SURVIVAL RATE OF EARLY LARVAL STAGE OF MARBLE GOBY, *Oxyeleotris marmoratus* UNDER DIFFERENT SALINITY CREATED BY SALT

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ABSTRACT

High mortality rate usually occurred during early larval stage of marble goby, *Oxyeleotris marmoratus*. A research done in UMS had shown that the early larvae had the highest survival rate and growth rate in 10 ppt seawater, while no survival up to 12 dAH although marble goby belongs to the freshwater species. This study was to establish seed production by looking the possibility of replace natural seawater with salt water as culturing water when seawater source is not available at inland area. Experiment was done on early larvae 0-10 dAH, larvae were introduced into different salinity created by salt. Survival of larvae was counted daily and the behaviour was observed. There was significant difference in survival rate across the different salinity created by salt (*P* < 0.05). None of the survival found in any salinity created by salt, all larvae died within five days. Salt water, pure NaCl was not recommended to be used in marble goby larval rearing.
ABSTRAK

Kadar kematian yang tinggi selalu wujud pada peringkat awal larva ikan ketutu, Oxyeleotris marmoratus. Satu kajian dilakukan di UMS telah menunjukkan bahawa kadar kemandirian serta kadar pertumbuhan larva adalah tertinggi dalam air laut 10 ppt, manakala tidak ada kemandirian sampai 12 hari lepas penetasan (dAH) walaupun ketutu merupakan spesies air tawar. Tujuan kajian ini adalah untuk meningkatkan pengeluaran benih dengan memerhatikan kemungkinan menggantikan air laut dengan air garam sebagai air penternakan semasa ketiadaan sumber air laut di kawasan daratan. Eksperimen telah dilakukan pada larva 0-10 dAH. Larva ikan diberi rawatan dalam saliniti air garam yang berbeza. Kemandirian larva ikan dikira setiap hari dan perlakuan larva diperhatikan. Perbezaan bererti antara kadar kemandirian dengan saliniti garam adalah wujud ($P < 0.05$). Tiada kemandirian dalam saliniti yang diperbuat dari garam, semua larva ikan mati dalam lima hari. Air garam, NaCl tulen tidak dicadangkan untuk digunakan dalam penternakan larva ikan ketutu.
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LIST OF ABBREVIATIONS

%  percentage
°C  degree centigrade
UMS  University Malaysia Sabah
dAF  day after fertilized
dAH  day after hatched
ppt  parts per thousand
DO  dissolved oxygen
IU  international unit
kg  kilogram
cm  centimeter
µm  micrometer
L  liter
Na  sodium
Cl  chloride
K  potassium
BW  body weight
SGR  specific growth rate
FCE  feed conversion efficiency
HCG  human chorionic gonadotrophin
SW  seawater
COJ  cod oil juice
CHAPTER 1

INTRODUCTION

1.1 Aquaculture in Malaysia

Aquaculture is defined as farming of aquatic organisms, including fish, mollusks, crustaceans and aquatic plants. Farming implies the ownership of organisms being cultivated in which intervention is applied in rearing process to enhance production (FAO, 2001).

Aquaculture has a great significance in socio-economic development and natural resource management. The total world capture fishery production is increasing due to the increased of human consumption, the new processing technique of seafood, and the improved of harvesting technology. In this case, aquaculture production can be organized according to market demand, in respect of preferred species, preferred size, quantity, preservation and processing. The contribution of aquaculture industry gives rise to availability of the product even during off-season.
However, aquaculture industry in Malaysia is still in an early developing stage. It is mostly conducted in small-scale and as a side income of the local farmers. Aquaculture productions contributed 13.2% or 202225 metric ton of the total fish productions in Malaysia, which cost RM1264.5 million in the year of 2004. Freshwater aquaculture contributed 27.5% of the total aquaculture production in 2004 (Malaysia Fisheries Department, 2004).

Although the contribution of aquaculture sector in total fish production is still low, the development status of this sector shown that it has a great potential to be improved in the future since Malaysia has so much natural areas that are suitable for aquaculture including lands, lakes and rivers, sea body with coral reefs, swamps, and mangrove areas. High-valued freshwater and marine species can be found in these water bodies which can attract more local farmers and company to involve in this field without importing the species from foreign country. Local fish demand, exportation, and commitment from the government are also some of the factors.

1.2 Freshwater aquaculture in Sabah

The history of freshwater aquaculture in Sabah was longer than the marine and brakishwater aquaculture. However, the development of freshwater aquaculture industry is yet slower than the latter. The total production of freshwater aquaculture in Sabah was estimated 5596.24 metric ton during year 2004, which was only 2.8% of the total aquaculture production (Malaysia Fisheries Department, 2004). Many farmers are practicing subsistence aqua-farming, so small scale of operations holding predominate in Sabah.
The major activity in freshwater aquaculture in Sabah is fish pond culture. While the major freshwater species cultured are tilapia, Javanese carp, Chinese carp, river catfish, kissing gouramy and marble goby. Recently there are several start-up operations on cage culture, tank culture and ornamental fish breeding and culture. There are also some small-scale operations in the culture of freshwater soft-shelled turtle and bullfrogs (Rayner, 1998).

