Study of optimal culture conditions for juvenile marble goby (*Oxyeleotris marmorata* Bleeker, 1852)

[1]Kriengkrai Seetapan, [2] Narongsak Puanglarp, and [1]Oraporn Meunpol

[1]Department of Aquaculture, Faculty of Fisheries, Kasetsart University, Bangkok, Thailand; [2]Center of Excellence for Marine Biotechnology, National Center for Genetic Engineering and Biotechnology (BIOTEC), National Science and Technology Development Agency (NSTDA), Bangkok 10400, Thailand
Coorresponding Author: kook82@hotmail.com

Abstract. Marble goby (*Oxyeleotris marmorata*(Bleeker, 1852)) is a freshwater fish species with high demand on market. However, its culture is under production due to insufficient fish seeds. High mortality rate of goby juvenile in hatchery are obtained partly because of an unsuitable culture condition and lack of appropriate larval feed. Therefore, this study aims to improve growth performance and also survival rate of marble goby fingerlings through the alteration of stocking density and shelter existence. After two months of experiment, the results showed that both factors had a positive role on growth performance and survival rate of marble goby fingerlings. Marble goby juveniles reared at 50 fish/m^2 and 250 fish/m^2 gained higher weight, length, and survival rate than the one reared at 500 fish/m^2 ($P<0.05$). Moreover, marble goby juveniles cultured with a shelter produced significantly higher length and weight gain ($P<0.05$) than the fish without a shelter. The survival rate of the experimented fish also was higher in fish with shelter than without shelter but the difference was not significant ($P>0.05$). In conclusion, it is suggested that the best stocking density for 0.17±0.01 g marble goby should be 250 fish/m^2 coupled with a shelter. More environmental factors for marble goby culture such as photoperiod and light intensity are also under investigation.
Keywords: *Oxyeleotris marmorata*, marble goby, density, shelter

Introduction

The marble goby (*Oxyeleotris marmorata* (Bleeker, 1852)) is a freshwater fish mainly cultured for food in tropical and semitropical countries such as Thailand, Vietnam and Cambodia. It has been exported to Japan, Korea, Singapore, Malaysia and China with high commercial value (Hoa and Yi, 2007; Wang *et al*., 2011). The demand of marble goby is increasing annually but the supply remains unchanged. The production of marble goby can not be increased due to the shortage supply of the fingerlings. Large-scale production of juvenile marble goby is still far from success. There are quite a few serious problems including slow growth during juvenile stage, peculiar feeding behavior, lack of formulated feeds, and high mortality rate (Lin and Kaewpaitoon, 2000).

Provision of stocking density and shelter are an important means of increasing growth and survival rate of some fish juveniles in aquaculture. The lower stocking densities always give the higher growth rate for several species, such as California halibut (*Paralichthys californicus*) (Merino *et al*., 2007), *Brachymystax lenok* (Zhang *et al*., 2008) and Nile tilapia (*Oreochromis niloticus* (L., 1758)) (Gibtan *et al*., 2008). In addition, shelters have been reported to increase survival and growth rate in some fish juveniles, such as black sea bass (*Centropristis striata* (L.)) (Gwak, 2003) and Arctic charr (*Salvelinus alpinus*, L.) (Benhaïm, 2009). If stocking densities and shelters are an important factor contributing to growth and survival in juvenile marble goby in the nursery grounds, it is likely that stocking density and shelter would play an important role under culture conditions. The objective of this study was to investigate the effect of stocking density and shelter on the growth and survival of marble goby juveniles under culture conditions.

Materials and Methods

Animals

Three thousand marble goby juveniles were bred from Pathumthani Inland Fisheries Research and Development Center, Pathumthani, Thailand. The fish size was 0.20±0.04 g in body weight and 2.56±0.07 cm in standard length. The marble goby juveniles were acclimated in 2 cement tank (6 m^3) for 2 weeks prior to the experiment. The water had constant aeration and 50% of the water was exchanged weekly. The photoperiod was 12:12 h (light:dark) and water temperature was 29±2 ^{o}C. During acclimatization period, the marble goby juveniles were fed with live *Moina* sp. to satiation twice daily at 08.00 and 17.00 h.

