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A N I N T E R N A T I O N A L J O U R N A L

Survival and the Growth of Pintado (*Pseudoplatystoma corruscans*) Post-larvae on Different Salinities

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ABSTRACT

The aim of this study was to evaluate the survival and growth of pintado, Pseudoplatystoma corruscans, post-larvae (PL) submitted to seven salinities: S1: 0; S2: 1.7; S3: 3.3; S4: 5; S5: 6.7; S6: 8.3 and S7: 10‰ distributed in a complete randomized design with three replicates. PL were stocked in 5-l round plastic containers at a density of 15 PL/liter and maintained in the dark. The water was salinized with iodine-free sodium chloride (NaCl). PL were fed six times a day with 500 Artemia sp. nauplii/PL. Survival was high up to salinity 1.7‰, both on the fifth and on the tenth day of experiment, but decreased quickly in salinities above 5‰. Better growth rates were observed in salinities 0 and 1.7‰, however, high growth observed in freshwater was due to cannibalism. Results showed that pintado larviculture would be suitable in 1.7‰ salinity water.

Key words: *Pseudoplatystoma corruscans*, salinity, pintado, *Artemia* sp., post-larvae, survival

INTRODUCTION

Although Brazil has high freshwater availability (Luz and Zaniboni Filho, 2000) and more than 2,700 indigenous fishes species catalogued (Miranda and Ribeiro, 1997), fish farming in the country began based on exotic fish (Miranda and Ribeiro, 1997; Zaniboni Filho, 2000; Borghetti et al., 2003) due to the introduction of hatchery techniques available for those species (Zaniboni Filho, 2000). Nevertheless, farming of indigenous species was stimulated by the increasing fish demand (Alvarado, 2003). Some of them grow more than the exotic species already farmed in the country, have better quality meat, besides the fact that they are already adapted to the regional environmental conditions (Meurer and Zaniboni Filho, 2000; Weingartner, 2002).

One of the main constrains faced in indigenous fish farming is the larviculture stage, when ideal farming (Weingartner, 2002; Luz and Portella, 2005) and feeding conditions for higher survival and growth rates are required. Other very common problem during larviculture is the high level of cannibalism that can be associated to genetic and behavioral causes (De Angelis et al., 1979). The cannibalistic behavior is characteristic to several indigenous species such as pintado *Pseudoplatystoma corruscans* (Behr, 1997), mandi *Pimelodus maculatus* (Luz and Zaniboni Filho, 2000), jaú *Paulicea lutkeni* (Zaniboni Filho and Barbosa, 1992), dourado *Salminus brasiliensis* (Moraes Filho and Shubart, 1955) and trairão *Hoplias lacerdae* (Luz et al., 2000). But because some of the factors that promote this behavior are environmental, they can be manipulated in a way

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to maximize survival and growth of the post-larvae produced (Weingartner, 2002). According to Dabrowski (1984), salinity can influence post-larvae feeding behavior and induce cannibalism. Rearing freshwater fish post-larvae in slightly salinized water have some benefits, such as reduction of diseases by intolerance to salinity and possibility to use marine live food items like *Artemia* sp. (Beaux et al, 2003; Reynalte-Tataje et al., 2003). This food item has high nutritional quality (Stappen, 1996) and culture technology is already available (Beux et al., 2003). *Artemia* sp. survival in slightly salinized water is extended, thus increasing fish feeding and reducing problems of poor water quality caused by the dead *Artemia* sp. decomposition (Beux and Zaniboni-Filho, 2006). Another advantage is directly related to fish osmoregulation. Salinized water reduces the osmotic gradient and consequently reduces energy consumption and promotes the increased growth (Baldisserotto, 2002; Sampaio and Bianchini, 2002).

For some freshwater fishes, such low osmotic gradient represents a reduction of about 20 to 40% in the metabolic rate, due to lower metabolism and reduced energy consumption to produce abundant urine in freshwater (Baldisserotto, 2002). Pintado, *Pseudoplatystoma corruscans* Agassiz (1829), is widely distributed in the Amazonas, São Francisco, Paraná, Paraguay and Uruguay river basins (Sato et al., 1997; Sverlij et al., 1998) and is one of the species with highest economic value among the American freshwater fishes (Miranda and Ribeiro, 1997), which has attracted cosumers and aquaculturists (Parra, 2003). It is one of the best indigenous species for fish farming because of its excellent flavor, no intramuscular bones (Lopes et al., 1996; Inoue et al., 2003), and fast growth in captivity fed on artificial diets (Sato et al., 1997). Although such great potential, farming of pintado still requires further information to develop a technology to produce fingerlings in large scale. Thus, the aim of this study was to evaluate the survival and growth of pintado post-larvae under different salinities.

