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Salinity and Stocking Density Effect on Growth and Survival of *Barbodes gonionotus* (Bleeker, 1850) Fry

¹M.I.M. Faizul and ^{1,2}A. Christianus

¹Institute of Bioscience, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

²Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

Corresponding Author: A. Christianus, Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia, 43400, Serdang, Selangor, Malaysia Tel: +60389474884

ABSTRACT

The effect of salinity and stocking density on the growth and survival of *Barbodes gonionotus* fry were studied. Experiments were carried out at the Aquaculture Research Station Puchong, Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia, Serdang, Selangor. Parameters measured once a week were total length (cm), weight (g) and survival (%). Water quality such as dissolved oxygen (DO), pH, ammonia, nitrite and temperature were monitored once in two days prior to the water change. During the study period, fry were fed *ad libitum* with commercial pellets (Star Feed with 42% Crude protein), two times daily at 09:00 and 17:00 h. In the first experiment, 2 cm *B. gonionotus* fry were used and placed in 6 glass aquarium (58×38×38 cm). Fry were cultured at three stocking densities, 3, 5 and 8 fry L⁻¹. At the end of culture period, it was found that *B. gonionotus* fry stocked at 3 fry L⁻¹ showed significantly higher ($p < 0.05$) final weight and total length. However, stocking density of 5 fry L⁻¹ resulted the highest percentage of survival at the end of the experimental period. In the second experiment, *B. gonionotus* fry were cultured in water with four different salinities, 0, 5, 10 and 15 ppt. Similarly, 2 cm fry were used and placed in 6 glass aquariums (58×38×38 cm) with 40 L water. Treatment with 15 and 20 ppt were terminated due to mass mortality between 3-7 days of exposure. As for the rest of the treatments, it was found that *B. gonionotus* fry cultured at 0 ppt showed significantly higher ($p < 0.05$) final body weight and total length as compared to 5 and 10 ppt. However, by the end of the experimental period, the percentage of survival was significantly the highest at 10 ppt. This study showed that *B. gonionotus* fry can be stocked at 3 fry L⁻¹ without adverse effect on its growth and survival and survive well at 10 ppt.

Key words: Stocking, survival, *Barbodes gonionotus*, final weight, total length

INTRODUCTION

Silver barb or scientifically known as *Barbodes gonionotus* (Bleeker, 1850) is a Malaysian indigenous riverine carp. It was first introduced as farm species in 1958. *Barbodes gonionotus* is able to breed the whole year round. It has body covered with moderately large, silver, chrome like scales with white fins. Silver barb is an important carp species cultured in several Southeast Asian countries like Indonesia, Thailand and Vietnam. It is omnivorous, feeding primarily on filamentous algae and submerged weeds. It was introduced to India in 1972 as biological control for aquatic weeds in open aquaculture system similar to grass carp (Jhingran, 1985). Industrial and

agricultural development caused the degradation of fish natural habitat and this posed negative impact on fish population in the wild (Sasi, 2011). These developments may cause acidic or alkaline water condition. Fish exposed to alkaline polluted water showed an increased in the plasma ammonia level (Chezhian *et al.*, 2012). The pH of most natural water ranges between 5.0 to 10.0 (Boyd, 1990) and this change depends on many factors such as acid rain, pollution and CO₂ from the atmosphere and fish respiration. Fish are poikilothermic animals, therefore their body temperature is the same as, or 0.5 to 1°C above or below the temperature of the water in which they live (Svobodova *et al.*, 1993). Common carp is generally regarded as a freshwater fish which grows rapidly in water of less than 0.5 ppt salinity (Zhang, 1989).

In Malaysia, there are many abandoned shrimp ponds. The use of these ponds to culture fish species is highly possible provided that the fish can tolerate a slight saline condition. Many local species can be considered as potential candidate. Due to the popularity of *B. gonionotus* as cultured species made it a likely candidate. Lack of information on the salinity tolerance and optimum stocking density of this species has led to this study.

MATERIALS AND METHODS

Location of study: This study was conducted from 4th July 2009 to 22nd August 2009, at Aquaculture Research Station Puchong, Department of Aquaculture, Faculty of Agriculture, Universiti Putra Malaysia, Serdang, Selangor.

Stocking fry: *Barbodes gonionotus* fry with average length of 2 cm were obtained from the Department of Fisheries, Bukit Tinggi Station, Pahang.

Stocking density: In this study, 6 glass aquariums (58×38×38 cm) were used. Culture was carried out under natural light cycle of 12 h light and 12 h darkness. Water source for this study was seasoned underground water. Approximately 1200 fry of silver barb were transferred into glass aquarium after 3 day acclimatization in a tank (1000 L). Three groups of fish at 3, 5 and 8 fry L⁻¹ were stocked in aquarium with 40 L water volume. Each treatment was carried out in duplicates. Random sampling for weight and length was carried out once a week for a period of 6 weeks.

