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Farming of cobia, *Rachycentron canadum* (Linnaeus 1766) in open sea floating cages in India

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ABSTRACT

Experiments on culture and growth performance of cobia were undertaken in marine cages installed in the Arabian Sea off Karwar on the south-west coast of India. Hatchery produced cobia fingerlings were stocked at two densities of 3.5 fish cubic m^{-1} and 14.1 fish cubic m^{-1} in circular HDPE cages. Mean weight and specific growth rate (SGR) of cobia stocked @ 3.5 fish cubic m^{-1} were 10.5 kg and 2.2% day^{-1}, respectively, at 300 days of culture (DOC). Cobia stocked @ of 14.1 fish cubic m^{-1} attained an average weight of 3.68 kg and SGR of 1.9% day^{-1} at 300 DOC. SGR was found to be positively correlated with water temperature and salinity during the culture period. No significant variation was found in SGR and feed conversion ratio of cobia stocked at two different densities. However, absolute growth rate, relative growth rate and mean weight of cobia varied significantly between the two groups.

Keywords: Cage culture, Cobia, Growth rate, *Rachycentron canadum*, Stocking density

Introduction

Cobia *Rachycentron canadum*, which attains a weight of 6 to 8 kg within a year under culture conditions, is designated as a promising candidate species for aquaculture due to its rapid growth, effective feed utilisation and high market value (Chou *et al.,* 2001; Arnold *et al*., 2002; Liao *et al*., 2004; Zhou *et al.,* 2006; Benetti *et al*., 2010). Cage culture of cobia was initiated in Taiwan in early 1990's where around 80% of marine cages were devoted to cobia culture (Liao *et al*., 2004). With the success of artificial propagation and larval production, it expanded to China and other south-east Asian countries (Zhou *et al*., 2006) in addition to Australia and United States (Benetti *et al*., 2010). Several investigations were carried out on the hatchery technology and grow-out culture of cobia in marine cages (Caylor *et al*., 1994; Franks *et al.,* 2001; Faulk and Holt 2006; Holt *et al*., 2007; Benetti *et al.,* 2008; Gopakumar *et al*., 2011).

In India, marine cage culture is currently gaining importance. The present paper reports the growth of cobia stocked at different densities in floating cages. The influence of water quality parameters on the growth of cobia was also studied.

Materials and methods

The present investigation was carried out in the marine farm of the Central Marine Fisheries Research Institute (CMFRI) at Karwar (14° 49' 914" N; 74° 06' 002" E) on the south-west coast of India. Circular HDPE cages (6m diameter) with a water volume of 142 m^3 were used in the present study for rearing cobia. The cages were tied with a HDPE inner net of 4.5 m depth and a braided outer net of 5 m depth. The circular shape of the nets in the water column was maintained by providing a ballast HDPE pipe (2" dia) at the bottom of each net, inserted with an iron rope (1.5" dia). The outer net had a mesh size of 80 mm. The mesh size of the inner net during the first 90 days of rearing period was 14 mm and this was then replaced with a net of 28 mm mesh size. The depth of the water column at the cage site was around 8 m and 7 m during high and low tides, respectively. Cobia fingerlings (2500 numbers; 15 ± 1.6 g weight, 20 ± 0.8 cm total length) were brought from the Marine Finfish Hatchery of the Mandapam Regional Centre of CMFRI, India. The fish were packed in polythene bags (10 fish bag^{-1}) containing 5 l of seawater (temperature: 20 °C; salinity: 32‰; pH: 8.2) and transported by road. The transit time was 20 h. On arrival, the fish were acclimatised, conditioned and thereafter divided into two groups of 2000 (Group I) and 500 (Group II) each and stocked in two cages. The stocking density of Group I and Group II were 3.5 cubic m^{-1} and 14.1 cubic m^{-1}, respectively.

