EFFECTS OF DIFFERENT WATER DEPTHS FOR AQUACULTURE PRODUCTION OF MARBLE GOBY, *Oxyeleotris marmoratus* JUVENILE

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DECLARATION

I declare that this dissertation is the result of my own independent work, except where otherwise stated.

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ABSTRACT

Marble goby, *Oxyeleotris marmoratus,* a carnivorous fish native freshwater in Southeast Asia region, is a high valued species in many countries. This fish has high demand, However the production is low when compared to the others freshwater fish due to high mortality occurred at early juvenile stage 40 days after hatch (d AH).The study has been conducted to determine the effects of different water depths on juvenile rearing of *O.marmoratus* at 40 d AH when they start to become benthic fish. There were three different water depth (3.0 cm, 7.0 cm and 14.0 cm water depths) tested and each experiment was done in triplicate. Juvenile was fed with rotifer, *Artemia salina* and pellet during this study. Results shows that different water depths have no significant different ($p > 0.05$) effect on survival and growth rate of the juvenile in each treatment when analyzed with one-way ANOVA. The present study found that the survival and growth rate of the juvenile is no trend with respect to different water depth and suggested the lowest water depth, which is 3.0 cm water depths, is the best water depth for the juvenile rearing in term of economic evaluation.

Keywords: Marble goby, Oxyeleotris marmoratus; water depth; survival; growth; production

ABSTRAK

Ikan ketutu, *Oxyeleotris marmoratus* merupakan ikan karnivor yang berasal di kawasan Asia tenggara, merupakan spesis yang bernilai tinggi di kebanyakan negara. Ikan ini mempunyai permintaan yang tinggi,Walaubagaimanapun penghasilannya adalah kurang berbanding ikan air tawar yang lain disebabkan berlakunya kematian yang tinggi pada peringkat awal juvenil iaitu pada 40 hari selepas menetas (40 d AH). Kajian telah dijalankan untuk menentukan kesan perbezaan kedalaman air terhadap pemeliharaan juvenil *O.marmoratus* pada 40 d AH ketika ia mula menjadi ikan bentik. Terdapat tiga kedalaman berbebeza (3.0 cm, 7.0 cm dan 14.0 cm) dan setiap kajian dijalankan dalam tiga replikat. Ikan juvenil diberi makan dengan rotifer, *Artemia salina* dan pelet sepanjang kajian dijalankan. Keputusan menunjukan bahawa faktor kedalaman air tidak mempunyai kesan yang signifikan ($p > 0.05$) dari segi kemandirian dan tumbesaran ikan juvenil itu setelah dianalisis dengan ANOVA satu hala. Kajian ini mendapati bahawa kemandirian dan tumbesaran ikan juvenil ini tidak mempunya icorak tertentu yang tepat pada perbezaan kedalaman air dan mengesyorkan kedalaman air yang terendah, iaitu 3.0 cm, adalah cara yang terbaik bagi pemeliharaan ikan juvenil jika dilihat dari segi ekonomi.

Kata kunci: Ikan ketutu, Oxyeleotris marmoratus; kedalaman air; daya hidup; pembesaran; penghasilan

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LISTS OF SYMBOL AND ABBREVIATION

ANOVA	analysis of variance
BW	body weight
cm	centimeter
d AH	day after hatching
DO	dissolved oxygen
g	gram
h	hours
l	liter
kg	kilogram
mg/l	milligram per liter
ml	mililiter
pH	unit of acidic and bes
ppm	parts per million
ppt	parts per thousand
RM	Ringgit Malaysia
SD	standard deviation
TL	total length
°C	degrees celsius
%	percentage

CHAPTER 1

INTRODUCTION

1.1 Aquaculture in Malaysia

Aquaculture can be defined as human activities to increase the aquatic organism production for commercial and food demand purpose (Lokman, 1992). Aquatic organisms include such as fish, mollusks, crustaceans, and aquatic plant (Welcomme, 1988). Fish is one of the aquatic organisms that become as protein source which is cheap and easy to obtain especially in Malaysia. In addition, fish are mainly chosen in every ethnic in our country. The protein demand has been increase due to increasing in population. Aquaculture sector plays an important role as a major supplier of animal sources to fulfill the protein demand.

Aquaculture in Malaysia began in 1920's with extensive polyculture in examining of introduce Chinese carps, silver carp and grass carp. The great changes began in early 1970's when the semi-intensive of shrimp culture in Johor take place. The involvement of fish farmer in aquaculture industry has been increase from time to time. According to Annual Fishery Statistic (1997), about 19,717 of fish farmers and culturist involved in the aquaculture sector and the profit from this sector increase form RM 462.20 million (1996) to RM 609.04(1997). In 2003, aquaculture production was at 194 139 tonnes (USD 308) about 20% of the total value of the fisheries in

Malaysia (FAO). Malaysia is still importing 30 to 40% of local demand fish from others country especially from Thailand and Indonesia (Lokman, 1992). In Malaysia, brackish water aquaculture is the predominant practices, but there is also freshwater fish and marine finfish culture.

