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RESEARCH ARTICLE

Short term culture of wild caught juvenile rabbit fishes (*Siganus javus*) in open sea cages at Palk Bay

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Abstract

Objectives: The main objective of the study was to collect and rear the unmarketable, small sized *S.javus* which is mostly rejected by the traditional fisherman. During fishing activities, under sized *S.javus* ranging in sizes from 25 to 40 kg (< 30-40 % of total catch/day) is being captured. Due to very low marketable value these small fishes (<250 g) get rejected. Therefore, we utilized this as an economically viable option for utilization as seeds for rearing until they reach the necessary marketable size. **Methods:** Undersized juveniles (12-16 cm, 40 -55 g) were collected from nearby Olaikuda village, Rameshwaram using traditional traps made using bamboo and odai tree bark (*Acacia planifrons*). The collected juveniles were stocked in sea cages and fed with locally formulated plant based feed containing 28-32 % crude protein. **Findings:** Harvesting was successfully done after 140 days with 90 % survival. The average growth rate achieved was 2.5 g /day with FCR of 2.01. This resulted in an average harvest size of 400 g/fish from its initial stoking size of 50 g with an attracted market value of Rs. 150/kg. **Novelty:** Till date, no attempts were made to commercialize such harvesting techniques for the species *Siganus javus* in pilot scale in India (Except James, 1984).

Keywords: Rabbit fish; Siganus javus; sea cage culture; rabbit fish culture; Siganidae

1 Introduction

Aquaculture industry is the fastest growing fish production sector with an average annual growth rate of 6.8 percent [1]. The trend of being the productive sector is slowly migrating from freshwater to brackish water, inshore marine and open seas. Open sea floating cage culture techniques have been mastered and has the potential to meet the worlds growing protein demands [2,3]. In 1962, Ablan & Rosario stated about the potential of rabbit fish mariculture. The rabbit fishes and milk fishes are having the ability to utilize the plant based protein for their survival and biomass development which is the cost effective way of producing fish protein[4–6]. Therefore, it has long been considered suitable for small scale and community level cage culture[6]. These fishes are popularly called rabbit fishes, spine foot or fox face (locally called "vella orah" and "salla orah" *S. canaliculatus*, *S. javus* respectively in Tamil). There are more than 29 species of rabbit fishes documented worldwide under the family Siganidae[7]. They are distributed in reefs around sea grass, mangrove, and estuarine habitats and also in shallow lagoons of tropical and subtropical coastal environments[8] and live in small schools of up to around 10 individuals as adults[9,10] feed on the bottom or benthic seaweed[11–13]. It is widely distributed throughout the Indo-Pacific, the Arabian Gulf to the Indo-Malay region, Western Australia and north to Hong Kong and Taiwan[14–17]. It can be adapted to high-density intensive culture methods in cage. Siganids are generally regarded as preferred food fishes in spite of their relatively small size. A few species of this group have been cultured because of their herbivorous food habits, rapid growth and economic value[18–21]. *Siganus javus* shows rich protein content[22,23].It is fleshly and its good taste makes it desirable to many in the Indo-Pacific and Eastern Mediterranean, particularly in the Pacific Islands. The existing demand and market potential for these fishes in the domestic market are growing consistently in India. Considering these vital facts, an attempt was made to culture these fishes in sea cages for which, juveniles of *Siganus canaliculatus*, *Siganus javus* and *Scarus ghobban* were collected from the traditional trap catches commonly practiced at this region[24]. The trap fish capture is one of the very old folklore methods in Indo-Pacific and Eastern Mediterranean, particularly in the Pacific Islands, West Indies. In India, trap fishing prevails in the Gulf of Mannar, Palk Bay[25–27] and Brahmaputra valley of Assam[27,28]. Fish traps made of native materials have probably been in use for centuries, usually using traditional trap made up of bamboo, odai tree bark (*Acacia planifrons*) (Figure 1 a), but now a days the most widely used fish traps are made of plastic safety fence net (HDPE or PE or PP) additionally strengthened with wooden sticks and flexible iron wire (Figure 1b)[24]. None of the countries have been involved in establishing commercial farming using this group of fishes. The present study intends to provide additional information on the growth rate, acclimatization to cage environment and food conversion efficiency of Siganids fishes which may help the farmers in planning their culture strategy.

