bigger group (375-450 g). A second culture trial was conducted with wild caught young fishes of approx. 100 to 140 g size and stocked them in a 9 m dia circular cage of 320 m³ culturable volume. Culture was conducted for 130 days with pellet feed and a survival rate of 95% with the growth rate of 0.61 g/day (total average weight gain of 79.0 g).

**[Key words:** Parrot fish, *Scarus ghobban*, trap fishing, sea cages and sea farming.]

**Introduction**

The blue barred parrot fish *Scarus ghobban* is a protogynous fish with fused teeth and bright colours found in tropical coral reef environments of Indian, Pacific and Atlantic Oceans. The major stomach content analysis of this fish revealed large quantities of calcareous powder forecasting its coral grazing behaviour causing bio-erosion of tropical reefs and is assumed to be responsible for the coral sand formation. It is estimated that a single fish of this species can produce up to 90 kg of sand/year. *S. ghobban* is gaining commercial importance owing to increased demand for human consumption and for its ornamental value. In the Gulf of Mannar (GoM) on the southeast coast of India, this species supports a small fishery and is sold either as fresh in local markets or exported (0.5 to 1.5 kg) as fillets or whole frozen mainly to Amsterdam. Live *S. ghobban* attracts good price (US $ 20-40/kg) in international market. Randall compiled the systematics of parrot fishes with an emphasis on its sexual dimorphism. Earlier studies on parrot fishes describe their phylogeny, ecology, demography, food and feeding, length-weight relationship, life history and bio-erosion capabilities. Varghese and Veeramani studied the length-weight relationship of *S. ghobban* in Indian waters and Sabetian studied the same in South Pacific region. However, no report is available on the growth of *S. ghobban* in sea cages. *Scarus ghobban* is the dominant reef fish captured live in considerable quantities between March and September in GoM area at a depth of 2-12 m by setting traps made up of synthetic and natural fibers in the fishing hamlets of Olaikuda, Vada-kadu, Ariyankundu and Nalupanai in Rameshwarm Island. The market preference of this fish is directly related to its size and categorized accordingly into 3 grades as small (<500 g), medium (500 to 1000 g) and premium (>1000 g) with price tags of ₹80, ₹250 and ₹350/kg, respectively. A majority of the catches are of the smaller size group giving low return to the fishers. As these fishes are caught...
live, growing the small fish to the next higher grade of above 500 g would increase its market value considerably in a short period. No attempt has yet been made anywhere to grow this fish commercially and the present study is the pioneering attempt to explore the possibilities of rearing small *S. ghobban* to obtain better market value and also to assess the potential of this species prior to considering it as a candidate for aquaculture. Acclimatization of parrot fish to the cage environment, stocking density, feeding behaviour and live fish transport were explored during the course of this experiment.

**Materials and Methods**

Experimental sea cage culture in Olaikuda (9° 19’ 9.3” N; 79° 19’ 44.7” E) was initiated in 1st week of August 2010 with high density poly ethylene (HDPE) cages fabricated and deployed at 6 m depth in the sea about 600 m away from the shore. The site was selected based on its comparatively favourable sea conditions for cage culture such as relatively calm and clear water, pollution free environment, availability of young parrot fish seeds and also the enthusiasm shown by the villagers (Fig. 1).

**Fabrication of sea cages and its mooring configuration**

Two types of HDPE cage models such as square (2 x 2 m²) and circular (9 m dia) were fabricated and deployed with single and multipoint mooring systems, respectively, in the culture site for marine finfish culture trials. Initially the square cages (2 Nos.) with dimensions of 2 x 2 m were fabricated with the 25 mm thick and 450 mm outer diameter HDPE pipes. Two types of nets, a fish holding net with 2.5 cm mesh size (knot to knot) on the inner side and a predator net with 6 cm mesh was fitted on the inner and outer sides of the HDPE frame, respectively. The gap between these two nets was maintained at 40 cm in all sides of the frame. The purpose of fish holding net was to accommodate the fishes to be grown and the predator net was to prevent the entry of larger fishes and other predators and also to minimize the clogging caused by seaweed fouling on the fish holding net. Suitable ballasts were prepared with 3.81 cm outer dia polyvinyl chloride pipe with cement packing to stretch these nets to maintain the square shape and thereby provide maximum space to the fishes reared. The square cages were moored with an appropriate single point mooring system as indicated in the Fig. 2. A conventional type circular cage with 9 m diameter was fabricated and deployed at 8 m depth region with above mentioned specification as shown in the Fig. 3.

