EFFECTS OF STOCKING DENSITY ON GROWTH, SURVIVAL AND BEHAVIORS OF AFRICAN CATFISH, *Clarias gariepinus* JUVENILE

NORHARYANTI BINTI AZIZ

A DISSERTATION SUBMITTED AS A PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE BACHELOR OF SCIENCE WITH HONOURS

AQUACULTURE PROGRAMME
SCHOOL OF SCIENCE AND TECHNOLOGY
UNIVERSITI MALAYSIA SABAH

MARCH 2006

PUMS99:1

UNIVERSITI MALAYSIA SABAH

BORANG PENGESAHAN STATUS TESIS@

EFFECTS OF STOCKING DENSITY ON GROWTH, SURVIVAL AND
ORS OF AFRICAN CATFISH, Clarias gariepinus JUVENILE

SARJANA MUDA AKUAKULTUR

NORHARYANTI BINTI AZIZ
(HURUF BESAR)

SESI PENGAJIAN: 2003

Membenarkan tesis (LPSM/Sarjana/Doktor Falsafah) ini disimpan di Perpustakaan Universiti Sabah dengan syarat-syarat kegunaan seperti berikut:-

Tesis adalah hakmilik Universiti Malaysia Sabah.
Perpustakaan Universiti Malaysia Sabah dibenarkan membuat salinan untuk tujuan pengajian sahaja.
Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institutsi pengajian tinggi.
Sila tandakan (/)

[ ] SULIT (Mengandungi maklumat yang berdarjah keselamatan atau Kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

[ ] TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

[ ] TIDAK TERHAD

Disahkan Oleh

DATANGAN PENULIS)

(TANDATANGAN PUSTAKAWAN)

etap: KG JAL BESAR,
G EMPAT, 16210
T, KELANTAN

PROF. DR. SHIGEHARU SENOO
Nama Penyelia

1/04/06

Tarikh: 21/04/06

N:- *Potong yang tidak berkenaan.
**Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa /organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT dan TERHAD.
@Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah dan Sarjana secara penyelidikan atau disertai bagi pengajian secara kerja kursus dan Laporan Projek Sarjana Muda (LPSM).

DECLARATION

I would like to declare that this dissertation is the result of my own independent work and original writing, except the data and facts that already stated with its sources and origins.

20 March 2006

.....

NORHARYANTI AZIZ

HS 2000-3505

AUTHENTICATION

	Signature
1. SUPERVISOR (Prof. Dr. Shigeharu Senoo)	.....
2. EXAMINER 1 (Dr. Siti Raehanah Muhd Shaleh)	.....
3. EXAMINER 2 (Mr. Kennedy Aaron Aguol)	.....
4. DEAN (Prof. Madya Dr. Shariff A. Kadir S. Omang)	.....

ACKNOWLEDGEMENT

First and foremost, I want to thank Prof Salem Mustafa, the director of IPMB for his supports to all the final year students of Aquaculture Science Programme. Then, I would like to express my appreciation to my supervisor Prof. Dr. Shigeharu Senoo for his strong support and endless encouragement to me in completing my final year project. I also want to dedicate my appreciation to Mr Julian Ransangan as the coordinator for Final Year Project for all his supports, information and suggestion Then, I would like to express my thanks to the all lecturer of Aquaculture Science Programme, Dr. Siti Raehanah Mohd Shaleh, Mr Kennedy Aaron, and Dr. Yukinori Mukai and for their comments and suggestion. Not to forget, all the IPMB hatchery staffs, research assistants especially Miss Audrey Tuzan and Miss Ching Pui-Pui, my course mates and friends for helping me especially within my 3 months experiments in hatchery and my thesis writing either directly or indirectly.My very special appreciation goes to my beloved family for their endless love, care, patients and support and understanding me. Without them, I will not be able to complete this final year project. For Siti Mariam Abu Hussain and family, thank you for your strong encouragement and your support make this possible.

