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Full Length Research Paper

Culturing a rabbit fish (*Siganus canalicullatus*) in cages: A study from Palk Bay, South East Coast of India

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Preliminary investigation on the culture of *Siganus canalicullatus* in floating cages in Mandapam coastal water has revealed that the fish has high culture potential in the region. It is euryhaline, inhabiting areas where salinities range from 23'/„ to 35.8O/„ ,. The fish grows faster on pelletted diets than on ordinary seaweeds. It is estimated that the fish would reach a marketable size of 20 cm fork length in 6 months; hence two crops can be harvested in a year. This would be a good source of income to fisher folk in Mandapam area.

Key words: *Siganus canalicullatus*, Mandapam coast, cage culture, fisher folk.

INTRODUCTION

Siganus canaliculatus, is a member of the family Siganidae, commonly known as rabbit fish. It is widely distributed throughout the Indo-Pacific from the Arabian Gulf to the Indo-Malay region, Western Australia and north to Hong Kong and Taiwan (Randall, 1995). *S. canaliculatus* occurs in coastal waters to depths of at least 40 m (Woodland, 1984). Juveniles form schools on algal and sea grass flats, feeding mainly on filamentous algae. Adults are also schooling and moving into shallows with the rising tide to feed on benthic plants (Randall et al., 1997). Siganids are generally regarded as good food fishes in spite of their relatively small size. Some species have been cultured because of their herbivorous food habits, rapid growth and economic value (Randall et al., 1997). Among other species *S. canaliculatus* is a commercially important species which is caught with a variety of gear, including bottom trawls and traps, in coastal waters throughout its range (Woodland, 1984). In the Arabian Gulf it is mainly caught using inter-tidal fence nets and dome-shaped wire traps. During 2002, 149 tonnes of *S. canaliculatus* were caught in the waters off the Emirate of Abu Dhabi in the United Arab Emirates (Grandcourt et al., 2007). Indian seas with adjacent lagoons / backwaters and estuaries are endowed with rich natural resources of marine plants and migratory animals. The 8129 km long coastline and 2.02 million Sq.km of EEZ is yet to be surveyed to identify the potential sites for floating cages. The potential species for mariculture out of a few thousand species of fin fishes, shell fishes and seaweeds are yet to be identified. *S. canaliculatus* culture is a good source of income for fisher folk near Mandapam area. Since India could earn a billion dollar export with (300,000 jobs) one item like shrimp farming in 10% of the coastal land, marine organisms and unutilized areas in the sea and land await to create a major breakthrough with a few million tonnes production worth of several billion dollars to the Nation.

DEVELOPMENT OF RABBIT FISH CULTURE IN INDIA COAST

S. canalicullatus is one of the most economically

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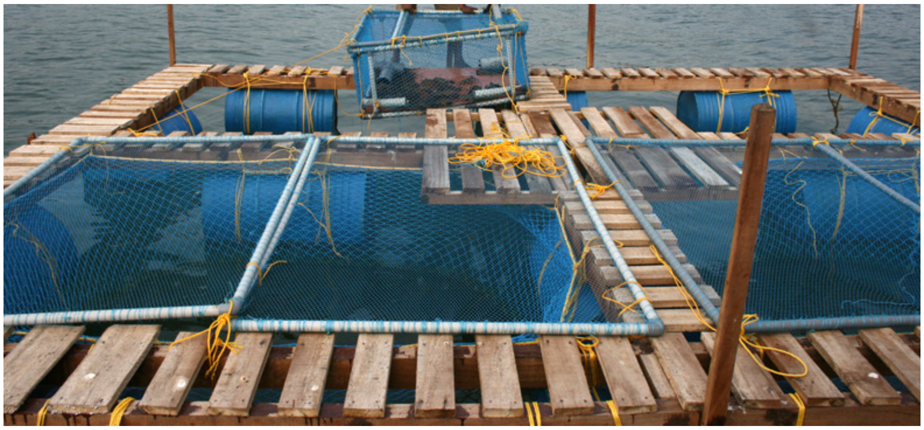

Figure 1. Wooden cage.