1.3 Introduction on marble goby, *Oxyeleotris marmoratus*

Marble goby, *Oxyeleotris marmoratus*, which also well-known as “ikan ketutu” or “soon hock”, is the widely distributed throughout Cambodia, Vietnam, Thailand, Malaysia, Singapore, Indonesia, the Philippines and Fiji (Inger & Chin, 1962; Mohsin & Ambak, 1983).

Marble goby is the largest freshwater member of the family Eleotridae. It is a carnivorous species that it preys on small fish and shrimps. This species likes to hide itself to place that does not expose to sunlight during daytime, a very passive species, hence one of the common name of “sleeper”; however, during nighttime it becomes a very active predator fish (Kottelat et al., 1993). They did prey on their food during both diurnal and nocturnal period, but during nocturnal period their intake is peaked.

Marble goby has been the target of culture species for local fish farmers, this is due to its high market value which its retail price is five times higher than other mass produced freshwater species (Figure 1.1). The demand of marble goby is considered high and is to be found in the live aquarium in Chinese seafood restaurant, it is the
most expensive freshwater table fish in Malaysia. Besides, the flesh structure, less of bones and high protein value (Amornsakun et al., 2003) might also some of the reasons that local fish farmers show intense heat towards the culture of this species.

In Malaysia, the seed supply of marble goby is inadequate, the aquaculture production of this species was only 93.83 tonnes in 2004 (Figure 1.2), this number of production is very low if compared to other major freshwater species. Traditionally, the fish has been caught from mining pools, reservoirs and rivers throughout country. Fish farmers usually dependent on the seeds from natural fisheries, this resulted in over fishing of marble goby in either west Malaysia or east Malaysia (Senoo et al., 1994). In other hand, the artificial seed production techniques of marble goby are not completely established yet, especially the larval rearing techniques.
Figure 1.1 Estimated Retail Value of Aquaculture Production on Some Major Freshwater Species, 2004. (Malaysia Fisheries Department, 2004)

Figure 1.2 Estimated Aquaculture Production on Some Major Freshwater Species, 2004. (Malaysia Fisheries Department, 2004)
1.4 Problems on marble goby larval rearing

Successful fish culture starts from the consistency of mass seed production. Supply of seeds should be continuous to meet the demand of market and to increase the production of such species. Marble goby has high fecundity which a female with average body weight (BW) 150 g can produce around 20000 numbers of eggs (Senoo et al. 1997), and the hatching rate is high. However, the seed production of marble goby is very low, research still been carried on nowadays to improve the larval rearing technique of marble goby.

During the larval development stage and young post-larvae stage of marble goby, mortality was estimated more than 90 %; the mortality in the early larval stages 5-10 days after fertilized (dAF) were much higher than those in the later larval stage (Tavarutmaneegul & Lin, 1988). Starvation, poor water quality, attack by ciliates and the detrimental effects of hormone treatment were the factors of high larval mortality discussed by Tan & Lam (1973).

Furthermore, the slow growth of the marble goby larvae and the minute body size that give rise to the fragile body makes it difficult to be cultured. Their relatively passive feeding behaviour makes them poor feeders; and small mouth size that limits the availability of food organisms which suits their mouth opening resulting in low survivorship (Tavarutmaneegul & Lin, 1988). Moreover, in hatchery of University Malaysia Sabah (UMS), research has been proven that the growth and survival rate of larvae from 0-10 days after hatching (dAH) is highest in 10 ppt seawater even though
marble goby is a freshwater species, while there were no survival up to 10 dAH in 0 ppt freshwater.

1.5 Significance of study

The significance of this study is to overcome the high mortality during early larval stage. Since 10 ppt seawater is necessary for larval rearing of marble goby, thus saltwater is introduced as culturing water. So, attention is being paid to the fish farmers at inland area, where the availability of natural seawater source is limited, whereas it is expensive to buy artificial seawater which has the similar mineral content with the natural seawater. If the fish farmers can produce saline water by using salt for marble goby larval rearing, they can make their own culturing water when seawater is not available. Besides that, they can save up cost since salt is easy to get in market and the price is cheap.

1.6 Objectives of study

The general objective of this study is to establish a seed production of marble goby. The idea of the experiment is emphasized on the fish farmers at inland area, where they are far from seawater source. Effort will be done to improve larval rearing of marble goby at inland area.

1. To replace natural seawater with saltwater as an alternative in marble goby larval rearing.

2. To determine the optimum salinity level created by salt which suits the growth and survival rate of early larval stage of marble goby.
3. To observe the behaviour of early larval stage of marble goby under different salinities created by salt.
CHAPTER 2

LITERATURE REVIEW

2.1 Marble goby

Marble goby is a species that originated from order of perciformes. It is classified under the suborder of gobioidei, and from the family eleotridae.

