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Growth and survival of juvenile cobia, *Rachycentron canadum*, at different salinities in a recirculating aquaculture system

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Abstract

Cobia (*Rachycentron canadum*) is an emerging aquaculture candidate for both offshore cage culture and land-based systems such as recirculating aquaculture systems. The ability to grow cobia at salinities other than oceanic (~34 ppt) could present culturists with additional production opportunities with this species. Culture at low salinities could also reduce the incidence of disease and simplify water management. In two trials of 8 weeks each, this study investigated growth and survival of juvenile cobia reared at salinities of 5, 15, and 30 ppt. The trials were conducted in 456-L tanks, with 10 fish per tank. Water temperature was maintained at 27±1 °C and dechlorinated municipal tap water (0 ppt, 56.8 ppm Ca^{2+}) was added to seawater (30 ppt, 325.3 ppm Ca^{2+}) in order to achieve treatment salinities. Early juveniles were used in both trials with average initial weights of 6.0 g for the first trial and 6.7 g for the second trial. During both trials, fish were fed to satiation twice daily with a diet prepared on site, and the amount fed was measured to determine feed efficiency. Fish from each tank were counted and weighed collectively each week until the end of each of the 8-week trials to monitor growth and survival. Survival among treatments was not significantly different in the first trial, but in the second trial survival was significantly lower in the 5 ppt treatment (68.3%) than in the 15 (90%) or the 30 ppt (92.5%) treatments. Feed efficiency was extremely high in both trials with all treatments ranging between 1.05 and 1.13. Fish reared at a salinity of 5 ppt grew as well or better than the fish reared at salinities of 15 and 30 ppt (mean weight gained, 96.2–115.3 g). This study indicates that culture of cobia juveniles may be practical in salinities as low as 5 ppt.

Keywords: Cobia; Salinity; Growth; Survival; Recirculating aquaculture system

1. Introduction

Cobia (*Rachycentron canadum*) is a migratory pelagic species that occurs in tropical and subtropical waters except for the central and eastern Pacific (Shaffer and Nakamura, 1989). In appearance cobia are similar to remoras (Echeneididae) but analysis of larval morphology has provided evidence that cobia are more closely related to dolphin-fishes (Coryphaenidae) (Ditty and Shaw, 1992). Cobia is a highly prized recreational species worldwide as well as a promising candidate for aquaculture because of its rapid growth rate and high quality flesh (Arnold et al., 2002). Since 1994, cobia have been successfully spawned in Taiwan from captive broodstock and represent one of the most economically important species currently cultured in that country (Liao et al., 2001). They have also been spawned in captivity at several aquaculture facilities in the US (Franks et al., 2001; Arnold et al., 2002; Kilduff et al., 2002; Benetti et al., 2003) and research on a larval

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rearing protocol is currently underway (Faulk and Holt, 2003, 2005). With little actual production to date, cobia is considered an emerging aquaculture species in the US and establishing the conditions required for optimal growth will play a key role in the development of future aquaculture efforts.

Currently, little is known of the optimal growing conditions for cobia. Cobia adults have been reported in salinities ranging from 22.5 to 44.5 ppt (Shaffer and Nakamura, 1989), but the development, distribution, and ecology of its early life stages are poorly known (Ditty and Shaw, 1992). Because salinity is an easily controlled variable and osmoregulation is an energy demanding process, fish growth may be maximized by selecting salinities which would decrease energy expended maintaining homeostasis (Sampaio and Bianchini, 2002). Research has shown that 20–50% of the total energy budget of fish is dedicated to osmoregulation, though recent studies suggest that it can be as low as 10% (Boeuf and Payan, 2001). In addition to a decrease in energy required for osmoregulation, salinity may play a directing role in fish growth by affecting consumption rates or the ability to digest and utilize feeds more efficiently. Marine species such as Atlantic cod (*Gadus morhua*) and turbot (*Scophthalmus maximus*) have been shown to exhibit increased growth rates (cod), food conversion ratios (cod), and food intake (turbot) when cultured at intermediate salinities of 12–19 ppt (Lambert et al., 1994; Gaumet et al., 1995; Dutil et al., 1997; Boeuf and Payan, 2001; Imsland et al., 2001).

At present, published work with cobia has shown that this species is able to tolerate salinities somewhat lower than oceanic, but do poorly at or below 15 ppt. Hassler and Rainville (1975) reported that eggs hatched successfully in salinities as low as 19 ppt, with reduced hatching rates and increased body abnormalities observed at 13 ppt. Denson et al. (2003) reported that juvenile cobia cultured in brackish water (5 and 15 ppt) exhibited significantly reduced growth and survival compared to fish cultured in sea water (30 ppt). Atwood et al. (2004) found that when juvenile cobia acclimated to 20 ppt were kept in tanks where the salinity was dropped by 2 ppt per day, mortality began at 8 ppt and was nearly complete at 2 ppt. In contrast, a preliminary trial conducted in our laboratory indicated that juvenile cobia reared in recirculating systems grew just as well in 5 ppt water as those reared in 30 ppt water. The present study was designed to further investigate the effects of different salinities (5, 15, and 30 ppt) on growth and survival of cobia juveniles reared in recirculating systems.

2. Materials and methods

The study was conducted at the Fisheries and Mariculture Laboratory (FAML) of the University of Texas Marine Science Institute. Two separate trials were performed using three identical recirculating aquaculture systems; one for each of the salinity treatments. Each system consisted of four 456-L tanks (37.8 cm high × 124 cm diameter) connected to a common biofilter. An in-line heat pump (Aqua Logic Inc., San Diego, CA) operated on a separate loop which heated or cooled each tank in all three systems without any water exchange between systems. Temperature was maintained in each system with a digital temperature controller and remained at 27 ± 1 °C throughout both trials. The photoperiod was maintained at 14 h light/10 h dark using fluorescent light banks.

In both trials, replicate groups of fish were reared in one of three salinities (5, 15, or 30 ppt). Temperature, dissolved oxygen (DO), and salinity were measured twice daily using a YSI 55 (YSI Incorporated, Yellow Springs, OH) for DO and a YSI 30 for salinity and temperature. To compensate for evaporation and water loss, dechlorinated tap water or filtered sea water was added as needed to maintain nominal salinities within ±0.5 ppt of the treatment salinity. Total ammonia–nitrogen (TAN) and nitrite–nitrogen were measured weekly using colorimetric methods (Thoman et al., 2001; Spotte, 1979) and never exceeded 0.50 or 1.0 ppm, respectively. The DO was maintained at ~5.5 mg/L with the use of an air stone in each tank and pH was modified by adding lite soda ash (OCI Chemical Corp., Shelton, CT) if it dropped below 7.6 (Accumet 900 pH Meter, Fisher Scientific). Tanks were scrubbed and siphoned weekly while fish were removed and weighed. Monofilament nets were used to cover the tanks to reduce fish losses from jumping.

2.1. Stocking and conditioning

For the first trial, juvenile cobia (~5.7 g) originally spawned at the Aquaculture Center of the Florida Keys (Marathon, FL), were obtained from American International Fisheries (Houston, TX). Upon arrival at FAML, fish were transferred to the experimental systems and were randomly stocked at a rate of 20 fish per tank. Fish fed aggressively from the first day after handling and were allowed to acclimate to the culture systems for 3 days. For the second trial, larval cobia were obtained directly from the Aquaculture Center of the Florida Keys and were reared on site until they were completely weaned onto a pelleted diet. They were then transferred