

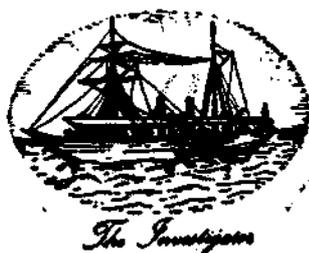
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PRELIMINARY STUDIES ON CULTURE OF FIN-FISHES IN CAGES IN THE COASTAL WATERS OF PALK BAY AT MANDAPAM

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ABSTRACT

The present study has been aimed at investigating the possibilities of culturing a few species of economically important marine fishes in suitable low cost cages suspended in coastal waters. In this paper, the results of a preliminary study on culture of rabbit fishes (*Siganus* spp.), groupers (*Epinephelus* spp.) and whiting *Sillago sihama* (Forsskal) in cages fabricated with different materials and suitability of cages are given. The experiments were conducted from March 1979 to October 1979. Five cages of the dimensions $1.5 \times 1.0 \times 1.0$ m and $1.0 \times 1.0 \times 1.0$ m were used. Among the five cages the one fabricated with palmyra leaf stalks was the cheapest but the two cages fabricated with nylon nettings were durable. These cages had been kept tied to casuarina poles and rested on the sea bottom at a depth of about 0.75 m at low tide level in coastal waters of Palk Bay.

Two species of rabbit fishes, namely, *Siganus canaliculatus* Park and *S. javus* Linnaeus were reared in cages. *S. canaliculatus* were reared in bamboo split cage ($1.5 \times 1.0 \times 1.0$ m). The initial sizes of *S. canaliculatus* ranged between 78 and 120 mm (7.5 and 24.0 g) and the stocking density was 60 nos/sq. m. *S. javus* were reared in two nylon net cages ($1.0 \times 1.0 \times 1.0$ m). In one cage (stocked in April) the size ranged between 67 mm and 90 mm (5.2 g and 13.0 g) and stocking density was 200 no/sq. m. In the other cage (stocked in May) the sizes ranged between 87 mm and 117 mm (11.5 and 32.3 g) and the stocking density was 160 no/sq. m. Initially for two months both the species were fed with a food prepared out of seaweed, prawn head, fish and rice bran mixed in equal proportions and later on instead of fish and rice bran, fish meal and ground nut oil cake were substituted. For *S. canaliculatus* the average growth increment per month was 8.5 mm and 3.1 g and for *S. javus* average growth increment per month was 6.2 mm and 2.0 g in one cage and 5.6 and 3.4 g in the other cage.

Two species of groupers, namely, *Epinephelus tauvina* (Forsskal) and *E. hexagonatus* (Forster) were stocked in palmyra leaf stalk cage ($1.5 \times 1.0 \times 1.0$ m). The stocking density rate was about 13 nos/sq. m and these were fed with chopped fish. The initial sizes of *E. tauvina* ranged from 173.0 mm to 354.0 mm (80.0 g and 580.0 g) and of *E. hexagonatus* from 224.0 mm to 300.0 mm (190.0 g to 380.0 g). After six months the size of *E. tauvina* ranged from 299.0 to 450.0 mm (405.0 g to 1,497.0 g) whereas *E. hexagonatus* has not shown any consistent increase in size.

In *Sillago sihama*, stocked in G.I. wire cage ($1.5 \times 1.0 \times 1.0$ m), the initial size of fish ranged from 63.0 to 95.0 mm (2.8 g to 6.0 g) and the stocking density was about 70 no/sq. m. This species was fed with fish meal and groundnut oil cake mixed in equal proportion. The average growth increment per month was 10.0 mm and 1.6 g from July to September.

INTRODUCTION

CAGE CULTURE of fish originated in the Far East and was later adopted in several countries. It has numerous advantages over other culture techniques but there are some serious limita-

tions which must be taken into consideration before it is applied on a large scale. Cage culture is being practiced in several countries with equal success in fresh (ponds, rivers, reservoirs, lakes), brackish and salt water environments. Cages may be resting on the bottom, floating at the surface (predominant

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type) or submerged (either floating in mid-water or resting at bottom). Materials used for fabrication of cages are netting, bamboo and metal, floating net cages having widest application. Ideally, cages have to be inexpensive, durable and easy to handle. These criteria are met in different ways, depending on the materials available locally, on the type of culture undertaken and on the possible investments which may be made according to local economic conditions. Artificial feeds used in cage culture vary from raw materials obtained locally to nutritionally balanced pelleted feeds. While most of the feeding is by hand, the use of mechanised feeders is increasing.

In this paper, results of preliminary experiments on the culture of a few species of fin-fishes in cages in the coastal waters of Palk Bay near Mandapam on the south east coast of India are given.

MATERIAL AND METHODS

The present experiment on culture of fishes in cages was carried out from March 1979 to October 1979 in the coastal waters of Palk Bay.

