Spawning and larviculture trials of cobia, *Rachycentron canadum* (Linnaeus, 1766) in the United Arab Emirates

Omer M. Yousif, Do V. Minh, Krishna K. Kumar, Abdul-Fatah A. Abdul-Rahman and Bui V. Hung[1]

Cobia *Rachycentron canadum*, the sole representative of the family Rachycentridae, is a migratory pelagic species that occurs in tropical and subtropical seas except for the eastern Pacific (Arnold *et al*. 2002). It is a gonochoristic species that has demonstrated the capacity for high fecundity and ease of induced and natural spawning in captivity (Holt *et al.* 2007, Benetti *et al.* 2008a). They are multiple batch spawners with a protracted spawning period (Faulk and Halt 2003, Benetti *et al.* 2008b). The information available on the timing of gonadal maturation in different parts of the world indicates that cobia spawn from April through September with the peak in spring and early summer (Kilduff *et al.* 2002, Faulk and Halt 2003).

Because of the success achieved around the world in commercial farming, cobia is sought as a potential candidate for aquaculture at Abu Al Abyad Island, Emirate of Abu Dhabi, United Arab Emirates (UAE). The real challenge, in such an attempt, is the ability of cobia to successfully cope with the harsh conditions prevailing on the island. The sea water temperature readings reach as high as 36ºC and salinity as high as 55 ppt. Despite this stressful environment, the productivity of the waters around the island is surprisingly high (Al Abdessalaam and Yousif 2002).

Fig. 1. Anesthetized cobia female cannulation.

This article reports the first trials on the potential of spawning and larviculture production of cobia at the Aquaculture Center, Abu Al Abyad Island (ACAAB), UAE. The trials were first conducted usign full strength natural seawater (51 ppt) of Abu Al Abyad Island and then later using diluted seawater (37 ppt).

Broodstock Management

In 2008 the broodstock, initially imported as fry from Taiwan in 2005 and grown in marine cages (51 ppt salinity) at ACAAB, were conditioned for spawning. From October to December 2007 they were fed trash fish and squid at five percent of body weight (BW) per day. From January to the anticipated spawning month of April 2008, the fish were fed trash fish and squid supplemented with minerals, vitamins and fish oil at 2-2.5 percent BW per day. During mid-March fish of both sexes were selected and transferred to 40 t indoor spawning tanks (STs). Only females with cannulated oocytes with an average diameter of ≥ 800µm (Figure 1) and running ripe males were selected for spawning. Clove oil (4-Allyl-2-methoxyphenol) in a dose of 0.01 ppm was used to anaesthetize the fish during cannulation and transportation from the cages to the STs. Thirty-nine females averaging 8.4 kg BW and thirty-nine males averaging 8.1 kg BW were stocked in each of the 40 t STs at a ratio of 1:1. The total number of brooders in each ST was 6 fish (total biomass per tank was 50.1 kg). Twenty one females were left to spawn naturally and 18 females were induced with a dose of human chrionic gonadotropin at 1,000 IU/kg BW. During the spawning period the water salinity was 55 ppt, water temperature ranged between 24 and 28ºC, dissolved oxygen ranged between 5-6 ppm and photoperiod was maintained at 12:12. All spawning, hatching and larval rearing tanks were plumbed to a common sand filteration system and an ultraviolet sterilization unit.

During the 2009 trials, the same protocol for broodstock management was followed except that all brooders were gradually acclimated in the STs to 37 ppt seawater in the first week of March. A total number of 15 females averaging 11.9 kg BW and 30 males averaging 9.3 kg BW (1 female:2 males)

were stocked for spawning. The broodstock adapted fairly well to the reduced salinity where they were observed to feed voraciously and actively swim around the STs.

Spawning and Hatching

During courtship, individual males and females were observed to pair up where males were swimming below the females and continuously hitting the belly of the females resulting in some injuries to their heads. Courtship lasted for almost six hours before spawning took place.

Fig. 2. Egg incubation baskets.

