

# Hatchery Production of Florida Red Tilapia Seed in Brackishwater Tanks: The Influence of Broodstock Age and Photoperiod

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## ABSTRACT

Production of Florida red tilapia seed (eggs, sacfry, and fry) in 34 m<sup>2</sup> above-ground tanks using recirculated brackishwater (12 ppt) was studied over a 5-month period on Lee Stocking Island (Exuma Cays, Bahamas). Four tanks were stocked with year class 1 (YCI) breeders, while 2 tanks were stocked with year class 2 (YCII) breeders at densities of 200 and 240/tank, respectively, and at a sex ratio of 3 females to 1 male, during December 1988. Seed production was studied under a natural or an accelerated photoperiod by clutch removal from mouthbrooding females at 15 to 16 day intervals from February through June 1989. Temperature was maintained at 27 - 30°C.

Average seed production (seed/m<sup>2</sup>/day) during the study period did not differ significantly among photoperiod treatments in either year class. Average production was significantly higher in YCI (52.3) than in YCII (36.0) broodstock, suggesting that it is advantageous to replace broodstock with yearling breeders each season.

## INTRODUCTION

Broodstock represent a significant cost to a commercial tilapia hatchery with respect to acquisition, increasing maintenance requirements with growth, and replacement. Previous studies have shown that reproductive performance in tilapias varies with age or size (Hughes and Behrends, 1983; Peters, 1983; Payne and Collinson, 1983; Siraj *et al.*, 1983; Watanabe and Kuo, 1985), factors of considerable importance to the efficient use of broodstock. No information is available concerning seed production relative to breeder age or size in Florida

red tilapia.

Photoperiod is known to be an important factor influencing the seasonal reproductive cycle in many fish species (Lam, 1983), but little information is available on the influence of photoperiod or other environmental factors on reproduction in tilapias (Jalabert and Zohar, 1982; Philippart and Ruwet, 1982).

The objectives of this study were to compare seed production between year classes I and II Florida red tilapia broodstock in brackishwater tanks under commercial-scale conditions, and to determine the effect of an accelerated photoperiod on seed production.

#### MATERIALS AND METHODS

This study was conducted at the Caribbean Marine Research Center on Lee Stocking Island (Exuma Cays, Bahamas) from December 1988 to June 1989. Broodstock consisted of year classes 1 (YCI) and 2 (YCII) Florida red tilapia, a hybrid strain originating from two euryhaline species (*Oreochromis urolepis hornorum* x *O. mossambicus*) (Behrends *et al.*, 1982).

Broodstock were held in six above-ground tanks (34.1 m<sup>2</sup>) containing brackishwater (12 ppt), prepared by mixing seawater (37 ppt) and groundwater (4–6 ppt). Each tank was supplied with aeration, and water was recirculated through a biofilter. Tanks were enclosed by clear, plastic greenhousing, and water temperature was maintained between 27–30°C.

Broodtanks were stocked from 21–24 November 1988, a period of low activity in the annual reproductive cycle of Florida red tilapia in the central Bahamas. Four tanks were stocked with YCI broodfish (age 1 year, 5 months) at densities of 200 and 240 fish/tank (5.9 and 7.1/m<sup>2</sup>), respectively, and at a sex ratio of 3 females to 1 male.

Broodfish were exposed to a natural or an accelerated photoperiod. Each treatment consisted of two tanks of YCI and one tank of YCII broodfish. Under the accelerated photoperiod, normal daylength was extended by using timer-controlled fluorescent lamps. Daylength was increased from 11 hours and 2 minutes to 11 hours and 45 minutes on 1 December, then increased at a rate of 15 minute/5 days until 1 February, when artificial daylength reached 14 hours and 30 minutes, while natural daylength was 11 hours and 15 minutes. The extended daylength was maintained until 26 June. Broodstock were fed *ad libitum* twice daily a commercially prepared diet containing 32% protein.

Following an initial collection on 6 February 1989 (experiment day 1), seed (*i.e.*, eggs, sacfry, and free-swimming fry) was collected from each broodtank at 15 to 16 day intervals through 26 June (experiment day 146). A total of 10 collections were made. At each collection, broodfish were crowded to one end of the tank, clutches removed from mouthbrooding females, and their total body lengths recorded. Body weight (BW, g) of each female was estimated from total length (TL, cm) using the equation,  $BW = 0.11 TL^{3.18}$ . Free-swimming fry were

collected from the broodtank using a seine and dipnet. Eggs and sac fry were counted by a areal method, while free-swimming fry were counted gravimetrically.