FAO reported that brackish water sp es accounted for more than 70% of the total aquaculture production in terms of value and quality. Marine shrimp accounted as a highest value of production which is about 65% of the total value of brackish water aquaculture production, and 52% of the total value of aquaculture production in 2003. Marine and brackish water aquaculture production were increase of more than 20% in comparison to production in 2002 while freshwater only recorded an increase of about 7%. The graph below (Figure 1.1) shows total aquaculture production in Malaysia according to FAO statistic:

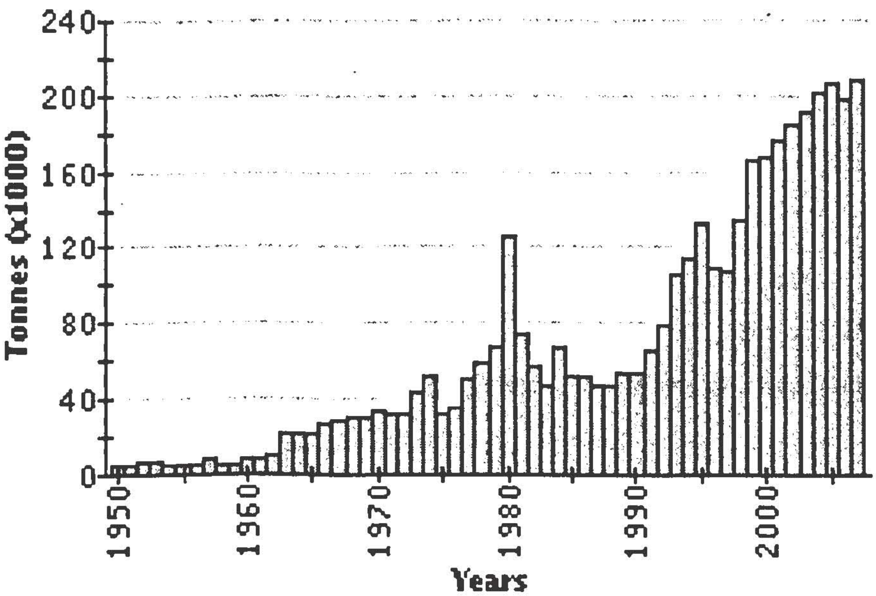

Figure 1.1 Aquaculture productions in Malaysia from 1950 to 2000 (Source: FAO Fishery statistic)

More research is needed to raise the aquaculture production which is significant to human and also to achieve the aim where by 2010, the aquaculture production will increase 200 percent.

1.1 Marble goby, *Oxyeleotris marmoratus*

Marble goby, *Oxyeleotris marmoratus* belongs to the Family Eleotidae, which is the largest freshwater fish. It can grow more than 20 kg in body weight and more than 50 cm in total length. This species can be found in Asia, such as Thailand, Cambodia, Vietnam, Singapore, Indonesia, Phillipines (Cheah *et al.*, 1994; Senoo *et al.*, 1994). The natural habitat of marble goby includes canal, rivers, reservoirs and swamps (Roberts, 1993). It is a facultative air- breather capable of surviving on the land for several days. Marble goby is a carnivorous fish, feeding on small fishes, shrimps, aquatic insect, mollusks and crabs (Larson and Murdy 2001). Since it has a delicious taste, non bony flesh and high protein value (Amornsakum *et al.*, 1997), it become popular, highly demand in the market and become commercial value in Malaysia, Cambodia, Vietnam, and Indonesia (Luong *et al.*, 2005) and (Hoa and Yi, 2007).

In Malaysia, many fish farmers want to make profit from this fish, but the seed supply is not enough due to overfished especially in West Malaysia. Mainly, fish middle men in Kuala Lumpur are importing this fish from Indonesia, Cambodia, and East Malaysia. Since most fish farmer depending on seed supply from wild, this might be problems for them to produce this fish. More than 2,600 tonnes of Eleotridae fish including marble goby were fished in Indonesia in 1990 (FAO, 1992). To overcome the inadequate seed supply problem, people find another alternative which is by using artificial seed production in hatchery. In 1994, the artificial seed production of this fish has been introduced in University Pertanian Malaysia (Senoo *et al*, 1994).

In UMS, the culturing of marble goby in larval stage has been succeed where they success to culture larval stage of marble goby at salinity of 10 ppt. However, there are others problems in culturing of marble goby especially at the early juvenile stage.