Experiments

Two experiments were conducted to estimate the importance of density and the shelter for the fish. The first experiment focused on the effect of stocking density on growth and survival. The second experiment focused on the effect of shelter on growth and survival.

The first experiment was conducted for a period of 8 weeks from June to July, 2011. The cages were installed at 20 cm above the tank bottom to allow sufficient flow of water underneath the cage. Three treatments differing in stocking densities were employed with 3 replicates each. Stocking densities were 50 , 250 and 500 fish/m^2. The marble goby juveniles were fed with living food organisms such as *Moina* sp. and Chironomus sp. larvae. During the experimental period fish were hand-fed to satiation twice a day at 08.00 and 17.00 h, respectively.

The second experiment was conducted for a period of 8 weeks from August to September, 2011. The cages were prepared as mentioned earlier. Two treatments were carried out and one treatment consisted of a shelter and the other without shelter (control). The experiment was conducted with 3 replicates per treatment. The shelter was made of black plastic corrugated pipe for car which was cut in half (70 mm external diameter). The tube had both internal and external grooves, creating a 33.0 cm length shelter with 12 grooves on both sides (Figure 1). The shelter had a screw at the start and the end of tube for weighing.

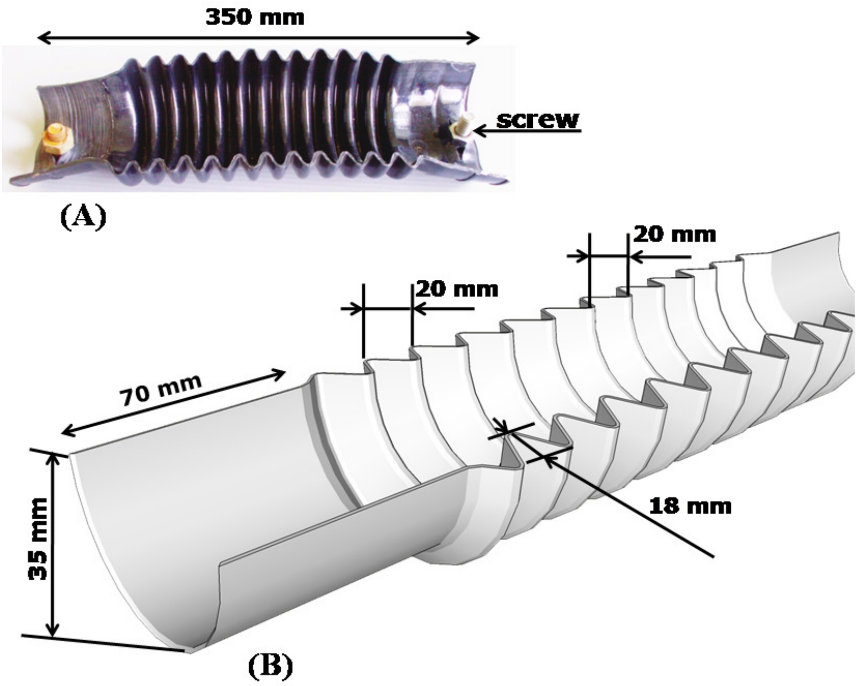

Figure 1. Shelter made of car corrugated pipe. (A) Overall view of the shelter. (B) Lateral view showing height, the groove width and height of one groove.

Determination of growth and survival rate

Growth and survival of all fish were measured biweekly. Growth performance was analyzed in terms of length and weight, Average daily gain (ADG), and Specific Growth Rate (SGR). The following formulae were used:

$$SGR\ (\%/day) = 100\ (Ln(FW-IW))/dt$$

where dt is the duration of the experiment in days; FW and IW are the final weight and initial weight, respectively.

$$ADG\ (g/day) = (Mean\ final\ weight - Mean\ initial\ weight)\ dt^{-}1$$

$$Survival\ rate\ (\%) = (Final\ fish\ number/Initial\ fish\ number)100$$

Analysis of experimental data

The result of the first experiment was analyzed by one-way analysis of variance (ANOVA) and the significance of the difference between means was tested using Duncan's multiple range test. Statistical methods were calculated and expressed as mean±S.D. Unless otherwise specified, a significance level of 95% was considered to indicate statistical differences ($P<0.05$). The result of the second experiment was compared using *t*-tests.