Feeding

Fish were fed with fresh chopped oil sardine (*Sardinella longiceps*) at the rate of 6% of biomass perday for the first 3 months. The feeding rate was reduced by 2% every 3 months for the following period. The fish were fed twice daily (split feeding) at 06 00 hrs and 18 00 hrs .

Regular sampling at fortnightly intervals was made during the entire culture period fhor monitoring the growth parameters of the fish. Random sampling was done by netting during feeding and the size of the sample varied between10 to 30 fishes. Length (cm), weight (g), weight gain (g), absolute growth (AG), absolute growth rate (AGR), relative growth (RG), relative growth rate (RGR) and specific growth rate (SGR) were analysed monthly using the following formulae:

$AG\ (g) = W_2 - W_1$

$AGR\ (g\ day^{-1}) = (W_2 - W_1)/(t_2 - t_1)$

$RG = (W_2 - W_1) / W_1$

$RGR = (W_2 - W_1) / W_1 \times (t_2 - t_1)$

$SGR\ (\%day^{-1}) = 100 \times (\log W_2 - \log W_1) / (t_2 - t_1)$

where, W_2 is the mean final body weight, W_1 is the mean initial body weight and t_2-t_1 represents the number of days between samplings.

Overall AG, RG, AGR, RGR and SGR were also analysed at the end of culture period using the above formulae where, W_1 represents mean initial weight of fish at the time of stocking, W_2 is the mean final weight of fish at the end of grow out period and t_2-t_1 represents the grow-out period.

FCR was estimated by calculating the ratio between the total weight of feed given and the total weight of fish at the end of the culture period (Benetti *et al*., 2010). Monthly FCR values were also estimated using the formula: FCR = TFC / BI where, TFC is the total amount of feed consumed (kg) and BI is the biomass increase.

Water quality parameters like temperature, pH, salinity and DO were monitored daily using portable instruments and critical parameters like ammonia, nitrate and nitrite were analysed at fortnightly intervals using standard methods (APHA 2004). Nets were regularly cleaned off biofoulers. Cage nets were examined routinely by diving. Mortalities were recorded by visual observation and removal of dead fish in the cages.

Results of the study were subjected to 'F' test to understand the significant difference between the parameters and experimental groups. Correlation analysis was performed to study the relationship between water quality and growth parameters.

Results

Overall mean values of various growth parameters are given in Table 1. Mean final weight of cobia at 300 DOC was 10.5 kg and 3.68 kg for Group I and Group II respectively (Fig. 1). Growth in weight was best expressed by the equation $y = 5.766e^{0.022x}$, $R^2 = 0.981$ and $y=6.997e^{0.019x}$, $R^2 = 0.963$ for Group I and Group II, respectively (Fig. 2). AG and RG values of Group I were 10485 g and 699 g, respectively. In Group II, AG and RG

Table 1. Growth parameters of cage cultured cobia

Parameters	Group I	Group II
Initial stocking density (fish cubic m^{-1})	3.5	14.1
Final stocking density (fish cubic m^{-1})	3.1	10.6
Initial age at stocking (dph)	60	60
Age at the end of culture (dph)	360	360
Growout duration (days)	300	300
Average initial size (g) at the time of stocking	15	15
Average final size (g) at the end of experiment	10500	3680
Absolute growth (g)	10485	3668
Relative growth (g)	699	30.57
Absolute growth rate (g day^{-1})	34.95	12.2
Relative growth rate (g)	2.33	1.02
Specific growth rate (% day^{-1})	2.2	1.9
Instantaneous growth rate (g day^{-1})	0.022	0.019
FCR	1.4	1.75

values were 3668 g and 30.57 g, respectively. AGR was found to be 34.95 g day^{-1} for Group I and 12.2 g day^{-1} for Group II. RGR of cobia was 2.33 for Group I and 1.02 for Group II, respectively. SGR values of Group I and Group II were 2.2 and 1.9, respectively at 300 DOC.