The problems generally encountered during early juvenile rearing of marble goby are the low survival and slow growth. This problem leads in decreasing of production of these species. According to Hoa and Yi (2007), marble goby juvenile usually takes approximately one year for fingerlings to grow from 5 to 50 g. Many studies have been done to improve the survival and growth of marble goby juvenile and one of the factors that maybe can contribute in the improvement of the survival and growth of this species is water depths. Therefore, this study will focus on the water depths for early juvenile stage of this fish.

1.2 Objectives

The aim of this study is to improve the rearing technique at early juvenile stage. Thus, this project was conducted with specific objective that is:

1. To determine the effects of different water depths for aquaculture production of Marble goby, *Oxyeleotris marmoratus* juvenile.
2. To determine the optimum water depths for rearing of *O.marmoratus* juvenile

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The early development of marble goby was described by Tan and Lam (1973). It was initially bred in Singapore (Tay *et al.*, 1974). However, very little biological information is available on this species except for few reports on its culture (Tan and Lam, 1973; Cheah, 1994), rearing condition (Abol *et al.*, 2005), growth and feeding performance cultured in reticulating aquaculture systems (Ambak *et al.*, 2006) and also effects of the different diets on growth and survival rate of the larval stage (Liem *et al.*, 2000).

2.2 General Characteristics of Marble goby, *Oxyeleotris marmoratus*

The marble goby is locally known as ikan Ketutu,Hantu,Ubi, Belantuk to Malays and 'Soon Hock' to the Chinese. It is widely distributed in the Southeast Asia region such as Mekong and Chao Praya basins, rivers and other water bodies in Malaysia, Singapore, Indochina, Philippines and Indonesia (Kottelat *et al*, 1993). This species is one of the profitable fish in Southeast Asian especially in Malaysia, Thailand and Indonesia (Rainboth, 1996). It is highly popular among costumer especially among the Chinese community due to its fine texture, tasty white flesh and is believed to healing properties. In Malaysia, fish farmers that cultured this fish largely depending on wild populations, fetching high price in the market.

2.2.1 Taxonomy

The marble goby belongs to the suborder Gobioidei in the order Perciformmes which is comprised of about 268 genera and approximately 2121 species (Nelson, 1994) and have been variously classified into families and subfamilies in recent times (Akihito *et al*, 2000). The taxonomic classification of marble goby is summarized below.

Class	: Actinopterygii (ray-finned fishes)
Order	: Perciformes (perch – like fish)
Family	: Eleotridae
Genius	: *Oxyeleotris sp*
Species	: *Oxyeleotris marmoratus*

2.2.2 Morphology and Habitat

Lim and Ng (1990) described that marble goby can be identified by its torpedo- like shape with large snake – like head, symmetrical patterning on the dorsal surface and rounded, outstretched pectoral fin, two dorsal fins and rounded caudal fin and separated pelvic fins. Marble goby has following taxonomic character: total dorsal spines 7-7; anal spines 1; anal soft rays – 8, with 60-65 predorsal scales; withour occellus on peduncle (Kottelat, 2001).

Marble goby is the largest freshwater fish which can reach 50 cm in total length and the largest gobioid fish may also reach 90 cm of total length (Zhong *et al,* 2004). It cans growth to a maximum size of approximately 65 cm standard length (Kottelat, 2001). Compare to the others freshwater fish, such as African catfish, this fish is slow moving. It is also known as nocturnal hunter, which means they are active during night time to search food and hide under woody, rocks and vegetation at day time. This fish is a carnivorous fish, primarily eats small fishes, crustaceans, aquatic insects, mollusks and crab (Larson and murdy, 2001). It can survive on land for a long time (Roberts, 1993). Marble goby can be found in shallow water such as river, lake, estuaries, and swamp. They live ephibentically (on the surface) over sandy and muddy substrate. The variation of the body color of this fish is influence by the color of the water and environment of its habitat; in brackish water, the body color is darker while, in clear water, the body color is clearer with spots on its body.

2.3 Importance of Marble goby in Aquaculture Industry

In Southeast Asia, marble goby has a high market value compare to the other freshwater fish which is RM40.58/kg (Luong *et al,* 2005) and its wholesale price in Malaysia ranges from RM 80 to RM 160/kg. Due to the high commercial value, it became a first grade fish and has been cultured mainly in Southeast Asian country. In Borneo, marble goby captured for markets in Singapore and Japan may fetch prices of about $20 per lb ($10 per kg) (Grzimek's Animal Life Encyclopedia, 2005).

The aquaculture production of marble goby in Malaysia was only 13.64 tonnes in 1991 which is less than 1% of the total production on freshwater fishes (Deparment of Fishery, 1992). The combination of aquaculture industries between Malaysia, Singapore and Thailand in year 2000 results 277 tons of marble goby which represent about 74% of the total global aquaculture of gobioid fishes.