Fig 1. a. Showing traps made of odai tree bark (Acacia planifrons), b. Showing traps made of Plastic

2 Material and methods

The present experiment was carried out at Olaikuda, (Lat: 9.335385 °, Lon 79.329911°) at Rameshwaram on the southeast coast of India. The site offers a variety of favourable sea conditions for cage culture such as relatively calm and clear water, pollution free environment, availability of juvenile rabbit fish seeds. The site parallels the fishing village Olaikuda was chosen for taking up the culture with a depth of around 8 and 7 m during high and low tides respectively. The ESSO-NIOT has custom designed the cages of 9 m dia made of high density polyethylene (HDPE) and deployed using Samson type anchors suitable for sandy bottom at 8 m depth which is about 1,800 m away from the shore. For the culture, 16 mm knotless Poly Ethylene meshes coated with antifouling paints was selected as fish holding nets. The cages were positioned in a multipoint grid mooring system capable of keeping the entire culture system in position irrespective of the sea conditions (Figure 2 a & b). Ballast weights were added to the fish cages in order to avoid the deformation of nets during the high current situations and the total cultivable volumes of these cages were 320 m^3 (Table 1).

The estimated growth rate of *S. Javus* was analysed as absolute and specific growth (weight in g) over the culture period, and the calculation is given in Table 2.

Table 1. Outline ofcage culture site, cage characteristics, and corresponding initial stocking density.

Parameters	Olaikuda
Distance from shore (km)	1.8
Depth (m)	8
Bottom profile	Sandy
Cage height (m)	6
Cage width (m)	9
Cage volume (m^3)	320
Number of fingerlings stocked	1150
Initial stocking density (m^3)	3.59

Table 2. Outline of parameters used to express results of Rabbit fish growth rates [29]

Parameter (unit)	Equation
Absolute growth (g)	AG = W2 − W1
Absolute growth rate (g/day)	AGR = (W2 − W1)/(t2 − t1)
Relative growth	RG = (W2 − W1) / W1
Relative growth rate	RG = (W2 − W1) / W1(t2 − t1)
Instantaneous growth rate (g/day)	IGR = (logW2 − log W1) / (t2 − t1)
Specific growth rate (%/day)	SGR = 100 × (log W2 − log W1) / (t2 − t1)
FCR	TFC / BI

W_1=initial wet weight of fish at stocking.
W_2=final wet weight of fish.
t_1=age at stocking.
t_2=age at end of grow out period.
L_t=total length at age t; a and b are constants.

