THE RELATIONSHIP BETWEEN THE DEVELOPMENT OF SENSORY ORGAN AND CHANGES OF SWIMMING BEHAVIOR AND OPTOMOTOR REACTION IN LARVAE OF PATIN (*Pangasius hypopthalmus*) AND SEABASS (*Lates calcarifer*)

STANLEY WONG VUN YEE

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AUTHORIZED

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

Date: April 18th, 2007

Stanley Wong Vun Yee

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AUTHENTICATION

Stanley Wong Vun Yee this Dissertation and was authorized by Dissertation Committee as follow the same requirement for the Degree of Bachelor of Science with honors.

Dissertation Committee | Signature

1. SUPERVISOR
Dr. Yukinori Mukai

2. EXAMINER 1
Dr. Sitti Raehanah binti Muhamad Shaleh

3. EXAMINER 2
Mr Muhammad Ali bin Syed Hussein

4. DEAN OF SST
Supt/KS Prof Madya Dr. Shariff A.K. Omang

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ABSTRACT

This experiment was conducted to study the development of sensory organs and the swimming behavior shown by Patin (*Pangasius hypopthalmus*) larvae and Asian Seabass (*Lates calcarifers*) larvae. Fish show positive rheotactic swimming behavior when they swim against water flow. Optomotor reaction is the ability of fish to response to pattern of stimulation moving over the eyes. All of the larvae used in this experiment were hatched in UMS hatchery. Swimming pattern, rheotactic behavior, optomotor reaction were observed both in larvae rearing tank and in experimental tanks. Histological observation was carried out to determine the morphology of eye and free neuromasts in both larvae. Patin larvae show clear rheotactic swimming behavior while Seabass show clear optomotor reaction during early larvae stages. Histology observation reveals that Seabass have well developed eyes during early larval stages. Contradictory, Patin larvae have smaller eyes; bigger eye indicates that it contained more visual cells which can improve the acuity and sensitivity of eye. Under microscopic observation, Seabass larvae have long cupulae while Patin larvae have somewhat short and more rounded cupulae. The presence of free neuromasts and the size of cupulae greatly determine the sensitivity of mechanoreception in fish. Broken, deformed cupulae will affect the fish swimming ability. Therefore, it is advisable not to transfer fish during early larvae stages.

ABSTRAK

Experiment ini dijalankan untuk mengenalpasti perkembangan organ deria serta cara berenang yang ditunjukkan oleh benih ikan patin (*Pangasius hypopthalmus*) dan ikan siakap (*Lates calcarifer*). Ikan menunjukan reaksi "rheotactic" apabila mereka berenang melawan aliran arus. Reaksi optomotor merujuk kepada kebolehan ikan untuk bertindak balas terhadap stimulasi yang bergerak merentasi mata mereka. Semua benih ikan yang digunakan dalam experiment ini diperoleh dari hatchery UMS. Corak berenang, kecenderungan ikan melawan aliran arus serta reaksi optomotor diperhatikan dalam tangki benih ikan serta dalam tangki experiment. Pemerhatian histologi dijalankan untuk menentukan morfologi mata serta Neuromasts bebas dalam kedua-dua benih ikan. Ikan patin mempamerkan kecenderuanagn melawan aliran arus dengan jelas manakala Ikan siakap menunjukan reaksi optomotor yang jelas pada awal perkembangan larvae. Pemerhatian histologi menunjukkan bahawa ikan siakap mempunyai mata yang berkembang dengan baik. Berlainan pula dengan ikan siakap, ikan patin mempunyai mata yang kecil; mata yang besar menunjukkan bahawa ia mengandungi lebih banyak sel yang dapat menambahkan ketajaman serta kepekaan penglihatan. Di bawah pemerhatian mikroskop, benih ikan siakap mempunyai cupulae yang panjang manakala ikan patin mempunyai cupulae yang lebih bulat dan pendek. Kehadiran neuromast bebas serta saiz cupulae mempengaruhi kepekaan "mechanoreception" ikan. Cupulae yang putus serta cacat akan menjejaskan keupayaan berenang dalam ikan. Dengan ini, adalah dinasihati supaya tidak memindahkan benih ikan pada awal perkembangan larvae.