## RESULTS

Seed production rates (seed/m<sup>2</sup>/day) did not differ significantly among photoperiod treatments in either year class. Data for both photoperiod treatments were therefore combined and production rates compared among year classes. Average seed production rate during the study was significantly ( $P < 0.01$ ) higher in YCI (52.3) than in YCII (36.0) broodfish (Table 1). Seed production rates, expressed as seed/tank/day, seed/female/day and seed/kg female/day were also significantly ( $P < 0.01$ ) higher in YCI than in YCII broodfish (Table 1). YCI and YCII female broodfish grew from average initial weights of 172 and 429 g to average final weights of 321 and 572 g, respectively, during the 146 day monitoring period.

Average clutch size during the study was significantly ( $P < 0.005$ ) higher for YCII (918) than for YCI broodfish (706) (Table 1). Eggs and non-swimming sac fry comprised a significantly ( $P < 0.005$ ) higher average percentage of total seed in YCII (86.5%) than in YCI (69.8%) broodfish (Table 1). Average percentage of females brooding clutches during the study was significantly ( $P < 0.005$ ) higher in YCI (25.5%) than in YCII (11.2%) broodfish (Table 1).

## DISCUSSION

While reproduction of Florida red tilapia in the central Bahamas occurs year round, there is an annual cycle of reproductive activity, with seed production reaching peak levels from May to June, while water temperature averages 28°C (Ernst *et al.*, unpublished data), and declining to lowest levels from December through February when water temperatures attain their annual minimum (16–20°C). Due to a susceptibility of fish to handling stress under low-temperatures, broodtank water temperatures were maintained from 27–30°C throughout the study, a range considered favorable for spawning (Rothbard and Pruginin, 1975).

Seed production was relatively high in both year classes by early February, suggesting that temperature may have a dominant influence on seed production in Florida red tilapia. Behrends and Smitherman (1983) induced winter spawning in *O. aureus*, *O. niloticus*, *O. mossambicus*, and *O. hornorum* by increasing water temperatures from 20 to 28°C under a simulated natural photoperiod, also suggesting a dominant influence of temperature on seed production.

Despite larger average clutch size in YCII than in YCI broodstock, seed production was lower in YCII broodfish due to a lower spawning frequency, suggesting fewer reproductively active individuals, or longer interspawning

**Table 1.** Average seed production rate, clutch size, percentage of females brooding clutches, and clutch composition for year classes 1 (YCI) and 2 (YCII) Florida red tilapia broodstock in brackishwater (12 ppt) tanks over 146 days. Data are presented as means  $\pm$  SEM for 10 collection periods.

	YCI	YCII	p <sup>b</sup>
seed/tank/day	1788 $\pm$ 121	1232 $\pm$ 179	0.01
seed/m <sup>2</sup> /day	52.3 $\pm$ 3.5	36.0 $\pm$ 5.2	0.01
seed/female/day	11.9 $\pm$ 0.8	6.8 $\pm$ 1.0	0.005
seed/kg female/day	48.5 $\pm$ 4.8	14.2 $\pm$ 2.3	0.005
seed/clutch	706 $\pm$ 22	918 $\pm$ 36	0.005
% ENS <sup>a</sup>	69.8 $\pm$ 2.0	86.5 $\pm$ 1.2	0.005
% brooding females	25.5 $\pm$ 1.8	11.2 $\pm$ 1.5	0.005

<sup>a</sup> ENS = eggs and non-swimming sac fry

<sup>b</sup> Significance level of difference among year classes (Wilcoxon's signed-ranks test).

periods for YCII females. Greater proportions of eggs and non-swimming sac fry in YCII broodtanks also suggests longer interspawning periods for the older fish.

Higher seed production per unit female weight in YCI than in YCII broodstock has also been observed in *O. niloticus* (Siraj *et al.*, 1983; Hughes and Behrends, 1983; Watanabe and Kuo, 1985) and *O. spilurus* (Ridha and Cruz, 1989). Ridha and Cruz (1989) recommended that *O. spilurus* of YCI and possibly II be used as broodstock and that older spawners be discarded as unproductive. Results of this study demonstrated that, as seed production in Florida red tilapia declines dramatically by the age of two years, it is important to replace broodstock with yearling breeders each season.

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