THE DEVELOPMENT OF SENSORY ORGANS AND CHANGES OF BEHAVIOUR IN LARVAE OF PATIN, *Pangasius hypophthalmus*

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

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I/We, members of the Dissertation Supervisory Committee, certify that this dissertation has fulfilled all the research requirements for the Bachelor Degree in Science with Honours, has been verified and is qualified for examination.

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ABSTRAK

Kajian dijalankan untuk mengenalpasti perkembangan organ deria dan perubahan kelakuan larva Patin, *Pangasius hypophthalmus* untuk tujuan memahami ekologinya serta memperbaiki kaedah pengkulturannya. Telur diperoleh dari Institut Penyelidikan Marin Borneo dan larva Patin dikultur dari peringkat penetasan sehingga juvenil. Penyampelan dilakukan setiap hari dan perkembangan organ derianya diperhatikan dengan menggunakan mikroskop cahaya. Larva diberi makan artemia dan serbuk makanan tiruan. Larva yang baru menetas mempunyai ukuran panjang keseluruhan (TL) 4.66±0.02mm (purata ± S.D.), tidak mempunyai pigmen di matanya dan larva tidak bergerak di dasar tangki. Larva berusia sehari (TL. 5.60±0.02mm), telah mempunyai mata yang berpigmen dan pembezaan telah berlaku di sel retinanya. Larva telah menunjukan tindak balas ke atas sentuhan dan berenang secara menegak. Larva berusia dua hari (TL. 6.79±0.03mm), lapisan retinanya kelihatan lebih ketara. Larva menunjukan reotaksis positif dan larva berenang secara mendatar. Larva berusia tiga hari (TL. 7.19±0.04mm), menunjukan fototaksis positif dan berenang secara aktif. Larva berusia tujuh hari (TL. 9.84±0.038mm), menunjukkan fototaksis negatif. Larva berusia 15 hari (TL. 13.31±0.123mm), perkembangan matanya telahpun sempurna. Larva berusia 30 hari (TL. 21.82±0.3758mm), telahpun mencapai tahap juvenil. Perkembangan neuromas bebas, reseptor perasa dan liang olfaktori bermula pada usia larva sehari dan jumlahnya bertambah dan berkembang dari sehari ke sehari. Perkembangan organ deria dan perubahan kelakuan memberi sumbangan yang penting dalam ekologinya di kawasan sungai dan dalam memperbaiki teknik pengkulturannya.

ABSTRACT

This study was conducted to examine the development of the sensory organs and changes of behaviour with the larval growth in Patin, *Pangasius hypophthalmus* for the purpose of understanding its ecology as well as to improve the larval rearing techniques. Eggs were collected from Borneo Marine Researched Institute and the larvae of Patin were reared from hatching to juvenile stage, sampled every day and observed under light microscope for the development of the sensory organs. The larvae were fed with artemia and artificial powder feed. Newly hatched larvae were 4.66±0.02mm (mean ± S.D) in total length (TL), eyes were not yet pigmented, and they lay at the bottom of the tank. At 1-day-old (TL. 5.60±0.02mm), they have pigmented eyes and the retina had differentiated into a few layers. They already responded to mechanical stimuli and swam vertically. At 2-day-old (TL. 6.79±0.03mm), the retina layers appeared more clearly. They showed positive rheotaxis and they swam horizontally. At 3-day old (TL. 7.19±0.04mm), they showed positive phototaxis and swam very actively. 7-day-old larvae (TL. 9.84±0.038mm), showed negative phototaxis. At 15-day-old (TL. 13.31±0.123mm), the eyes development were completed. At 30-day-old (TL. 21.82±0.3758mm), Patin already reached the juvenile stage. The few neuromasts, taste buds and olfactory pits started to develop at 1-day-old and they were increasing from day to day. The development of those sensory organs and changes of behaviour contributed importantly to the larvae on its ecology at the river and improvement of its larval rearing.

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cm	centimetre
d	day
dAH	days after hatching
hAH	hours after hatching
DO	dissolved oxygen
kg	kilogramme
g	gram
L	litre
ml	mililitre
mm	millimetre
ppt	part per thousand
TL	total length
S.D	standard deviation
µm	micrometre
%	percentage
^0C	degree celcius
±	more or less
$IUkg^{-1}$	international unit per kilogramme

CHAPTER 1

INTRODUCTION

1.1 Sensory Organs

The sensory system is the most important system not only in humans but in all living creatures. The sensory system has its very own sensory organs to sense different types of sense such as; eyes for sight, ears for hearing, nose for smelling, tongue for tasting and the skin for the sense of touch.

The aquatic and terrestrial environments present few fundamentally different sensing opportunities for their inhabitants (Atema, 2003). The right temperature, the pH value and density of the environment will be able to present its inhabitants with opportunities to gather information through their sensing organs that should help them to do a range of activities from looking for mates to spawning to running for shelter.