In 2008 the females successfully spawned either naturally or through induction. The fish usually spawned in the evening and eggs were collected the following morning. The spawning period extended for 38 days (March 25-May 01) during which the females yielded a total of 12,206,600 eggs out of which 61.13 percent were good eggs. At the initiation of the spawning trials the floating eggs were collected in fine-meshed 400µ collection buckets placed at the overflow waters from the spawning tanks. The volumetric estimates (approx. 425 eggs/mL) and quality of the collected eggs were determined using a graduated cylinder. However, it was observed that out of the first collections of 2.6 million buoyant eggs, only 7 percent good eggs were separated by the measuring cylinder. This suggested that the eggs were damaged during the collection process through the overflow pipe and, hence, that collection method was replaced by manual collection of the floating eggs by trawling a fine-meshed scoop net to and fro across the water surface of the STs. Fertilized eggs, averaging 1.14-1.24 mm diameter, were transferred to 600 µ mesh incubation baskets (200 L working volume) at an average density of 360 eggs/L. All hatching buckets were placed in 5 t rectangular fiberglass tanks with flow-through filtered and sterilized seawater (Figure 2). About 88 percent of the fertilized eggs produced in 2008 were incubated in 51 ppt seawater at a water temperature of 25-28ºC. The hatching rate attained after 32-38 hours was 37.1 percent. On the other hand, 865,200 fertilized eggs were incubated in 37 ppt seawater and the hatching rate attained was 66 percent.

In 2009 all trials of cobia spawning and egg incubation were conducted at 37 ppt. The spawning period extended for 28 days (March 30-April 26) during which all fish spawned naturally at 24-28ºC yielding 19.16 million eggs out of which 70.96 percent were fertilized good eggs. Incubated eggs hatched after a period of 36 hours at a water temperature of 26.4ºC. The average hatching rate recorded was 70 percent (Table 1).

Larval Rearing

The larval rearing tanks (LRTs) used during both spawning seasons were indoor rectangular concrete or fiberglass tanks ranging in volume from 4-40 t and all were equipped with flow-through filtered and sterilized seawater systems. Cobia larvae ranging in size from 2.8-3.2 mm were stocked at a rate of 30 larvae/L.

In the first two days posthatch (ph), larvae in all LRTs were kept under complete darkness by covering the tanks with green mesh sheets. During that period water exchange was carried out during night at a rate of 100-200 percent. On day 3 ph, the green covers were removed and algae, *Nannochloropsis* sp., was added daily at a rate of 10-25 percent of water volume in each LRT. In addition to the natural photoperiod, overhead fluorescent lighting was provided 12 hours during day time. Green algae, artificial lighting and gentle aeration of the LRTs were provided throughout the rearing period. The water temperature in the LRTs ranged from 22-32ºC. From day 3 to 11 ph, rotifers *Brachionus rotundiformis*, 66-146µm, (enriched for 6-8 hours with super HUFA,[2] >45 percent ω3 fatty acids, >16 percent eicosap-

entaenoic acid, >30 percent docosaheexaenoic acid [DHA], >2.0 percent arachidonic acid prior to feeding) were offered. Rotifers were added twice daily to maintain a density of 10-15 individuals/ml in the LRTs. During rotifer feeding water exchange was done only during night at a rate of 30-50 percent of volume.

From days 8 to 25 ph, enriched *Artemia* nauplii were added to the LRTs at 0.5-1 nauplius/ml. Additionally, copepod nauplii collected from the shrimp ponds were provided to the larvae from days 10 to 25 ph at a rate of ≤1 individual/ml. The addition of artificial feed (Love larva[3]) started on day 15 ph with the small feed size of 198 µm (57.40 percent crude protein, 12.42 percent fat) until day 25 ph. From days 20 to 35 ph, artificial feed of medium size 308-476 µm (crude protein 58.35 percent, 13.94 percent fat) was added and, from days 30 to 40 ph, the larger size artificial feed, 680-1058 µm (crude protein 56.23 percent, 3.52 percent fat) was provided (Figure 3).

No newly hatched larvae reared in 51 ppt seawater during 2008 fed and all died on day 3 ph. It was reported that in Taiwan, cobia food uptake was reduced by 50 percent when salinity was increased from 35 ppt to 43 ppt and when it was increased to 47 ppt, food uptake virtually stopped and mortality began (ACE 2003).

