

Effect of stocking density on laboratory rearing of mullet fingerlings, *Mugil platanus* (Günther, 1880)

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ABSTRACT. The effect of stocking density on production of *Mugil platanus* fingerlings in laboratory was analyzed. Five stocking densities were evaluated: 1, 3, 5, 10 and 15 mullet/L. After 28 days, the highest growth rate was reported for animals reared at the lowest stocking density (1 mullet/L). Survival rate and water quality were also higher at the lowest stocking density. Although more fingerlings were produced at 10 mullet/L, greater number of animals decreased the water quality, which was reflected in their reduced growth and survival rates. *M. platanus* fingerlings should be reared in commercial production at intermediate stocking densities (3-5 mullet/L) but higher water exchange rates are recommended for lower ammonia concentration.

Key words: fish culture, stocking density, mullet, *Mugil platanus*.

RESUMO. Efeito da densidade de estocagem no cultivo de tainha, *Mugil platanus* (Günther, 1880) em laboratório. Estudou-se o efeito da densidade de estocagem sobre a produção de alevinos de *Mugil platanus* em laboratório. Foram testadas cinco densidades de estocagem em duplicata: 1, 3, 5, 10 e 15 tainhas/L. Os peixes foram alimentados duas vezes ao dia, sendo oferecido alimento na proporção de 10% do peso vivo de cada tanque. O melhor crescimento foi observado para os animais cultivados na menor densidade de estocagem (1 alevino/L). Observaram-se neste tratamento a melhor qualidade de água e a maior sobrevivência. Por outro lado, o maior número de animais foi produzido na densidade de 10 alevinos/L; entretanto, isto foi obtido às custas de uma menor qualidade da água, que se refletiu em uma redução no crescimento e na sobrevivência. No caso de produção comercial, os alevinos de *M. platanus* poderiam ser cultivados em uma densidade de estocagem entre 3 e 5 alevinos/L; contudo, a taxa de troca de água deveria ser mais elevada, para manter a concentração de amônia mais baixa do que aquela observada neste trabalho.

Palavras-chave: piscicultura, densidade de estocagem, tainha, *Mugil platanus*.

Mullet farming is carried out in Asia, Europe and America (Hepher and Pruginin, 1981). The most cultivated species in the world is *Mugil cephalus* (Eda *et al.*, 1990). Mullet can be reared either in monoculture systems or together with other fishes and crustaceans (Benetti and Fagundes Netto, 1991).

Mugil platanus has been recommended for aquaculture in the south and southeast regions of Brazil. Godinho *et al.* (1988) observed that although the biology and ecology of *M. platanus* are well known, data on aquaculture are scarce. There are reports in literature about mullet reproduction (Andreatta *et al.*, 1983), toxicity of nitrogen compounds (Santos *et al.*, 1993; Miranda Filho *et al.*, 1995), feeding during fingerling (Sampaio *et al.*,

1998) and grow out phases (Benetti and Fagundes Netto, 1991).

While the technology for artificial reproduction and larva rearing are not well established, the experimental farming of *M. platanus* may be conducted with fingerlings captured in the wild (Scorvo Filho *et al.*, 1988). In the region neighboring the Lagoa dos Patos estuary, it is possible to capture *M. platanus* fingerlings and adults all year long, especially during winter and spring (Vieira, 1991). However, care should be taken with regard to overfishing to avoid depletion of available resources.

Stocking density is an important factor in determining production costs with respect to investment required by the farming structure. Christiansen *et al.* (1982) reported that to reach maximum growth rate, stocking density might vary

as a function of behavioral adjustments, food availability and water quality. Fishes confined at high densities may present chronic stress, which may result in lower growth rates, higher susceptibility to diseases, and increased mortality rates (Blackburn and Clarke, 1990). On the other hand, there are also species in which growth rate is maximized at higher stocking densities, as observed for *Dicentrarchus labrax* and *Rhamdia quelen* fingerlings by Papoutsoglou *et al.* (1998) and Piaia and Baldisseroto (2000), respectively.

Scorvo Filho *et al.* (1992) verified that the ideal density for rearing *M. platanus* fingerlings in freshwater ponds is 5 individuals/m². However, there are no reports on ideal density for laboratory rearing, specially in saltwater. The objective of this work was to evaluate the effects of on stocking densities rearing of *M. platanus* fingerlings under laboratory conditions.

Material and methods

The experiment was carried out at the Laboratory of Mariculture, Department of Oceanography, University of Rio Grande. *M. platanus* fingerlings were captured with fishing nets (5 mm mesh) at Lagoa dos Patos estuary. Fingerlings were transported to the laboratory and acclimated in two 500L-tanks filled with water similar to the collecting site (10‰ salinity and 15°C temperature). The tanks were equipped with constant aeration and kept under natural photoperiod (13L:11D). The fingerlings remained in the tanks for two weeks, during which, temperature and salinity were gradually increased to reach experimental conditions (30‰ and 22°C), believed to provide better growth rates than the salinity and temperature conditions found at collection site (Sampaio *et al.*, 1998).