Mean weight of cobia varied significantly ($p<0.05$) between the two groups. AGR of Group II showed a significant ($p<0.05$) increase from 180 days of culture (DOC) to 240 DOC in Group II (Fig. 3). A significant ($p<0.05$) difference in AGR and RGR values between two groups was observed. SGR decreased with an increase in

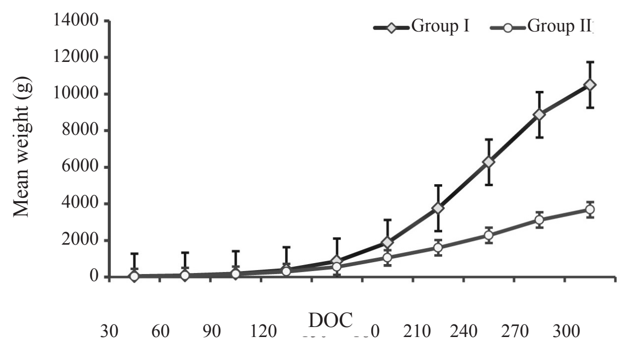

Fig. 1. Mean weight of cobia reared in open sea cage (vertical bars indicate SE)

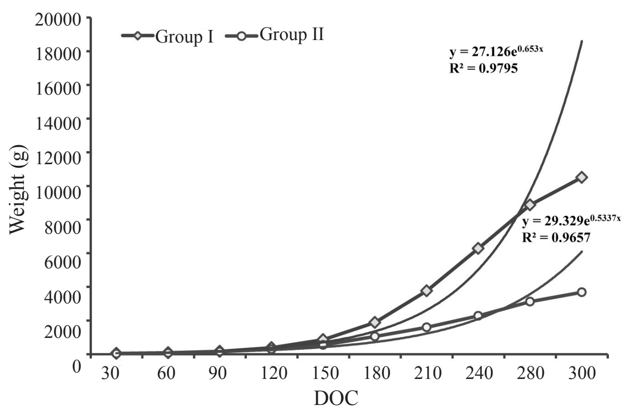

Fig. 2. Growth of cobia stocked at two different densities

the DOC in both the groups (Fig. 4). No significant ($p>0.05$) variation was observed in the SGR of cobia between the two groups. Similarly, no significant ($p>0.05$) difference in biomass increase was found between the groups.

The percentage survival in the present study was 90 in Group I and 75 in Group II. Final density was recorded as 3.1 and 10.6 fish cubic m^{-1} for Group I and Group II, respectively. FCR values of Group II varied from 1.1 to 3.5 and those of Group I varied from 1.1 to 3.8. FCR values steadily decreased with an increase in biomass of both the groups and the overall FCR was 1.4 and

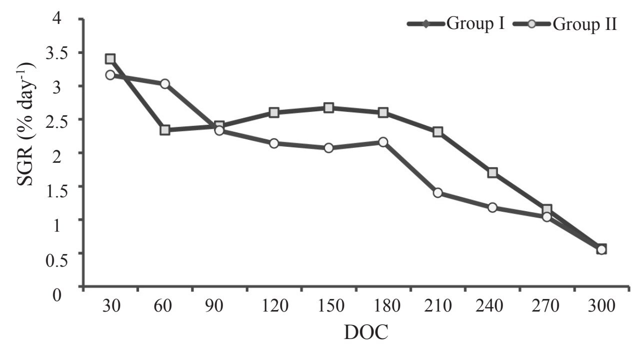

Fig. 3. Specific growth rate of cage cultured cobia at two different stocking densities

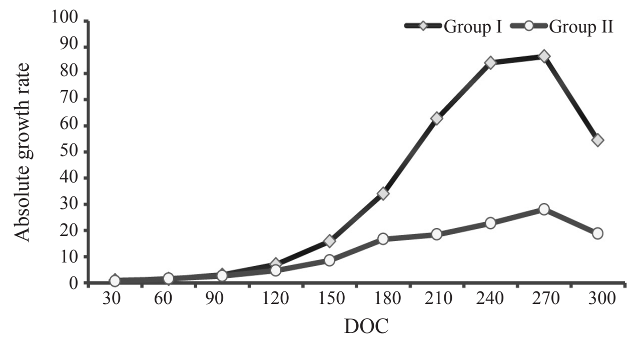

Fig. 4. Absolute growth rate of cage cultured cobia at two stocking densities

1.75 for Group I and II, respectively at 300 DOC (Fig. 5). There was no significant ($p>0.05$) difference between FCR values of the two groups.