ABSTRACT

The African catfish (*Clarias gariepinus*) is one of most popular freshwater fish and have a high demand in Malaysia. However, during rearing time, they show an inconsistent on growth and survival rate because stocking density. For this experiment, the *C. gariepinus,* 30 days after hatching (AH) were taken from the hatchery of Borneo Marine Research Institute (IPMB). *C.gariepinus* was kept in nine aquariums at low, medium and high density (5/L, 10/L and 15/L). Length was measured to the nearest centimeter and weight to the nearest gram. The juvenile were then assigned at random to nine aquariums (7L aquarium). The juvenile were fed 3 times daily using commercial pellet at 3% of total body weight for each treatment. The juvenile were measured in term of total length and body weight and survival were measured every 5 days for 1 month. It was found that the growth rate were similar for all stocking density tested. The survival rate was significantly decreased with increasing stocking density, while swimming activity increases with increasing stocking density. Cannibalism which appears depend on stocking density is higher in high density because of overcrowding and competition for space and food. Low density was the best result for rearing juvenile of *C. gariepinus* which gives the highest survival rate and to avoid cannibalism. This study is can be used as a reference for fish producers to rear the juvenile fish especially in small scale production system.

ABSTRAK

Keli Afrika (*Clarias gariepinus*) merupakan salah satu spesis ikan air tawar yang paling popular dan mempunyai permintaan yang tinggi dalam pasaran Malaysia. Walaubagaimanapun, semasa peringkat penternakan ia menunjukkan pertumbuhan dan kadar kemandirian yang tidak konsisten kerana menggunakan kepadatan stok yang berbeza. Dalam eksperimen ini *C. gariepinus* berumur 30 hari selepas menetas diambil dari hatceri Institut Penyelidikan Marin Borneo (IPMB). *C. gariepinus* disimpan dalam sembilan akuarium pada kepadatan stok rendah, sederhana dan tinggi (5 ekor /L, 10 ekor/L dan 15 ekor/L). Panjang ikan dan berat ditentukan. Juvenil dimasukkan secara rawak dalam sembilan akuarium (7L akuarium). Juvenil diberi makan 3 kali sehari menggunakan makanan ikan komersil pada kadar 3% daripada jumlah berat badan untuk setiap rawatan. Keputusan menunjukkan pertumbuhan adalah sama untuk semua ketumpatan stok tetapi kadar kemandirian berkurangan secara bererti dengan peningkatan ketumpatan stok. Kanibalisma muncul bergantung pada ketumpatan stok iaitu kadarnya meningkat dengan peningkatan ketumpatan stok kerana keadaan terlalu padat dan persaingan untuk mendapatkan ruang dan makanan. Ketumpatan rendah adalah paling bagus untuk penternakan juvenile *C. gariepinus* yang mana memberikan kadar kemandirian yang paling tinggi dan dapat mengelakkan kanaibalisma. Kajian ini boleh digunakan sebagai rujukan kepada para pengusaha ikan bagi penternakan juvenile terutama sekali untuk pengeluaran yang berskala kecil.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PHOTOS

LIST OF ABBREVATIONS

AH	After hatching
BW	Body weight
cm	Centimeter
D.O	Dissolved oxygen
°C	Degree centigrade
°F	Degree Fahrenheit
df	Degree of freedom
g	Gram
kg	Kilogram
L	Litre
mm	Milimetre
ppt	Part per thousand
%	Percentage
TL	Total length

CHAPTER 1

INTRODUCTION

1.1 Overview of Aquaculture

Fish is important for human as nutritious human food supplying protein for the growing human populations. Aquaculture is an essential industry providing a crucial part of the world's food supply and can be the answer for some of the world's future protein need. There are many term uses to define the mean of aquaculture. Aquaculture can be defined as the farming of aquatic animals (fishes, mollusks, and crustaceans) reared for food in fresh, brackish, or marine waters (Bardach, 1997). Food and Agriculture Organisation (FAO) defines aquaculture as "farming of aquatic organisms including fish, mollusks, crustaceans and aquatic plants" (FAO, 1995). This industry includes the husbandry, management, nutrition and breeding of all useful aquatic organisms.

