Effect of light green and dark brown colored tanks on survival rates and development of tambaqui larvae, *Colossoma macropomum* (Osteichthyes, Serrasalmidae)

Marcelo Mattos Pedreira[1]* and Lúcia Helena Sipaúba-Tavares[2]

*[1]Departamento de Ciências Biológicas , Escola de Farmácia e Odontologia de Alfenas, Rua Gabriel Monteiro da Silva, 714, 37130–000, Alfenas, Minas Gerais, Brasil. [2]Centro de Aqüicultura, Universidade Estadual Paulista, Via de Acesso Paulo Donato Castellane, s/n, 14870-000, Jaboticabal, São Paulo, Brasil. *Author for correspondence. e-mail: marmape@zipmail.com.br*

ABSTRACT. The color effect on survival rate and development of tambaqui larvae, *Colossoma macropomum*, in fish tanks, during a 20 day period, was analyzed. Larvae were fed "ad libitum" and measurements of four limnological variables were conducted daily. Water temperature varied between 24 to 27.8°C and 24.0 to 27.7°C in the dark brown and light green colored tanks, respectively. Dissolved oxygen level remained over 6.5 mg/L, pH was alkaline and water conductivity higher than 30 µS/cm. The dark brown treatment displayed significantly ($P < 0.05$) lower survival rate compared to treatment with light green. Identical effect, however, was not reported with average weight, biomass and larvae total length. Results showed that tank color influences larvae survival rates, where the light green color makes it easier for the larvae to visualize the prey.

Key words: tank color, larviculture, tambaqui, *Colossoma macropomum*.

RESUMO. Efeito das cores dos tanques, verde clara e marrom escura, na sobrevivência e desenvolvimento de larvas de tambaqui, *Colossoma macropomum* (Osteichthyes, Serrasalmidae). O objetivo deste trabalho foi analisar o efeito da cor dos aquários na sobrevivência e desenvolvimento de larvas de tambaqui *Colossoma macropomum*, num período de 20 dias. As larvas foram alimentadas "ad libitum" e diariamente foi realizada amostragem de quatro variáveis limnológicas. A temperatura da água oscilou de 24,0 a 27,8 ºC no marrom- escuro e de 24,0 a 27,7ºC no verde-claro; a concentração de oxigênio dissolvido permaneceu acima de 6,5 mg/L; o pH manteve-se alcalino e a condutividade, acima de 30 µS/cm. O tratamento marrom-escuro apresentou sobrevivência média significativamente menor ($P < 0,05$) que o verde-claro. O mesmo não ocorreu com os dados de peso médio, biomassa e comprimento total das larvas. Os resultados obtidos confirmaram que ocorre uma interferência da cor dos aquários na sobrevivência larval, onde o verde claro facilitou a alimentação através da visualização da presa pela larva.

Palavras-chave: cor do tanque, cultivo de larvas, tambaqui, *Colossoma macropomum*.

Colossoma macropomum (tambaqui) is a freshwater species originally from the Amazon basin that presents great aquaculture potential when compared to that of other indigenous species. This species is omnivore, feeding mainly on plankton and fruits. It is resistant to low dissolved oxygen levels and can survive long periods of sever hypoxia. Moreover, its flesh has excellent nutritive value (Araújo-Lima and Goulding, 1997).

Food is a primary factor in fish initial development. However, some physical characteristics of culture such as color contrast between the tank and the food, and proper lighting are important factors which influence larvae visual perception. Adjustment of these parameters may increase efficiency of capture and thus contribute positively for growth and survival rates (Ostrowski, 1989).

Recently, Tamazouzt *et al.* (2000) reported that the effect of color contrast between tank, prey and lighting on survival and growth rates of freshwater fish larvae cultivated in closed systems are fundamental requirements for high productivity.

With an increase in culture and consumption of tambaqui in Brazil, it is important to establish a relationship between physical conditions of the medium and fish development. Few studies emphasize the influence of the tank color in larviculture, and even less for tropical species.

A more accurate knowledge of physical factors influence on development and survival rates of this species is relevant for Brazilian aquaculture. Therefore, this work aimed at determining the effect of the tank color on the survival rate and development of tambaqui larvae, *C. macropomum*, fed on natural plankton.

Material and methods

Larvae origin. *Colossoma macropomum* larvae were obtained by induced hatching, supplied by Centrais Eletricas de Minas Gerais (CEMIG) and were bred in CAUNESP laboratory. Three-day-old larvae, average total length of 6.63 mm and average weight of 0.82 mg, were kept in 5 light green plastic tanks and 4 dark brown plastic tanks, in 10 L tanks at a density of 10 larvae/L, under constant aeration and environmental conditions of photoperiod, 1053 ± 332 lux, for a period of 20 days (from 1/19 to 2/8/1998). Larvae were fed *ad libitum* daily, with natural plankton. The plankton (Protozoa, Rotifera, Copepoda, Copepoda nauplii, Cladocera, Ostracoda, Insecta, invertebrate egg and unidentified), collected in tanks at Centro de Aquacultura (UNESP, Jaboticabal), was selected in 68μm mesh screen, and further fractionated in 1000μm sieve.