Salinity tolerance: *Barbodes gonionotus* fry were acclimatized to saline condition in two tanks (1000 L). Treatments used were 0, 5, 10 and 15 ppt. Prior to the experiment, fry were gradually acclimatized from 0 to 15 ppt, for an increment of 5 ppt at every two days. Fry were placed in glass aquarium once achieving the required salinity level during the acclimatization process. Stocking density for each aquarium was 3 fry L⁻¹.

Survival and growth: The percentages of survival and average of growth rate were recorded throughout the study period. Digital balance was used to measure the weight and ruler to measure the total length.

Water quality measurements: Water quality parameters were measured two times a week, prior to water change. Water parameters measured were dissolved oxygen (DO), pH, ammonia, nitrite and temperature. These parameters were measured using YSI DO meter, YSI pH meter, Hanna test kit (ammonia) and API master test for nitrite.

Feeding: Fry were fed *ad libitum* with commercial pellets Star Feed, two times daily at 09:00 and 17:00 h. Uneaten feed and waste were siphoned from the aquarium 30 min after each feeding.

Statistical analysis: The treatments were tested using one way analysis of variance (ANOVA) and comparison between treatments with LSD's test. All data in percentages were transformed using Arcsine before being used for ANOVA.

RESULTS AND DISCUSSION

Stocking density effect on growth and survival of *B. gonionotus* fry

Weight and total length of *B. gonionotus* fry: There were significant difference ($p < 0.05$) in the final weight for *B. gonionotus* fry reared at 3, 5 and 8 fry L^{-1} . Stocking density of 3 fry L^{-1} produced the highest ($p < 0.05$) final weight gain followed by 5 and 8 fry L^{-1} (Table 1). Stocking of fry at higher density is known to cause strong competition for food and space, hence, the lower final weight of fry for stocked at 5 and 8 fry L^{-1} . As for final Total Length (TL), stocking of 3 fry L^{-1} showed the best result ($p < 0.05$) as compared to 5 and 8 fry L^{-1} . Study on Cobia showed that higher stocking between 5 to 10 larvae/L produced lower length increments (Hitzfelder *et al.*, 2006).

The survival percentages of *B. gonionotus* fry: Significant different ($p < 0.05$) in the percentage of survival was observed between all treatments (Table 1). Highest survival at the end of the culture period was at stocking density of 5, followed by 3 then 8 fry L^{-1} .

Water quality of *B. gonionotus* fry: Table 2 showed the ranges for water quality parameters (DO, pH, ammonia, temperature and nitrite) monitored during the experimental period. *B. gonionotus* was able to tolerate water with DO, pH, ammonia, nitrite and temperature ranges from 3.77-5.50 ppm, 7.40-7.90, 1.55-8.0 ppm, 0.49-1.64 ppm and 25.2-27.8°C, respectively. These

Table 1: Mean weight, length and survival of *Barbodes gonionotus* fry reared at different stocking densities at the end of 6 week culture period*

Stocking density (fry L^{-1})	Weight (g)		Total Length (cm)		Survival (%)	
	Initial	Final	Initial	Final	Initial	Final
3	0.75±0.12 ^a	2.20±0.23 ^a	2.00±0.11 ^a	5.34±0.21 ^a	100±0 ^a	80.00±0.43 ^b
5	0.75±0.29 ^a	1.78±0.24 ^b	2.00±0.17 ^a	5.02±0.35 ^a	100±0 ^a	83.00±0.23 ^a
8	0.75±0.25 ^a	1.65±0.22 ^b	2.00±0.09 ^a	4.66±0.22 ^b	100±0 ^a	71.33±0.24 ^c

Mean±SD with the same superscripts in the same column are not significantly different at $p > 0.05$, *Volume water per aquarium = 40 L

Table 2: Ranges for water quality parameters for the cultured of *Barbodes gonionotus* fry at different stocking densities during the 6 weeks culture period

Water parameter	Ranges stocking density (fry L^{-1})		
	3	5	8
Dissolved oxygen (ppm)	4.26-5.50	4.21-5.33	3.77-5.23
pH	7.56-7.68	7.56-7.90	7.40-7.90
Ammonia (ppm)	1.56-7.33	1.55-8.00	1.56-8.00
Nitrite (ppm)	0.49-1.55	0.82-1.56	1.00-1.64
Temperature (°C)	25.3-27.6	25.3-27.6	25.2-27.8

ranges are quite close to those required by carp (Renukardhya and Varghese, 1986). Increase in ammonia was observed during the cultured period. This is likely due to the increased fish size thereby increasing the amount of waste excreted.

Salinity effect on growth and survival of *B. gonionotus* fry

Weight and total length *B. gonionotus* fry: During the gradual salinity acclimatization, more than 50% of fry died after 7 days being transferred into 15 ppt. water. While all fry died after 3 days in 20 ppt. Therefore, treatments using 15 and 20 ppt were not carried out. Final weight for *B. gonionotus* fry reared at water salinities 0, 5 and 10 ppt are as shown in Table 3. Fry cultured at 0 ppt resulted in the most significant ($p < 0.05$) final weight and total length, followed by 5 and 10 ppt. This study showed that *B. gonionotus* fry can grow well up to 10 ppt salinity even though in nature this fish live in freshwater.