MATERIALS AND METHODS

This study was carried out at São Carlos Fish Culture Station (EPISCar), in São Carlos (27°04’39”S; 53°00’14” W), Santa Catarina state, Brazil, during December 2002. Wild pintado broodstock collected from the Uruguay River kept in captivity for about three years, fed with extruded feed and juvenile fish of other species were used to produce the post-larvae (PL). Broodstock fishes were selected according to criteria described by Woynarovich and Horváth (1983) and then transferred to laboratory to induce reproduction with carp pituitary extract, following the procedure described by Zaniboni Filho and Barbosa (1996). Two hundred and forty degree-hour after the last hormone application, gametes were stripped and submitted to dry fertilization (Woynarovich and Horváth, 1983). Eggs were then stocked in 200-l cylindro-conical incubators with constant water flow. After hatching, post-larvae were observed under a stereomicroscope to confirm the mouth opening and those with mean total length (± standard deviation) of 4.45 ± 0.03 mm and mean weight of 0.57 ± 0.04 mg were siphoned from the incubators, counted and transferred to the experimental units (UE). Stocking density was of 15 PL/L and the UEs were maintained for ten days in the dark. White round plastic containers (5 – l) were used as UEs without water flow but with continuous aeration. Each UE held 75 post-larvae. Treatments consisted of seven different salinities: S1: 0 (freshwater); S2: 1.7; S3: 3.3; S4: 5.0; S5: 6.7; S6: 8.3 and S7: 10‰, distributed in a complete randomized design, with three replicates. Treatment water was prepared by adding iodine-free salt (NaCl) weighed in a 0.01-g precision scale.

Exogenous feeding was started together with the experiment and it was composed of *Artemia* sp. nauplii. at a daily ration of 500 nauplii/PL. Nauplii were distributed in six daily feedings at four hours interval, starting at 0800h. Water quality parameters were measured as follows: temperature and dissolved oxygen concentration twice a day with an YSI-55 oxygen-meter; pH every afternoon with an YSI-60 pHmeter; and total ammonia and nitrite concentrations every two days, in the afternoon, using the colorimetric method. Unionized ammonia (NH_3) concentration was calculated from total ammonia concentration according to temperature, pH and salinity using the equation of Johansson and Wedborg (1980) *apud* Lemarié et al. (2004). After measuring the water quality parameters, UEs were siphoned daily with a thin hose and a 0.2 mm mesh net. This procedure reduced water volume in about 40%, which was immediately replaced with previously prepared water in the respective salinities, tested and at the same temperature of the UEs.

On the fifth day of the experiment, survival was assessed using the formula S = (N_{IQ}*100/N_I), where: S was survival rate (%) on the fifth day; N_{IQ} was the number of live PL on the fifth day; and N_I was the initial number of post-larvae. On the tenth day, post-larvae were fixed in a 4% formaline solution (Nakatani, 1998) for weight and length analyses. Post-larvae were weighed on an analytical scale of 0.1 mg precision and total length was measured under a stereomicroscope, equipped with ocular micrometric (10×). After the measurements, allometric condition factor (K) was calculated using the formula proposed by Le Cren (1951): $K = Wt/Lt^{b}$, where Wt = total weight; Lt = total length; and b = weight-length regression coefficient. Regression analysis (Zar, 1996) was used to evaluate the data at a 5% level of significance. In this study, nomenclature used for the Brazilian indigenous species was the one described by Zaniboni Filho (2000) and commonlyused by Brazilian fish farmers, where the term post-larvae (PL) corresponded to the phase in which the larvae initiated exogenous feeding.

RESULTS

Water temperature, pH, and dissolved oxygen concentrations were similar among the treatments and they were within the acceptable range for fish farming (Boyd, 1990). Temperature was stable, with mean values (± standard deviation) of 24.57 ± 0.21°C in the morning and 25.44 ± 0.05°C in the afternoon. pH was inversely proportional to the salinity levels, with a mean value of 7.75 ± 0.06. Mean dissolved oxygen concentrations were 7.79 ± 0.12 mg/L in the morning and 7.46 ± 0.07 mg/L in the afternoon. Regression analysis showed a relation of dependency (P<0.05) among total ammonia (NH_4), unionized ammonia (NH_3) and nitrite (NO_2) in the different salinities. These parameters tended to increase when salinity decreased (Table 1). Highest mean values of total ammonia, unionized ammonia and nitrite were found in the freshwater (S 0‰).