Hydrological Variables. The lowest and highest air temperatures were measured daily by a maximum/minimum thermometer. Water temperature and dissolved oxygen contents were measured with an oxymeter YSI 55 and determination of pH was conducted by a digital pH-meter, Corning PS 15. Conductivity was measured by a digital conductvimeter Corning PS 17.

Every three days, 30% of the water volume was siphoned for renewal and cleaning of the tank.

Hydrological variables were graphically compared and not analyzed statistically.

Growth and Survival Rates. The values for survival rate, average weight, biomass and total length were measured at the end of the experiment. For each repetition (4 dark and 5 light), larvae total was weighed with Scientech AS 210 scale. Value was defined as biomass which, divided by the number of individuals, resulted in larva average weight. Larva total length was determined by an ocular micrometer. A total of 134 individuals were measured, 44 and 90 larvae from the dark and light treatment, respectively. Survival rate, average weight, biomass and total length results were analyzed by t-test for comparison of two independent variables, with 0.05 significance level. Data were analyzed with a computerized statistical program (SAS Institute, Inc. Cary, North Carolina, USA).

Results

Average survival rate (± standard deviation) for tambaqui larvae in the dark tanks was 9.4 ± 20.9%, significantly lower ($P < 0.05$) when compared to the light tanks, 67.5 ± 41.6%. Average weight, biomass and larva total length values in the dark tanks were 21.6 ± 12.7 mg; 0.7 ± 0.9 g and 1.4 ± 0.1 mm, respectively. These results were not significantly different ($P < 0.05$) from results obtained for light tanks 32.3 ± 23.3 mg; 1.5 ± 0.6 g and 1.5 ± 0.2 mm for average weight, biomass and total length, respectively (Table 1).

Table 1. Average values (± standard deviation) of survival, weight, biomass and length found for *Colossoma macropomum* larvae after 20 days of culture under two treatments: light green and dark brown fish tanks

	Survival (%)	Weight (mg)	Biomass (g)	Length (mm)
light	67.5 ± 41.6a	32.3 ± 23.3a	1.5 ± 0.6a	1.5 ± 0.2a
dark	9.4 ± 20.9b	21.6 ± 12.7a	0.7 ± 0.9a	1.4 ± 0.1a

Average values in the same column, followed by different letters are significantly different ($P < 0.05$), according to *t test*

Water temperature during the experimental period varied from 24.0 to 27.8°C, with intervals of 24 to 27.8°C and 24.0 to 27.7°C, for the dark and light tanks, respectively. Air temperature varied between 24.5 and 33°C. Generally, the temperature varied within the range of environmental conditions, or rather, from 24 to 25.5°C, at the beginning of the experiment up to the fifth day. After a temperature peak, values oscillated again between 24.8 and 27.6°C for both treatments.

Dissolved oxygen concentration varied from 6.5 to 7.5 mg/L during the experiment, with intervals of 6.7 to 7.9 mg/L and 6.5 to 7.9 mg/L for the dark and light tanks, respectively. On the first day of the experiment, dissolved oxygen level displayed a peak, 7.9 mg/L; afterwards it decreased and remained between 6.5 and 7.5 mg/L. Probably, aeration and lack of ration in the medium caused the initial peak. Throughout the experimental period, dissolved oxygen concentration displayed three peaks for both treatments, on the 1st, 11th and 16th days, with 7.4, 7.5 and 7.4 mg/L, respectively. The lowest dissolved oxygen concentration was observed on the 6th day, 6.5 mg/L for the light treatment.

During the experimental period, pH varied from 7.2 to 8.2, with intervals of 7.2 to 8 and 7.4 to 8.2 for dark and light tanks, respectively. The pH values remained alkaline, decreasing rapidly between the second and 4th day, varying from 7.4 to 7.8 and after that there was an increase up to the 11th day, when higher values were observed. From the 11th day onwards, pH decreased in the dark tank until the end of the experiment, when it presented the lowest value on the last day, 7.2. In the light tank, pH decreased until the 16th day, and after that there was an increase on days 17th and 18th, with values 8.2 and 8.2, respectively. After that values decreased again, but remained higher than in the dark tank.