Aquaculture is one of the most important industries around the world and has a long history. Most publications on aquaculture refer to the long history of fish culture in Asia, Egypt and Central Europe (Pillay, 1990). The first publication on the subject of fish culture was by Fan Li, who wrote during fifth century B.C. about carp production in

China (Stickney, 1994). Then, Egyptians have been involved in tilapia culture while common carp culture began in Europe during the Middle Ages. Aquaculture may be classified in extensive, semi-intensive, intensive or superintensive system. This industry starts the operation from the small-scale activity and extended by the time.

Aquaculture is important industry and has benefits in economic and social. In addition to supplying fresh high-protein food for human consumption, aquaculture has proved to be an economic industry useful in several other activities (Nash, 1995). Aquaculture can sustaining fisheries and taking exploitation pressure off of wild fish populations. It has a potential to supplement and replace wild captured species. Another importance is, it provide income for fish farmers and live hoods for workers. It also can help in sustaining pleasant and fisherman in rural areas and reducing the drift population to urban centres.

Aquaculture has been practiced for centuries, particularly in Asia, now has grown dramatically and was a major industry in many areas of the world. In 1998, according to the (FAO), aquaculture provided about 26% of global fisheries production and 33% of food fish (Davenport *et al.,* 2003).Asia has increased its relative contribution to world supplies of animal products from aquaculture from 78% in 1984 to 89% in 1998 (Howgate *et al.*, 2002). This developing country dominates world aquaculture production which producing 90% of the total production.

As human being increase in population by time, the demands for the sources of protein also increase. Global fisheries demand has been estimated to be 110 – 120 million tons in year 2000, at 1988 prices (Nash, 1995). Conversely almost 29 % of the world catch are used for other purposes such as reduction to oils and animal feeds. There are only 22.6 % (or 21.0 million tonnes) is marketed fresh, frozen (25 %), cured (10.9 %) or canned (12.9 %) (Nash, 1995). Although it was far to fulfilling but its potential to contribute to food supplies in all the areas around the world, farmed production is an important balancing factor, which complements natural harvest.

With proper planning and concerted effort made, especially with participation of the many world organizations, this industry will spearhead the quest to increase fish production in the future and will fulfilling the world's future protein need.

1.2 Family of Clariidae

More than 2000 species of catfish, representing at least 31 families, occur in marine or fresh water around the world (Burgess, 1991). There are only a few families of catfish species cultured as food which are in the families Clariidae, Ictaluridae, Pangasidae, and Siluridae. The clariids are the most important group, and all species are often simply called 'African catfish' (Parker and Nash, 1995). They can live in a variety of freshwater environments, including quiet waters like lakes, ponds, and pools. They are also very prominent in flowing rivers, rapids, and around dams.

The clariids species is important and was the most popular freshwater fish around the world. There are several advantages by culturing catfish such as high growth rate, strong resistance to disease and low density DO and very adaptive to extreme environment condition. Besides that, there was wider variety of omnivorous feeding habits which there were not specific in their food requirement (http://animaldiversity.ummz.edu/site/accounts/information/Clarias_gariepinus.htm1).

Catfish is a very good food source for humans because of its good taste. In the world, there are a many variety of catfish species has been cultured. They are farmed extensively in many areas around the world. The mass production of catfish species can be continuously increasing, if all the aspect in culturing are consider especially in broodstock management, water management and culturing technique.

1.3 Description of the African Catfish

African catfish (family Clariidae) was the most popular freshwater fish species around the world. This species is one most important of the catfish species currently farmed in tropical freshwater (Hogendoorn and Vismans, 1980; Appelbaum and Kamler, 2000). The catfishes can be found in marine and fresh water area. The different species (*C.lazera, C.senegalensis, C.massambicus and C.gariepinus*) can be found in different part of Africa. This catfish has many local names in countries where it is distributed. The classification of African catfish is:

Class: Actinopterygii

Order: Siluriformes

Family: Clariidae

Genus: Clarias

Scientific name: *Clarias gariepinus*

Common names: African catfish, Sharptooth catfish (English)

Keli Afrika (Malaysia)

Hige-Namazu (Japan)

Skerptandbaber (Afrikaans)

Garmut (Arabic)

African catfish are origin from Native of Africa, Niger and Nile Rivers and now found in a variety of parts around the world. They are found as far south as South Africa and north into northern Africa. They have also been introduced in Europe, the Middle East, and in other parts of Asia. This species have been introduced in Malaysia in the 1980s and has become one of the most popular aquaculture species (Baidya and Senoo, 2002).