2.4 Larval Rearing

Larval rearing is important to mass produce healthy seed. In larval rearing, aspects that most important is management of rearing environment and the feeding. However, according to Liao *et al.* (2001), a complete finfish larvaculture generally involve three phases of technique which is broodfish management, larval rearing and feed preparation. Broodfish management involves collection of brood stock, maturation and spawning, egg collection and egg incubation. A good broodfish management will produce a high quality of eggs and larvae. The improvement of larviculture can be seen when the seed are produce, holding them for further use, growing them in the pond, and using modern, advance facilities and treatments for complete larviculture practices. Lacks of knowledge on larval food requirement contribute in failure of larval rearing. Therefore, understanding of larval morphology and behavior is necessary in order to improve the larval rearing technique.

2.5 Water Depth Practices in Aquaculture

Water depths are one of the factors that can determine the survival and growth of aquatics life. This has been proven by Mohamed M.Abdeel-Aa (2007) through his study, where the deep water showed better growth than shallow water for tilapia. El-sayd *et al.* (1996) found out that the growth performance and survival in Nile tilapia were significantly affected by pond depth and water temperature. The temperature ranges are varying in different water depths due to heat content in the water. The temperature will shows negative effect on growth performance of the fish when temperature is below 21°C due to stress condition.

Depth is usually determined for reasons related to construction costs, habitat preference of the primary cultured species, or because of management of cohabiting organisms such as phytoplankton, benthos or rooted macrophytes (McLarney, 1984). In fish farming, the common practiced of water depths of pond about 1 m, however based on previous study, the ponds should be as shallow as is consistent with the requirements of the cultured animals, if optimal productivity is desired and nutrients are non-limiting. In term of dissolve oxygen, deep ponds are more prone to density stratification, which lead to depletion of dissolved oxygen especially during the night (Boyd, 1990 ; Chang, 1989).

The culturing technique in term of water depths can be also varies in different stage of fish based on their species and behaviors. According to Liao *et al.* (2001), the larval rearing in concrete tank for indoor system in Taiwan is practically done in 100 – 200 cm with volume less than 100 m^3 while for the outdoor system, the water depth is 100 – 150 cm with volume more than 100m^3. The difference of the system results in different survival and growth and also the cost construction for the larval productions.

Table 2.1 Comparison of two rearing systems for larval rearing in Taiwan.

Characteristics	Indoor	Outdoor
Pond and tank water depth	100 – 200 cm	100 – 150 cm
Water volume	< 100 tonnes	> 100 tonnes
Larval survival rate	High	Unstable
Feed supply and water control	Poor	Easy
Larval growth	Slow	Fast
Larvae quality	Poor	Good
Production cost	High	Low
Filamentous alga growth	Impossible	Possible

2.6 Effects of Water Depth

2.6.1 Stocking density

In Culturing fish, the depth of the water that needed is depends on the fish species and the stocking density (Marcel Huet, 1995). This is due to different needed of the dissolve oxygen in different species of fish, for example for Salmonid fish they need high level of dissolve oxygen compare to carp. Johnson (1986) reported that fish need about 5 mg oxygen/liter or more to avoid stressful conditions.

There is well- known relationship in fish culture that greatly affects management strategies, as the stocking density increase the average size of harvested fish decrease. This is correlative with the space of the tank or pond. The space of the tank or pond reduces in increasing of stocking density.

2.6.2 Thermal Stratification

Thermal stratification is the separation of water into distinct layers. This is cause by the absorption of sunlight energy by water. Water absorbs about 30% of the energy in sunlight as heat. The absorption of sunlight energy is different following the water depth. Water consists of two layers which are the surface layer called epilimnion and the denser layer called hypolimnion. Hargreaves (2003) reported that warmer, less dense layer of water float over the top of cooler layer that is denser. Consequently, fish are concentrated in the upper layer above the thermocline, and the fully capacity of the water is not utilized (Yoo, 1994).

As the sun continues to heat the water at the top, the difference in temperature between the top and bottom water becomes greater. The temperature will affect the content of dissolve oxygen in the water. The dissolve oxygen will decrease in increasing of the temperature. The dissolve oxygen is lower in layer hypolimnion compare to eplimnion layer due to decomposition of organic matter from phytosynthesis and metabolic waste from aquatic animals (Yoon, 1994).The decreasing of the dissolve oxygen may lead to mortality of the aquatic life.

It is interesting discovery that the 3.0 cm water depths can be used to culture *O.marmoratus* jevenile in term of economic evaluation hen the three treatment of water depth have not significant different on survival and growth of this species.

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