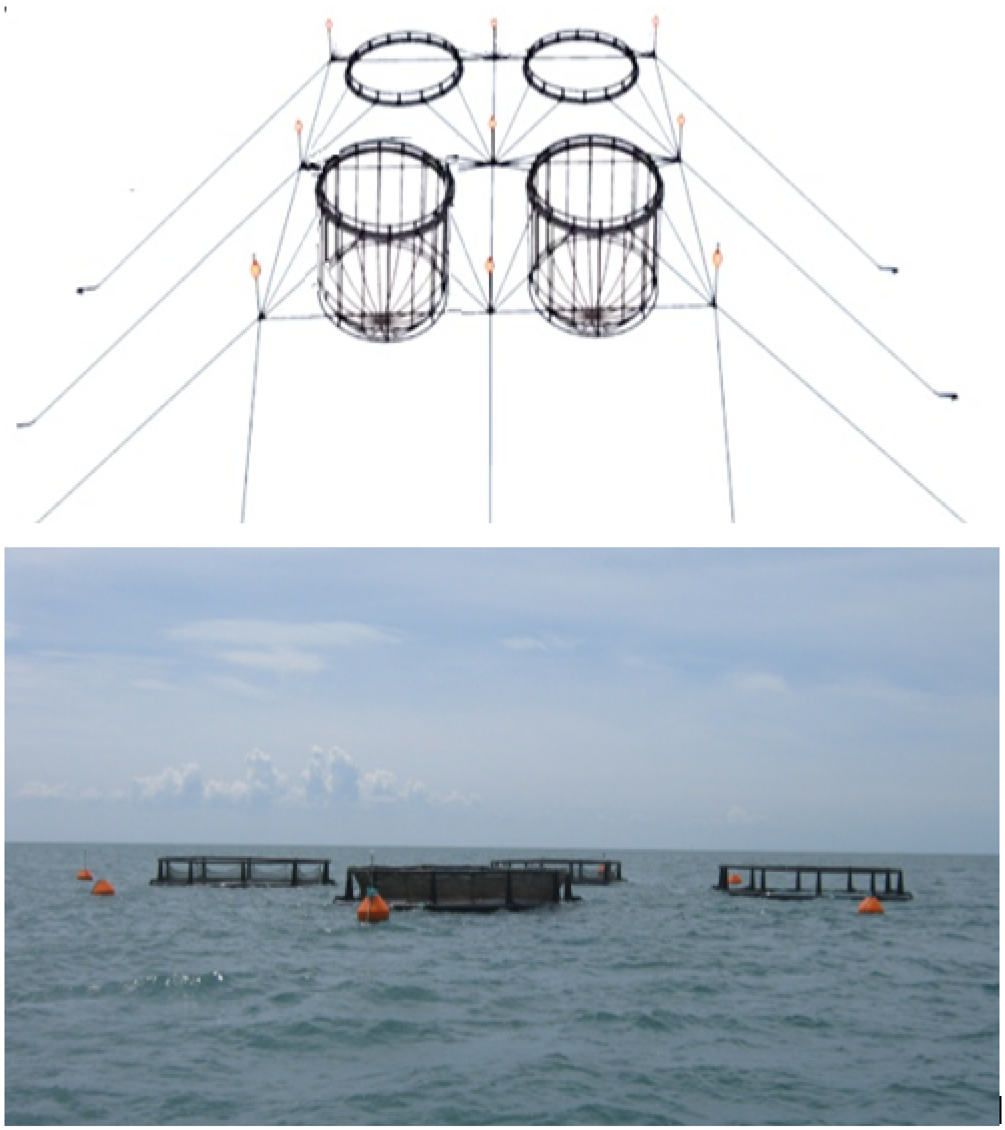

Fig 2. a. Showing 3D dimension of multipoint grid mooring system, b. Floating circular cages (9 m Ø), Olaikuda

Seed collection

During the month of May, juvenile and under sized fishes weighing below 75g were collected from Olaikuda from the trap fishermen on a daily basis. On an average, 35-75 fishes were stocked in sea cages each day. Before stocking the rabbit fish juveniles in cages, a thorough check was conducted to assess their health status. The total length and weight of each juvenile were meticulously measured and recorded. A total of 1,150 juvenile Siganids measuring between 12 and 16 cm in total length and 40 and 55 g weight were collected within a period of two weeks in this manner. The fishes were stocked at a density of 4 / m^3 which resulted in the initial total biomass of 58.65 kg of stocking.

Transportation of juveniles to cages

Several trials were undertaken prior to the transportation of live fishes and the live fish transportation methodology was standardized for better survival. At first, the fishes were transported in plastic buckets (30 L) with a battery aerator and the perceptions uncovered that the fishes began discharging huge amounts of mucous which stifled the gills and along these lines diminished the proficiency of oxygen swapping scale which brought about high death rates. An elective methodology was endeavoured to utilize conventional net bags (locally called Aracha) (Figure 3 a) which can be hauled in water segment up to the pens from the fishing site. This conventional cage configuration was improved by adding 2 mm thick iron rings in the centre to give a non-folding shape to make sure the accessibility of the gap inside the cage bags (Figure 3b). This minimized skin aberration while transporting the fishes[28].

