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Growth performance of the seabass *Lates calcarifer* (Blotch) in sea cage at Vizhinjam Bay along the south-west coast of India

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ABSTRACT

The growth potential of the Asian seabass, *Lates calcarifer* in floating sea cage was assessed by rearing them in a large HDPE floating cage moored at Vizhinjam Bay, south-west coast of India. Seabass seed (mean weight and mean total length, 2.5 g and 53 mm respectively) were nursery reared in hapas in December 2008, fed on pellet feed and grown to an average size of 28 g and 135 mm in 60 days, with a survival rate of 60%. Subsequently, the juveniles were stocked into the cages at a stocking rate of 60 nos. m^{-3} in February 2009, fed on trash fish and reared for a period of 112 days during which they grew to an average size of 540 g and 328 mm. Weight gain per day increased from 0.2 g in December 2008 to 7.71 g in May 2009, while SGR decreased from 5.88 to 2.47. The hydrological parameters *viz.*, temperature, pH, salinity, dissolved oxygen and microbial load recorded were at optimal levels for the normal growth of seabass. The results obtained indicated that cage culture of seabass in the sea can provide significant advantages in terms of faster growth and effective utilisation of water volume.

Keywords: Cage culture, Growth, *Lates calcarifer*, Seabass

Introduction

The marine fish production trend shows that fish harvest from the wild remains stable or is declining and efforts must be directed towards aquaculture, with a focus on proposing new alternatives of fish production that does not affect wild stocks. Cage farming is one alternative to enhance the production. The Asian seabass or giant seaperch, *Lates calcarifer,* commonly known as 'bhetki' in India is an important coastal, euryhaline carnivorous fish in the Indo-Pacific region. 'Barramundi' or Asian seabass is a commercially important aquaculture species in Australia and south-east Asia. Production of seabass in Australia has steadily increased for the past 15 years and this trend is expected to continue (Boonyaratpalin and Williams, 2002; Thirunavukkarasu *et al.,* 2004). It is farmed in both brackishwater and freshwater ponds, as well as in cages of coastal waters in Malaysia, Indonesia, Thailand, Taiwan and in Australia. This fish fetches a high market price due to its delicately-flavoured white meat. It has fast growth rate, can be fed with artificial feed or trash fish, and can be bred in captivity, thus making it a candidate species suitable for aquaculture (Dunstan, 1959; Sirikul, 1982; Davis and Kirkwood, 1984; Sakaras, 1987; Barlow *et al*., 1996; Boonyaratpalin *et al*., 1998; Singh, 2000). Recent studies have focused on determining optimal feeding practices (Williams and Barlow, 1999) and nutritional requirements for juvenile seabass (Catacutan and Coloso, 1997; Boonyaratpalin *et al*., 1998; Coloso *et al*., 1999; Williams and Barlow, 1999; Murillo-Gurrea *et al*., 2001). Mass production of seabass in captivity through induced breeding techniques has been standardised under Indian conditions (Thirunavukkarasu *et al.,* 2001). Larval and nursery rearing techniques have also been standardised for better survival and growth (Kailasam *et al.,* 2001; 2002) at the Central Institute of Brackishwater Aquaculture (CIBA), Chennai.

Although this fish can be cultured in both freshwater as well as seawater, the species is generally cultured in sea cages located in river mouths or estuaries (Boonyaratpalin *et al*., 1989). During the present investigation, the growth performance of seabass was evaluated in a large floating sea cage anchored at Vizhinjam Bay, south-west coast of India.