Figure 2. HDPE, Low cost cage developed at Karwar (Source Dr. Philipose CMFRI Karwar).

important herbivorous fish captured in the palk and Gulf of mannar. In some landing centres it forms up to 30% of the total catch, but on an average it is between 5 and 10%. The species is mainly captured in traps (Bwathondi, 1980) baited with seaweed of the genera *Kappaphycus alvarezii,* Ulva spp., *Hypnea* spp. and *Enteromorpha* spp. The herbivorous habit coupled with the great demand for this species along the coast make it a most suitable fish for culture in the region. Therefore, the potential water bodies for mariculture in India are hardly utilized. Palk Bay, Gulf of Mannar, Lawsons Bay near Vizag, Karwar, Goa, Ratnagiri, Andaman and Nicobar Islands, Lakshadweep have great potential for mariculture. Hence, the interest in floating cage culture emerged.

METHODOLOGY

Cage culture for *S. canalicullatus*

Two types of cages were normally used for the experiments, namely wooden and HDPE cages. The wooden cages were made of hard wood frames. Wire mesh, nylon netting, or wooden laths were tied onto the frame. Some of the cages were fitted with both doors and feeding troughs, the remainders were fitted only with doors (Figure 1). The HDPE cage may take a minimum of 4 to 5 crops to recover the input cost whereas low cost cage can recover the investment in a single crop itself (Figure 2 and Table 1). The diameter of the HDPE cage and low cost cage was 6 m and depth of the net also is 6 m. Hence area wise both the cage gives the same performance and the dates of introducing the fish into the cages were recorded. Fish in the wooden cages were fed on algae,

Table 1. Specifications of the parts used.

Part	Material	Size /quantity
Floating pipe inner Filled with PUF	HDPE140 mmø 10 kg/cm²(PE100 grade material	6 m dia
Floating pipe outer	HDPE140 mmø 10 kg/cm² (PE100 grade material	8 m dia
Middle ring	HDPE90 mmø 10 kg/cm² (PE100 grade material	Catwalk
Base supports	250 mm,HDPE	8 nos.
Vertical supports fixed with T joints, using fusion welding as well as with SS bolts and nuts	90 mm,HDPE	0.8 m height 16 hooks
Diagonal support	90 mm, HDPE 10 kg pressure	8 nos
Buoys, filled with PUF	350 mm dia with end caps(10 kg)	
Mooring clamps	14 mm,4"mooring clamps	3 nos
Mooring chain MS	10 mm	
Ballast pipe	HDPE, 63 mm ,circular	8 m dia
Mooring swivel	MS	
Outer net, Braided HDPE, 3 mm/80 mm square mesh	Provided with SS rings of 12 mm thickness, for connecting to the cage frame	7 m dia and 5 m depth, 18 rings bottom12 ring top
Inner net, Twisted HDPE net 1.25 mm/30-35 mm mesh size	With SS rings	6m dia and 5.3 m depth12 rings top
Bird net,1.25 mm/80 mm twisted HDPE		6 m dia
Hapa, Nylon with 8/10 mm mesh	2.5 × 2.5 × 3 m rectangular shape	
Chain 80 grade MS 10 mm	3T working load,7T stretching load,11 breaking load	
D shackle 1'',1/2'' and 3/4" MS	(3T,0.5T,3Tworking load)	
Swivel 1'' forged steel 80 grade	3T working load	
Solar blinkers	Water proof shock resistant red colour blinking light	3 Nos

particularly *K. alvarezii, Ulva reticulata, Hypnea* spp. And *Enteromorpha;* while in the plastic cage they were fed on *Ulua fusciata* (Delile) mixed with fish (mainly sardines and fresh fish) ground together in the form of pellets. Enough algae were supplied to the wooden cages to last at least one week, but in the plastic cages fresh pellets were given to the fish every day.