Before the fingerlings were distributed in experimental units, 30 individuals were randomly selected for initial biometry. These individuals were then anesthetized with MS-222 (50 ppm), blotted dry with paper towel and weighed in electronic scale (1 mg precision). The fingerlings were transferred to 100L plastic tanks filled with 50L of water, at densities 1, 3, 5, 10 and 15 mullet/L. Initial mean (\pm SD) weight of fingerlings was 250 \pm 49 mg.

Temperature was maintained at 22°C by submersed heaters (300 W) equipped with thermostat. During the experimental period, salinity was monitored with an optical refractometer with 1‰ precision. Water samples were collected weekly to monitor total ammonia concentration, according to methodology suggested by UNEP (1988).

Number of dead fingerlings was determined daily. Feces were then siphoned out, and approximately 100% of the water volume in each tank was renewed.

Fingerlings were fed on commercial diet (Salmonideos Crescimento, Supra-Alisul) containing 46% crude protein and 6% lipid. The diet was previously grounded and sieved. The fraction retained between 600 and 300 μ m mesh was used. Fishes were fed twice a day (total ration about 10% live body weight), 50% in the morning and 50% in the afternoon. Ration amount was corrected weekly, based on the biomass of each tank.

Growth rates were evaluated weekly by biometry following the same procedure used at the end of acclimatization period.

Stocking density effects on the rearing of *M. platanus* fingerlings were evaluated by the following parameters:

- Survival rate, $S = [(N_i - N_f) / N_i] \times 100$, where N_i = initial number, N_f = final number;
- Daily specific growth rate, $G = [(\ln W_f - \ln W_i) / t] \times 100$, where W_f = final weight, W_i = initial weight, t = time (days);
- Number of fingerlings produced, $NFP = (S \times N_i) / 100$;
- Final biomass, $FB = N_f \times W_f$;
- Final stocking density, $FSD = N_f / V$, where V = volume;
- Apparent feed conversion rate, $AFC = OF / (FB - IB)$, where OF = offered food, IB = initial biomass.

The experiment lasted 28 days and a completely randomized design was used, with duplicates for each treatment. Results were analyzed by linear regression analysis at 5% significance level, using software Statistica 5.0.

Results

At the highest stocking density of 15 mullet/L, only 26% of them survived past 14 days. Therefore this treatment was prematurely terminated and results were not taken into consideration in the following analyses. In all the other treatments *M. platanus* survival rates decreased with increasing stocking density (Figure 1).

Total ammonia concentration increased proportionally to stocking density (Figure 2). Mean ammonia concentrations over the last week of the experiment reached 0.80 and 3.5 mg N-NH₃+NH₄⁺/L at 1 and 10 mullet/L, respectively.

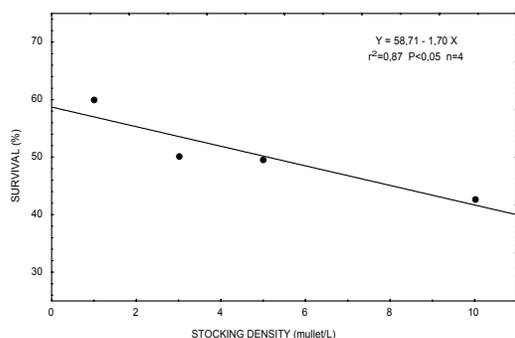


Figure 1. Effect of stocking density on survival of mullet *Mugil platanus* fingerlings reared for 28 days in laboratory

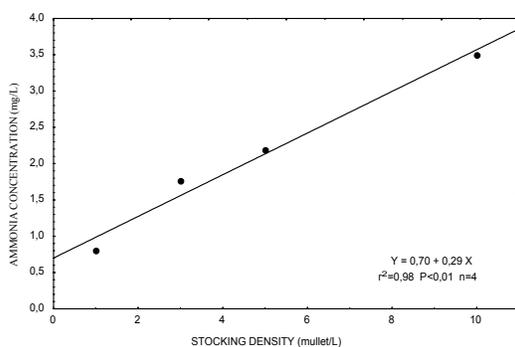


Figure 2. Effect of stocking density on ammonia concentration (mg N-NH₃+NH₄⁺/l) in mullet *Mugil platanus* fingerlings reared for 28 days in laboratory

Growth rate was also directly affected by stocking density. Weight of fingerlings submitted to higher stocking densities was lower (Figure 3), which resulted in reduced specific growth rates (Figure 4).

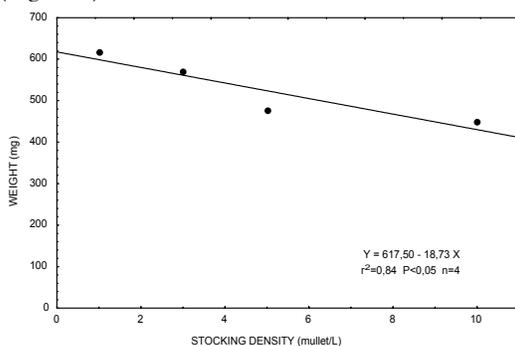


Figure 3. Effect of stocking density on weight of mullet *Mugil platanus* fingerlings reared for 28 days in laboratory

Stocking density was negatively related to apparent food conversion rate. At stocking density of 1 mullet/L, apparent food conversion was 2.7, while

10 mullet/L yielded an average food conversion of 4.4 (Figure 5).