Materials and methods

Nursery rearing of seabass seed

A total of 6600 seabass seeds procured from the Rajiv Gandhi Centre for Aquaculture (RGCA) hatchery at Sirkazhi, Tamil Nadu, were air lifted from Chennai on 20th December 2008 to Thiruvananthapuram and brought to the cage culture facility at Vizhinjam. The fishes were conditioned on the previous day of transportation without any feeding. They were oxygen packed early in the morning at the rate of 50 nos. per pack. Two hapas, each having 2.5 m length, 2 m breadth and 1.5 m depth installed in the bay, were used for nursery rearing. Seeds were acclimatised to the rearing conditions by keeping the polythene bags containing the seeds in hapas for about 15 min followed by slow addition of water from the bay to the polythene bag before releasing the seed into one of the hapa. The seed (size range : 48-58 mm TL and 2-3 g weight) were stocked at the rate of 450 m^{-3}. After one month, one more hapa of the same dimensions was added and the fishes were distributed, reducing the stocking density to 250 m^{-3}. They were fed on artificially formulated floating feed, 4 times daily until satiation so that fishes stop coming up for feed. Frequent grading was carried out and the shooters were removed to avoid cannibalism. Following 60 days of nursery rearing, on 20th February 2009, a total of 4025 fingerlings of average size 28 g and 135 mm were caught from the hapa and released into the floating cage for further rearing.

Rearing of seabass fingerlings in the floating sea cage

Cage culture was conducted in a circular floating sea cage having 5 m dia and 4 m depth provided with circular frame made of HDPE pipes for floatation. The cage was provided with a catwalk railing and a stable inner net of 20 mm mesh size. The cage net was 4 m deep with a flattened bottom. Cage was protected with a predatory net of 50 mm mesh size. A bird net was fixed on the top of the cage to prevent feeding by birds. The entire cage was positioned by ballast and ropes tied to the mooring chain to withstand and absorb underwater pressure especially from winds and currents. The total effective volume of the net was 70 m^3. It was moored at a depth of 10 m, about 50 m away from the shore in the Vizhinjam Bay and hence protected from strong waves and water currents.

Before stocking, the data on total length, and body weight of random samples of animals were recorded. The fish were fed @ 5-8 % of body weight daily in the morning throughout the experimental period. The feeding regime followed was: 8% of body weight at 20 to 100 g size range, 6% at 100- 300 g size and 3-5% at 300-500 g. The cage was inspected at every 10 days' interval by underwater diving. The quantity of feed required was determined by examining regularly the quantity of feed consumed by the fishes and the rate adjusted accordingly. Periodical sampling of fishes were also carried out once in every 15 days to ascertain health status and growth of the seabass stocked in cages. Important parameters *viz*., weight gain (%), weight increase (g day^{-1}) and Specific Growth Rate (SGR) (% body weight day^{-1}) were estimated using following formulae:

Weight gain (%) = [(Final mean body weight-Initial mean body weight)/ Initial mean body weight] x 100

Weight increase (g per day) = (Final mean body weight-Initial body weight)/Number of days

SGR (% body weight p\er day) = [(ln final mean body weight-ln initial mean body weight)/ Number of days] x 100

Water quality parameters

Water quality parameters *viz*., temperature, salinity and pH at the cage culture site were monitored on a daily basis while, dissolved oxygen and total bacterial load were analysed once in a week as per APHA (1998).

Results and discussion

Water quality

The details of the water quality parameters recorded during the study period in the cage are given in Table 1. The temperature, salinity, pH, dissolved oxygen, and the total microbial load recorded in the cage were in the range 26 to 29 °C, 33.40 to 35.81 ppt, 7.68 to 8.32, 4.12 to 5.18 ml l^{-1} and 2.0 x10^2 to 4.4 x 10^5 CFU ml^{-1} respectively.

Seabass has an extremely wide thermal tolerance range (15–40 °C) and they are cultured at temperatures from 22 to 35 °C (Tucker *et al*., 2002). According to Mackinnon

Table 1. Water quality parameters recorded during seabass rearing period in the floating cage.