The values of water quality parameters studied are shown in Table 2. Monthly mean values of water quality parameters were as follows: temperature: 28.3±0.3°C; salinity: 24.8±2.9‰; DO: 4.5±0.2 mg l^{-1}; pH: 8.2±0.02; ammonia: 0.02±0.001 mg l^{-1}; nitrate: 2.1±0.5 mg l^{-1}; nitrite: 0.4±0.05 mg l^{-1}. A positive correlation (r=0.7 and 0.6 for Group I and Group II, respectively) was observed between temperature and SGR of cobia in both the groups (Fig. 6). SGR and salinity were also found to be positively correlated (r=0.9 and 0.8 for Group I and Group II, respectively) in both the groups (Fig. 7). No correlation was observed between SGR and other water quality parameters in both the groups.

Discussion

In the present study, the mean final weight of cobia stocked at a lower density of 3.5 cubic m^{-1} was found to be better than in cobia stocked at higher density of 14.1cubic m^{-1}. Benetti *et al.* (2010) recorded an average weight of 6 kg in cobia stocked at lower

Table 2. Water quality parameters at cage culture site

Parameter	Mean ±SE
Temperature (°C)	28.3±0.3
Salinity (‰)	24.8±2.9
Dissolved oxygen (mg l^{-1})	4.5±0.2
pH	8.2±0.02
Ammonia (mg l^{-1})	0.02±0.001
Nitrates (mg l^{-1})	2.1 ± 0.5
Nitrites (mg l^{-1})	0.4 ± 0.05

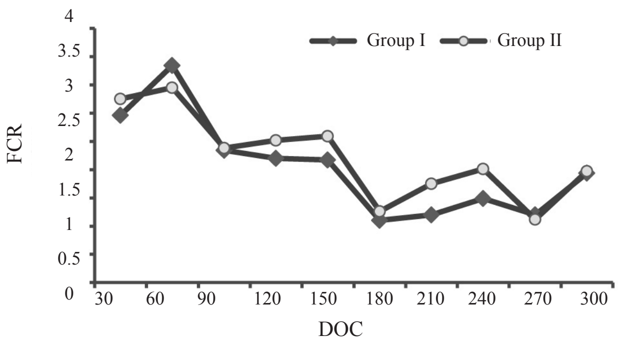

Fig. 5. FCR values of cobia reared in open sea cage

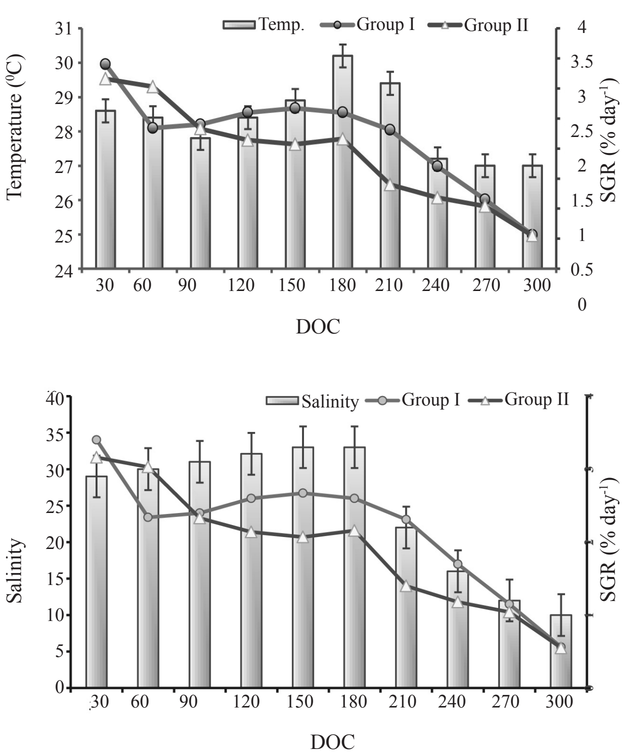

Fig. 6. SGR of cage reared cobia in relation to: (a) Water temperature; (b) Salinity (vertical bars indicate SE)