The substratum of the area is predominantly sandy with patches of mud. In the open sea areas, the substrate is mainly a sandy grass bed with several tide pools. The mean depth of the area is 2 m at low tide and about 5 m at high tide. The plastic cages were set about 200 from seashore area. The substrate was sandy, and the depth of water was over 5 m at high tide. CMFRI cages are very suitable for culturing the rabbit fish near Mandapam areas (Figures 3, 4 and Table 2).

Figure 3. Concrete tank culture for *S. canalicullatus* (Source FAO).

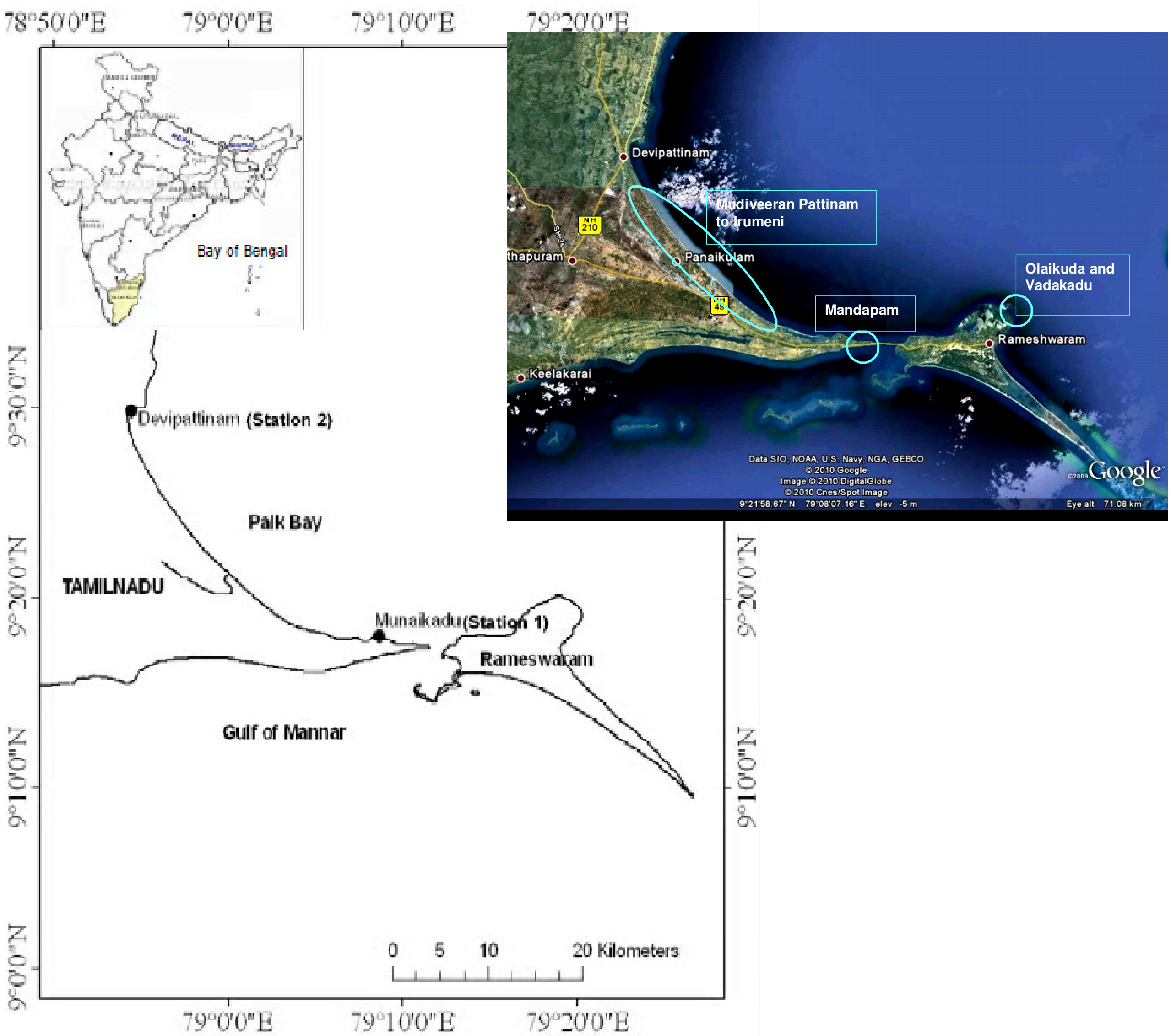

Figure 4. Map showing entire Palk Bay region.