Sampling days	Temp. (ºC) (Mean ± SD)	pH (Mean ± SD)	Salinity (‰) (Mean ± SD)	Dissolved oxygen (ml l^{-1}) (Mean ± SD)	Microbial load (cfu ml^{-1}) (Mean ± SD)
Dec. '08	26.7±0.99	7.68±0.01	35.68±0.45	4.41±0.62	1.56x10^5
Jan. '09	26.25±1.50	8.32±0.09	33.75±0.50	5.05±0.34	2.0x10^2
Feb. '09	27±1.15	8.15±0.05	33.75±0.50	4.53±0.01	2.03x10^4
Mar. '09	28±1.15	8.22±0.15	34.33±0.52	4.97±0.04	4.4x10^5
Apr. '09	29.1±0.04	8.29±0.13	34.33±0.52	5.18±0.23	2.4x10^2
May '09	29.2±0.42	8.22±0.17	33.00±0.02	4.12±0.01	1.35x10^5
June '09	28.4±1.98	8.24±0.15	34.12±0.40	4.76±0.08	2.7x10^5

(1989), little or no growth occurs at about 20-22 °C, and increase in general activity and feeding is noticeable with each degree of increase at temperatures around 25 °C. However, optimal temperatures for growth and food conversion were observed above this level, probably in the range 27-30 °C, which is partly substantiated by Kungvankij *et al*. (1984) who reported the optimum temperature range for seabass to be 26-32 °C whereas Katersky and Carter (2005) opined that in the case of juvenile seabass, growth is optimised at temperatures from 27 to 36 °C and that they have a much wider range for maximum growth efficiency. Being a euryhaline species, seabass can be farmed either in freshwater, brackishwater, or seawater (Cheong, 1989). Other water quality parameters suitable for the rearing of seabass, as given by Kungvankij *et al*. (1984), are pH 7.5-8.5 and dissolved oxygen 4-9 ppm. According to Schipp *et al*. (2007) optimum temperature for growth of seabass is between 28 and 32 °C and the salinity range is 0–36 ppt. The values of environmental parameters obtained in the cage site during the present investigation were within the ranges suggested by Kungvankij *et al*. (1984), Cheong, (1989) and Schipp *et al*. (2007). The growth rate of cultured seabass recorded from the cage in the present study showed substantial increase which could be attributed to the favourable environmental parameters in the cage site, though cannibalism was observed occasionally.

Growth and survival

During nursery rearing, the juveniles accepted pelleted feed very well and the shoaling behaviour to feed on the floating feed was also noticed (Fig. 1). A total number of 6600 seabass fingerlings of mean weight 2.5 g and mean length 53 mm, stocked in hapas grew to an average size of 28 g and 135 mm in 60 days with a survival rate of 60%. Kailasam *et al*. (2001) observed a survival rate of 65% in higher stocking densities of 20 and 30 nos.l^{-1} in experimental conditions at CIBA, Chennai. One of the reasons for the mortality is the cannibalism observed during nursery rearing. Seabass fry is a highly carnivorous and voracious feeder and development of fast-growing individuals (shooters) during the larval phase drastically reduces the survival rate mainly through cannibalism (Kailasam *et al*., 2002). During the present investigation, weekly grading (Fig. 2) was carried out the remove the shooters (Fig. 3) inorder to avoid cannibalism.

Fig. 1. Shoaling seabass juveniles in hapa at the sight of feed

Due to some unforeseen reasons, emergency harvest of the fishes was done after 172 days post-stocking, (Fig. 4 and 5). A total of the 1027 fishes having size range of 367 to 900 g weight and 280 to 450 mm length (mean weight 540 g and mean length of 327 mm) were harvested.