Table 1 - Mean values (± standard deviation) of water quality parameters during pintado (*Pseudoplatystoma corruscans)* larviculture in different salinities.

Parameters (mg/L)	**Salinities [1]**			
	S 0.0	S 1.7	S 3.3	S 5.0
Total ammonia [2]	0.52 ± 0.03	0.47 ± 0.08	0.38 ± 0.07	0.38 ± 0.11
Unionized ammonia [3]	0.028 ± 0.001	0.025 ± 0.004	0.007 ± 0.001	0.007 ± 0.002
Nitrite [4]	0.37 ± 0.06	0.28 ± 0.04	0.21 ± 0.03	0.20 ± 0.07

[1] S 0‰ - freshwater; S 1.7 – salinity 1.7‰; S 3.3 – salinity 3.3‰; S 5.0 – salinity 5.0‰, [2] $y = -0.035x + 0.51$ $r^2 = 0.60$, [3] $y = -0.0052x + 0.029$ $r^2 = 0.80$, [4] $y= -0.039x + 0.35$ $r^2 = 0.66$.

PL highest survival rates were observed in the salinities between 1.7 and 5‰, and both on the fifth and on the tenth day of experiment, survival showed to be dependent on salinity (P<0.05) (Fig. 1). In freshwater, reduced survival rate was observed among post-larvae of heterogeneous sizes. Salinities above 5‰ were too high for pintado larviculture and total mortality was observed 24 hours after commencement of the experiment.

Dependency relationship (P<0.05) between weight-length and salinity was observed. The highest values were observed in the treatments with lower salinities (Fig. 2).

Mean allometric condition factor decreased as salinity increased (P<0.05) (Fig. 3).

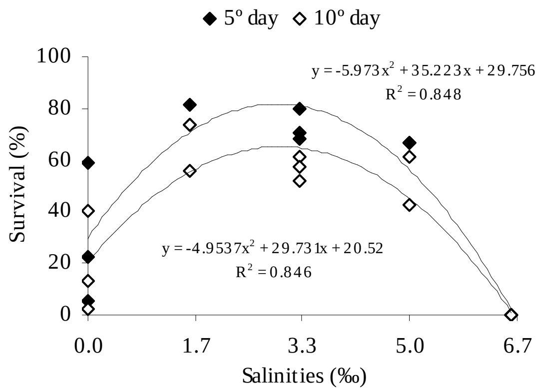

Figure 1 - Survival on the fifth and on the tenth day of experiment of pintado (*Pseudoplatystoma corruscans*) post-larvae submitted to different salinities

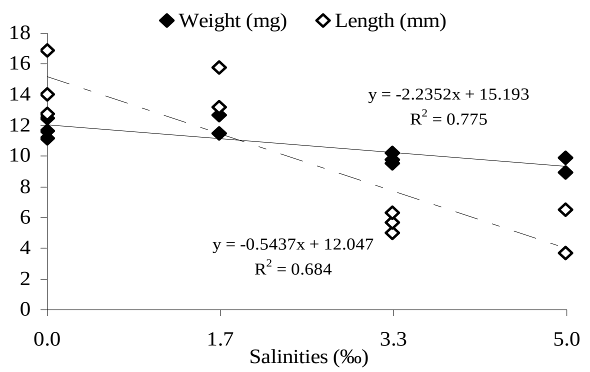

Figure 2 - Total weight and total length on the tenth day of experiment of pintado (*Pseudoplatystoma corruscans*) post-larvae submitted to different salinities

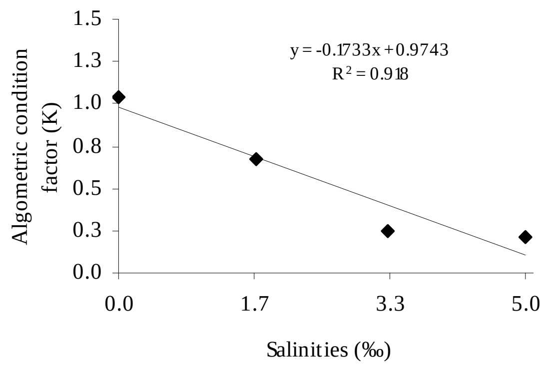

Figure 3 - Mean allometric condition factor (K) on the tenth day of experiment of pintado (*Pseudoplatystoma corruscans*) post-larvae submitted to different salinities