Percentage of survival for *B. gonionotus* fry: There were significant differences ($p < 0.05$) in the percentage of survival for *B. gonionotus* fry between all treatments (Table 3). However, culture at 10 ppt produced the most significant ($p < 0.05$) survival followed by 5 and then 0 ppt. High mortality at 0 and 5 ppt was due to the occurrence of *Ichthyophthirius multifiliis*. This was confirmed through microscopic observation on the body smear of the infected fry.

Water quality of *B. gonionotus* fry: Table 4 showed the ranges of water parameters (DO, pH, ammonia, temperature and nitrite) measured during this experiment. The ranges for water quality parameters monitored during this experiment was 5.31-6.43 ppm, 7.50-7.75, 1.81-5.58 ppm, 0.63-1.00 ppm and 25.2-26.9°C, respectively. It was observed that partial water change can reduce the level of ammonia in the culture water.

Table 3: Mean weight, total length and survival rate of *Barbodes gonionotus* fry reared at different salinities, at the end of the 6 weeks culture period*

Salinity (ppt)	Weight (g)		Total length (cm)		Survival (%)	
	Initial	Final	Initial	Final	Initial	Final
0	1.02±0.22 ^a	2.01±0.25 ^a	2.0±0.21 ^a	5.44±0.23 ^a	100±0 ^a	69±0.21 ^a
5	1.02±0.13 ^a	1.75±0.24 ^b	2.0±0.22 ^a	5.11±0.25 ^b	100±0 ^a	96±0.22 ^b
10	1.02±0.32 ^a	1.90±0.25 ^b	2.0±0.29 ^a	5.10±0.12 ^b	100±0 ^a	97±0.32 ^c

Mean±SD with the same superscripts in the same column are not significantly different at $p > 0.05$, *Volume water per aquarium = 40 L

Table 4: Ranges of water parameters for *Barbodes gonionotus* fry culture at different salinities for the 6 weeks culture period

Water parameter	Ranges salinity (ppt)		
	0	5	10
Dissolved oxygen (ppm)	5.31-6.43	5.35-6.40	5.33-6.42
pH	7.5-7.75	7.55-7.70	7.5-7.65
Ammonia (ppm)	1.81-5.58	1.85-5.50	1.88-5.55
Nitrite (ppm)	0.63-1	0.65-1	0.65-1
Temperature (°C)	25.2-26.9	25.2-26.8	25.2-26.9

Stocking density and salinity tolerance: The management of water quality is one of the important factors in productive fish farming. Range for pH for during the experimental period for these experiments is 7.40-7.90. This is within the range of 6.5 to 9.0, optimum range for freshwater fish culture (Boyd, 1990). Fishes are usually intolerant to pH extremes of less than 5 and above 9 (Randall, 1991). Ammonia levels measured in this study is considered to be toxic, however according to Boyd (1979), effects of short-term exposure may vary between species. For some fishes, effects can be seen when ammonia is between 0.1 to 0.3 mg L⁻¹ (Boyd, 1979). Normally warm-water fish are more tolerant to ammonia than cold-water fish. Ammonia levels are lower at the beginning and become higher towards the end of the experiment probably due to the waste excretion and excess feed. As fry size increases, waste excretion also increased and this may have deteriorating effect on the water quality in culture system (Zailie, 2009).

In this study, *B. gonionotus* fry can tolerate salinity up to 10 ppt. This finding is similar to that of *Puntius* hybrid (Hafiz, 2009) and *Carassius auratus* (Du, 1986). Although, salinity tolerance varies between species, for example *Cyprinus carpio* can tolerate 8.5 ppt (Du, 1986) and *Hypophthalmichthys molitrix*, 9 ppt (Von Oertzen, 1985). Du (1986) stated that the salinity range for the optimal growth of carps is between 0 to 2.5 ppt. According to Hafiz (2009), length increment for *Puntius* hybrid was better when fry were cultured in 0 ppt. However survival rate for *B. gonionotus* was much better when cultured in water with salinity between 5 to 10 ppt. Similar finding was observed for the survival of *Barbodes* hybrid as reported by Hafiz (2009).

CONCLUSIONS

Based on the findings of this study, it can be concluded that the best stocking density for optimal growth and survival of *B. gonionotus* is at 3 fry L⁻¹. As for salinity, *B. gonionotus* were able to tolerate up to 10 ppt. Therefore, it can be recommended that after gradual acclimatization, *B. gonionotus* fry can be introduced into brackish water pond with salinity up to 10 ppt. This species can be considered as suitable candidate to be cultured in abandoned brackish water shrimp's ponds. Study also indicates that culture of fish in slightly saline condition of at least 5 ppt can reduce or prevent the occurrence of *I. multifiliis* infection on fish fry.

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