Fig. 2. Hand grading of seabass during nursery rearing

Fig. 3. Shooters sorted during grading

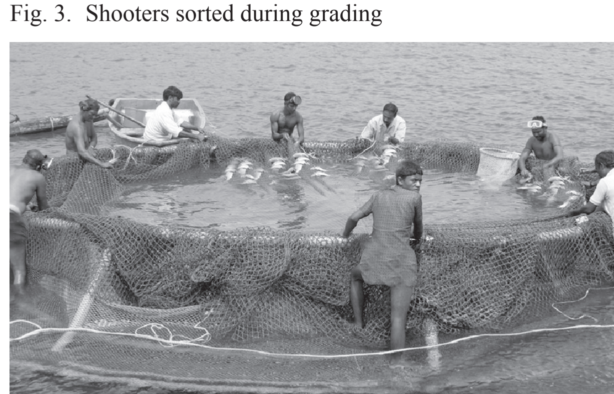

Fig. 4. Harvesting of seabass from cage

Fig. 5. Harvested seabass

Data on growth, monthly percentage weight gain, weight gain per day and SGR of *L. calcarifer* in the cage are given in Table 2. The stocking rate followed was 450 m^{-3} during the first month and 250 m^{-3} during the second month. Sakaras (1987) demonstrated that stocking density of 100 to 300 nos. m^{-3} used in cages while stocking with larger seabass juveniles having 16 cm and 60 g initial size, results in final body weight of 573.3 and 505.4 g respectively in 7 months. Weight gain per day during the initial period ranged from 0.2 to 0.38 where as the SGR ranged from 5.88 to 4.13. This is consistent with the previous reports by Katersky and Carter (2005), where SGR was 5.6% per day at 27 °C in a 20 days duration experiment using 5 g fish. In the present study, SGR decreased from 5.88 to 2.47 in the 6 months rearing period. There is an inverse relationship between SGR and fish weight and therefore, SGR decreases as fish weight increases (Jobling, 1994). Eusebio and Coloso (2000) determined SGR to be 4.1 day^{-1} for 40 g fish raised at 27–28 °C and Catacutan and Coloso (1997) found SGR of 5.0 day^{-1} when water temperatures ranged from 26.5 to 29 °C for 57 g fish.

In Thailand, stocking density followed in cages is between 40-50 m^{-3} initially, later thinning to 10-20 m^{-3} (Kungvankij *et al.,* 1984). In Singapore, similar stocking protocol is followed: initially 40-50 m^{-3} for 20-100 g size, reducing to 33 m^{-3} at 100-700 g and some farmers practise a second thinning to 27 m^{-3} at 300 g (Cheong, 1989). The final average size of seabass at the time of harvest (about 6 months) in the present study was 540 g and 328 mm. This is in conformity with the growth of seabass over 500 g in six months given by Schipp *et al*. (2007) and the growth recorded by Mackkinnon (1989) wherein 45 days old fishes of mean length 50 mm grew to 300 mm (390) g in 4 months period.

The results of the present study indicate that cage culture of seabass, *L. calcarifer,* in the sea can provide significant advantages in terms of faster growth and effective utilisation of water volume as compared to pond systems thus making it an alternative culture approach to enhance production.

Table 2. Growth and production details of seabass *Lates calcarifer* recorded during cage culture

Sampling day	No. of days (post-stocking)	Weight (g) (Mean ± SD)	Length (mm) (Mean ± SD)	Monthly % Wt. gain	Wt. gain (g day^{-1})	SGR
22. Dec. ‘08	1	2.5 ±0.9	53 ±5.2		0.20	5.88
31 Dec. ‘08	10	4.5 ±0.8	74 ±4.3			
15 Jan. ‘09	25	7.6 ±1.2	83 ±7.7	260.00	0.38	4.13
31 Jan. ‘09	41	16.2 ± 4.0	115 ±11.8			
15 Feb. ‘09	56	28.2 ± 7.8	135 ±13.8	133.95	0.78	3.04
28 Feb. ‘09	69	37.9 ± 13	143 ±14.7			
15 Mar. ‘09	84	47.5 ± 16	152 ±16.3	135.36	1.65	2.76
31 Mar. ‘09	100	89.2 ± 27	167 ±18.4			
15 Apr. ‘09	115	125 ± 55.2	189 ±25.8	133.18	3.96	2.82
30 Apr. ‘09	130	208 ± 96.5	210 ±26.3			
15 May ‘09	145	375 ±108.7	234 ±29.5	114.90	7.71	2.47
31 May ‘09	161	447 ± 116.2	287 ±36.4			
12 Jun. ‘09	172	540 ± 123.4	328 ±41.9			

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