Conductivity varied between 30 and 65 µS/cm, with values 30 to 60 µS/cm and 30 to 65 µS/cm, for the dark and light tanks, respectively (Figure 1). Due to fish excrements and daily rationing conductivity increased during the experimental period, practically doubling its value at the end of the experiment. In general, the light tank displayed higher values compared to those of the dark tank. It became more evident from the 13th day up to the end of the experiment. During the last three days of the experiment, conductivity in the dark tank decreased, varying between 45 and 57 µS/cm.

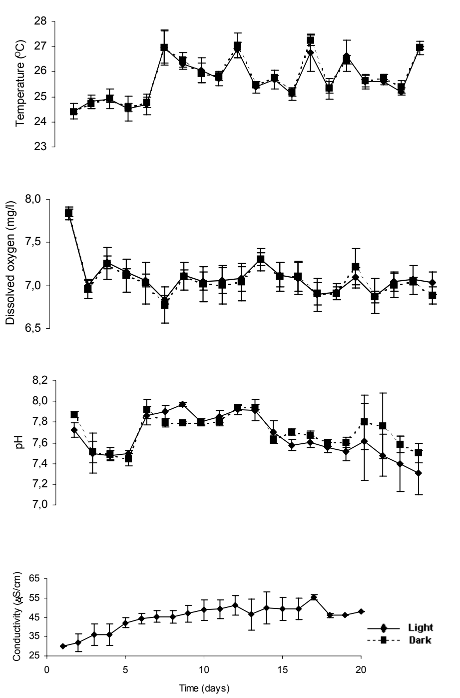

Figure 1. Average values and standard deviation of limnological variables for the light green and dark brown fish tanks of tambaqui larviculture, *Colossoma macropomum*, for a period of 20 days

The waste from leftover ration, feces and dead larvae could be easily seen owing to the color contrast in the light tanks. Higher contrast also facilitated observations with respect to larva behavior, which were highly active, constantly swimming in the water column, capturing preys or escaping predation.

Culture medium, larvae, food and excrements were more evident in the light tank because of better contrast; however, management was the same in both treatments.

Discussion

The increasing ability of prey perception during larval development is of fundamental importance for larvae development and survival; therefore, the lighting system employed in the larviculture might affect directly the ability of prey capture by the larvae.

The higher survival rate in the light tank was related to the higher perception of the prey by the larvae as a consequence of increasing contrast between food and tank color. This is vital for the successful capturing of prey during the larvae's first days of life, causing higher survival rates. This behavior has also been reported by Tamazouzt et al (2000) when studying fresh water perch (*Perca fluviatilis*).

Fish larvae are visual predators with high feeding rate during the day and a decline of this activity during the night (Heath, 1992). Some larvae, such as *Trachurus lathami*, feed almost exclusively during the light period, since during the night most larvae do not present prey in the digestive tract (Pedreira, 1997). In spite of being visual predators, fresh water fish larvae must have other sensorial organs which are more developed than those of sea fish larvae, since they live in muddy water.

Some larvae, such as *Trachurus declivis* and *Engraulis anchoita,* display a feeding behavior that needs a moderately amount of light (Young and Davis, 1992; Freire, 1995). Fish larvae adapt themselves to certain light intensity according to species and developmental stage.

In current study *C. macropomum* larvae were submitted to moderate light intensity, 1053 lux, closed environment, with natural photoperiod and transparent water. Probably these factors influenced directly larvae weight and length, without significant differences ($P > 0.05$) among the studied treatments. Similar results were observed for *P. fluviatilis* larvae which had higher survival rates under moderate light intensity of approximately 250 lux (Tamazouzt *et al.*, 2000).

Planas and Cunha (1999) reported that high light intensity (1000 – 2000 lux) on the tank surface and highly transparent waters are commonly utilized since low visibility may affect performance during prey capture. While studying different fish tanks submitted to natural lighting, during larva first feeding, Nass *et al.* (1996) verified that light reflex on the tank surface is important for larvae distribution in the water, since they tend to search for the optimum lighting. Roo *et al.* (1999), while studying *Pargus pargus* larvae, suggested that due to development of the visual system, it was necessary to change light intensity during larval phase.

Although light intensity affects directly food capture and, consequently, growth and survival rates, this effect seems to diminish during fish developmental stages.

Light intensity is very important during the first days of life of tambaqui larvae when the efficiency of prey capture is low. However, in this study, light intensity influenced more directly the survival rate than the larval development.

The utilization of the appropriate color in culture tanks has been previously discussed. According to Tamazouzt *et al.* (2000), *P. fluviatilis* larvae displayed higher survival rates when placed in light gray fish tanks and higher growth rates in white and light gray fish tanks. Nass *et al.* (1996) reported that dark fish tanks reproduced better natural light conditions and fish tanks with white walls had a negative effect on the development owing to larvae negative phototaxy. Ostrowsky (1989) observed that dourado larvae (*Coryphaena hippurus*) presented survival rates higher than 50% in black fish tanks, while in translucent ones, survival rate reached 25%. Deson and Smith (1996) reported higher prey perception by *Morone chrysops* larvae fed on rotifers while placed in transparent or black fish tanks, due to good contrast between the rotifer and dark tank color.