Larvae reared at 37 ppt in 2008 yielded 8,000 fully metamorphosed 8.60 cm total length, 1.82 g fingerlings by day 40 ph for an overall survival rate of 1.03 percent. The 2009 trials, where fish were spawned, hatched and reared 37 ppt, generated a total of 48,428 fingerlings averaging 7.40 cm in length and 1.90 g BW (Figure 4)/ The average survival rate attained was 0.54 percent.

Cannibalism was believed to be the major cause of mortality during the later stages of larval rearing from day 20 ph. To reduce cannibalism and size variability cobia were graded daily by size after day 20 and large individuals were separated out and stocked in different LRTs (Figure 5). It was also believed that the quantity of copepods provided to the larvae (≤1 individual/mL) was not sufficient to maintain

Table 1. Cobia spawning and hatching performance at ACAAB during the 2008 and 2009 trials.

No. Broodstock	Spawning period (days)	Salinity (‰)	Av. water temp. (ºC)	No. eggs incub.(10^3)	Incub. period (hrs)	Hatching rate (%)
Year 2008						
39♀:39♂	38	51	26	7461.89	34	37.10
3♀:3♂	7	37	26	865.20	34	65.85
Year 2009						
15♀:30♂	48	37	26.4	12699.05	36	69.98

Table 2. Larval rearing of Cobia at ACAAB during the 2008 and 2009 trials.

Salinity (‰)	No. larvae stocked (10^6)	Rearing period (days)	Av.water temp. (ºC)	No. fingerlings	Survival rate (%)
Year 2008					
51	1.99	40	25	0.0	0.0
37	0.78	40	25	8000	1.03
Year 2009					
37	9.74	37	27	45000	0.54

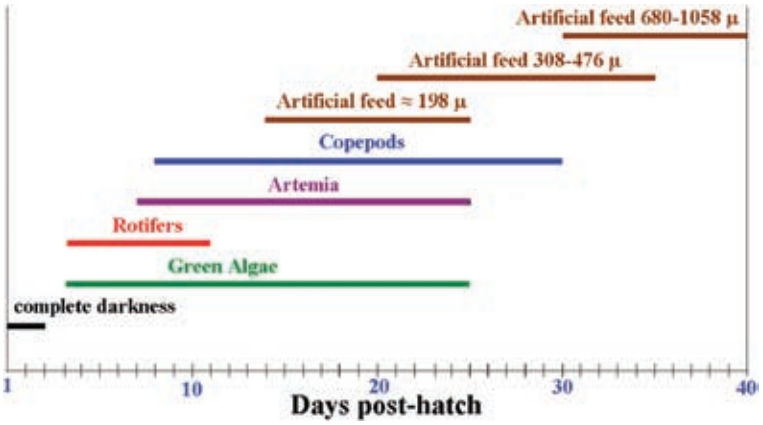

Fig. 3. Feeding schedule for larval cobia rearing.

Fig. 4. Forty-day weaned cobia.

good growth and survival rates. Improved growth, survival and/or rate of normal pigmentation have been documented for several marine fish species fed copepods alone or as a supplement to the traditional diets of rotifer or *Artemia* nauplii compared with traditional diets alone (Størttup and Norsker 1997, McEvoy *et al.* 1998, Nanton and Castell 1998, Payne *et al.* 2001, Graeb *et al.* 2004). The superiority of copepods over enriched *Artemia* was attributed to their higher levels of acid (DHA; 22:6n-3) and other polyunsaturated fatty acids (McEvoy *et al.* 1998, Shields *et al.* 1999). Therefore, it is highly recommended to pay special attention to this live food component in future larval cobia rearing and higher levels of copepods should be considered (≥2 individuals/mL).

Fig. 5. Cobia grading.

After weaning the 40 day ph larvae were gradually adapted to 51 ppt and further grown for 30 days in either 40 t circular concrete tanks at a density of 75 fish/m^3 or in 55 m^3 nearshore cages at a stocking density of 100 fish/m^3.

Conclusion

The results obtained during the 2008 cobia spawning trials under hypersaline conditions of natural seawater of Abu Al Abyad Island (51 ppt), provided a clear indication of the inappropriateness of such a high salinity level for the propagation and larval rearing of the species. However, the results obtained under a more moderate salinity of 37 ppt demonstrated the possibility of successfully spawning and rearing of in the area. The survival rates obtained diromg both seasons were unsatisfactory and further research under local conditions to optimize larviculture operations is recommended. Important in this respect are broodstock management, stocking densities, larval feeding and grading.