Results and Discussion

Growth and survival of fish

<u>*Effect of stocking density on growth and survival*</u>

Biweekly growths (length and weight) of marble goby juveniles are shown in Figure 2. The increase in length and weight was the highest in fish reared at 50 fish/m^2 followed by 250 fish/m^2 and 500 fish/m^2. Growth and survival parameters of fingerlings are shown in Table 1. The initial length and weight of the fish stocked in all the cases were in proximity. The fish reared at 50 fish/m^2 showed the highest gain in both length (6.33±0.29 cm) and weight (2.81±0.40 g) compared to the fish reared at 250 fish/m^2 and 500 fish/m^2. The mean final length, weight, length gain, weight gain, ADG, SGR and survival rates in fish reared at 50 fish/m^2 was significantly higher than that reared at 500 fish/m^2, while fish reared at 250 fish/m^2 was not significantly different from fish reared at 50 fish/m^2 but was significantly different from fish reared at 500 fish/m^2. The causes might include competition for food and habitat due to higher density of fish (Rahman *et al*., 2005). In addition, aggressive behavior has been found to increase with decreasing stocking density (Hossain *et al*., 1998).

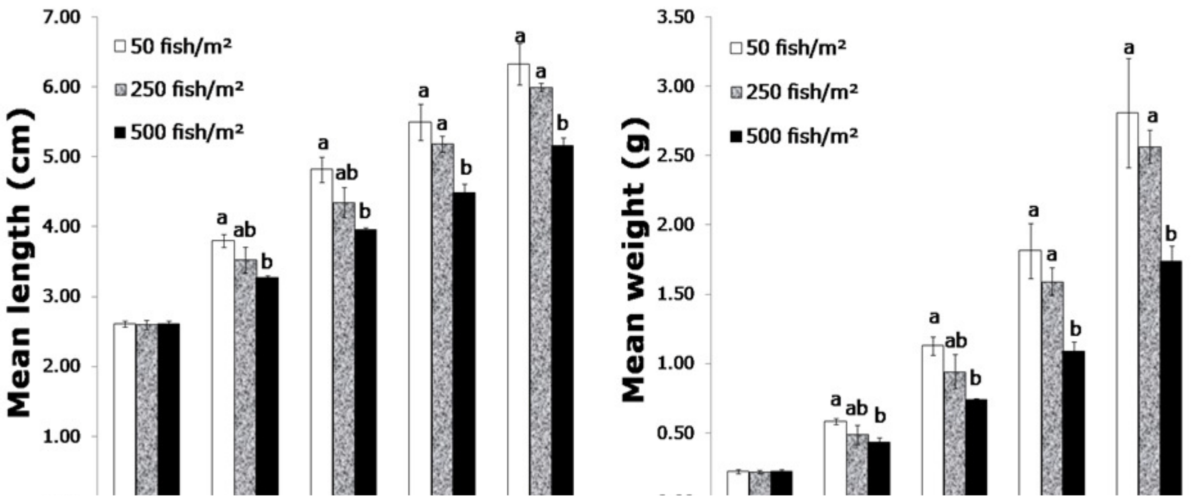

Figure 2. Biweekly mean length (cm) gain (A) and weight (g) gain (B) of marble goby juveniles under different densities.

Table 1. Growth performance and survival of marble goby juveniles under different densities after 8 weeks of rearing; mean±SD with ranges in parentheses

Parameters	Stocking density (fish/m^2)		
	50	250	500
Initial length (cm)	2.61 ± 0.04^{a}	2.61 ± 0.06^{a}	2.61 ± 0.05^{a}
Final length (cm)	6.33 ± 0.29^{a}	6.00 ± 0.06^{a}	5.16 ± 0.13^{b}
Length gain (cm)	3.72 ± 0.29^{a}	3.3 ± 0.12^{a}	2.55 ± 0.15^{b}
Initial weight (g)	0.22 ± 0.01^{a}	0.22 ± 0.01^{a}	0.22 ± 0.01^{a}
Final weight (g)	2.81 ± 0.40^{a}	2.57 ± 0.12^{a}	1.74 ± 0.1^{b}
Weight gain (g)	2.59 ± 0.40^{a}	2.35 ± 0.13^{a}	1.51 ± 0.12^{b}
Average daily gain (ADG) (g/day)	0.043 ± 0.007^{a}	0.039 ± 0.002^{a}	0.025 ± 0.002^{b}
Specific growth rate (SGR) (%/day)	4.21 ± 0.30^{a}	4.07 ± 0.16^{a}	3.42 ± 0.19^{b}
Survival rate (%)	100.00 ± 0.00^{a}	92.67 ± 2.13^{a}	68.00 ± 5.57^{b}

Values in the same row having the same superscript are not significantly different (*P>0.05*). Values in the parenthesis indicate the range.