CONTENTS

LIST OF FIGURE

No. Figure **Pages**

LIST OF PHOTO

LIST OF TABLES

LIST OF APPENDIX

No. Appendix		**Pages**

CHAPTER 1

INTRODUCTION

1.1 Experiment Introduction:

Human have five types of sensory system comprising of smell, sight, taste, hearing as well as touch. Fish also have such sensory system in helping them in body coordination as well as finding food.

Larval rearing is the most difficult part in an aquaculture system as early mortality rate is very high. The main factors that contribute to the high mortality rate will be nutrition deficiency resulting from poor feeding as well as predatory behavior among larval fish. Larval fish utilized their entire sensory system in helping them in feeding and locomotion; thus, they can swim towards food and away from predator.

Successful farming depends on understanding the behavior of fish, especially during larval stages when technical difficulties often results in high mortality in the hatchery. In order to fully understand the fish, we need to study their morphological as well as physical changes.

The development of sensory organ greatly related to the changes of behavior in larval fish. Larval fish depend on their behavioral capabilities to survive in the wild, particularly on their abilities to locate and capture prey as well as to avoid predators. (Cobcroft and Pankhurst, 2003). The observation and examination on the development of sensory organ in larval fish and the correlation between the developments with changes of behavioral capabilities provides insight into the ecology of larval fish in the wild. (Cobcroft and Pankhurst, 2003). Such observation and examination enables condition suited to the development of sensory function be extracted and used for larval culture.

Fish spend their life time in water, thus it is in our interest to study the swimming behavior of fish and the correlation between their behaviors with their daily activities. This study is conducted to find the possible relationship between development changes in sensory organs and swimming behavior in larval fish.

1.2 Targeted Species of Larval Fish

Two species were targeted in this experiment. They were Patin (*Pangasius hypophthalamus*) and Asian Seabass (*Lates calcarifer*) larvae.

1.2.1 Patin (*Pangasius hypophthalmus*)

Patin (*Pangasius hypophthalmus*) is a freshwater fish. It is found in tropical water mainly in Thailand, Laos, Cambodia, Vietnam and Malaysia. This species have many other common names such as Pla Sawai, Sutchi Catfish, Iridescent Shark and River catfish. It is an active swimmer and dwells in the middle part of water bodies. Patin has a big mouth and an elongated body that resembles the body of a shark. The body is silver to blue with silver iridescence and they have a deeply forked tail. They are omnivorous fish. In aquaculture industry, they are fed with pellets or kitchen waste. They have special arborescent organ that can let them get oxygen directly from the air thus enables them to survive in low DO water.