Table 2. The different stages involved in culture of *S. canaliculatus*.

Stages	Characteristics
Feed and feeding rate	Predominantly herbivore, feed voraciously on macro algae.Seaweeds provide rich foods for juveniles and abundant in summer months, diurnal feeder Coprameal, tapioca leaves and seaweed, chopped fish and fish meal pellets at the rate of 5 to 7% body weight. May-Dec – 213 days culture, pellet feed fed in a feeding tray with 1.2 mm particle size at 7% body weight, 6 days a week and then replaced with 2 mm size at 3% body weight and finally 4 mm size (Bwathondi, 1982)
Spawning period	Recruitment peaks February – April during new moons; Young pass through transparent planktonic larva.
Collection of fry	Bagnet, seine net used to collect 3 weeks old frys (1.5 - 3.0 cm in length)
Growth period	13.4 g juvenile grows to 181.3 g in 89 days. (Gross fish production 18.8 kg / m^3)
Stocking	Stocking 250 fish / m^3 (2000 fish / cage of 8 m^3) (FCR 2:1)
Control	A service species to control biofouling in fish cages.
Spines and Colour	Spines are sharp and venomous. Females slightly larger and less colourful.
Size of the eggs	– 0.7 to 1.0 mm eggs.
Bait	Green alga
Maturity	Maturity in one year – Female reaches 24 cm in 4 years and male 22 cm in 3 years.
Gonads development	Gonads stay in a state of dormancy from midsummer through late winter. Gonad increases in size in March and attains peak in April, size declines afterwards and returns to dormancy (Al-Ghais, 1993)
Selling price	Retail price US $ 3.68 / kg in UAE (Yousig et al., 2005)
Nursery	Hatchery bred fingerlings of 3.38 g (6.31 cm) stocked in 5 × 5 × 2.5 m^3 (55 m^3 volume) floating cage nets with 20 mm square mesh nylon, attached to a square steel pipe frames, shaded from direct sunlight by green sheets, floated by1 × 0.5 × 0.4 m^3 Styrofoam buoys, stocking density 8 / m^3 and 12 / m^3

RESULTS

Reproduction cycle

The defined spawning period of *S. canaliculatus* supports the contention that seasonal reproductive cycles are common among tropical fishes (Robertson, 1990; Montgomery and Galzin, 1993; Sadovy, 1996). Spawning for this species has been reported to occur between January and April in both the Philippines and Singapore (Soh, 1976) and Sadovy (1998) reported spawning of *S. canaliculatus* in Hong Kong to occur between March and June. The 4 month main spawning period determined here (April to July) corresponds to the duration of the spawning period in other locations. Whilst there were no fish recorded in spawning condition during the winter months, what individual spent were observed in January. Furthermore, there was a small peak in the gonadosomatic index in November, suggesting that a second but less well-defined spawning season exists. A second, although less pronounced, spawning period has also been suggested for this species in Singapore, the Philippines and Palau based on the presence of juveniles and fry during two distinct periods of the year (Lavina and Alcala, 1973). Additionally, Ntiba and Jaccarini (1990) conclusively identified two major spawning seasons for S. sutor in the coastal waters of Kenya.

The reproductive cycle of *S. canaliculatus* in the southern India, therefore appears to be representative of the general pattern observed at other locations throughout the Indo-Pacific. Female biased sex ratios are a characteristic (though not diagnostic) feature of

Table 3. The maturity stages of *S. canaliculatus* (S.M Al-Ghais 1993).