The fish, one of the aquatic inhabitants, is equipped with sensory organs such as the eye, inner ear, free neuromasts, taste buds, and the olfactory organ. Each of these organs represents the sense of sight, hearing, vibration or physical stimuli, chemical stimuli, and smell or odour respectively.

With sensory organs, fish will be alerted to the presence of food, mate, and predator. The presence of the sensory organs will affect the behaviour of the fish. By studying and understanding the morphology, sensory organs and the behaviour of the fish, information on the basic biology of fish can be obtained. This information should shed some light and provide better understanding of the fish, especially at its larval stage.

The larval stage is the most difficult part in aquaculture. The rearing of the larvae needs the most intensive care compared to the other stages of development in fish. Mortality has also been reported to be highest at this stage. This is because the larvae are still weak and extra care is critical for them to survive well.

Many factors may affect the early life mortality in fish. These include the lack of basic biological knowledge, viral and bacterial infections as well as nutrient deficiencies. The basic biological knowledge is most important as it will guide the breeder to understand the larvae. Basic biological knowledge involves studying its life cycle, its physical characteristics (Zakaria Ismail, 2003) and its preference adaptations (most suitable and desirable environment). This information will help in determining the feeding efficiency and the best environment to avoid diseases so as to encourage optimal growth.

Morphology, sensory organs and behaviours are components which make up the study contributing to the basic biological information of larvae. Morphology involves the study of the general structures of the larvae. The sensory organs activate the different

senses in the fish, while behaviour concentrates on the attitude of the fish towards various conditions. This study aims to improve the larval rearing techniques of the chosen species.

1.2 Catfish Culture

In aquaculture, the most freshwater species cultured are tilapias, carps and catfishes. For tilapia, the black tilapia (*Oreochromis mossambicus*) and the red tilapia (*O. niloticus*) are the popular species cultured. The famous carp cultured are the common carp (*Cyrinus carpio*), Javanese carp (*Puntius gonionotus*), bighead carp (*Aristichthys nobilis*), silver carp (*Hypophthalmichthys molitrix*), and grass carp (*Ctenopharyngodon idella*). While for the catfish, *Clarius gariepinus, C. macrocephalus*, *C. batrachus* and *Pangasius hypophthalmus* are the most cultured.

Catfishes are considered to be warm–water fishes because they are more tolerant to higher water temperatures compared to other species (Burton, D, 1996). Different countries culture different species of catfish, for example, the aquaculturists in the United States of America culture Channel Catfish (*Ictalurus punctatus*). In Europe they culture Sheat Fish (*Siluris glanis*), Indian aquaculturists culture Asian catfish (*C. batrachus*) and *Heteropneustes fossilis*. In Thailand, Malaysia, and the Philippines aquaculturists culture several Asian catfish *C. batrachus* and *C. macrocephalus*, while in Africa they culture the African catfish (*C. gariepinus*).

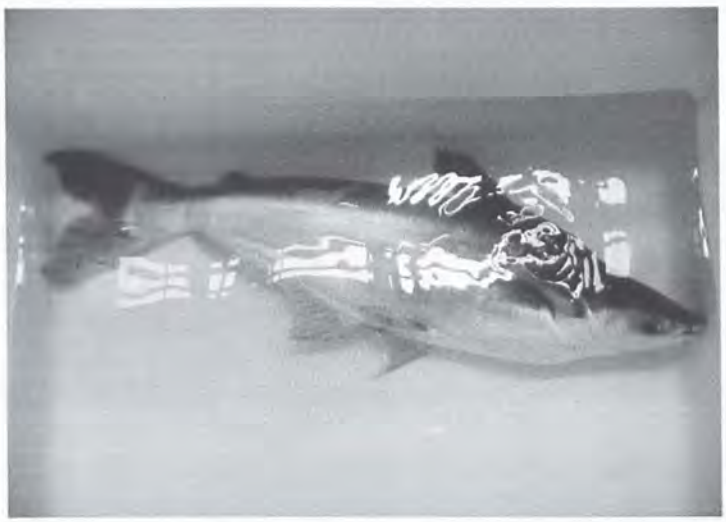
In Asia, pangasiids and clariids catfishes are particularly suitable and popular for catfish culture. The River catfish (*Pangasius hypophthalmus*) is cultured in many countries in the Asia region (Baidya, 2004). Other freshwater species are also widely cultured and the production is higher than the catfishes. However, the total volume of catfishes cultured has been increasing for the past 20 years. *Pangasius hypophthalmus, P. miconema* and *P. larnaudii* are the major pangasiids cultured in Thailand, Laos, Cambodia and Vietnam (Baidya, 2004).