![Fig. 1- Map showing the cage culture site at Olaikuda, Rameshwaram Island, India](image1)

![Fig. 2- Anchoring & mooring configuration of square cage*](image2)

*Fish holding net: 2.5 cm mesh size and 2 mm thickness; Predator net: 6 cm mesh size and 3 mm thickness; HDPE cage frame: 450 mm dia. 25 mm thickness; Galvanized chain 10 mm thickness; Primary anchor: 200 kg; Secondary anchor: 150 kg; and Polypropylene rope 25 mm thickness.

**Live fish transportation**

Juvenile parrot fishes were collected from trap fishermen of Olaikuda village and transported to the culture cages. Live fish transportation was standardized after many trials. Initially the fish were transported in plastic tubs with battery aerator, during the process the fishes started secreting large quantities of mucous which choked the gill rackers and reduced the efficiency of oxygen exchange rate causing ultimately stress and mortality of the fishes. Hence, an attempt was made to use traditional net bag (Fig. 4a) which can be dragged in water column to the cage site. This was later improved by adding 2 mm thick iron rings in the middle of the net bag to give a non-collapsible shape to the bags (Fig. 4b) which minimized the skin aberration while transporting the fishes.
Stocking, feeding and cage maintenance

The healthy fishes were initially stocked in 1 m³ Fiber Reinforced Plastic (FRP) cage for quarantine/observation purpose. After 24 hrs of observation, the active fishes were transferred to grow out cages. Before stocking in the grow out cages, weight of the fish were recorded and sorted into 2 size groups as 200-245 g (214.00 ± 16.63 g) and 375-450 g (425.00 ± 20.64 g) and stocked separately in two square cages. The fishes were fed twice a day with low value shrimp head waste @ 8–10% of total biomass stocked. The shrimp head waste purchased from the nearby trawl landing centre was selected over low value feed for the trial as it was found to be preferred by the parrot fishes during initial feed preference trials and also owing to its consistent availability. The fishes stocked during the first week of August faced an unusual wind and wave action that caused mass mortality in both the cages during the first week of stocking itself. The dead fishes had skin abrasions, reddening of eyes and empty stomach due to the rough weather which caused friction with the knotted nets. To reduce the friction and the subsequent rashes, a polythene sheet was overlaid at the inner bottom up to 30 cm height of the fish holding net. The cages were restocked with new seeds during early morning or late evening hours to minimize the heat shock to the fishes. The fish restocked were grown in the cages for 2 months from August to October. The unconsumed feed and exoskeletons (carapace with rostral spines) were removed in the early hours every day to maintain a clean environment in the cages. To study the growth and survival of the parrot fish in caged environment, a second culture trial was initiated in subsequent year during the fair weather period of this site i.e. June to October for the period of 130 days with wild caught smaller fishes of approx. 100 to 140 g size and stocked in a 9 m dia circular cage of 320 m³ cultivable volume with the estimated stocking density of 4 kg/m³. Nets were routinely cleaned to reduce drag and maintain consistent water flow through the cages. Daily diving was performed in both the locations for observation of nets and removal of dead fishes. Feeding and mortalities were recorded daily.

Physicochemical parameters such as salinity (%), temperature (°C), pH and dissolved oxygen (DO; mg/L) were measured with YSI (Model 563A) water quality measuring probe. Nutrients levels were estimated by following APHA manual of standard procedures. In order to estimate the growth rate, 4 nos. of active fishes from both size groups in square type cages were pre weighed and tagged. After harvest, the tagged fishes were separated and measured and the growth was calculated by deducting the initial weight (IW) from the final weight (FW) of the fish. In case of the 9 m dia circular cage, the fishes were sampled every 15 days to measure wet weight. The growth rate (GR) was calculated by

Fig. 3- a. Circular cage (9 m Ø) and b. its multi-point mooring used for parrot fish culture at Olaikuda*

*Fish holding net = 0.8 cm mesh size and 1.4 mm thickness; floating HDPE cage frame: 200 mm dia. 8 mm thickness; galvanized chain 2.5 cm thickness (250 kg; 8 nos.). A - indicating the position of Samson anchor: 250 kg.

