UNIVERSITI PUTRA MALAYSIA

THE EFFECTS OF DIFFERENT AERATION RATES IN THE LARVAL REARING OF SOME CYPRINIDAE SPECIES

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By

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Thesis Submitted in Fulfilment of the Requirements for the Degree of Master of Science in the Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia

1992

ACKNOWLEDGMENT

I would like to express my deepest and heartfelt gratitude and sincere appreciation to my supervisor, Professor Dr. Ang Kok Jee, Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia, for his invaluable suggestions, guidance and encouragement throughout the study period. I also wish to heartily express my indebtedness to Dr. Fatimah Md. Yusoff, lecturer and Head of Department of Aquaculture, and Dr. Chan Hooi Har, Lecturer, Faculty of Fisheries and Marine Science, who as Co-supervisors always gave their suggestions and advice to the solution of problems that arose in the course of the present study.

Sincere appreciation is also extended to the following persons who have been instrumental in the presentation of this dissertation. Dr. Capt. Mohd. Ibrahim Hj. Mohamad, Associate Professor and Dean of Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia, who gave me the opportunity to undertake the present study and showed profound sympathy and support. Mr. Ayob bin Ahmadi, Manager of the Fish Hatchery Unit, Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia, and the Hatchery staff for their assistance in the field work. Professor Dr. Yukio Yamada, Faculty of Veterinary Medicine and Animal Science, Professor Dr. Shin-ya Iyama, Faculty of Agriculture, Mr. Cheah Sin Hock, Dr. Patimah

Ismail, and Mr. Liew Hock Chark, lecturers, Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia, who encouraged me and gave advice during the study period.

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LIST OF ABBREVIATIONS

AR	Aeration Rate
DO	Dissolved Oxygen
fish/L	Fish per Liter
HDPE	High Density Polyethylene
mg/L	Milligram per Liter
PVC	Polyvinyl Chloride
StD	Stocking Density
SD	Standard Deviation
TC	Tank Cleaning
TL	Total Length
WE	Water Exchange
WT	Water Temperature

Abstract of Thesis Submitted to the Senate of Universiti Pertanian Malaysia in Fulfillment of the Requirements for the Degree of Master of Science.

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by

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July 1992

Chairman : Professor Dr. Ang Kok Jee

Faculty : Fisheries and Marine Science

A study was undertaken to develop an appropriate technology of fish seed production in the tropics in order to overcome the constant water scarcity and its high operational cost. Accordingly, three experiments were carried out at the Fish Hatchery Unit, Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia to determine the optimum aeration rate and stocking density for fish larval rearing.

In the first experiment, one hundred larvae of Puntius gonionotus, Cyprinus carpio, and Carassius auratus were reared for 20 days respectively in tanks with four different aeration rates ; 0, 50, 500, and 5,000 mL/min. From the results of the

first experiment, the aeration rates of 0 and 50 mL/min, 50 and 500 mL/min, and 50 mL/min were found to be the optimum rates for the larval rearing of Puntius gonionotus, Cyprinus carpio, and Carassius auratus respectively. In the second experiment, five types of air diffusers (cotton, artificial sponge, wood, and long and short factory made air stones) were tested to choose the suitable air diffuser for the third experiment. The factory made small airstone was chosen because of its effective oxygen supply, easy handling, uniform aeration bubbles, and low cost. Taking the results of above experiments, the third experiment was planned and conducted to determine the effects of different aeration rates and stocking densities on the larval rearing of Cyprinus carpio. The larvae were reared in tanks for 20 days exposed to 0, 25, 250, 500, 1,500, 3,000 mL/min, and 500 mL/min + WE + TC with the stocking densities of 1, 2, and 4 fish/L. The 500 mL/min + WE + TC was treated with water exchange (WE) and tank cleaning (TC). The aeration rate of 250 mL/min with the stocking density of 4 fish/L was found to be the most suitable for the larval rearing of Cyprinus carpio. Water exchange and tank cleaning were not necessary for the larval rearing of Cyprinus carpio using this system.

Abstrak tesis dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi sebahagian daripada syarat-syarat untuk mendapatkan Ijazah Master Sains.

KESAN-KESAN DARIPADA KADAR PENGUDARAAN YANG BERBEZA DALAM PEMELIHARAAN LARVA BEBERAPA JENIS SPESIS CYPRINIDAE

oleh

Shigeharu Senoo

Julai 1992

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Satu kajian telah dijalankan bagi mencari teknologi yang sesuai di dalam pengeluaran benih-benih ikan di kawasan tropika untuk mengatasi masalah kekurangan air yang selalu berlaku di samping kosnya yang tinggi. Berhubung dengan itu, tiga eksperimen telah dijalankan di Unit Penetasan Ikan, Fakulti Perikanan dan Sains Samudera, Universiti Pertanian Malaysia untuk menentukan kadar pengudaraan dan kepadatan yang optimum di dalam pemeliharaan larva.

