EFFECTS OF DELAYED FIRST FEEDING ON FEEDING ABILITY, GROWTH AND SURVIVAL OF MARBLE GOBY, *Oxyeleotris marmoratus* LARVAE

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ABSTRACT

EFFECTS OF DELAYED FIRST FEEDING ON FEEDING ABILITY, GROWTH AND SURVIVAL OF MARBLE GOBY, *Oxyeleotris marmoratus* LARVAE

The effects of delayed first feeding on feeding ability, growth and survival of marble goby, *Oxyeleotris marmoratus* larvae were studied under controlled conditions. Three experiments were designed to achieve the objectives of this study. Larvae were reared in six different delayed first feeding times which were 0, 12, 24, 36, 48 and 60 hours delayed first feeding (hDFF) for Experiment I and III, while for Experiment II, it was reared in 0, 1, 2, 3, 4 and 5 days delayed first feeding (dDFF). Experiment I was conducted to examine the effect of delayed first feeding on the larval nutrition transition period (NTP) by measuring the yolk sac volume and oil globule volume changes and absorption period, morphometrical changes of body height (BH), muscle height (MH) and gut height (GH) at different delayed first feeding time and intestinal epithelium height changes for fed at 0 hDFF and starved larvae. From the results, it showed that, 0 hDFF treatment has the longest NTP (50 h) and, as the delayed first feeding time prolonged, the yolk sac was consumed rapidly and even led to shorter NTP. It was observed that, larvae reared in 0 and 12 hDFF showed significantly higher (P<0.05) BH, MH and GH compared to other treatments. Meanwhile, larvae showed no significant differences (P>0.05) in 0, 12 and 24 h intervals of intestinal epithelium height changes for fed and starved but significantly lower (P<0.05) for 36, 48 and 60 hDFF larvae. Experiment II was conducted to investigate the effect of delayed first feeding on larval feeding ability by examining feeding incidence and intensity. Feeding incidence for 1 and 2 dDFF significantly higher (P<0.05) compared to 0 (63.33 %), 3 (36.67 %), 4 (36.67 %) and 5 dDFF (30.00 %) treatments. Meanwhile 0 (29 ind.larva^{-1}) and 1 dDFF (26 ind.larva^{-1}) larvae showed significantly higher (P<0.05) feeding intensity compared to 3 (16 ind.larva^{-1}), 4 (13 ind.larva^{-1}) and 5 dDFF (3 ind.larva^{-1}) with no significant difference with 2 dDFF (22 ind.larva^{-1}). Based on the findings of larval feeding incidence, the larval point of no return (PNR) was determined between 3 to 4 dDFF which is coincidence with 4.5 to 5.5 dAH. Experiment III was conducted to determine the effect of delayed first feeding on larval growth (TL) and survival (%) until 15 dAH.The results revealed that 0 (3.32±0.02 mm), 12 (3.42±0.08 mm), 24 (3.32±0.02 mm) and 36 hDFF (3.28±0.16 mm) showed significantly higher (P<0.05) growth compared to 48 (3.22±0.11 mm) and 60 hDFF (3.14±0.08 mm) treatments. Meanwhile result on the survival had shown 0 (52.67±10.37%), 12 (46.67±6.71%) and 24 hDFF (39.67±8.07%) showed significantly higher (P<0.05) survival compared to other treatments. From the results the first feeding of *O.marmoratus* larvae can be delayed up to 24 h with no significant differences (P>0.05) in all parameters. However, it was suggested that the first feeding of *O.marmoratus* larvae should be initiated at 0 hDFF (36 hAH) at 29±0.5°c for the enhancement of larval feeding ability, growth and survival.