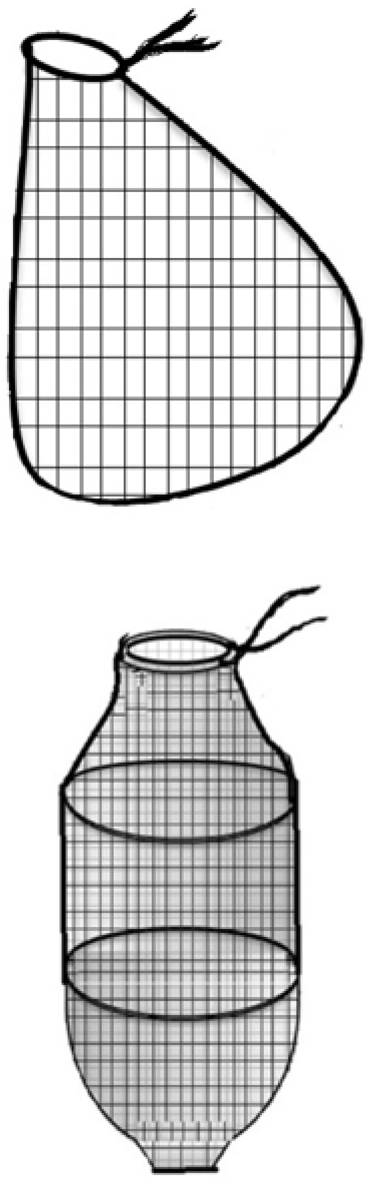

Fig 3. a. Traditional mesh bag, b. Modified traditional mesh bag

Feeding and cage maintenance

The fishes were fed with locally formulated plant based feed with 28-32% crude protein levels. 4% of fish total biomass per day for the initial two months. The feeding rate was then reduced by a percent every couple of months for the following culture period. The fish were fed twice daily (split feeding) @ 40% at 06:45 hrs and 60% at 14:45 hrs. After feeding the fishes in the morning, they were very closely monitored by diving into the cage. Dead fishes, if any, were removed from the mortality bag and were documented. The net, HDPE frame, and brackets were regularly cleaned to keep them devoid of fouling of fouling organisms on daily basis, to ensure the proper water exchange and avoid net damage.

Water quality and growth rate

Water quality parameters such as temperature (°C), salinity (‰), dissolved oxygen (DO; mg/L) and pH were measured using YSI (Model 563A) water quality probe on daily basis. Nutrient levels were estimated by following APHA manual of standard procedures. Every 15 days once random sampling of fishes was made using scoop net during the whole culture period to assess the growth rate of the fishes with a sample size of 10 to 15 fishes and measured the total length (TL) and weight (g) (Figure 4). Absolute growth rate (AGR), absolute growth (AG), relative growth rate (RGR), relative growth (RG), and specific growth rate (SGR) were assessed twice in a month (Table 2).