Dalam eksperimen pertama, seratus larva Puntius gonionotus, Cyprinus carpio dan Carassius auratus diternak selama 20 hari dengan 0, 50, 500 dan 5000 mL/min pengudaraan di

dalam tangki masing-masing. Keputusan yang didapati daripada kajian di atas ialah, kadar-kadar pengudaraan 0 dan 50 mL/min, 50 dan 500 mL/min dan 50mL/min masing-masing merupakan kadar yang optimum untuk Puntius gonionotus, Cyprinus carpio, dan Carassius auratus. Dalam eksperimen kedua pula, lima jenis penyebar udara (kapas, span tiruan, kayu dan batu udara jenis panjang dan pendek) telah diuji bagi memilih penyebar yang paling sesuai untuk eksperimen ketiga. Batu udara kecil telah dipilih kerana bekalan oksigen yang efektif, mudah dijaga, buih-buih seragam dan murah. Mengikut keputusan daripada eksperimen di atas, eksperimen ketiga telah dirancang dan dijalankan untuk menentukan kesan-kesan kadar pengudaraan yang berbeza dan kepadatan yang sesuai dalam pemeliharaan larva Cyprinus carpio. Larva dipelihara dalam tangki-tangki 0, 25, 250, 500, 1,500, 3,000 mL/min, dan 500 mL/min + WE + TC dengan kepadatan 1, 2, dan 4 ekor/L. Untuk tangki 500 mL/m + WE + TC, penukaran air dan pembersihan tangki selalu dilakukan. Kadar pengudaraan 250 mL/min dengan 4 ekor/L didapati paling sesuai untuk larva Cyprinus carpio. Penukaran air dan pembersihan tangki tidak perlu untuk pembiakan larva Cyprinus carpio dengan sistem ini.

CHAPTER I

INTRODUCTION

Many governments in the tropical region emphasize development and expansion of aquaculture in their planning. Their main objectives are to produce sufficient protein to the population, increase income for fishermen and farmers, and extend the export market for foreign exchange earning (OFCF, 1980; Souma, 1986; Masuda, 1986; Ang, 1990; Chua and Tech, 1990; Pillay, 1990). Most of the countries in the region are developing countries and some of these are least-developed countries (IDJC, 1987). Therefore, the technology for the development of aquaculture should be acceptable and compatible with their financial resources, level and state of experience.

In general, the technology in the various fields of aquaculture are available in the tropical region. Some of these are integrated agriculture-aquaculture farming system (Delmendo, 1980; Tan and Khoo, 1980; FAO, 1986), monosex culture in some Sarotherodon species (FAO, 1981; 1986; Yata and Miyashita, 1988), and induced spawning technique by hormone injection for some species (Lee and Wade, 1973; Woynarovich and Horvath, 1980; Thalathiah et al., 1988; Pathmasothy and Lim, 1988; Takashima, 1989). However, the aquaculture industry

still faces a lot of problems. The main problems are the shortage of seeds, availability of proper feeds, disease, and aquatic pollution (Ang, 1990; Tripathi, 1990; Watanabe and Nomura, 1990) .

One of the main problems in fish seed production is in the use of appropriate technology for a specific situation for a particular country or region. Therefore, there is an urgent need to develop an appropriate technology of fish seed production for an accelerated development and expansion of aquaculture in the tropical region. At present, there are various methods of fish seed production in practice in different countries. They may be in the form of extensive, semi-intensive, and intensive methods. The adaptation of a particular fish seed production method is based on the species of fish to be cultured, location, water quality parameters, social and economic considerations.

Some Sarotherodon species and Cyprinus carpio are produced by the extensive method in Malaysia and some African countries (FAO, 1981; Souma, 1986). In the case of Sarotherodon, a mouth-brooder, the brood fish are stocked in a pond and then the parents spawn and take care of the larvae (Hepher and Pruginin, 1981; Yata and Miyashita, 1988). The seeds are produced naturally and easily, but this method is only useful for a few species in extensive fish culture in ponds. The mortality of larvae is high during the larval and nursery stages in this method.

The seed production of Puntius gonionotus, Labeo rohita, and Cyprinus carpio in Malaysia and Thailand and Cyprinus carpio and Carassius auratus in Japan are carried out using semi-intensive seed production method (Matsui, 1963; Inaba, 1976a; Ahmad et al., 1977; Malaysia, Kementerian Pertanian Dan Pembangunan Luarbandar, 1987; Thailand, Department of Fisheries, 1988). The artificially collected eggs are hatched in the hatchery and the larvae are released into ponds with adequate plankton growth (Nose et al., 1973). However, in this production method, some preliminary steps such as the elimination of predators (fish and insects) and proper pond fertilization to increase plankton production should be done before the release of the larvae (Inaba, 1976a; Hepher and Pruginin, 1981). However, the eradication of predators from ponds are difficult. In the tropical region, predatory insects migrate into ponds all the year round. It is also difficult to completely eradicate predatory fish from earthen ponds. Thus one may encounter high mortality during the larval and nursery stages.

