EFFECT OF SALINITY ON GESTATION PERIOD, FRY PRODUCTION, AND GROWTH PERFORMANCE OF THE SAILFIN MOLLY *(POECILIA LATIPINNA* LESUEUR) IN CAPTIVITY

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Abstract

Breeding and growth trials were carried out with *Poecilia latipinna* in different salinities (0.5, 10, 15, 25, and 35‰) and effects on gestation period, fry production, and fry growth (75 days) were examined. Results showed that while *P. latipinna* successfully spawned in all salinities, there was a significant difference in fry production among treatments. The minimum gestation period was 28 days in all salinities except fresh water (0.5‰); the maximum fry production was obtained in 25‰. Fry growth was highest in 10‰ and significantly differed ($p<0.05$) from the rest of treatments in terms of weight gain, specific growth rate (SGR), and feed conversion ratio (FCR). Maximum SGR was 3.35% per day in 10‰ salinity. FCR ranged 4.28-5.67. The results suggest that the optimum salinities for breeding and rearing *P. latipinna* are around 25‰ and 10‰, respectively.

Introduction

Livebearing *Poecilia latipinna* (Lesueur), commonly called sailfin molly, is a popular ornamental fish bred commercially in many countries throughout the world including tropical India (Ghosh et al., 2003). This fish is highly recommended for beginners in ornamental fish breeding as it is hardy and very easy to breed with simple water holding facilities; no hi-tech accessories or excessive human efforts are required (Ramachandran, 2002). Many researchers demonstrated the remarkable tolerance of poeciliid fishes in wide

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ranges of temperature (Bennett and Beitinger, 1997) and salinity (Kristensen, 1969; Nordlie and Mirandi, 1996; Haney and Walsh, 2003). Sailfin mollies tolerate a wide range of salinity from 0 to 120‰ (Kristensen, 1969). Nordlie et al. (1992) reported the occurrence of wild poeciliid fishes (guppies and mollies) in fresh water and brackish waters. However, most aquarium hobbyists and ornamental fish farmers keep and breed sailfin mollies in fresh water (Ramachandran, 2002; Ghosh et al., 2003).

Salinity is a major influencing factor on reproductive physiology in fishes (Ellis et al., 1997; Watanabe et al., 1998; Claireaux and Lagardere, 1999). Although several investigators reported salinity tolerance of poeciliid fishes (Kristensen, 1969; Nordlie et al., 1992; Arai et al., 1998), no scientific work on the effect of salinity on breeding and growth performance of *P. latipinna* has been done. The goal of the present study was to assess the effect of salinity on breeding and growth performance of *P. latipinna* in captive conditions.

Materials and Methods

Fish and salinity acclimatization. Four hundred 5-week-old *P. latipinna* were purchased from a local ornamental fish farm, brought to the laboratory in oxygenated bags, and acclimatized to laboratory conditions in fresh water (bore well). To avoid size and age differences, fry spawned on a single day were selected and stocked in a 4000-l concrete tank. After three days, five batches of 60 young fish were randomly restocked into five 1000-l circular fiberglass tanks with fresh water. The fry were gradually acclimatized to one of five salinities (0.5, 10, 15, 25, and 35‰) by increasing the salinity of the ambient water with sea water at the rate of 2‰ per day until the final salinity was reached. Fish kept in 0.5‰ salinity (fresh water) served as the control. Fish were raised to maturity and survival and behavior in the respective salinities were observed.

Breeding trial. Fish were sexed according to the presence or absence of the male genital organ ('gonopodium', a modified anal fin). Fish lacking this organ were considered female (Dawes, 1991). At maturity, female brooders (3.12–3.17 g) were separated from the common holding tanks and stocked into 500-l circular fiberglass tanks at the rate of one female per tank. Two males were selected and introduced into the tanks containing the females every 20 days. The males were left in the tanks three days and kept separately in the same salinity for the rest of the cycle. Each salinity treatment had six replicates. The tanks contained plastic plants to offer hideouts for the free-swimming fry and were closed with net screens to prevent brooders from jumping out.

The breeding trial was carried out for six months excluding the initial acclimatization period. Health and fertility of the fish were observed daily. For each spawning, the total number of fry (fry production), gestation period (number of days between two successive spawnings), and weight of the newly released young were recorded. The newly released young were regularly removed from the brooder tanks and transferred to separate tanks. They were fed formulated feed in the form of paste 3-5 h after spawning. Broodstock were weighed prior to stocking and after each spawning. Live fish were transferred to a tarred vessel containing the same habitat water and weighed on an electronic scale (Metler™) to the nearest 0.01 g. Several fry from each spawning were sacrificed for weighing.

Growth trial. A separate growth trial (75 days) was conducted with young from the fourth spawning. The young (one week old) were stocked in 100-l circular plastic troughs (at 25 young/trough) in the same salinity in which they were spawned, with three replicates per treatment. Experimental conditions and water quality parameters were similar to those of the broodstock. Daily observations were made of survival and health. Samples of fry were weighed fortnightly (as described above) and weight increments were determined. At the conclusion of the growth trial, the mean weight gain and survival of each salinity treatment were determined. Analyzed parameters included: feed conversion ratio (FCR) = dry feed offered/weight gain and specific growth rate (SGR) = $[(\ln W_t - \ln W_i) \times 100]/T$, where W_t = mean final weight, W_i = mean initial weight and T = total experimental days.

