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First experience in the larviculture of cobia, *Rachycentron canadum* (Linnaeus, 1752) in India

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ABSTRACT

Cobia aquaculture has been gaining momentum internationally and has spread to more than 23 countries, half of them in the Asia-Pacific region. Envisaging the prospects of cobia farming in India, broodstock development was initiated and the first successful induced breeding was achieved in March 2010. Larviculture was experimented in Fibre Reinforced Plastic (FRP) tanks as well as Reinforced Cement Concrete (RCC) tanks and protocols were evolved. Green water technique employing the microalga, *Nannochloropsis oculata* was used. The critical stage for the larvae was from 5 to 9 days post-hatch (dph), when cumulative mortality reached around 90%. Enriched rotifers were fed from 3 to 10 dph and enriched *Artemia* nauplii from 9 to 18 dph. Weaning with larval inert feed was initiated from 18 dph and grading was carried out once in four days to avoid cannibalism. The study was conducted for 31 days and the final larval survival noted in the FRP and RCC tanks were 2 and 1%, respectively. At the end of the experiment, the specific growth rate of larvae in the FRP system was 30.1% of body weight per day, while the same in RCC tank was 28.3% of body weight per day. The low survival and specific growth rate of larvae in the RCC tanks could be attributed to the low densities of live feed maintained. The present experience indicated that cobia seed production can be successfully practised and by refining the methodology, the survival and growth can be enhanced to achieve commercial level fingerling production.

Keywords: Cobia, Feeding protocol, Larviculture, *Rachycentron canadum*, Specific growth rate

Introduction

Cobia, *Rachycentron canadum* has emerged as a lucrative species for warm water mariculture in recent years. Fast growth rate, adaptability for captive breeding, low cost of production, good meat quality and high market demand especially for *sashimi* industry are some of the attributes that make cobia an excellent species for aquaculture. Under culture conditions, cobia can reach 3-4 kg body weight in one year and 8-10 kg in two years. The species has protracted spawning season, can spawn in captivity and the fecundity is very high. Cobia aquaculture was initiated in 1990s in Taiwan (Yeh, 2000; Liao *et al*., 2004). Large scale seed production technology was developed during 1997 which led to the development and expansion of cage culture industry in Taiwan (Yeh *et al.,* 2000). Thereafter cobia aquaculture has gained momentum in Asian countries especially Taiwan, Vietnam, China, Philippines, Indonesia and Iran. Recently, Australia and Marshall Island have started developing hatchery technology and farming of cobia. In the west, research intensified in the late 1990s when the first successful spawns were obtained from captive broodstock fish (Arnold *et al*., 2002). Several advancements were made since then (Caylor *et al*., 1994; Du Paul *et al*., 1997; Franks *et al*., 2001; Schwarz *et al.,* 2006, 2007; Holt *et al*., 2007a; Bennetti *et al*., 2008b; Bennetti *et al*., 2010). Today cobia aquaculture has been initiated in over 23 countries, half of them in the Asia-Pacific region. Global aquaculture production of cobia has increased rapidly from mere 9 t in 1997 to nearly 30,000 t in 2007.

India is a late starter in cobia research. Envisaging the prospects of cobia farming in India, broodstock development was first initiated at the Mandapam Regional Centre of Central Marine Fisheries Research Institute in sea cages in 2008 and the first successful induced breeding was achieved in March 2010 (Gopakumar *et al.,* 2011). The larviculture protocol followed and the results obtained are communicated in the present paper.

Materials and methods

Newly hatched larvae were stocked in 15 fiber reinforced plastic (FRP) tanks and two reinforced cement

concrete (RCC) tanks of 5 t and 100 t capacity each, respectively. Each FRP tank was filled up to a volume of 3 t and each RCC tank filled up to 70 t. In each FRP tank, on an average, 50,000 larvae were stocked at an approximate stocking density of 17 larvae per litre. In each RCC tank, 5,75,000 larvae was stocked at a stocking density of 8 larvae per litre.