Effect of shelter on growth and survival

Biweekly growth (length and weight) of marble goby juveniles was shown in Figure 3. The increases in length and weight were found to be higher in fish provided with shelter than that without shelter. Growth parameters of fish juveniles were shown in Table 2. The initial length and weight of fish stocked in all the cases were in close proximity. The fish with shelter showed the higher gains in both length (5.45±0.13 cm) and weight (2.04±0.10 g) when compared to fish without shelter. However, the mean final length and weight of fingerlings provided with shelter was higher than that without shelter (*P<0.05*). As shown by other authors on Arctic charr (Benhaïm *et al*., 2009), the survival rate is always higher in fish provided with shelter than that without shelter. But in this study, the difference is not significant (*P>0.05*). Over the study period, the survival rate was 95.33% among fish provided with shelter and 90.00% among fish without shelter. Provision of shelter is an important means of increasing survival and growth as already observed in African catfish fingerlings (Hossain *et al*., 1998). Fish without shelter had greater energy loss associated with much higher mobility (Millidine *et al*., 2006).

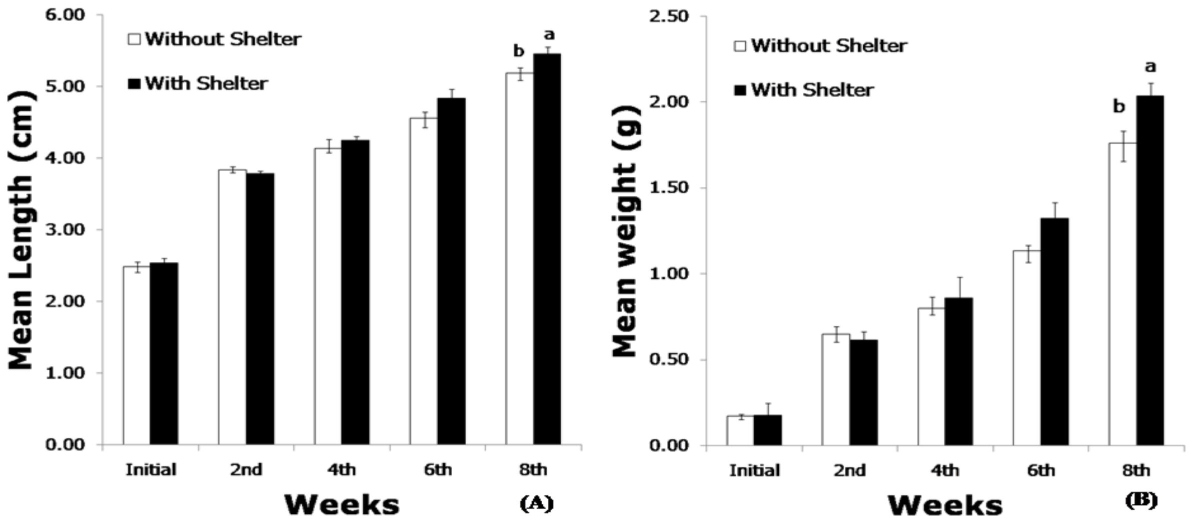

Figure 3. Mean±S.D. length (A) and weight (B) difference in fish provided with or without shelter. Significant difference (*P*<0.05) between fish provided with or without shelter are represented by a different latter above the bar (Student's *t*-test (two-tail)).