In the intensive seed production method, there are various techniques of larval rearing in use depending on fish species. According to Inaba (1976b), the intensive seed production of Salmo gairdnerii irideus is conducted by continuous running water system. For example, to rear 10,000 larvae for a period of 20 days, it requires 20 to 30 metric tonnes of fresh water

per day, indicating the large volume of water required for such a method.

In Japan, the seeds of Pagrus major are effectively produced by intensive method (Watanabe and Nomura, 1990). The technique has been developed and become more sophisticated in the last two decades (Keitoku, 1987). The larval rearing began in a static water system and then shifted to a water exchange system and later to a running water system. The bottom of the rearing tank is cleaned daily by using a siphon or a mechanical water pump. Using this technique, Keitoku (1987) was able to produce about 9,600 of Pagrus major seeds per metric tonne of water. Although the production was very high, this technique is not recommended for developing countries because of its high capital investment and operational cost.

When we consider fish seed production in the tropical region or developing countries, the major constraint facing any fish hatchery is water supply. The problem in water supply may be in the form of:

(1) Water shortage during the dry season as in Zambia (Zambia, Department of Fisheries, 1983; 1985).
(2) Difficulty of water intake in the monsoon season as in some South East Asian countries.
(3) Water from many rivers, dams, and ponds is often unsuitable for larval rearing due to pollution such as their water may be muddy or silty.

(4) High cost of construction and maintenance of water supply system (Zambia, Department of Fisheries, 1983; 1985).

These problems are fairly common in hatcheries not only in Zambia and Malaysia but also in Japan. Thus, it is necessary to find an appropriate and simple technology to produce as many fish seeds as possible by using the least amount of water to reduce operational cost.

The main purpose of adequate water supply to rearing tanks in hatcheries is to improve the water quality especially to increase dissolved oxygen in water (Sano, 1988; 1989). The installation of an aeration system to the hatchery can solve this problem and increase the dissolved oxygen in water. When aeration system is compared with water supply system, the facilities of aeration system can be constructed much cheaper than that of water supply system. Air is not a limiting factor at all and is available anywhere.

The various aeration methods are important techniques in fish culture and fish seed production. Fish culturists should aim to produce fish seed using an efficient and economical production system. Therefore, it is imperative that they make a proper design to include appropriate aeration system to suit local condition in their fish seed production operation.

However, installation and operation of aeration system in many hatcheries appear to be done very carelessly and unsatisfactorily. A lot of drawbacks in aeration system in

several hatcheries in Malaysia were observed (Senoo, personal observation). Some of these problems are lack of air regulators and air diffusers, air leakage from the distributing pipes and joints, and improper design of the aeration system. Therefore, the role and importance of aeration system in hatcheries should be reconsidered and studied in larval rearing for fish seed production. There is an urgent need to study the roles of aeration in fish larval rearing since information on this is lacking though it is widely used by hatchery operators. For example there is no quantification on the optimum rate of aeration, density related or physical effects of aeration on fish larvae themselves. In many hatchery manuals and publications (Jhingran and Pullin, 1985; NICA, 1986; Yamasaki et al., 1991), though installation of aeration system has been given emphasis but no detailed information on the rates, capacity and effect of aeration on larval rearing are available.

The important considerations in the design of fish seed production system in tropical regions are the simplification of design and operation, low running cost, and consistent production. Therefore, a study to achieve these goals was undertaken.

General Objective

The general objective of this study is to find a simple and consistent production system to produce as many seeds as possible using least amount of water. To achieve this objective, three experiments were conducted.

In the first experiment, the larvae of Puntius gonionotus, Cyprinus carpio, and Carassius auratus were reared in tanks with different aeration rates in order to determine their effects on the larvae. The preliminary results obtained from this study were utilized to design the subsequent experiments.

Puntius gonionotus (Lampam Jawa) and Cyprinus carpio (Lee Koh) are popular freshwater fishes in Malaysia. The total production of Puntius gonionotus and Cyprinus carpio in Malaysia were 746.33 and 143.36 metric tonnes respectively in 1987 constituting about 27.3% and 5.0% of total production of fresh water fishes respectively (Malaysia, Department of Fisheries, 1987). Carassius auratus (gold fish) is a popular aquarium fish. Recently, Carassius auratus culture has become popular in Malaysia. Some fish farmers in the state of Johor, Malaysia are producing Carassius auratus on big scale and exporting them to the United States of America.

The second experiment was carried out to determine the suitability and economic feasibility of the hand made and factory made air diffusers which were to be used in the third