Green water technique employing the microalga, *Nannochloropsis oculata*, was used during the larviculture up to the weaning period. Enriched rotifers and *Artemia* with DHA SELCO (INVE Thailand) were used as live feed. From 18 day post-hatch (dph), the larvae were weaned with artificial feed (INVE Thailand). Grading was initiated from 18 dph onwards to avoid cannibalism. Due to limited facility available for live feed production, only about half the density of algae, rotifers and *Artemia* could be maintained in RCC tanks when compared to the FRP tanks. Rotifer enrichment with DHA SELCO was carried out for a period of 24 h prior to usage. The *Artemia* nauplii were enriched with DHA SELCO for a period of 12 h prior to usage.

Natural photoperiod was used for both types of rearing tanks with illumination curtailed up to 70% using translucent FRP sheets in the hatchery roof. Salinity (by hand-held refractometer), dissolved oxygen, DO (by Winkler's method) and temperature (using mercury thermometer) were recorded in each tank daily. Salinity and temperature ranged from 33-35 ppt and 28-29 °C respectively. The DO recorded ranged from 4.5 to 6 mg l^{-1}.

Dead larvae collected using appropriate strainers during the period of water exchange were counted daily for estimating the mortality. On alternate days, the larval length in 150 specimens was measured to the nearest mm. Photomicrographs were taken using Zeiss Stemi-2000C Stereo-microscope and Canon Powershot-G10 camera. The study was conducted for a period of 31 days.

Specific growth rate (SGR) was calculated, as follows, to estimate the percentage body weight increase per day.

$$SGR = \frac{\ln \text{final weight (g)} - \ln \text{Initial weight (g)}}{\text{Duration of the experiment (days)}} \times 100$$

Results and discussion

Larval feeding protocol

The density of different types of feed provided, feeding frequency and water exchange details in the FRP and RCC tanks are given in Table 1. The FRP larviculture tanks had green water at a density of about 1 x 10^5 cells ml^{-1} and enriched rotifers at a density of 10 to12 nos. ml^{-1} from 3 to 10 dph. From 9 to 18 dph, the larvae were fed two times daily with enriched *Artemia* nauplii at a density of 3-5 nos. ml^{-1}. During this period, co-feeding with rotifers was also continued up to 12 dph due to the presence of different size groups of larvae. Green water was also maintained in appropriate densities in the larval tanks. From 18 dph onwards, the larvae were partially fed with larval inert feeds, in addition to enriched *Artemia* nauplii. The

Table 1. Cobia larviculture feeding protocol

Green water / Feed	DPH	Density		Frequency of feeding	Water exchange	
		FRP tanks	RCC tanks		FRP tanks	RCC tanks
Green water (*N. oculata*)	0 – 2	1 x 10^5 cells ml^{-1}	1x 10^2 cells ml^{-1}	Nil	0 %	0 %
Green water +Enriched rotifer	3 – 10	10-12 nos. ml^{-1}	5-6 nos. ml^{-1}	2 times day^{-1}	20%	5 %
Green water + Enriched *Artemia* nauplii	9 – 18	3-5 nos. ml^{-1}	1-2 nos. ml^{-1}	2 times day^{-1}	70%	25 %
Enriched *Artemia* nauplii + formulated feed (300-500 µ particle size)	18 – 25	Weaning started	Only enriched *Artemia* nauplii	2 times day^{-1}. In FRP tanks, formulated feed was provided 30 min., before live feed	100% Grading on every third day	30 % No grading
Formulated diets (300-500 µ to 600-800 µ)	25 dph onwards	Formulated feed was provided *ad libitum*	Weaning started	3 times day^{-1}	100 – 200% Grading on every third day	30 % Grading on every third day
Formulated diet (0.8-1.2 mm)	30 dph	Formulated feed was provided *ad libitum*	Formulated feed was provided *ad libitum*	3 times day^{-1}	100 – 200% Grading on every third day	30 % Grading on every third day

size of weaning feeds used was 300-500 μ up to 25 dph. From 25 dph onwards, only formulated feed in the size range of 300-500 μ to 600-800 μ were used.