Diet and feeding regime. Feed was formulated to contain 451 g crude protein and 61 g crude lipid per kg feed, with conventional feed ingredients as recommended by Kruger et al. (2001). Broodstock and fry were fed *ad libitum* in three rations per day (at 08:00, 13:00, and 18:00). Two hours after feeding, fecal matter and unconsumed feed were siphoned from the tank bottom and discarded. In the growth trial, to calculate feed intake, uneaten feed was manually sieved from fecal matter, washed with distilled water, dried in an oven (55°C), pooled for each replicate, and weighed.

Experimental conditions. The photoperiod was 12 h light:12 h dark. Continuous aeration was provided from an aquarium air compressor through airstones. Water was exchanged at 50% per day. Dissolved oxygen, pH, and nitrite-nitrogen and ammonia-nitrogen concentrations in the water were measured once a week according to the methods of Strickland and Parsons (1972). Salinity was measured regularly with a refractometer (Atago, Japan) after water exchange. Water quality parameters for all treatments were salinity 0.5-35‰, temperature 25-28.5°C, pH 7.4-8.2, dissolved oxygen >5.67 mg O_2/l, total ammonia-nitrogen 0.06-0.09 mg/l, and nitrite-nitrogen 0.09-0.18 mg/l.

Statistical analysis. Data were analyzed by a one-way ANOVA using the Statistical Analysis Software Program of SPSS 10. Duncan's Multiple Comparison Test was used to determine differences between treatment means (Duncan, 1955). The correlation of the weight gain of the brooders to the fry yield was determined for each spawning in each salinity. Results were considered statistically significant if p<0.05.

Results

Fish behavior. The fish successfully acclimatized to the respective salinities. Swimming and feeding behavior were normal in all salinities. Fish kept in salt water ingested more food than those in fresh water and had better coloration. Males in the saltwater tanks continuously chased females for mating while those in the control tanks showed no such behavior.

Breeding performance. Fish released young in all salinities (Table 1). The earliest fry were released in the 15‰ salinity tanks after six days. During the second spawning, the gestation period in all five batches was 28-35 days. From the third spawning onwards, fish in all but the 0.5‰ salinity treatment spawned once in 28 days. There were no significant differences in gestation period among the salt water treatments, but the difference between brooders kept in fresh water (0.5‰) and those kept in salt water was significant. In the sixth spawning, fry production was highest in the 25‰ treatment and lowest in the freshwater treatment (Table 2). A few underdeveloped young were obtained in the first spawning in all salinities. There was a significant correlation between the fry yield and weight gain of the female brooders. Generally, the number of young increased with the brooders weight in all salinities.

Growth performance. All growth trials proceeded without interruption or disease. There were no significant differences in survival among fish of different salinities (Table 3) but there were significant differences in weight gain, FCR, and SGR.

Discussion

Several investigators demonstrated the wide salinity tolerance of poeciliid fishes (*P. sphenops,* Kristensen, 1969; *P. latipinna,* Nordlie et al., 1992; *P. reticulata*, Arai et al., 1998; *Limia melanonotata*, Haney and Walsh, 2003). In addition, many works documented the wild occurrence of *P. latipinna* in fresh and salt water environs such as rivers, ponds, lakes, mangrove swamps, coastal marshes, estuaries, and back waters (Peterson, 1990; Schlupp et al., 1992). During acclimatization in the present study, normal feeding and swimming behavior indicated that the mollies were not under stress. The chasing behavior of the male in the salt water treatments indicates that salt water is suitable for stimulating reproduction.

Underdeveloped fry in the first spawning may have resulted from handling stress caused during the transfer of the brooders from the common holding tanks (1000-l) to the

Table 1. Growth performance, gestation period, and fry yield of adult female *Poecilia latipinna* grown in different salinities.

Parameter	*Salinity (‰)*				
	*0.5**	*10*	*15*	*25*	*35*
Initial weight (g)	3.12±0.14	3.14±0.17	3.15±0.16	3.17±0.13	3.12±0.21
Final weight (g)	5.90±0.76^{a}	6.19±0.59^{b}	6.42±0.55^{b}	6.97±0.58^{b}	5.97±0.60^{a}
Weight gain (g)	2.78±0.45^{a}	3.04±0.36^{b}	3.27±0.25^{b}	3.79±0.42^{b}	2.84±0.35^{a}
Gestation period (days)[1]	32±1.5^{b}	28±0^{a}	28±0^{a}	28±0^{a}	28±0^{a}
Fry yield[2]	192±8.0^{a}	203.0±7.2^{b}	202.3±13.6^{b}	313.7±16.1^{c}	198.3±9.3^{ab}
Correlation (r)[3]	0.856	0.970	0.863	0.948	0.966

Means in the same row with different superscripts are significantly different (p<0.05).
* freshwater control
[1] average of six consecutive spawnings
[2] total of six consecutive spawnings
[3] relationship between mean weight gain of brooders and mean fry yield for four consecutive spawnings

Table 2. Fry yield of female *Poecilia latipinna* grown in different salinities for six consecutive spawnings.