Fig. 4 - Types of (a) traditional and (b) modified bags used for live transportation of S. ghobban
Filamentous algal growth was observed on the seaweed culture rafts in August 2010. The algal growth progressed to heavy bloom in September and created many problems for the sea weed culture. Thick blooms of the algae surrounded the seaweeds, preventing its growth and ultimately leading to its death and putrification. Settling of algal filaments was observed up to a height of 2 feet at the bottom and covering the anchors and mooring chain in and around cage culture site. The thick growth of algae also completely covered the mouth of fish traps placed at 4-5 m depth and the fish cage was not spared as the nets were severely clogged (Fig. 5, 6 and 7).

Results and Discussion

The range of water quality parameters recorded in sea water at the culture site is given in Table 1. Temperature of the study area varied between 27.3 and 29.7˚C, which was very close to the recommended range (25-30˚C) for tropical finfish aquaculture.

<table>
<thead>
<tr>
<th>Water Temp. (˚C)</th>
<th>pH</th>
<th>Salinity (‰)</th>
<th>DO (mg/L)</th>
<th>TSS (mg/L)</th>
<th>NO₂ (mg/L)</th>
<th>NO₃ (mg/L)</th>
<th>NH₃-N (µmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27.30-29.70</td>
<td></td>
<td>8.00-8.27</td>
<td>34.20-34.80</td>
<td>2.98-5.96</td>
<td>8.32-38.16</td>
<td>0.11-12.40</td>
<td>3.11-0.02</td>
</tr>
<tr>
<td>Mean (X)</td>
<td>±0.71</td>
<td>±0.07</td>
<td>±0.21</td>
<td>±0.93</td>
<td>±10.03</td>
<td>±0.27</td>
<td>3.93-0.20</td>
</tr>
</tbody>
</table>

A mild salinity variation observed in the culture site (34.2 and 34.8) was comparable to the observations for the same season at this location. The pH ranged from 8.00 to 8.27. During the cage culture period, the dissolved oxygen was between 2.98 and 5.12 mg/L in bottom water and 4.7 - 5.96 mg/L in surface water. Lower level of DO (2.98 mg/L and 3.10 mg/L) was observed in the early hours at 2 am and 4 am (Fig. 8), respectively, in bottom waters of 6 m depth, which is comparable with the observations on DO depletion during alg bloom. Total suspended solids (TSS) levels were recorded between 8.32 and 38.16 mg/L which are comparatively higher than the suitable level of <10 mg/L for cage culture site. Higher quantity of TSS recorded during the month of October was attributed to the decomposition and disintegration of dead algal cells (Lyngbya sp). The nutrients levels such as ammonia (0.02 - 0.37 mg/L), nitrite (0.11 - 0.91 mg/L) and nitrate (3.11 - 12.40 mg/L) recorded at this site were comparable to the previous studies in Palk Bay and within the optimal range suggested for fish farm.

The seaweed (Kappaphycus alvarezii) also was being cultured in floating wooden rafts adjacent to the fish cages by local fishermen.

Live transportation of S. ghobban from the fishing ground to the cage site was standardized after many trials. In the first method, where the fish were kept in tub containing aerated water with battery aerator, 90% of the fish died due to gill chocking caused by excess mucus released by them. Another attempt was made to transport these live fishes by net bags used for dead fish collection which was dragged to the cage site in immersed condition in sea water at a speed of 1.5 knot / hr. It resulted in the reduction of mortality up to 50% but the dead and live fish had injuries such as scale loss, abrasion in skin and reddening of the snout region. Though the second method provided good water circulation to the fishes, the shrinking nature of the bags when dragged caused injuries leading to subsequent mortality. To overcome the shrinking of net while dragging and to maintain a definite circular shape to provide sufficient place for the fish two circular iron rings (2 mm thickness) were introduced (Fig. 3). The modified fish transporting bag improved the survival of the fishes up to 90% during transportation.

Underwater observations revealed that the fish preferred to stay at the bottom of the cages and during windy periods the cage frames were
lifted frequently by waves which lead to sudden jolting to the culture system causing injuries to the fish. This unexpected event of rough weather caused mass mortality of fish in the first week of stocking owing to the fish hitting the knots in the nets and getting injured. Such a problem was also reported for other cage grown fishes in knotted net bags. The dead fish had signs of tail rot, fin rot, snout injuries and reddening of skin. When a polythene sheet was overlaid on the inner bottom of the fish holding net there was considerable recovery of injured fish. The cages were then hauled close to the shore where much protected areas were available to reduce adverse effect of waves on the cages. The above decision was made based on the observation on the quarantine cage (1 m³) deployed in the near shore region where the fishes were safe and comfortable during the same turbulent weather. After this intervention, the mortality of fishes was brought to a halt.