Acknowledgments

The authors are grateful to the staff of the Aquaculture Center at Abu Al Abyad Island for their sustained hard work and enthusiastic cooperation.

Notes

[1]Aquaculture Center, Abu Al Abyad Island, Department of the President's Affairs, P.O. Box 372, Abu Dhabi, United Arab Emirates, Fax: 00971-2-8839112, E-mail: omeryousif@gmail.com

[2]Salt Creek, Utah, USA.

[3]Hayashikane Sangyo, Co. Ltd., Japan.

References

Al abdessalaam, T.Z. and O.M. Yousif. 2002. The marine environment and mariculture of Abu Al Abyad. Pages 39-65 *In* R.J. Perry, editor. The Island of Abu Al Abyad. Environmental Research and Wildlife Development Agency, Abu Dhabi.

ACE (Aquaculture Consultancy and Engineering). 2003. Cobia *Rachycentron canadum*. Aquaculture leaflet: 0302. www.ace4all.com/docs/Cobia.htm

Arnold, C.R., J.B. Kaiser and G.J. Holt. 2002. Spawning of cobia *Rachycentron canadum* in captivity. Journal of World Aquaculture Society 33:205-208.

Benetti, D.D., B. Sardenberg, A. Welch, R. Hoeing, M.R. Orhun and I. Zink. 2008a. Intensive larval husbandry and fingerling production of cobia *Rachycentron canadum*. Aquaculture 281:22-27.

Benetti, D.D., M.R. Orhum, B. Sardenberg, B. O'Hanlon, A. Welch, R. Hoeing, I. Zink, J.A. Rivera, B. Denlinger, D. Bacoat, K. Palmer and F. Cavalin. 2008b. Advances in hatchery and grow-out technology of cobia *Rachycentron canadum* (Linnaeus). Aquaculture Research 39:701-711.

Faulk, C.K. and G.J. Holt. 2003. Lipid nutrition and feeding of cobia *Rachycentron canadum* larvae. Journal of the World Aquaculture Society 34:368-378.

Graeb, B.D.S. and J.M. Dettmers. 2004. Fish size and prey availability affect growth, survival, prey selection and foraging behavior of larval yellow perch. Transractions of the American Fisheries Society 133:504-514.

Holt, G.J. C.K. Faulk and M.H. Schwarz. 2007. A review of the larviculture of cobia *Rachycenron canadum*, a warm water marine fish. Aquaculture 268:181 – 187.

Kilduff, P., W. DuPaul, M. Oesterling, J. Olney, Jr. and J. Tellock. 2002. Induced tank spawning of cobia , *Rachycentron canadum*, and early larval husbandry. World Aquaculture 33(2):35-38.

McEvoy, L.A., T. Naess, J.G. Bell and O. Lie. 1998. Lipid and fatty acid composition of normal and malpigmented Atlantic halibut *Hippoglossus hippoglossus* fed enriched artemia: Comparison with fry fed wild copepod. Aquaculture 163:237-250

Nanton, D.A. and J.D. Castel. 1998. The effects of dietary fatty acids on the fatty acid composition of the harpacticoid copepods, for use as live food for marine fish larvae. Aquaculture 163:251-261

Payne, M.F., R.J. Rippingalea and J.J. Cleary. 2001. Cultured copepods as food for west Australian dhufish (*Glauscosoma hebraicum*) and pink snapper (*Pagrus auratus*) larvae. Aquaculture 194:137-150

Shields, R.J., J.G. Bell, F.S. Luizi, B. Gara, N.R. Bromage and J.R. Sargent. 1999. Natural copepods are superior to enriched *Artemia* nauplii as feed for halibut larvae (Hippoglossus hippoglossus in terms of survival, pigmentation and retinal morphology: Relation to dietary essential fatty acids. Journal of Nutrition 129:1186-1194.

Størttup, J.G. and N.H. Norsker. 1997. Production and use of copepod in marine fish larviculture, Aquaculture 155:231-248.