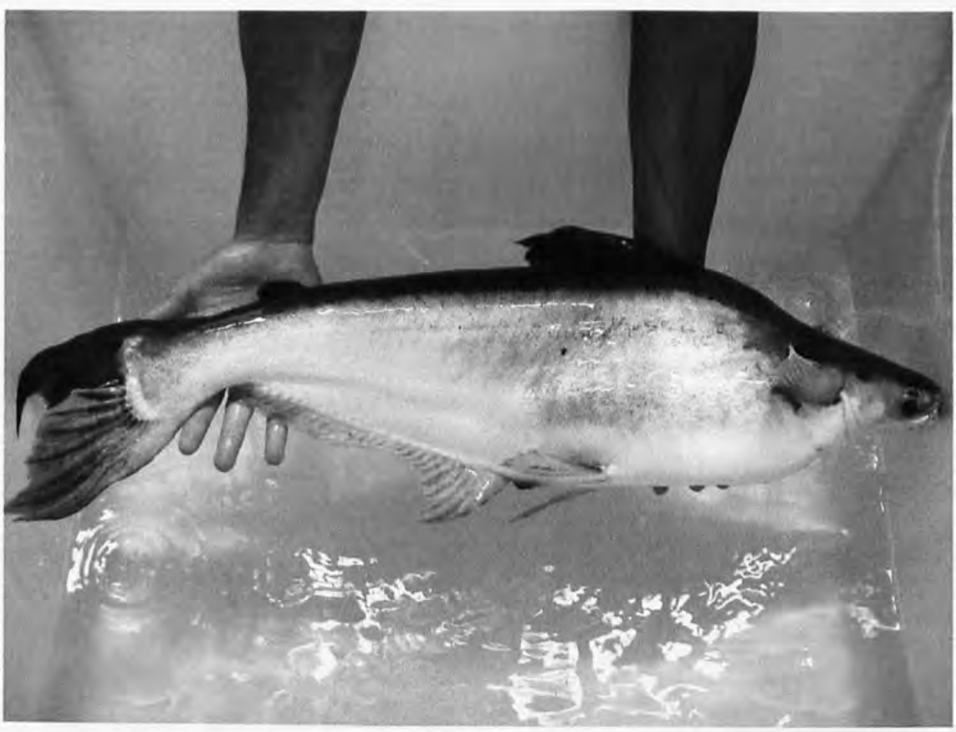

Photo 1.1: Patin (*Pangasius hypophthalmus*) brood fish in UMS hatchery.

This species is used in this experiment is because it can be mass produced and they are omnivorous species whereby they can consume a variety range of feed given to them. Due to its abilities to survive in low DO water and have a high growth rate, it has gain popularities among aquaculturist. Unfortunately, problems such as cannibalism and mass mortality occur in early larval stages, therefore it is in our interest to study their behavior and have a better understanding on the larval fish.

1.2.2 Asian Seabass (*Lates calcarifer*)

Asian Seabass (*Lates calcarifer*) is a euryhaline species. It can survive in marine as well as freshwater. It has a very extensive range in tropical and semi-tropical areas of the Indo-Pacific: eastern edge of the Persian Gulf to China, Taiwan and southern Japan, southward to southern Papua New Guinea and northern Australia. Another name for Asian Seabass is Barramundi. Locally in Malaysia, it is known as Siakap.

Asian Seabass is characterised by its pointed head, concave forehead, large jaw extending behind the eye and rounded caudal fin. It has a first dorsal fin with seven or eight strong spines and a second soft-rayed dorsal fin of ten or eleven rays. Adult Asian Seabass have blue to green-grey color at their back, silvery on the sides, and white color below their body. Juveniles are mottled brown with a distinct white stripe from the dorsal fin to the snout (Barnabé, 1995)