Five cages were fabricated using different materials. All the cages were rectangular in shape and the frames were made of palmyra wood. Of these, two cages had the sides covered with nylon twine nettings (2.0 mm thickness), the first one had the mesh size of about 10 mm and the other of about 15 mm. These two cages had the dimensions of 1.0 m \times 1.0 m (1.0 m²). The other three cages had the dimensions of 1.5 m \times 1.0 m \times 1.0 m (1.5 m²). Among these three cages, the first one had all the sides covered with palmyra leaf stalks closely nailed together, the second one had the sides covered with closely nailed bamboo splits and the third one had been covered on all sides with G.I. wire mesh (5 mm). All the five cages had been provided with a

half-door to facilitate opening and closing the cages for purposes of feeding etc. These cages were tied along the four corners to casuarina poles erected at a depth of about 0.75 m at low tide level at the Palk Bay side off Manakkad near Mandapam. These cages were placed on the bottom and one concrete block was tied to the bottom of the cage to serve as an anchor to keep it in the position.

Three groups of fishes, namely rabbit fishes, groupers and whiting were selected for experimental culture in the cages. Among rabbit fishes, two species namely *Siganus canaliculatus* Park and *S. javus* Linnaeus and among groupers two species, namely, *Epinephelus tauvina* (Forsk.) and *E. hexagonatus* (Forster) were collected. The *Siganus* spp. were collected from shore seine operations and *Epinephelus* spp. were collected using fish traps. About 100 numbers of *S. canaliculatus* were collected in the middle of March and the size ranged between 71.0 mm and 91.0 mm (4 g and 10 g) with an average size of 83.0 mm and 7.1 g. These were reared in a 12' diameter plastic pool till April middle and were then transported to bamboo split cage (1.5 m²). During one month period about 10 numbers had died and the remaining 90 numbers were stocked in the cage (60 no/sq. m). The size range at the time of stocking was 78.0 mm (7.5 g) to 120.0 mm (24.0 g) with an average size of 91.0 mm (9.9 g).

About 400 *S. javus* were collected during April-May. The first batch of about 200 numbers were collected in the middle of April and the size ranged between 67.0 mm (5.2 g) and 90.0 mm (13.0 g) with an average size of 73.9 mm (8.0 g). These were stocked in one nylon net cage (1.0 m²) having the mesh size of about 10 mm. The second batch of about 200 numbers were collected in the middle of May and of these about 160 were stocked in another nylon net cage (1.0 m²) having a mesh size of about 15 mm. The size of the

fish ranged from 87.0 mm (11.5 g) and 117.0 mm (32.3 g) with an average size of 103.1 mm (19.2 g).

Eleven numbers of *Epinephelus tauvina* ranging in size from 173.0 mm (80.0 g) to 354.0 mm (580 g) and eight numbers of *E. hexagonatus* ranging in size from 224.0 mm (190 g) to 300.0 mm (380.0 g) were stocked in palmyra leaf stalk cage (1.5 m³) and the stocking density rate was about 13 no/sq. m.

119 numbers of live *Sillago sihama* were collected in the middle of July, using a drag net and of these 13 died during transportation. 106 numbers were stocked in the G.I. wire mesh cage (1.5 m³). The sizes ranged from 63.0 mm (2.8 g) to 95.0 mm (6.0 g) and the average size was 81.9 mm (4.1 g).

The *Siganus* spp. were fed with a composition of prawn head, fish, rice bran and seaweed mixed in ratio of 1 : 1 : 1 : 1 initially for two months. Later on, instead of fish and rice bran, fish meal and ground nut oil cake were substituted. The *Epinephelus* spp. were fed with chopped fish. *Sillago sihama* were fed with fish meal and groundnut oil cake mixed into 1 : 1 proportion. All the fishes were fed once daily. Monthly measurements were taken to record the growth rates.

RESULTS

Cost of cages

Among the five cages the cost of the palmyra leaf stalk cage was the lowest (1.5 m³ cage — Rs. 182) and that of G.I. wire mesh was the highest (1.5 m³ cage — Rs. 315). The cost of the bamboo split cage (1.5 m³ cage — Rs. 195) was lower in comparison to two nylon netting cages (Rs. 254 and Rs. 270).

Suitability of cages

The cages were put in the sea in March '79 and the conditions of the cages were observed till October '79. The two nylon net cages

were in good condition throughout the period. The palmyra leaf stalk cage was in good condition till September and afterwards a few stalks had become soft and could not withstand the wave action. In the bamboo split cage on a few occasions longitudinal gaps widened as a few splits had come off. The G.I. wire mesh cage was in good condition till September and subsequently in October while removing the cage the mesh along the side corners was torn off as the mesh had been weakened at these areas by shaking of mesh in water movement. The palmyra wooden frames in all the cages were in good condition throughout the period. All the cages were heavy and submerged to the bottom. Of all the cages, nylon net cages were easy to handle. Fouling was not much during the period. Barnacle settlement was observed to some extent on the upper frames of the cages especially on the inner sides. In palmyra leaf stalk cage and in bamboo split cage organisms like algae, sponges had grown on the lower half of the inner sides of the cage and these prevented water movement to some extent. These could be easily cleaned.