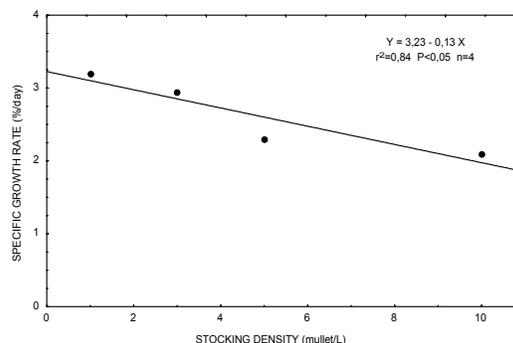


Figure 4. Effect of stocking density on specific growth rate of mullet *Mugil platanus* fingerlings reared for 28 days in laboratory

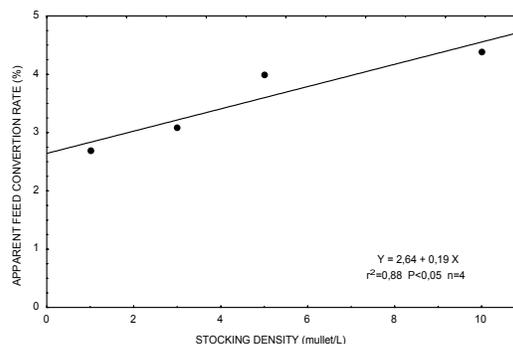


Figure 5. Effect of stocking density on apparent food conversion of mullet *Mugil platanus* fingerlings reared for 28 days in laboratory

In spite of higher ammonia levels, reduced survival and growth, the number of animals produced, biomass and final stocking density were directly proportional to the initial stocking density (Table 1).

Table 1. Effect of stocking density on number of fingerlings produced (NFP), final biomass (FB), and final stocking density (FSD) of mullet *Mugil platanus* fingerlings reared for 28 days in laboratory

Parameter	Stocking density				Equation	n	P	r ²
	1	3	5	10				
NFP	33	89	147	231	$y = 22,04 + 21,68 x$	4	<0,01	0,98
FB (g)	20	51	70	104	$y = 18,87 + 8,92 x$	4	<0,05	0,96
FSD(mullet/L)	0,7	1,8	2,9	4,6	$y = 0,44 + 0,43 x$	4	<0,01	0,98

Discussion

Stocking density is an external factor that may influence growth rate and behavior of fish (Refstie and Kittelsen, 1976). Wallace *et al.* (1988) investigated the rearing of *Salvelinus alpinus* at

different stocking densities and determined that animals reared at high stocking densities displayed higher growth rates. On the contrary, Trzebiatowski *et al.* (1981) recorded that growth and mortality rates of *Salmo gairdneri* were inversely proportional to stocking densities. Gomes *et al.* (2000) reported reduced weight of *Brycon cephalus* larvae at relatively higher stocking densities. Since there was no influence on survival rate, the number of larvae produced was maximized at the highest stocking density. Results show the complexity of determining the stocking density effect on fish farming, since even species of same family might respond distinctly to high stocking density culture.

Ammonia concentrations in different treatments were high, but not enough to cause acute mortality of *M. platanus* fingerlings (Miranda Filho, 1993). However, this may explain low growth and survival rates at high densities. Apparent food conversion rate corroborates this hypothesis, since higher conversion rates were found at higher densities. This fact suggests that not all the food supplied was consumed, or if consumption was total, the food was not properly used, which contributed decisively to lowering the water quality.

Schooling fish should not be stressed by high stocking densities. Some species even show higher growth rates at high stocking densities, as with *Dicentrarchus labrax* (Papoutsoglou *et al.*, 1998). *M. platanus* is a schooling species too and despite the negative influence of high stocking densities on growth, no aggressive behavior was observed in the different treatments. More detailed studies should be conducted concerning this aspect so the actual cause of growth suppression at high stocking densities may be evaluated.

The objective of a hatchery is to produce a large number of healthy fingerlings. In this research it has been reported that growth and survival of *M. platanus* were inversely proportional to the stocking density. Consequently, high stocking densities should be avoided when rearing this species. It is advisable to work with intermediate densities (3-5 mullet/L) in order to optimize facilities. In this case, even though growth will not be the best, a larger number of fingerlings are produced. However, a higher water exchange rate should be employed to eliminate metabolites and improve water quality, providing conditions for better results in terms of growth and survival.

Acknowledgments

The authors are deeply in debt to the technical personnel at Laboratory of Mariculture, FURG for

their help during the experiment. Thanks are also due to FAPERGS and PIBIC CNPq/FURG for the financial support given to M. B. Tesser and A. H. Ferreira throughout this research.

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Received on February 07, 2001.

Accepted on March 30, 2001.