Spawning	*Salinity (‰)*				
	0.5	*10*	*15*	*25*	*35*
1	19.0±3.0^{b}	19.3±2.5^{b}	16.3±4.5^{a}	22.0±3.0^{c}	17.7±1.5^{a}
2	30.3±6.4^{b}	31.3±1.5^{b}	27.3±7.3^{a}	41.0±7.5^{c}	28.0±6.2^{a}
3	32.7±2.8^{a}	33.0±2.0^{a}	38.0±2.0^{b}	47.7±2.5^{c}	31.7±4.0^{a}
4	34.7±2.8^{a}	33.7±3.2^{a}	37.0±2.0^{a}	60.7±1.5^{b}	34.3±4.1^{a}
5	37.3±4.1^{a}	40.0±3.6^{a}	41.0±1.0^{a}	64.3±5.1^{b}	39.0±6.0^{a}
6	38.0±6.5^{a}	45.7±2.5^{b}	42.7±1.5^{b}	78.0±7.5^{c}	47.7±2.5^{b}

Means in the same row with different superscripts are significantly different (p<0.05).

experimental tanks (500-l). In all treatments, the first spawning occurred as early as 6-25 days after the initial stocking, perhaps indicating that embryos were in an advanced development stage at the start of experiment.

The main finding of this study was that salinity has a noticeable positive impact on the breeding performance of *P. latipinna*. Although young were released irregularly during the first spawning, the gestation period was consistently recorded as 28 days in all treatments except the fresh water (35 days)

Table 3. Growth performance of juvenile *Poecilia latipinna* fed formulated feed in different salinities.

Parameter	*Salinity (‰)*				
	0.5	*10*	*15*	*25*	*35*
Initial weight (g)	0.05±0.00	0.05±0.00	0.04±0.00	0.05±0.00	0.05±0.00
Weight gain (g)	$0.57±0.01^{a}$	$0.88±0.02^{d}$	$0.74±0.06^{c}$	$0.72±0.03^{c}$	$0.66±0.01^{b}$
FCR	$5.48±0.65^{cb}$	$4.26±0.20^{a}$	$5.03±0.69^{ab}$	$4.90±0.36^{a}$	$5.67±0.51^{c}$
SGR (%)	$2.83±0.04^{a}$	$3.32±0.04^{c}$	$3.18±0.08^{bc}$	$3.06±0.05^{b}$	$3.04±0.05^{b}$
Survival (%)	92.00±4.0	98.67±2.3	96.00±4.0	94.67±2.3	96.00±4.0

Means in the same row with different superscripts are significantly different ($p<0.05$).
FCR = food conversion ratio; SGR = Specific growth rate

from the second spawning onwards, suggesting that salinity stimulates breeding in *P. latipinna.* It may be that salinity influences the endocrine system of the fish, evidenced by the continuous chasing of female fish by the males in the common holding tank. Similar observations were made by Milton and Arthington (1983) and Dawes (1991) when one tablespoon of common salt per gallon of water was added to molly tanks. Gestation periods are poorly documented in livebearing species. According to Milton and Arthington (1983), embryonic development in poeciliids varies 26-63 days. These authors reported on the role of temperature and photoperiod but not on salinity. Dawes (1991) reported that the optimal temperature for reproduction of livebearers is 22-26°C. However, in tropical India, temperature is not a factor.

The highest fry production was in the 25‰ salinity, the lowest in the 0.5‰ and 35‰ treatments, implying that 25‰ salinity is optimum for breeding. The lower fry yields in the other salinities may have resulted from higher energy expenditures on osmoregulation, which in turn may have restricted the reproductive performance of the brooders.

Generally, in all treatments the number of young increased with subsequent spawnings, perhaps because of the positive correlation between fish body weight and fry production (Tamaru et al., 2001). Milton and Arthington (1983) reported that in wild populations of swordtail, fecundity is linearly related to body size. Chong et al. (2004) recently reported a positive correlation between fecundity and parental body size in *Xiphophorus helleri*.

Little information is available on the nutritional requirements and growth of *P. latipinna* in captive conditions. Kruger et al. (2001) reported that the diet for *X. helleri* should contain at least 45% crude protein and 6% lipid level for best growth performance. Since *P. latipinna* and *X. helleri* are closely related within the Poeciliidae family, the diet in the present study was formulated to contain the same nutrient compositions. With such a diet, the young fish grew best in 10‰ salinity. This salinity may be isosmotic to the body fluids of poeciliid fishes so that less energy was consumed for osmoregulation and more energy was available for growth. Results of the study show that while the fry yield of *P. latipinna* was highest in 25 ‰ salinity, growth was highest in 10‰ salinity.

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