ABSTRAK

Kesan menunda pemberian makanan pertama terhadap keupayaan untuk makan, tumbesaran dan kemandirian larva marble goby, Oxyeleotris marmoratus diselidiki secara kawalan. Tiga experimen direka untuk mencapai objektif penyelidikan ini. Larva ketutu dipelihara di dalam enam masa pemberian makanan pertama yang berbeza iaitu 0, 12, 24, 36, 48 dan 60 jam tundaan pemberian makanan pertama (hDFF) bagi experimen I dan III, namun bagi experimen II, larva dipelihara di dalam 1, 2, 3, 4 dan 5 hari tundaan pemberian makanan pertama (dDFF). Experimen I di dijalankan untuk mengkaji kesan menunda pemberian makanan pertama terhadap tempoh transisi gizi (NTP) dengan mengukur isipadu pundi telur dan tempoh penyerapan di setiap rawatan, perubahan morphometrik bagi ketinggian badan (BH), ketinggian otot (MH) dan ketinggian usus (GH) dan perubahan ketinggian sel epithelium usus bagi ikan yang di beri makan pada 0 hDFF dan larva ikan yang di laparkan. Keputusan menunjukkan, rawatan pada 0 hDFF mempunyai NTP (50 jam) paling panjang dan apabila masa pemberian makanan pertama ditunda lebih lama, pundi telur digunakan dengan lebih cepat dan menyebabkan NTP semakin pendek. Didapati larva ikan di rawatan 0 dan 12 hDFF menunjukkan BH, MH, dan GH keberertian yang lebih tinggi ($P<0.05$) berbanding rawatan lain. Sementara itu, perubahan sel epithelium usus menunjukkan tiada perbezaan bererti ($P>0.05$) bagi larva ikan yang diberi makan dan dilaparkan pada selang masa 0, 12, dan 24 jam namun menunjukkan perbezaan beerti yang lebih rendah ($P<0.05$) bagi ikan yang dilaparkan bagi selang masa 36, 48 dan 60 hDFF. Eksperimen II dijalankan untuk menilai kesan menunda pemberian makanan pertama terhadap kadar insiden dan intensiti makanan bagi larva ketutu. Kadar insiden makanan pada hari 1 dan 2 (96.67%) penundaan pemberian makanan pertama (dDFF) menunjukkan perbezaan bererti ($P<0.05$) berbanding 0 (63.33 %), 3 (36.67 %), 4 (36.67 %) dan 5 dDFF (30.00 %). Sementara itu, 0 (29 ind.larva^{-1}) dan 12 dDFF (26 ind.larva^{-1}) menunjukkan intensiti makanan yang lebih tinggi dengan perbezaan bererti yang lebih tinggi berbanding rawatan 3 (16 ind.larva^{-1}), 4 (13 ind.larva^{-1}) dan 5 dDFF (3 ind.larva^{-1}). Berdasarkan keputusan tersebut, titik tidak kembali (PNR) bagi larva ikan adalah di antara 3 ke 4 dDFF yang mana bersamaaan dengan 4.5 ke 5.5 dAH. Eksperimen III dijalankan untuk memeriksa kesan menunda pemberian makanan pertama terhadap tumbesaran dan kemandirian larva . Keputusan mendedahkan 0 (3.316±0.02 mm), 12 (3.42±0.08 mm), 24 (3.316±0.02 mm) dan 36 hDFF (3.28±0.16 mm) menunjukkan pertumbuhan yang paling tinggi dengan perbezaan bererti ($P<0.05$) berbanding rawatan 48 (3.22±0.11 mm) dan 60 hDFF (3.14±0.08 mm). Sementara keputusan bagi kemandirian larva ikan menunjukkan 0 (52.67±10.37%), 12 (46.67±6.71%) dan 24 hDFF (39.67±8.07%) menunjukkan perbezaan bererti ($P<0.05$) yang paling tinggi bagi kemandirian larva ikan berbanding rawatan lain. Daripada keputusan yang diperolehi, pemberian makanan pertama bagi larva ketutu boleh ditangguhkan sehingga 24 jam tanpa memberi kesan signifikan bagi semua parameter tetapi kajian ini mencadangkan masa pemberian makanan pertama bagi larva ketutu harus diberikan pada 0 hDFF (36 hAH) pada suhu 29±0.5°c untuk meningkatan keupayaan untuk makan, pembesaran dan kemandirian.

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LIST OF ABBREVIATIONS

ANOVA	analysis of variance
BMRI	Borneo Marine Research Institute
BH	body height
BW	body weight
dDFF	days delayed first feeding
DO	dissolve oxygen
et al.	and others, and the rest
ed.	edited, edition, editor
FAO	Food and Agriculture Organization
g	gram
GH	gut height
h	hours
hAH	hours after hatching
hAF	hours after fertilization
HCG	human chorionic gonadotrophin
H& E	haematoxylin and eosin
HDPE	high density polyethylene
hDFF	hours delayed first feeding
IU	International unit
Kg	kilogram
L	Litre
M	meter
m^3	cubic meter
mg	milligram
MH	muscle height
min	minute
ml	milliliter
mm	millimetre
NAP 3	Third National Agriculture Policy
N.D	not data