For tambaqui larvae, light colored tanks presented higher survival rate, probably due to the intense color of tropical freshwater plankton, varying from brown, orange and red to blue (Matsumura-Tundisi and Silva, 1999), in addition to better lighting obtained by the light reflex in the light tank. The latter increases larvae efficiency to capture the prey.

In their study of grouper larvae, *Epinephelus suillus*, in translucent and black fish tanks, Duray *et al.* (1996) reported that in translucent tanks the larvae on the 14th culture day were larger, but survival rates failed to increase significantly. Krise and Meade (1986) argued that too high light intensity caused blindness. It should thus be carefully controlled to facilitate prey capture. Some authors obtained better results in dark fish tanks, noting however, that tank colors that provided higher contrast with preys also displayed better results.

In this study, the limnological variables did not differ among the treatments, only conductivity displayed an increase in the light treatment during the end of the experiment, probably due to the activity in the system caused by light intensity and higher number of larvae. The light color fish tanks optimized the culture of tambaqui larvae, due to better contrast between the prey and the tank.

Acknowledgments

We would like to thank Fundação de Amparo e Pesquisa do Estado de São Paulo for its financial support. Thanks are also extended to Dr. Newton Castagnolli for the use of laboratory.

References

ARAÚJO-LIMA, C.; GOULDING, M. *So fruitful a fish*: ecology, conservation, and aquaculture of the Amazon's tambaqui. New York: Columbia University Press, 1997.

DENSON, M. R.; SMITH, T. I. J. Larval rearing and weaning techniques for white bass *Morone chrysops J. World Aquacult. Soc.*, v. 27, no. 2, p. 194-201, 1996.

DURAY, M. N. *et al.* The effect of background color and rotifer density on rotifer intake, growth and survival of the grouper (*Epinephelus suillus*) larvae. *Aquaculture*, Amsterdam, v. 146, p. 217-224, 1996.

FREIRE, K. M. F. *Alimentação de larvas de Engraulis anchoita (Teleostei: Engraulididae) na plataforma continental do Rio Grande do Sul, Brasil*. 1995. Dissertação (Mestrado) - Departamento de Oceanografia, Fundação Universidade do Rio Grande, Rio Grande, 1995.

HEATH, M. R. Field investigations of the early life stages of marine fish. *Adv. Mar. Biol.*, London, v. 28, p.1-174, 1992.

KRISE, W. F.; MEADE. J. W. Review of the intensive cultured of walleye fry. *Prog. Fish-Cult.*, v. 48, no. 2, p. 81-89, 1986.

MATSUMURA-TUNDISI, T.; SILVA, W. M. Crustáceos copépodos planctônicos. In: ISMAEL, D. W. *et al.* (Ed.). *Invertebrados de água doce*. São Paulo: Fundação de Amparo e Pesquisa do Estado de São Paulo, 1999. p. 93-100.

NASS, K. *et al.* Illumination in first feeding tanks for marine fish larvae. *Aquacult.. Eng.*, Amsterdam, v. 15, no. 4, p. 291–300, 1996.

OSTROWSKI, A. C. Effect of rearing tank background color on early survival of dolphin larvae. *Prog. Fish-Cult.*, v. 51 no. 3, p. 161-163, 1989.

PLANAS, M.; CUNHA, I. Larviculture of marine fish: problems and perspectives. *Aquaculture*, Amsterdam, v. 177, p. 171-190, 1999.

PEDREIRA, M. M. *Alimentação e hábito alimentar de larvas de Trachurus lathami (Teleostei: Carangidae) na região de Ubatuba, Estado de São Paulo*. 1997. Dissertação (Mestrado) - Instituto Oceanográfico, Universidade de São Paulo, São Paulo, 1997.

ROO, F. J. *et al.* Development of red porgy *Pargus pargus* visual system in relation with changes in the digestive tract and larval feeding habits. *Aquaculture*, Amsterdam, v. 179, p. 499–512, 1999.

TAMAZOUZT, L. *et al.* Tank wall colour and light level affect growth and survival of Eurasian perch larvae (*Perca fluviatilis*). *Aquaculture*, Amsterdam, v. *182*, p. 85-90, 2000.

YOUNG, J. W.; DAVIS, T. L. O. Feeding ecology and interannual variations in diet of larval jack mackerel, *Trachurus declivis* (Pisces: Carangidae), from coastal waters of eastern Tasmania. *Mar. Biol.*, Berlin, v. 113, p. 11-20, 1992.

Received on December 22, 2000.
Accepted on February 16, 2001.