density (13.3 m^{-3}) and 3.5 kg stocked at a higher density (23.3 m^{-3}) after 363 and 343 days post-hatching. Cobia with a stocking density of 3 nos. m^{-3} cultured for a period of 8 months by feeding with pellet feed in offshore grow-out cages reached a market size of 6 to 8 kg in 8 months (Liao *et al*., 2004).

The SGR was found to decrease with an increase in DOC in both the groups in the present investigation. Similar observations were recorded by Benetti *et al*. (2010) where a noticeable decrease in the growth rate of cobia at 300 days post-hatching was observed. They also reported that the growth rate of cobia was faster when compared to those of *Lutjanus analis* (Benetti *et al*., 2002) and *Dicentrarchus labrax* (Kavadias *et al.,* 2003) reared in floating marine cages.

In the present investigation, survival rate decreased in the initial months which could be due to mortalities because of stress during transportation. Benetti *et al*. (2010) reported a wide variation in survival rate of cobia in grow-out culture with a low survival rate of 10% due to diseases and escapes from cages. Survival rate of cobia in small scale cage farms at harvest ranged from 50 to 70% while the survival rate of commercial cage farms was only 30 to 40% (Liao *et al*., 2004).

A positive correlation was observed between temperature and SGR of cobia in both the groups. Liao *et al.* (2004) found retarded growth in cobia at low temperature and decrease in temperature below 16°C lead to mass mortalities. Yu and Ueng (2007) observed that the growth rate of cobia varied considerably with water temperature reaching the highest values at 28.6°C to 30.5°C. The authors further stated that growth rate was faster during summer compared to winter. Sun *et al.* (2006) observed 44% improvement in growth of cobia with a rise in temperature of 4°C. Benetti *et al.* (2010) reported that both temperature and stocking density influence the growth rate of cobia. They observed 23% faster growth rate of cobia with a rise in temperature of 2.3°C.

The present study also revealed a positive correlation between salinity and SGR. Salinity had an immediate and significant effect on the growth of juvenile cobia with a salinity of about 30% being optimum for the culture of juvenile cobia (Chen *et al.,* 2009). However, Resley *et al.* (2006) reported that juvenile cobia reared at a salinity of 5‰ grew better than the fish reared at salinity of 15 and 30‰. Benetti *et al*. (2010) recorded lower salinity (2.6‰) and DO (0.8 mg l $^{-1}$) values at cage site, but did not find any influence of these low values on growth rate of cobia.

FCR values steadily decreased with an increase of biomass in both groups during the culture period. Liao *et al.* (2004) recorded FCR value of 1.5 for cobia reared in grow-out cages. Benetti *et al*. (2010) observed a variation in FCR values between 1.3 and 2.2 and the overall estimated FCR of cobia was 1.8 at 10 months culture period. A similar trend was observed in the present study.

In conclusion, the present study, being the first report of cobia farming in floating net cages from India, recorded better values with respect to several growth parameters studied, at a low stocking density of 3.5 fish cubic m^{-1} when compared to values at high stocking density of 14.1 cubic m^{-1}. The final mean weight of cobia in the two groups exhibited a wide variation at 300 DOC but statistically no significant difference was observed in SGR and FCR of both the groups. Water temperature and salinity were also found to have an influence on SGR. An initiation was made on marine cage farming of cobia in India and further studies are required to standardise optimum levels of feeding, stocking density, carrying capacity and environmental factors to achieve sustainable open sea cage farming of cobia.

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