DISCUSSION

Fish survival and growth can be influenced by the water quality (Dou et al., 2003). Except for the unionized ammonia (NH_3), water quality parameters observed in the experiment varied within the acceptable range for the culture of most tropical fish species (Sipaúba-Tavares, 1994; Vinatea, 1997). According to Foss et al. (2003), ammonia toxicity to fish and other aquatic organisms is attributed mainly to the unionized form, and its negative effect can start occurring from concentrations above 0.02 mg/L. In salinities 0 and 1.7‰, NH_3 concentrations above 0.02 mg/L were registered in more than 50% of the measurements. Increase of this parameter in the lower salinities could be justified by the mortality of *Artemia* sp. nauplii, which deposited on the bottom of the tanks. However, such unionized ammonia concentrations did not seem to have affected pintado (*Pseudoplatystoma corruscans*) post-larvae as lower salinities treatments showed the highest growth rates. Apparently, post-larvae survival was not influenced by the water quality but by the tested salinities, since one of the best survival results was seen at 1.7‰ salinity. Increased ammonia concentrations due to death and decomposition of *Artemia* sp. nauplii could be minimized by increasing the water rennovation and more frequent cleaning of the experimental units (Katavic, et al., 1989; Catharin, 2003). In this study, higher survival rates were found between 1.7 and 5‰ salinities. Other Pimelodidae fishes also performed better during larviculture in the salinized water, showing good performance until a determined salinity, above which they started to show reduced growth and survival. The maximum water salinity for the larviculture of *Steindachneridion scripta* (Schütz et al., 2000) and *Pimelodus maculatus* (Weingartner, 2002) is 2‰ and for *Rhamdia quelen* post-larvae is 4.5‰ (Reynalte-Tataje et al., 2003). High survival rates between 1.7 and 5‰ salinities could be explained by the higher food availability, i.e., *Artemia* sp. nauplii survived longer and they were better distributed in the water column, promoting higher post-larvae food intake. Similar situation was reported by Weingartner (2002) in a study with *Pimelodus maculatus* post-larvae fed on *Artemia* sp. nauplii.

Introduction of *Artemia* sp. nauplii in the UEs caused pintado posto-larvae to swim intensely in all the tested salinities. According to Kolkovski et al. (1997), *Artemia* sp. secretes amino acids that stimulate the appetite and the orientation towards the food. Qin et al. (1997) also observed higher survival rates when *Channa striatus* larvae were fed live *Artemia* sp. nauplii rather than with disencapsulated cysts, which was attributed to a disuniform distribution of the cysts in the water column since the nutritional composition of the *Artemia* sp. disencapsulated cysts and nauplii was similar (Ortega, 2000). Reduced PL survival in the freshwater could be due to the fast death of nauplii and deposition on the bottom of the tanks. Weingartner (2002) tested the larviculture of *Pimelodus maculatus* in the freshwater, observed that the post-larvae swam through the water column while nauplii died quickly and deposited on the bottom of the tanks. Dead *Artemia* sp. nauplii can have reduced nutritional value due to fatty-acid oxidation and protein degradation (Kerdchuen and Legendre, 1994). Feeding frequency should be increased to reduce the problem associated to the use of *Artemia* sp. nauplii in the freshwater (Reynalte-Tataje et al., 2000). In this study, post-larvae were fed six times a day and it was not enough to guarantee constant food availability. Probably motivated by this, post-larvae in freshwater showed higher heterogeneity of size and cannibalism, bigger individuals attacked smaller ones on the yolk sac. This behavior was also seen by Behr (1997) in inadequate feeding conditions.

Cannibalism can occur due to insufficient food availability, population density, turbidity, light intensity, shelter, and larvae heterogeneous sizes (Pienaar, 1990), further to nutritional factors, such as feed composition that do not meet the nutritional requirements (Fox, 1975). According to Pienaar (1990), cannibalism can be controlled by the food availability, although other authors state that it can just reduce it (Loadman et al., 1986; Wright and Giles, 1987). In this study, cannibalistic behavior was observed only in the freshwater treatment. Cannibalism was also observed in *Pseudoplatystoma corruscans* (Cardoso et al., 1988; Behr, 1997) but not as intense as in other Brazilian fish post-larvae like some *Brycon* and *Salminus*. Salinities above 5‰ were too high for pintado larviculture, as all post-larvae died 24 h after the exposition. Other Pimelodidae fishes showed higher sensibility and total death was observed in salinity above 2‰ for