The RCC larviculture tanks had green water at a density of 1 x 10^2 cells ml^{-1} and enriched rotifers at a density of 5-6 nos. ml^{-1} from 3-10 dph. During 9-18 dph, the larvae were fed twice a day with enriched *Artemia* nauplii at a density of 1-2 nos. ml^{-1} Thereafter the protocols of feeding followed were as in the case of the FRP tanks. The use of microalgae in marine fish larviculture is regarded as extremely important from environmental, nutritional and economic perspectives (Benetti *et al*., 2008a).

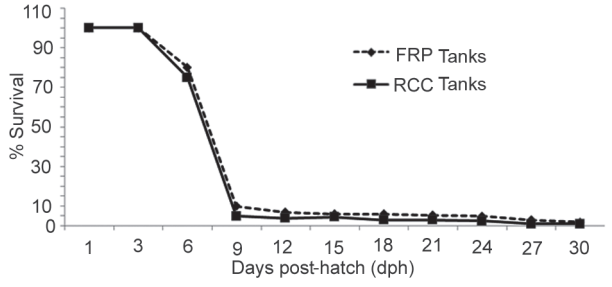


Fig. 1. Survival percentage of cobia larvae in two larviculture systems

A good deal of literature is available on the feed and feeding protocols of cobia larvae (Faulk and Holt, 2005; Holt *et al.,* 2007b; Benetti *et al*., 2008a; Nhu *et al.,* 2010). The green water technique for larviculture was also widely used for other marine finfishes (Nhu *et al.,* 2010). Nhu *et al*. (2010) reported successful use of enriched rotifers in cobia larviculture from 3 to 11 dph. Subsequently, they used freshly hatched nauplii of *Artemia franciscana* during 8-13 dph and enriched *Artemia* nauplii during 11- 28 dph. The initial stocking density was 30-50 larvae l^{-1}.

Benetti *et al*. (2008a) maintained a stocking density of 5 to 10 cobia larvae l^{-1}. They fed the larvae with *Isochyrsis galbana* C-strain at a density of 5-10,000 cells ml^{-1} from 3 dph and enriched rotifers (*Brachionus plicatilis*) at a density of 3-5 nos. ml^{-1} up to 9 dph. From 7 dph onwards, the larvae were also fed with enriched *Artemia* (*A. franciscana* GSL strain) nauplii at a density of 0.1-1 no. ml^{-1}. The larvae were completely weaned onto dry starting diets between 20-22 dph.

In yet another feeding protocol reported by Faulk and Holt (2005), the larvae were fed with enriched rotifers on 3-7 dph and newly hatched *A. franciscana* nauplii during 6-9 dph followed by 24 and 48 h enriched *Artemia* until weaning. In the present study, the rotifers and *Artemia* were enriched with DHA SELCO. An experiment by Faulk and Holt (2005) on cobia larviculture with enriched rotifers and *Artemia* suggested that the enrichment of rotifers might be less important than the enrichment of *Artemia*.

Larval survival

The larval survival in FRP and RCC tanks are given in Fig. 1. Though the data on survival percentage is given at an interval of 3 days, mortality was noticed from 5 dph onwards. The critical stage for the larvae was from 5-9 dph when they resorted entirely to exogenous feed from yolk sac feeding. During the period, high cumulative mortality of about 90% was recorded in the FRP tanks and 95 % in the RCC tanks. Thereafter, the mortality was marginal in both FRP and RCC tanks. On 30 dph, the survival percentages noted in the FRP and RCC tanks were 2 and 1% respectively. The reduction in the survival percentage in the RCC tanks could be attributed to the lower densities of live feeds maintained.