In Malaysia, aquaculture is a relatively new development. Careful planning and numerous efforts have been initiated but much more needs to be done before the goal of measuring up to international standards can be achieved. For catfishes, *Clarias* spp. and *Mystus nemurus* have been cultured since the early 1960s. After that, *C. batrachus*, *C. macrocephalus*, *C. gariepinus*, the hybrid of *C. macrocephalus* and *C. gariepinus* were cultured after researchers from other countries were successful with several attempts of seed production. *Pangasius hypophthalmus* was introduced and cultured in the 1980s, where the production was lower than the *C. gariepinus* but, the retail price was higher (Baidya, 2004).

1.3 Target Species

For this study, one species is selected. The target species is the River Catfish, which is scientifically called *Pangasius hypophthalmus*.

The River catfish is a freshwater fish that is widely distributed in the South East Asia region. *Pangasius hypophthalmus* can be found in large rivers of the Mekong and Chao Phraya basins and is very common in the Lower Mekong River (Nam So *et al.*, 2006). This catfish belongs to the Pangasidae family.



Picture 1.1 Brood stock of the River Catfish, *Pangasius hyphophthalmus.*

Because of their wide distributions, the River catfish have been named differently according to the country where they are found. River catfish have been called Iredescent Shark, *Sut Chi* Catfish, *Pla Sawai*, and locally it is known as *Patin*.

The River Catfish do not have scales. Therefore, their bodies are easily injured when they accidentally scratch themselves upon tank walls or other sharp materials. The colour of the river catfish body is gray or black at the top and fades to white on the belly. The body colour depends on the water condition. If the water is in good condition, they

may seem to appear darker (black). But if the water condition is bad, they may be lighter (light gray). The bad condition of the water can make them easily susceptible to diseases.

Morphologically, their fins are soft rayed, but they have sharp spines that are located on the dorsal and pectoral fins. The spines are believed to be the defence structures toward protection. The River Catfish have a deeply forked caudal tail and because they are one of the catfish species, they are equipped with eight elongated barbels. These barbels are arranged four on the lower jaw, two above the nares and each one at the tip of the upper jaw.

The River Catfish have many advantages in aquaculture as they are omnivorous and highly resistant to low levels of oxygen (DO). They are also strong and resistant to diseases and it is possible to produce them in great numbers because they can endure the artificial seed production. Besides, they are fleshy and tasty with a high market demand in the local market.

With these potentials, the river catfish can be a good source of income in the aquaculture business. Unfortunately, the high early-life mortality rates of this species and the occurrences of cannibalism bring about some mass production problems. Both problems appear in the larval stage of this species. One possibility that these problems occur is due to insufficient basic biological knowledge about the larvae. Thus, equipping oneself with the basic biological knowledge is imperative in order to be successful in catfish culturing. To gain knowledge in this aspect, the breeder needs to concentrate on

the morphological changes, sensory organs development and behaviours of the River Catfish.

1.4 Location of Experiment

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

1.5 Objectives

The objectives of this study are:

1. To observe, understand and document the changes in behaviour of the *P. hypophthalmus* larvae.
2. To gather basic information on the *P. hypophthalmus* larvae specifically the development of their sensory organs and morphology.
3. To suggest improvement in rearing techniques of *P. hypophthalmus* larvae using the information gathered on the development of their sensory organs and changes in their behaviour.

CHAPTER 2

LITERATURE REVIEW

2.1 Morphological Changes

Morphology is defined as the science that deals with the forms or structures of animals and plants (Eapen, 1999). Morphological changes thus deal with form and structures, as distinct from function.

Dynamic morphology aims to explain the qualitative and quantitative changes in growing animals as adaptations to changing demands of function and environment (Osse, J.W.M. and Van Den Boogart J.G.M.,1999). The transformation of larvae into juvenile or from juvenile into adult form is an example.

Studies have shown that the morphological changes are highly related to the environmental and biotic fluctuations. The change in habitat (from pelagic phase to a benthic–oriented juvenile and adult phase) has a strong influence on the rapid change in the morphology of the fish (McCormick, 1993).

If the habitat is conducive for the changes in the fish, then the fish morphology will change accordingly, often benefiting the fish community (Osse, J.W.M. and Van Den Boogart J.G.M.,1999).

For larvae, studies have shown that the growth of the larvae is influenced by the temperature during the incubation of the eggs. Laboratory studies have shown that higher egg incubation temperatures produce smaller larvae at the time of hatch (Jordaan *et al.*, 2006).

2.2 Sensory System

The sensory system is the most important component for the fish - just as crucial the sensory system of the humans is to them. However, fishes have more senses than the humans. Besides the senses of sight, hearing, smell and taste, they have an elaborate lateral system to detect vibrations. In addition, a fair number of species have modified part of this lateralis system for electro-reception (Bone *et al.*, 2004; Moyle, P. B., and Cech Jr., J., 1996).

The differentiation of the sensory tissue has a conservative response to environment and biotic fluctuations (McCormick, 1993). This shows that the sensory organs development is significantly influenced by the environment and the biotic variation. With these sensory organs, fish will be able to detect and capture prey while at the same time, avoiding the predators.

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