Pimelodus maculatus (Weingartner, 2002) and 3‰ for *Pseudopimelodus zungaro* (Reynalte-Tataje, 2000). As the development of the osmoregulatory system is complete only at the end of the larval phase (Stamatis, 2001), high mortality rates have been reported for several species in high salinities, showing insufficient ions excretion and osmoregulatory impairments (Lein et al., 1997). That is a fact that can justify the high mortality of pintado post-larvae in this study in salinities above 5‰. Tilapia, *Oreochromis niloticus*, larvae showed similar survival when they were maintained in salinities up to 15‰, above which survival was drastically reduced (Watanabe et al., 1985). Similar result was observed in this study when salinity was above 5‰. Results showed that weight and length were higher in salinities 0 and 1.7‰. However, it is important to mention that the high growth obtained in the freshwater treatment may be due to the cannibalism practiced by post-larvae. Higher growth at 1.7‰ salinity could be promoted by the reduced energy consumption to maintain osmoregulation. According to Sampaio and Bianchini (2002), freshwater fishes body fluids are in higher osmotic and ionic concentrations than the environment, which, thus demands high energy consumption to maintain the osmoregulation. Decreased gradient between the environment and body fluids can reduce energy consumption to osmoregulate and, consequently, results in increased fish growth (Baldisserotto, 2002; Sampaio and Bianchini, 2002). Energy spent on the osmoregulation varies among fish species, some use 1 to 2% of the total energy and other freshwater fishes can reduce the metabolic rate in 20 to 40% (Baldisserotto, 2002). Low water salinity in post-larvae fish farming has less effect on the growth and survival than high salinities, as observed by Specker et al. (1999) for *Paralichthys dentatus*. Several freshwater fish species show maximum growth and survival rates when reared in slightly salinized water, up to 5‰, such as *Cyprinus carpio* (Lam and Sharma, 1985), *Odontethes hatcheri* (Tsuzuki et al., 2000), *Heterobranchus longifilis* (Fashina-Bombata and Busari, 2003), whereas others like *Ictalurus punctatus* show reduced fingerling growth (Baldisserotto, 2002). In salinities above 1.7‰ reduced growth of pintado may have been caused by the high energy consumption to maintain inverse osmoregulation, i.e., eliminating salt and retaining water. In this way, fish should compensate that additional energy consumption to maintain the ionic regulation by increasing the food intake (Sampaio and Bianchini, 2002). Pintado post-larvae allometric condition factor was high when reared in freshwater and tended to decrease in higher salinities. Such fact observed in freshwater could be possibly related to comfortable salinity or cannibalism caused by the low food availability, as nauplii died and deposited on the bottom of the tank few minutes after the introduction in the water.

CONCLUSIONS

Survival rate was similar in the treatments with salinities between 1.7 and 5‰; however, better growth rates were found in salinities between 0 and 1.7‰. Therefore, larviculture of pintado (*Pseudoplatystoma corruscans*) could be recommended in 1.7‰ salinity water.

RESUMO

O objetivo deste estudo foi avaliar a sobrevivência e o crescimento de pós-larvas (PL) de pintado, *Pseudoplatystoma corruscans,* submetidas a sete salinidades: S1: 0; S2: 1,7; S3: 3,3; S4: 5; S5: 6,7; S6: 8,3 e S7: 10‰, distribuídas num delineamento inteiramente ao acaso, com três repetições. As pós-larvas foram estocadas em recipientes plásticos circulares com volume de 5 litros, numa densidade de 15 pós-larvas/litro e mantidas em fotoperíodo escuro. A água de cultivo foi salinizada com cloreto de sódio (NaCl) não-iodado. As pós-larvas foram alimentadas seis vezes ao dia na proporção de 500 náuplios de *Artemia* sp/PL/dia. A sobrevivência apresentou crescimento mais acentuado até a salinidade de 1,7‰, tanto no quinto como no décimo dia de experimento, decrescendo bruscamente em salinidades superiores a 5‰. Os maiores valores de crescimento foram observados nas salinidades de 0‰ e 1,7‰, porém, o elevado crescimento observado em água doce foi decorrente do canibalismo. Pelos resultados obtidos, recomenda-se o cultivo de pós-larvas de pintado em água salinizada a 1,7‰.

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