NTP	nutrition transition period
OGV	oil globule volume
pH	potential hydrogen
PNR	point of no return
ppt	part per thousand
MYR	Malaysia Ringgit
SD	standard deviation
spp.	species
µm	Micrometer
UMS	Universiti Malaysia Sabah
YV	yolk sac volume

LIST OF SYMBOLS

° C	degree centigrade
µ	micro
>	greater than
<	less than
%	percent

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CHAPTER 1

INTRODUCTION

1.1 Aquaculture Status in Malaysia

The increasing of human population has lead extra pressure on the demand for fish because the capture of wild stock alone is unable to meet the escalating demand (Hihelgo, 2008). According to the United Nation (UN) projections, world population was rising from 6.8 billion in 2009 and expected to reach 9.1 billion in 2050 and the escalating of the human population have increased the food demand (FAO, 2009). Hence, the development of aquaculture has been seen to be one of the solutions to fulfill the demand. Furthermore, the stagnating status of global capture of wild stock and the increasing of human population, aquaculture is perceived as having the greatest potential to supply enough fish in the future to meet the growing demand for safe and quality aquatic food (FAO, 2010).

To become a developed country status by the year 2020, the Malaysian government has recognized the significance of sustainable aquaculture as an integral part of efforts to develop and increase its natural resources which focusing on the fisheries and aquaculture production (Othman, 2008). In order to do so, Ministry of Agriculture and Agro-based Industry (MOA) through the Department of Fisheries Malaysia has zoned the aquaculture industry via Aquaculture Industry Zone (ZIA) Programs throughout Malaysia. This program has been identified as suitable for the development of commercial scale for aquaculture projects (Department of Fisheries Malaysia, 2007).

Globally, fish has become an important export commodity in many countries. In Malaysia, both fisheries industries and aquaculture production has become one of the contributors to the country's food productions. Referring to Malaysia Fisheries Department statistic in 2008, the fisheries industries which contributed to the production was about 1.4 million metric tonnes which came from inshore and deep sea fishery with the total production value of Malaysia Ringgit (MYR) 5.5 billion. Meanwhile, the aquaculture production contributed about 0.354 million metric tonnes with the value of MYR 1.74 billion for the wholesale price (Department of Fisheries Malaysia, 2008). These induced the production from the Malaysian Fisheries Department which produced fries and hatchling amounted to 3.02 and 3.8 million tails respectively (Department of Fisheries Malaysia, 2008).

Besides contributing to the fish production, aquaculture can also benefit the livelihoods of the poor. Edwards (1999) reported that, aquaculture can contribute either through an improved food supply or through employment and increased income by benefiting either directly to household farming aquatic products or indirectly from the increased availability of low-cost fish in local markets. In Malaysia, aquaculture has contributed to the employment by providing about 83,873 fishermen and 18,148 fish culturist from all races in Malaysia (Department of Fisheries Malaysia, 2008).

With a lot of advantages that can be offered through aquaculture industry, many efforts have been made especially to culture high value fishes. Either marine or freshwater species, both can give a lot of advantages since the demands for high valued species is increasing coupled with the improved economic situation in Malaysia and the increasing of people's living standard (Senoo *et al.*, 1997; Musa and Nuruddin, 2005). Among the freshwater fishes, marble goy, *O. marmoratus* is one of the high valued species and has the potential for mass production.

1.2 Introduction of Marble Goby, *Oxyeleotris marmoratus*

Marble goby, *O. marmoratus* is known as "Ikan Ketutu" or "Ikan Hantu" in Malay and "Soon Hock" in Chinese dialect, and commonly known as "Sandy Goby" (Senoo *et al.,* 1994a). *O. marmoratus* is the largest freshwater Eleotridae and this fish can grow to more than 2 kilogram (kg) in body weight (BW) and can reach up to 50 centimeters (cm) in total length (TL) (Senoo *et al.,* 1994c). Figure 1.1 shows the adult marble goby, *O.marmoratus* female, 660 g in body weight (BW) and 34.5 cm in total length (TL). This species is mainly distributed in the Southeast Asia region such as Thailand, Cambodia, Vietnam, Singapore, Indonesia, Philippines, and Fiji (Mohsin and Ambak, 1983; Cheah *et al.,* 1994; Senoo *et al.,* 1994a).