*Scarus ghobban* is reported as a primary consumer feeding on sea grass and benthic algae associated with corals and stones. It was observed in the present study that it prefers to feed on crustaceans such as shrimps and crabs as well in captive condition. Hence, during the culture, shrimp head waste, a low cost by product from shrimp processing units, was used as feed. Fishers in the locality use crustacean waste as bait to capture the fish by traps. These bottom dwelling fishes will wait for the feed to come to the mid column water before coming up to consume it. Due to this nature, sufficient quantity of sea sand was mixed with the feed (shrimp head waste) to enable it to sink. Fishes reared in 9 m Ø sea cages (smallest weight group) were however fed with commercial slow sinking pellets (Brand: Lucky star; size: 3-5mm) prepared for sea bass.

The results obtained after 2 months rearing of *S. ghobban*, such as GR, mean final body weight and final biomass of different size groups (200-245 g and 375-450 g) are given in table-2. The stocking density of 8.5 kg/m³ can be further improved as the fishes are domicile in...
nature without much aggression in the cage environment. Increment in the average weight of the fish was considerably higher (98 g, GR 1.61 g/day) in the bigger fishes and less (44 g, GR 0.73 g/day) in smaller fishes. Growth rate of the *S. ghobban* is comparable with other commercial fish species such as Snappers (1.82 g/day in the 110 g size group) and groupers.

The smaller parrot fish cultured in 9m Ø sea cages with pellet feeding (Lucky star-sea bass feed; size: 3-5mm) for a period of 130 days, had a survival rate of 95% with a 0.61 g/day increase in growth rate and the overall weight gain of 79 g (Fig. 9 & 10).

**Table 2: Summary of growth parameter estimates of *S. ghobban* from square and circular cages**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>100 – 140</th>
<th>200 – 245</th>
<th>375 – 450</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean initial weight (g)</td>
<td>125.00 ± 9.40</td>
<td>214.00 ± 16.63</td>
<td>425.00 ± 20.64</td>
</tr>
<tr>
<td>Mean final weight (g)</td>
<td>204.00 ± 27.82</td>
<td>252.00 ± 11.62</td>
<td>523.00 ± 20.32</td>
</tr>
<tr>
<td>Days of culture (d)</td>
<td>130</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Avg. wt. increment</td>
<td>79</td>
<td>44</td>
<td>98</td>
</tr>
<tr>
<td>Initial biomass (kg)</td>
<td>162.5</td>
<td>85.23</td>
<td>85.16</td>
</tr>
<tr>
<td>Final Biomass (kg)</td>
<td>251.9</td>
<td>59.28</td>
<td>66.49</td>
</tr>
<tr>
<td>Average GR (g/day)</td>
<td>0.61</td>
<td>0.73</td>
<td>1.61</td>
</tr>
<tr>
<td>Survival (%)</td>
<td>95</td>
<td>59</td>
<td>63</td>
</tr>
</tbody>
</table>

**Fig. 10 - Growth performance of fishes stocked in 9m dia**

**Conclusion**

The results of the present study reveals that parrot fishes can be grown in the sea cages like any other fishes presently being used for sea farming. These fishes can be acclimatized to the cage culture system and fed with crustacean wastes or with formulated pellet feed for growing them for a shorter duration of 2 to 3 months for value addition. Since these fishes prefer to live at the bottom, the depth of the cage needs to be a minimum of 2 to 3 meters. While feeding the fishes, it should be ensured that the feed sinks to the bottom of the cages since the fish prefer to wait for the feed to sink to the middle of the water column to feed. The effect of rearing these fishes in a cage environment for a longer duration needs to be studied to know the nutritional requirement and suitable density for culture. In the absence of hatchery produced seeds, the potential of the sustainable wild parrot fish seed collection needs to be assessed prior to initiating a community level mariculture programme. As fishermen stated, blooming of filamentous alga in this region was a new phenomenon, however, the blooming caused major damages to the sea weed culture and local fishery. Therefore, periodical observation on occurrence of the bloom is highly essential to practice successful sea cage culture of parrot fish in this region.

Two groups of fishermen comprising 4 members in each group were involved in cage culture of parrot fishes during their fishing season. Since, there is no commercial feed available to get better growth, the fishermen always depend on shrimp head waste as feed, which is not available in all the seasons. Hence, the fishermen expressed their requirement on formulation of suitable feed is highly essential to get better growth to continue this culture for all the seasons.
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References