Stage 0	Immature	No easily visible sexual organs in body cavity.
Stage I	Maturing	Gonads thread-like, transparent, can be distinguished into testis or ovary.
Stage II	Early developed	Gonads begin to swell and occupy nearly one fourth of body cavity, but still translucent
Stage III	Mid-developed	Gonads larger, testes opaque, no sperm differentiated, ovaries translucent with small eggs visible microscopically
Stage IV	Ripe	Testes usually white, some sperms expelled from core when testis is cut. Ovary opaque solid, eggs fully formed and numerous, eggs not translucent
Stage V	Running	About to spawn. Gonads turgid, filling body cavity. Milt and eggs expelled from genital apertures on application of a slight pressure on both sides of genital area.
Stage Via	Early spent	Gonads reduced in size. Ovary reddish color. Testes yellowish white in color.
Stage VIb	Half spent	Gonads much reduced in size. Eggs seen by naked eye. Testes flat, greyish color.
Stage Vic	Late spent	Gonads flaccid. Ovary reddish in color. Testes dull-gray color, soft, empty, fleshy in its appearance.

protogynous species (Sadovy, 1996). Being dioecious, *S. canaliculatus* would not be expected to have a sex ratio that differed significantly from unity. The apparent female bias could be due to the fishing gear differentially targeting the larger females, and/or sex specific habitat preferences with females being more abundant in areas that are fished. It is also possible that errors occurred when sexing fish in our study, in particular those that were immature, further emphasizing the need for histological diagnosis. The age-based catch curve used for estimating the annual instantaneous rate of total mortality (Z) relies on the assumptions that all of the age groups used in the analyses were equally vulnerable to the fishing gear and equally abundant at recruitment. Failure of these assumptions may have introduced errors and Z may have been overestimated if larger fish were less vulnerable to the fishing gear or, for example, if adult fish underwent migrations. A survey of the biomass of demersal species in the Arabian Gulf waters of the United Arab Emirates showed seasonal changes in the abundance of *S. canaliculatus*, with a defined peak during August (Shallard, 2003). Therefore, it is possible that the size and age compositions and associated estimates of Z may have been biased by ontogenetic or spawning migrations (Table 3).

DISCUSSION

CMFRI has started mariculture with Chanos Chanos in 1958 to 1959, followed by oysters, mussels, clams, shrimps and a few species of fin fishes. Pearl culture programme was successfully developed in 1972 with *Pinctada fucata* and *Pinctada margaritifera* in 1981. Culture technology for edible oyster *Crassostrea madrasensis* was also developed by CMFRI during the 1970s. Hence Nodal agencies, National Fisheries Development Board (NFDB) come forward to help the coastal poor by arranging training program in Sea bass cage culture with collaboration with CMFRI. State fisheries also create the awareness programme regarding the cage culture of *siganus* spp. in Mandapam areas to increase the yield. Sea cage culture of *siganus* spp. requires careful nursery rearing and farm rearing. Nursery rearing is to be strictly done in dedicated facilities to achieve better growth. Feeding with algae like *Kappaphycus Ulva reticulata, Hypnea* spp. and *Enteromorpha;* at regular intervals in required quantity helps to achieve better growth rate without cannibalism. Frequent net exchange of the cage helps to maintain excellent water quality in the cage and prevent outbreak of diseases.

Conclusion

Cage farming of fin fishes and shell fishes are required to increase production and also to increase employment opportunities for the fishermen community in the coastal areas. Results obtained world over had shown that cage culture can yield very high production rates. Finfish culture with huge potential is yet to takeoff. The plausible reasons could be lack of awareness of the public, reliable technology for sustainable production of cultivable marine organisms from hatchery seed production to grow-out culture, open access to the marine environment without a lease policy for aquaculture, lack of confidence of the investors in protecting the property put up in the sea and dietary habits of a large population without fish eating or with restricted fish diet in their life.

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