2.1.1 Morphology

Koumans (1953), Hoese (1986), Akihito et al. (1988), and Kouttelat et al. (1993) reported that fish which are from the family eleotridae are identified as small to moderate gobioid fish (to about 60 cm, usually to 20 cm); with typically stout body. The head is short, broad, and usually scaly; typically with a series of sensory canals and pores, and cutaneous papillae. It has blunt snout. The teeth of the family eleotridae usually small, sharp, and conical, in several rows in jaws. Its gill membranes broadly joined to isthmus.
The Eleotridae consists of two separate dorsal fins; the first with six to ten flexible spines while the second with one flexible spine and six to 15 soft rays. The origin of the anal fin is just posterior to a vertical with origin of second dorsal fin; anal fin is made up from one weak spine and six to 12 soft rays (terminal ray of second dorsal fin and anal fin divided to its base, but only counted as a single element). Pectoral fins in Eleotridae are broad, with 14 to 25 rays. And for the pelvic fins, they are always separated; these fins are long and with one spine and five soft rays. In other hand, the caudal fins are broad and rounded, with 15 to 17 segmented rays (Koumans, 1953; Hoese, 1986; Akihito et al., 1988; Kouttelat et al., 1993).

The scales are small to large, either cycloid or ctenoid. Lateral line is absent on body. The colours of the eleotridae are variable but one interesting point is the pattern on the dorsal surface is symmetrical.

2.1.2 Biology of fish

Eleotridae occur in fresh or brackish waters, although some species are truly marine. One genus (Calumia) is found on coral reefs. They are bottom-dwelling fishes and most species are carnivorous. Many are relatively inactive, hence given the common name of ‘sleeper’. The family, found in all subtropical and tropical waters (except the Mediterranean and its tributaries), comprises approximately 40 genera and 150 species; 15 genera and 28 species are recorded from the Western Central Pacific. Although most eleotridae are small sized, species of Oxyeleotris from this area may reach 60 cm. The marble goby, Oxyeleotris marmoratus is highly esteemed as food in Thailand, Malaysia, and Singapore, and is cultured in cages. Other species of Oxyeleotris, and
Estuarine species such as *Pogoneleotris heterolepis*, may also be sought after by artisanal fishers (Koumans, 1953; Hoese, 1986; Akihito *et al.*, 1988; Kouttelat *et al.*, 1993).

Marble goby is considered a first grade fish in Thailand and Malaysia as well as other country in Southeast Asia, it is a commercially important species for inland fisheries (Amornsakun *et al.*, 2003). It is a very popular and highly demanded fish in the market, while the high cost of the fish has inspired considerable research into the production of the marble goby since 1970s (Tan & Lam, 1973; Tay *et al.*, 1974a, 1974b; Ang, 1978; Suwarnsart, 1979).

According to Senoo *et al.* (1994), the availability of good and healthy brood fish is necessary for seed production under artificial condition. With the aid of sufficient feeding, good water quality and proper handling can produce healthy brood fish. Malaysia has an advantage of marble goby culturing because of the climate weather, the water temperature is around 27-32 °C throughout the year and this draw the marble goby can be matured whole year.

### 2.2 Salinity

Salinity is an important factor in the survival, metabolism, and distribution of many fish. Larvae of some species of fish that spawn in freshwater migrate relatively early in their life histories to marine or estuarine conditions.
Salinity is the measure of the total concentration of all dissolved ions in water. Sodium chloride (NaCl) is the principal ionic compound in seawater, but most inland ponds contain substantial concentrations of other ionic compounds (salts) such as compounds of sulfate and carbonate. Salinity also can be measures according to the density the salts produce in water, the refraction they cause to light or by electrical conductance (Rick Parker, 2002). The result in all case is reported in parts per thousand (ppt) salinity.

According to Wurts (1998), to adapt to the aquatic environment, fish had to either remain in low salinity environments, or they had to evolve mechanisms to replace water lost through osmosis to the seawater and to remove salts absorbed from the increasingly saline ocean. To inhabit freshwater, fish had to replace salt lost through diffusion to the water and eliminate excess water absorbed from the environment. While in sea water, fish must drink salt water to replace lost fluids and then eliminate the excess salt.

Salinity is one of the most potent abiotic factors in the life of marine and brackishwater organisms besides temperature (Kinne, 1963). The eggs and larvae of many marine fish are euryhaline and eurythermal (Battaglene, 1995), however the tolerance of larvae to combinations of salinity and temperature is species specific, and may change during ontogeny and be influenced by maternal environmental conditions (Blaxter, 1969; Alderdice, 1988; Howell et al., 1998).

Salinity can affect yolk utilization and larval growth and survival by influencing the amount of energy needed for osmoregulation (Howell et al., 1998).
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