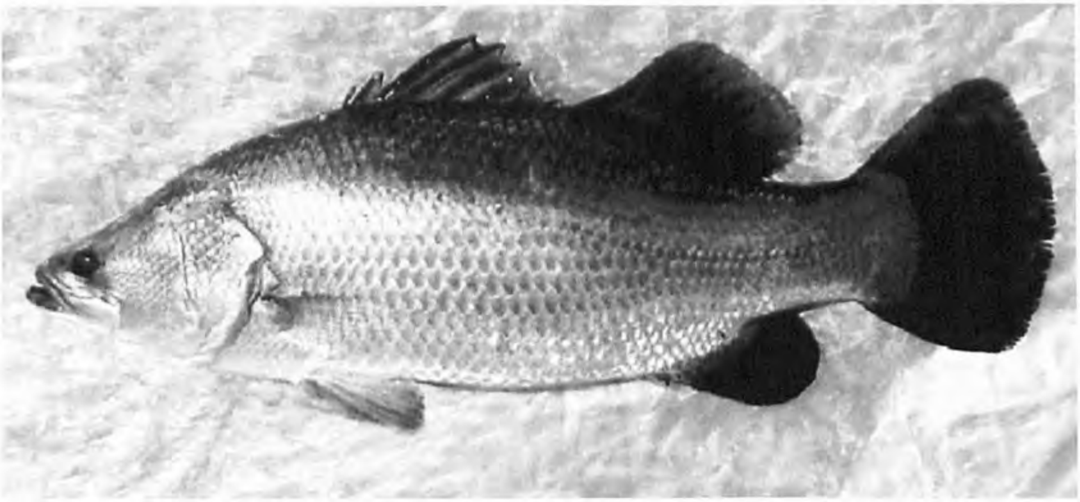

Photo 1.2 Asian Seabass (*Lates calcarifers*) brood fish

The species is sequentially hermaphroditic, most of the larval attained maturity as males and transform into female after at least one spawning season; most of the larger specimens are therefore female. Small fish are almost exclusively male with the percentage of females increasing with overall length (Allan & Stickney, 2000). In the wild, males and females migrate into estuaries to breed, and then return to their original river systems. Asian Seabass is popular among culturist due to its ability to withstand disease and have a high growth rate.

1.3 Location of Experiment

The experiment was conducted in hatchery of Borneo Marine Research Institute (BMRI), University Malaysia Sabah (UMS).

1.4 Objectives

The main purposes of this study are:

1. To observe the development of sensory organ in larval fish histological and morphologically.
2. To study the changes of swimming behavior in larval fish, related to the development of sensory organ.

CHAPTER 2

LITERATURE REVIEW

2.1 Sensory Organs

Aquatic organisms have evolved and developed wide variety of sensory organs that enable them to respond towards environmental changes in their vicinity through their lateral line and vision, or from further distance by hearing and chemical sensing (Chiu and Chang, 2003) Therefore, animals receive information through their well developed sensory organ and that sensory information will reach the central nervous system through the processes of stimulation, transduction, transmission and interpretation.

The role of sensory organ in larval fish is very important to ensure the survival abilities of the larval fish. This study will test mainly the eyes and lateral line of targeted species as both sensory organ plays pretentious role during early larval stages.

2.1.1 Eyes

How the visual environment affects fish abilities to survive in the wild ultimately depends on the anatomy and physiology of the eyes (Evans, 2004). The eyes of fish are designed in such a ways that light can enters almost from every direction either from above, below, forward or behind (Myberg and Fuiman, 2002). The major optical components in fish eyes consist of the cornea, lens, and retina. Light enters the fish eyes and focused on the retina. Retina responds to the presence of light and signals it to the brain through the optic nerve (Tomita, 1971). Different species have different eyes structure. Carnivorous species have larger eyes compared to herbivores species as they rely on visual system in prey location, while other species like blind cave fish (*Astyanax fasciatus mexicanus*) don't have eyes and Four-eyes fish (*Anableps anableps*) have eyes divided into two parts that enable them to see below and above the water surface at the same time (Pankhurst and Eager, 1996).

The development of eyes also plays important role in fish optomotor reaction (OMR). Experiment done on Milkfish (*Chanos chanos*) shows that OMR in Milkfish undergoes major change through metamorphic stage, and become strong and almost perfect in juveniles. (Kawamura and Hara, 1980).

2.1.2 Lateral Line

Motions in water provide numbers of sensory information that can be used by aquatic animals for orientation as well as communication. Motions in water are generated by animate sources such as prey or predator movement and by inanimate sources such as water current, wind and changes in temperature (Mogdans *et al.*, 2004). To detect and interpret those motions in water, aquatic animals have evolved highly sophisticated hydrodynamic receptor systems. The hydrodynamic receptor mention above will be the mechanosensory lateral line (Mogdans *et al.*, 2004).

In fish, lateral line is a series of pores containing nerve endings that run down both sides of the body. Free neuromasts are distributed throughout the surface of the head and along the lateral line and they are considered as part of the lateral line. Each neuromast is a mechanosensory organ that is sensitive to low frequency (1~200Hz) vibrations (Moorman, 2001). Inputs from these nerves are used primarily for food localization, navigation, schooling behavior, and finally predator avoidance (Moorman, 2001).

Two types of neuromasts can be distinguished. The first one will be superficial neuromasts which occur freestanding on the skin, pits, or on skin. The second will be the canal neuromasts which are located in sub-epidermal canals that are in contact with the water through canal pores (Mogdans *et a.l*, 2004). The shape of the neuromasts is in circular or elliptical form with diameters ranging between less than 100 μm up to 600 μm

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