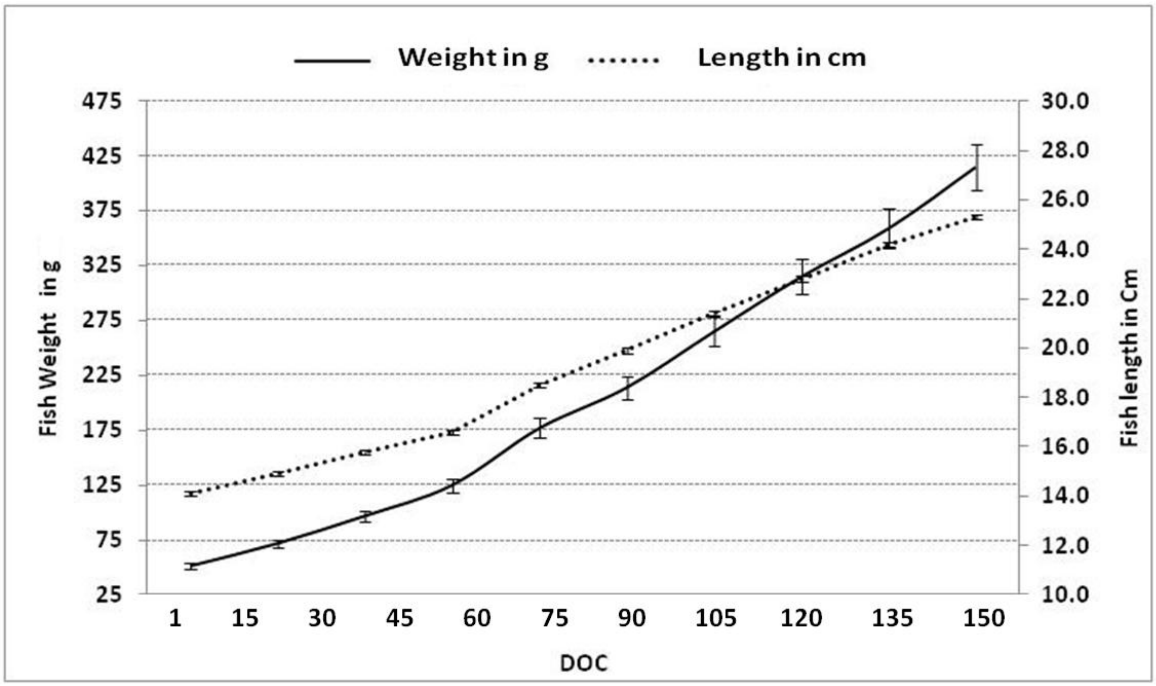

Fig 4. Rabbit fish weight against length

3 Results and Discussion

The stocking size of the fishes collected in the month May had an average size and weight of 13 ± 2.82 cm and 50 ± 15.5 g respectively. One month later, the average length increased to 1.7 cm (45 g). The individual length ranged between 14.6 to 16.1 cm (85 and 108 g). The total mortality during the culture period was 105 and among the dead fishes, 88% of mortality has occurred during the initial 15 days. The remaining 12% of death happened in between the remaining culture periods (19^{th} May to17^{th} June) 78.5 kg of feed was consumed and 43.49 kg total biomass was increased, first month food conversion ratio was 1.8, average length 0.06 cm and biomass 1.52 g / day were increased within initial 30 days of culture. The culture duration, length and weight of the sampled fishes over the period of time were represented in Figure 4. During the culture period Physicochemical parameters (Table 3) recorded were of the order of average salinity 31 ppt (min 29 max 33, temperature 27.9°C (min 26 max 30), pH 8.03 (min 7.60 max 8.70) and dissolved oxygen (DO: mg / L) average 6.50 (min 5.62 max7.20). The total biomass achieved during the culture was 434 kg from 59 kg in 140 days utilised 875 kg feed with the feed conversion ratio (FCR) of 2.01. Partially harvested photos are presented (Figure 5). The previous cage culture results documented by James[30] were only 17.2 g (27.9 mm) in 5 month duration against the present avg. 375 g. The average rabbit fish landing in this region was quantified as 25 to 40 kg (about 160 fishes) / week / person during the landing months of February to November, every year at Olaikuda. A substantial share (30 to 40 %) of the catch belongs to undersized fishes of below 250 g. As there is no legal size restriction exists in the country for catching fishes, capitalizing the stock of unmarketable size fishes is a vital task. In order to add value to these undersized fishes and idea of treating these juveniles as a seed resource was implemented to rear them till they reach the marketable size. If even one third of this pool is utilised for rearing, it is possible to accumulate at least 250 to 400 fishes / week during peak months of trap catch per fishermen.

Fig 5. Harvested fishes (*Siganus javus*)

Table 3. Outline of cultured period(19^{th} May to 5^{th} October) ranges and means in water quality parameters from Olaikuda Cage sites.

	Temperature (°C)	Dissolved Oxygen (mg/l)	Salinity (g/l)	pH
Average	27.9	6.50	30	8.03
Minimum	26	5.62	29	7.60
Maximum	30	7.20	33	8.70

4 Conclusion

The experimental findings show that the rabbit fishes (*S. Javus*) can be cultured in the sea cages like any other Culturable fishes. Observations during the culture activities revealed that these fishes could adapt to the cage system without much complexity when fed with a formulated pellet feed. The fishes grew within a shorter duration of 3 to 4 months to attain the necessary marketable size. However, the effect of rearing these fishes in a cage environment for longer duration needs to be studied in detail. Important factors such as the nutritional requirement (feed formulation) and ideal conditions to meet the required density in the early stages need to be analyzed. In the absence of hatchery produced seeds, the potential of the sustainable wild rabbit fish seed collection needs to be assessed prior to initiating a mariculture programme. The formulation of specific plant based ingredients feed and artificial propagation of *Siganus sp.* seeds will pave the way for large scale sea farming which can increase fish production and in turn generate additional employment and alternate income for the coastal fisherman community.

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