Table 2. Growth performance and survival in fish provided with or without shelter after 8 weeks of rearing; mean±SD with ranges in parentheses

Parameters	Treatments	
	without shelter	with shelter
Initial length (cm)	2.48±0.07^{a}	2.53±0.07^{a}
Final length (cm)	5.19±0.09^{b}	5.45±0.13^{a}
Length gain (cm)	2.71±0.02^{b}	2.92±0.08^{a}
Initial weight (g)	0.17±0.01^{a}	0.17±0.02^{a}
Final weight (g)	1.76±0.07^{b}	2.04±0.10^{a}
Weight gain (g)	1.59±0.07^{b}	1.86±0.09^{a}
Average daily gain (ADG) (g/day)	0.026±0.001^{a}	0.031±0.002^{a}
Specific growth rate (SGR) (%/day)	3.88±0.15^{a}	4.10±0.14^{a}
Survival rate (%)	90.00±3.46^{a}	95.33±2.31^{a}

Values in the same row having the same superscript are not significantly different (P>0.05). Values in the parenthesis indicate the range.

Conclusions

In conclusion, low density and shelter enhance growth and survival rates of marble goby juveniles. The experiments suggest that marble goby juveniles should be rearing at 250 fish/m^2 in pond (based on economic and/or operational criteria). The provision of shelters is assumed to be a necessary requirement for intensive rearing of marble goby juveniles.

Acknowledgements

We are grateful to the Pathumthani Inland Fisheries Research and Development Center, Pathumthani, Thailand; Mr Kriengkrai Sahassanonta and Miss Jirapa Phosri for providing useful information about marble goby culture.

References

Benhaïm D., Leblanc C.A., Lucas G. 2009. Impact of a new artificial shelter on Arctic charr (*Salvelinus alpinus*, L.) behaviour and culture performance during the endogenous feeding period. Aquaculture, 295: 38–43.

Boyd C.E. 1979. Water quality in warmwater fish ponds. Agriculture Experiment Station, Auburn, Alabama.

Gibtan A., Getahun A., Mengistou S. 2008. Effect of stocking density on the growth performance and yield of Nile tilapia (*Oreochromis niloticus* (L., 1758)) in a cage culture system in Lake Kuriftu, Ethiopia. Aquac. Res., 39: 1450-1460.

Gwak W.S. 2003. Effects of shelter on growth and survival in age-0 black sea bass, *Centropristis striata* (L.). Aquac. Res., 34: 1387-1390.

Hoa N.P., Yi Y., 2007. Prey ingestin and live food selectivity of marble goby (*Oxyeleotris marmorata*) using rice field prawn (*Macrobrachium lanchesteri*) as prey. Aquaculture, 273: 443–448.

Hossain M.A.R., Beveridge M.C.M., Haylor G.S., 1998. The effects of density, light and shelter on the growth and survival of African catfish (*Clurias gariepinus* Burchell, 1822) fingerlings. Aquaculture, 160: 251–258.

Lin C.K., Kaewpaitoon K. 2000. An overview of freshwater cage culture in Thailand. In: Liao I.C., Lin C.K. (eds.), Cage Aquaculture in Asia: Proceedings of the First International Symposium on Cage Aquaculture in Asia, pp253-257, Asian Fisheries Society, Manila, Philippines and World Aquaculture Society–Southeast Asian Chapter, Bangkok, Thailand.

Merino G.E., Piedrahita R.H., Conklin D.E. 2007. The effect of fish stocking density on the growth of California halibut (*Paralichthys californicus*) juveniles. Aquaculture, 265: 176–186.

Millidine K.J., Armstrong J.D., Metcalfe N.B. 2006. Presence of shelter reduces maintenance metabolism of juvenile salmon. Funct. Ecol., 20: 839–845.

Rahman M.A., Mazid M.A., Rahman M.R., Khan M.N., Hossain M.A., Hussain M.G. 2005. Effect of stocking density on survival and growth of critically endangered mahseer, *Tor putitora* (Hamilton), in nursery ponds. Aquaculture, 249: 275– 284

Wang Q., Zeng W.W., Li K.B., Chang O.Q., Liu C., Wu G.H., Shi C.B., Wu S.Q.. 2011. Outbreaks of an iridovirus in marbled sleepy goby, *Oxyeleotris marmoratus* (Bleeker), cultured in southern China. J. Fish Dis., 34: 399–402.

Zhang Y.Y., Jia Z.Y., Ji F., Mou Z.B. 2008. Effects of stocking density on survival, growth and size variation of juvenile *Brachymystax lenok* (Pallas, 1773). J. Appl. Ichthyol., 24: 685–689.