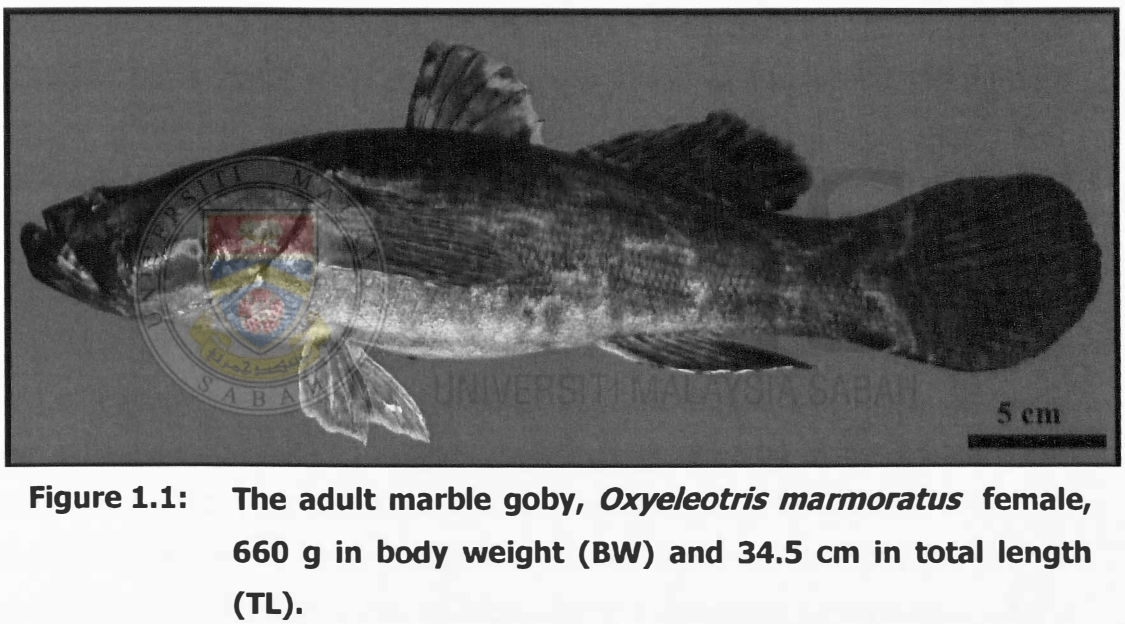

Figure 1.1: The adult marble goby, *Oxyeleotris marmoratus* female, 660 g in body weight (BW) and 34.5 cm in total length (TL).

O. marmoratus is known as one of the popular food fish with high market demand. It was reported to be a high value freshwater fish species in a few Southeast Asian countries such as Malaysia, Thailand, Singapore, Indonesia (Senoo *et al.*, 1997; Lin and Kaewpaitoon, 2000; Amornsakun *et al.*, 2003; Luong *et al.*, 2005). This species often served in many restaurants due to its high demand, its delicious taste, non-bony flesh and high protein value (Amornsakum *et al.,* 2003). *O. marmoratus* is preferred by the Chinese community because it is believed to

have healing properties for men's health. The comparison of value and production between *O. marmoratus* and some major cultured freshwater fishes in Malaysia in 2008 is presented in Figure 1.2. In terms of value, *O. marmoratus* showed the highest wholesale price (MYR 49.17/kg) compared to the other freshwater species such as freshwater catfish (MYR 1.50/ kg) (DoF, 2008). But in terms of production, this species had lower production compared to the other freshwater fish.

1.3 Improvement of *O. marmoratus* Larval Rearing

The decreasing of the natural resources of *O. marmoratus* due to over fishing has encouraged the breeding efforts in order to achieve consistent eggs collection. Breeding of this species was successfully done through natural (Phinal, 1980; Senoo *et al.* 2003) and artificial spawning method (Tan and Lam, 1973; Senoo *et al.*, 1994a) but a stable mass seed production is not yet established due to high mortality at the early larval stages (Tavarutmaneegul and Lin, 1988; Ang, 1990; Senoo *et al.*, 1994a).

With the establishment of breeding techniques for this species, attempts to develop culture techniques and further understand the life-history in early developmental stages of *O. marmoratus*, serious attention by many researchers is crucial (Pham, 2001; Amornsakun *et al.*, 2002; Udompo, 2002; Abol-Munafi *et al.*, 2005; Van *et al.*, 2005). Many studies were carried out on this species such as life history related to feeding, larval development and starvation (Amornsakun *et al.*, 2002), feeding regime (Amornsakun *et al.*, 2003) and the optimum rearing water (Senoo *et al.*, 2003; Senoo, 2008). These previous studies have provided baseline information about the larval rearing optimized the mass seed production which resulted to higher improvement on the larval survival and growth of *O. marmoratus* (Amornsakun *et al.*, 2002).