Rearing of the fishes

Siganus canaliculatus: The initial sizes of the fishes in March ranged from 71.0 mm to 91.0 mm (4.0 g to 10.0 g) with the average size of 83.0 mm and 7.1 g. In about one month, the average size increased to 91.0 mm and 9.9 g. The individual sizes ranged between 78.0 mm and 120.0 mm (7.5 g and 24.0 g). Of the stocked 100 fishes about 10 died during March and the remaining 90 were stocked in the bamboo split cage in April. The average size increased to 101.1 mm in length and 13.0 g in weight in May and 108.5 mm and 16.4 g in June. The average growth increment for about 3 months was 25.5 mm and 9.3 g. Thus the average growth increment per month works out to 8.5 mm and 3.1 g. The average growth increments in different months varied between 7.5 mm (2.8 g) and 10.0 mm (3.4 g).

63 numbers survived till May and 57 numbers till June. However, subsequently in the month of July, most of the fish had escaped through a gap that had formed in the cage as a bamboo split had come off. Only four fishes could be recovered. The average size was 124.5 mm and 28.0 g.

S. javus : In nylon net cage 200 numbers of *S. javus* weighing about 1,437.0 g were stocked in April. The sizes ranged between 67.0 mm and 90.0 mm (5.2 g and 13.0 g) and the average size was 73.9 mm and 8.0 g. The average size increased to 111.1 mm and 19.7 g by October. The average growth increment for about six months was about 37.2 mm and 11.7 g and the average growth increment per month works out to 6.2 mm and 1.95 g. The average growth increment was almost nil during June-July and the growth increment was more comparatively in April-May and August-October. The average growth increments in different months ranged between 0.1 mm and 16.0 mm (0.0 g and 6.2 g) in different months. 121 numbers survived till October which works out to nearly 60% of the initial stocking. The total weight was 2,358 g.

In another nylon net cage about 160 numbers of *S. javus* weighing a total of 2,055 g were stocked in May. The sizes ranged between 87.0 mm and 117.0 mm (11.5 g and 32.3 g). The average size was 103.1 mm and 19.2 g. It increased to 131.0 mm and 36.4 g by October. The average growth increment for about 5 months was 27.9 mm (17.2 g) and it works out to 5.6 mm and 3.4 g per month. The average growth increments in different months varied from 0.4 mm to 20.1 mm (0.2 g to 11.0 g). 52 numbers only survived which works out to 32.5% of the initial stocking weight. The total weight was 1,973 g.

Epinephelus tauvina : The initial sizes of 11 numbers ranged between 173 mm and 354 mm (80.0 g and 580 g) in April. The average size was 241.7 mm and 234.1 g. The total weight

was 2,575 g. In October the sizes ranged between 299 mm and 450 mm (405 g and 1,497 g). The average size had increased to 355.6 mm and 758.0 g. The average growth increment per month was 19.0 mm and 87.3 g. The monthly growth increment in individuals ranged between 3.0 mm and 57.0 mm and the average growth increments in different months varied between 6.7 mm and 34.2 mm (62.3 g and 117.8 g). Till October, 8 numbers survived (72.7% of initial stocking number) and the total weight was 6,506 g.

Epinephelus hexagonatus : 8 individuals with initial sizes ranging from 224 mm to 300 mm (190.0 g to 380.0 g) were stocked in April. 3 numbers had escaped in May and for the remaining five the sizes ranged between 234 mm and 318 mm in October. In this species the growth increments were negligible and the maximum growth increment observed was 6.0 mm in one month. Many individuals did not grow at all and remained on the same size.

Sillago sihama : 106 numbers were stocked in July and the sizes ranged from 63.0 mm (2.8 g) to 95.0 mm (6.0 g) and the average size was 81.9 mm (4.1 g). In August the average size increased to 99.3 mm (6.5 g) and in September to 102 mm (7.3 g). The average growth increment for two months was 20.1 mm and 3.2 g. The average growth increment per month works out to about 10 mm and 1.6 g. In October the cage mesh had torn off and all fish had escaped.

The results of the experiments on the growth of various species are summarised in Table I.