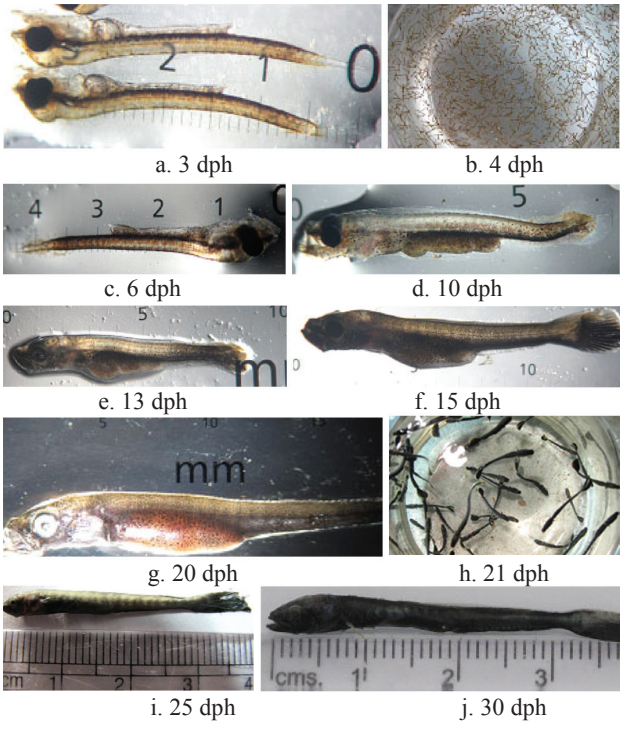
Faulk and Holt (2005) reported that survival of 16 dph cobia larvae (15 mm SL) significantly improved from 12 to 25% by addition of live algae (*I. galbana* or *N. oculata*) to the rearing tanks. Holt *et al*. (2007b) reported that survival was significantly reduced when live prey were eliminated before 25 dph. Hitzfelder *et al*. (2006) negatively correlated cobia growth and survival with increasing density (1 to 20 larvae l^{-1}) in 300 l tanks with temperature and photoperiod control. At high density all larvae did not initiate feeding and mortality was high over the first 10 days.

Growth pattern

The different stages of larvae and fingerlings are presented in Fig. 2. It was noted that the growth pattern was similar in both larviculture systems up to 13 dph (Fig. 3). Growth rate increased thereafter in the FRP tanks when compared to the RCC tanks. On 31 dph, the mean length of larvae noted in the FRP tanks was 64.8 mm and the same in RCC tanks was 52.6 mm.

The specific growth rate (SGR) of larvae in the FRP system was observed to be 30.1% body weight per day, while the same in RCC tank was estimated to be 28.3% body weight per day. Lower concentrations of live feed in the RCC tanks when compared to the FRP tanks could be the major factor which resulted in lower mean length and SGR in RCC tanks. The larvae of cobia showed SGR of 12.5-19.2% body weight per day when reared in fertilized ponds in southeastern United States (Weirich *et al*., 2004). Holt *et al.* (2007b) reported SGR of ~31 % body weight per day in cobia larviculture conducted in 1100 l tanks at 28.5 °C.

Even though the present study is the first one of its kind conducted in India, several limitations including the lack of state of the art hatchery led to the low survival rates obtained. Survival and growth, therefore can be improved by augmenting the required facilities and perfecting the feeding protocols. The present experience indicates that



dph : days post-hatch

Fig. 2. Larval growth pattern of cobia in FRP and RCC tank systems

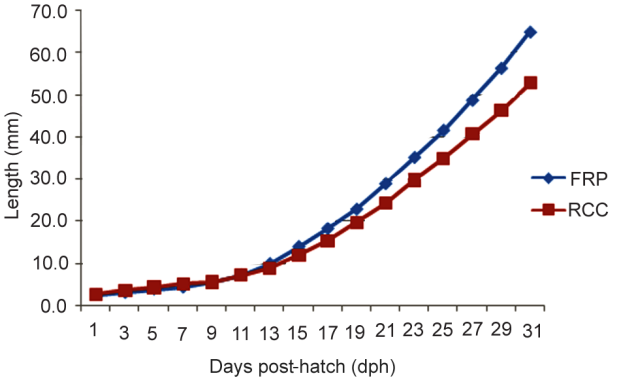


Fig. 3. Different stages of cobia larvae and fingerlings

cobia larviculture can be successfully practised in India by refining the technology. Consistent production of cobia fingerlings all through the year can pave the way for the development of cobia aquaculture in the country.

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