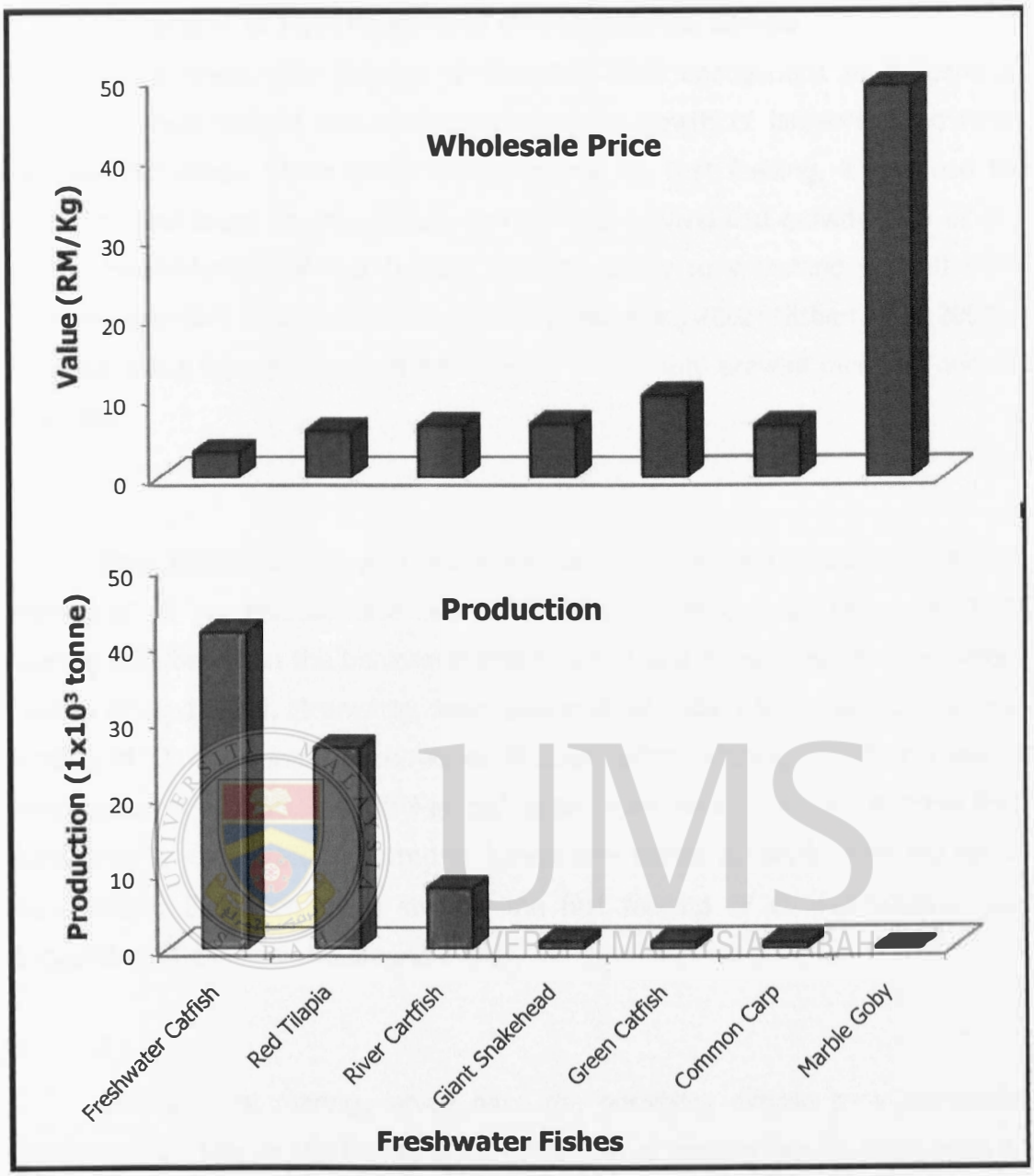

Figure 1.2: Comparison of wholesale price and production of some major cultured freshwater fish in Malaysia in 2008. Freshwater catfish, red tilapia *Oreochromis* sp., river catfish, *Pangasius hypophthalmus*, giant snakehead *Channa micropeltes*, green catfish, *Mystus nemurus*, common carp, *Cyprinus carpio* and marble goby, *Oxyeleotris marmoratus*.

Source: Department of Fisheries Malaysia (2008)