REMARKS

Although vast expanses of water areas suitable for cage culture are available in India, serious attempts have so far not been made to culture fishes in cages in fresh water or salt water. The only experiment on record is the experimental culture of fishes in cages conducted

TABLE 1. Details of size ranges and mean sizes (in parentheses) of different species in cages from April to October 1979 (length in millimetres and weight in grams)

Month	<i>S. canaliculatus</i>		<i>S. javus</i> (I cage)		<i>S. javus</i> (II cage)		<i>E. tauvina</i> *		<i>Sillago sihama</i>	
	Length	Weight	Length	Weight	Length	Weight	Length	Weight	Length	Weight
March	.. 71-91 (83) (in aquarium tank)	4-10 (7.1)	..	—	—	—	—	—	—	—
April	.. 78-126 (91)	7.5-24 (9.9)	67-90 (73.9)	5.2-13 (8)	—	—	173-354 (241.7)	80-580 (234.1)	—	—
May	.. 88-119 (101.1)	9-23 (13.0)	74-91 (82.2)	7.2-13.5 (9.2)	87117 (103.1)	11.5-32.3 (19.2)	197-370 (275.1)	90-740 (300.0)	—	—
June	.. 93-118 (108.5)	10.5-21 (16.4)	74-94 (86.3)	8-13.6 (11.3)	111-149 (123.2)	21.5-49.8 (30.2)	210-394 (282.6)	125-895 (362.3)	—	—
July	.. —	—	78-98 (86.4)	(11.2)	(125.1)	23.5-53 (30.8)	224-40 (298.3)	174-972 (438.6)	63-95 (81.9)	2.8-6 (4.1)
August	.. —	—	84-100 (88.8)	10-16.0 (11.9)	111-144 (125.5)	19-45.6 (31)	250-420 (322.8)	220-1150 (542.8)	80-117 (99.3)	3.5-11 (6.5)
September	.. —	—	84-105 (95.1)	10-18 (13.5)	110-147 (188.5)	20-46 (32.3)	285-437 (343.9)	340-1300 (660.6)	80-117 (102)	3.5-11 (7.4)
October	.. —	—	96-125 (111.1)	12-28 (19.7)	120-153 (131.)	24-51 (36.4)	299-450 (355.6)	405-1497 (758)	—	—
Average growth per month	.. 8.5	3.1	6.2	2.0	5.6	3.4	19.0	87.3	10.0	1.6

* Growth data on *E. hexagonatus* are not given as the species has not shown any consistent growth.

at Ghorajan beel, a vast derelict water body, situated on the north bank of river Brahmaputra near Gauhati in Assam (Dehadrai *et al.*, 1975). This experiment was conducted for a period of three months only with split bamboo mat cages of 152 × 76 × 76 cm size. The growth and production of *Heteropneustes fossilis* and *Anabas testudineus* were studied in different stocking densities. Few years ago some experiments were conducted by the Central Marine Fisheries Research Institute for rearing oilsardine and mackerel in floating cages in the sea and also in the estuary. Oil sardines could be kept successfully for four and a half months in cages in the estuary. While the experiments have proved that these fishes could be kept in cages without artificial feeds the increase in growth was not impressive. Therefore, the present preliminary study on culture of fishes in cages in the marine environment is the first concerted effort of its kind.

In the present experiment different materials have been used for constructing cages in order to study the suitability of local materials, their durability and cost structure. Among these cages with nylon nettings seem to be more suitable than those made of other materials *viz.*, palmyra leaf stalk, bamboo and metal. Palmyra leaf stalks and bamboo splits work out cheaper but their durability in sea water has not been satisfactory. This can be overcome to some extent by curing of the materials before using. Nevertheless meshed coverings are more advantageous than those longitudi-

nally nailed materials (leaving vertical gaps for flow of water) for culturing fishes from very small sizes. Fouling also could be greatly avoided by using nylon nettings.

Among the fishes cultured, only groupers gave encouraging results. In *E. tauvina* the growth per month has been about 19.0 mm and 87.0 g. The yield has been about 2.5 times in about six months. The survival rate was about 73%. Therefore, this species may be suitable for culture in cages. In Malaysia *E. tauvina* has been reared in floating pens and it has been found that fingerlings of 8 to 15 g require 2 to 3 months to attain marketable size of 900 g which works out to an average growth of about 71 g per month. When an artificial feed prepared in moist pellet form was offered the growth has been enhanced by 11.5% (Anon, 1977). In the present experiment *S. canaliculatus* has shown a growth of 8.5 mm and 3.1 g per month. According to Lam (1974), in Philippines, Lavina and Alcalá (1973) have recorded a growth of 8 cm in about 3 months, 10 cm in about four and a half months and 14 cm in about seven months for the species and in Singapore Ben Tuvia *et al.* (1973) have found the species to grow to about 120 grams in about 9-11 months. In the present experiments, *S. javus* also did not show good growth and the average growth was only about 5.6 mm to 6.2 mm and 2.0 g to 3.4 g. However, since these fishes are known to grow fast in floating cages (Lam, 1974) more experiments seem to be necessary before coming to conclusions.

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