OPERATIONAL MOSQUITOFISH PRODUCTION:

BROOD STOCK MANAGEMENT

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ABSTRACT

Mature mosquitofish were held at three sex ratios; 1:1, 1:2, 1:5 males to females for 95 days. Females were induced to drop young at 65 and 95 days and fry production recorded. Fish held at the ratio of 1:1 produced more fry than the other two ratios.

INTRODUCTION.-The mosquitofish, *Gambusia affinis*, has been used in mosquito control for many years (Haas and Pal, 1984). Due to their chronic shortage during peak mosquito breeding seasons, artificial culture of mosquitofish has been employed with various results.

Culture in ponds has met with limited success. Cold water temperatures, bird predation and the need for persistent aquatic weed control are major constraints. Fortunately, intensive culture systems have shown promise.

Important growth factors for intensive culture of mosquitofish have been investigated. Systems stocked at one fish per liter of water have optimal fish biomass gain (Drazba and Gall, 1980; Downs and Beesley, 1983). Mosquitofish grown at a water temperature of 25°C exhibit optimal growth efficiencies (Wurtsbaugh and Cech, 1983; Downs and Beesley, 1983) and Sawasa (1974) reported a 13:11 L:D photoperiod to be optimal for growth while Gall (1983) reports 16:8 L:D to be optimal for growth and reproduction. Though recent strides have been made in intensive culture other aspects such as reproduction still need examination.

Our intent is to develop operational technology for mosquitofish production. A production system will have two components. One component being a brood stock system to produce gravid females; the other, a hatchery, to obtain fry from gravid females.

The basic parameters to investigate for a brood stock system are sex ratios of brood stock and brood stock density. This work focuses on the first parameter. The proper sex ratio is important as fertilization of all brood females may not take place if the ratio of males to females is too low. Conversely if the ratio is too high the possibility of male-male aggression (Itzkowitz, 1971) may influence male-female interaction.

MATERIALS AND METHODS.-Mosquitofish were harvested from a local stock pond. Large females who did not pass through a 5 mm bar grader were excluded from spawning trials. Selected females were separated into three groups of 256. Each group was individually isolated in spawning baskets in separate tanks in the hatchery described below.

The hatchery consists of two identical systems. Each system consists of four fiberglass culture tanks (.91 m x 2.13 m x .46 m), one cylindrical polypropylene filter (208 liters) filled with 5 cm plastic bio-rings and fiberglass sump (.56 m).

Water was circulated via a 1/10 hp. pump and took 2.1 hours to cycle through the system. A 10 gallon water heater maintained water temperature at 25°C and water loss due to evaporation was replaced via a float valve. A 14:10 L:D photoperiod was maintained by overhead fluorescent lights.

The spawning baskets are plastic strawberry baskets lined with 8 x 8 mesh fiberglass screen. These baskets retain females while allowing newborn fry to escape.

Mature females void of fertilized embryos were desired to begin the experiment. To ensure this, females were initially isolated for one week in the hatchery and induced to drop fry by raising the water temperature to 30°C. They were then moved to a greenhouse system for three weeks to further develop ova. They were isolated for one week in the hatchery a second time and the process was repeated.

The greenhouse system consists of a post and truss greenhouse (15.25 m x 5.49 m) covered with greenhouse corrugated fiberglass. Contained within are three fiberglass circular tanks (3.66 m x .91 m) connected to a common biofilter, two cylindrical polypropylene tanks (568 liters) filled with 7.5 cm bio-rings and a 1.07 m wooden sump.

Water temperature was maintained at 24°C±2 by a 125,000 B.T.U. swimming pool heater. A 14:10 photoperiod was maintained with fluorescent lights. Water was circulated at 303 liters per minute by a .4 hp. sump.

No fry were observed in the hatchery after the second isolation nor did females show any signs of being gravid. They were now introduced to males to begin the mating trials.

Mature males were introduced into the greenhouse tanks at ratios of 1:1, 1:2 and 1:5, males to females (Table 1). Fish were allowed to mate for three weeks, females were collected, placed in the hatchery and the above spawning procedures were used. Number of males in the greenhouse

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were recorded at each isolation. After one week in the hatchery, females were returned to the greenhouse with the males. Fry production was recorded and the cycle was repeated for one additional spawn.

Fish were fed six times daily by automatic feeders at a daily rate of 5% of their biomass. Salmon starter (Rangen Mfg.) was used throughout the trials.

All tanks were scrubbed and siphoned monthly accounting for approximately 50% makeup water being added monthly.

A Hach DREL water quality kit was used weekly to monitor ammonia, nitrate, nitrite, dissolved oxygen, pH, carbon dioxide and chlorine levels in the greenhouse.

RESULTS.-Number of fry produced in each group was directly related to the ratio of males to females (Table 1). The first isolation produced 1764, 1604 and 1248 fry at the sex ratios 1:1, 1:2 and 1:5 respectively. The second isolation produced 520, 450, and 400 fry. Whether there was a higher proportion of gravid females in the 1:1 group or individual females actually dropped a higher average number of fry was not determined. On the basis of informal observations it is suspected that there was a higher proportion of gravid females. Regardless, there was a direct relationship between the number of males per tank and the number of fry produced.

Mortality of fish over the experiment was greater than expected. Female survival was 61%, 70% and 66% for the sex ratios 1:1, 1:2 and 1:5 respectively. Male survival was 46%, 64% and 64%.

Water quality was good throughout the experiment. Ammonia levels varied between .02-.37 mg/1. Dissolved oxygen ranged between 7.3 - 10.8 ppm. No significant variations in water quality were noted between tanks.

Females averaged .88 g at the start of the experiment and averaged 1.5 g at the conclusion. Males remained relatively the same size, .30 g at the start and .38 g at the end. This translates to a daily growth rate of 1.2% for females. Male growth rates are insignificant as they cease growth upon maturation (Kromholtz, 1948).

DISCUSSION.-The goal of the mosquitofish aquaculture facility is to produce the maximum number of fish. The female mosquitofish held at a 1:1 ratio with males clearly produced the most fry. Based on our previous fish density research (Downs and Beesley, 1983) it is projected that our greenhouse system can support 35 times the number of females. If fry production for each sex ratio is multiplied by this factor the difference in fry production between the ratios becomes more significant. It is expected as hatchery efficiency is improved this difference will be even greater.

The high mortality realized in this experiment may be due to senescence. We originally started this experiment with females retained by the 5 mm bar grader ($\bar{x}$ = 1.3 grams). After one month 50% of the females had died when there was no indication of infection and water quality parameters were excellent. We therefore selected smaller females to alleviate the possibility of senescence yet their growth was sufficient to exceed that of our previous set up. The rapid growth and reproduction demand placed on these fish may "burn out" the fish faster than normal which may lead to a continual need to replace brood stock every two to three months. There was no way to determine age of males selected and mortality may simply be attributed to the old age of male stock we selected.

On the basis of the above data and our stated goal of maximal fry production a 1:1 male-female ratio seems desirable. Future work will focus on brood stock densities, brood stock mortality, female isolation for dropping fry and brood stock replacement schedules.

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Table 1.-Male:Female Brood Stock Ratio's and Related Fry Production.

	1:1			1:2			1:5		
days	m	f	fry	m	f	fry	m	f	fry
0 pre-mating	-	256	-	-	256	-	-	256	-
35 males intro.	219	219	-	112	225	-	44	218	-
65 1st isolation	162	196	1764	90	205	1604	30	198	124
95 2nd isolation	104	162	520	70	182	450	28	157	40
Survival (%)	47	63		63	71		64	61	

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