African catfish live in a variety of freshwater environments. They can be found in streams, ditches, ponds and lagoons (Blakely and Hrusa, 1989). They are widely tolerant of extreme environmental conditions. The presence of an accessory breathing organ enables this species to breathe air when very active or under very dry conditions. They are also able to secrete mucus to prevent drying and are able to burrow in the muddy

substrate of a drying body of water. African catfish are omnivorous and there is no specific in their food requirement. They are feeds on insects, crabs, plankton, snails and also take young birds, other fishes, plants and fruits.

The body are elongated with fairly long dorsal and anal fin. The dorsal fin has 61-80 soft rays and the anal fin has 45-65 soft rays. The mouth is large and subterminal. They have four pairs of barbells located around the mouth. Their coloring of body is dark grey or black dorsally and cream colored ventrally. The head is large, depressed and heavily boned with small eyes. They have strong fins with spines (http://animaldiversity.ummz.edu/site/accounts/information/Clarias_gariepinus.htm1)

1.4 Problems of African Catfish Culture

African catfish are very good food source for human. It has a possibility for mass production as they are farmed extensively all over areas in the world especially in Asia. The demand of this catfish is higher throughout the year. Many people involved in African catfish culture because it is easy to be cultured as they are very strong and can adapt to the extreme condition. In Asia, catfish can mature anytime during the year and produce big number of eggs during their spawning time. According to Hogendoorn and Vismans, (1980) in their experiment on artificial reproduction of catfish, the same female can be induced to spawn several times throughout the year, but this considered being practical in terms of egg volume and quality (Parker and Nash, 1995).

Even this species are very strong and easy to culture, they still facing problems such as to determine the exactly ideal and suitable number of fish that should be stock in order to meet the optimum growth and survival which can give the high net profit in production system. In Malaysia, most farmers has not yet established in the stocking density. Different farm apply different stocking density where some farm operate in low density and some are in high density. The same situation was also happen in UMS hatchery and the productions are not consistent from time to time.

Stocking density is the one most important factor to be considered before starting any operation in fish production. It can affect the growth and survival, cannibalism and uneven sizes (size heterogeneity). As the fish density increase, the growth will decrease. Consequently, stocking density and fish growth will influence costs and economic returns. Many factors may be responsible for the relationship between growth and density. Generally, fish grow more slowly at high densities because of increased social interaction (including competition for feed and space) and because of poor water quality associated which may cause stress.

In general, fish losses increase at higher culture densities. High density will affect lower survival because of stress condition and appearance of cannibalism which affected a high mortality in fish. The major factor which causes the cannibalism is the variation sizes in sibling. Cannibalism occurred more frequently in heterogeneous than in the homogeneous size group (Dou *et al.*, 2002). To meet a high return in operation and

production of African catfish, the fully concentrating must gives to the stocking density program before start any operation.

1.4 Objectives of Study

The general objective of this research is to determine the effect of stocking density on growth and survival rate in African catfish. The specific objectives are:

1) To identify the best stocking density that gives the higher growth survival rate on African catfish
2) To observe of swimming activity in different stocking density
3) To observe the appearance of another phenomenon affected by stocking density

Information that will be provided by this work should be beneficial to produce high production of catfish. Fish producers may use this information to determine the most efficient stocking density which gives the higher growth and survival before starting any operation.

CHAPTER 2

LITERATURE REVIEW

2.1 African Catfish

More than 100 species of the genus *Clarias* have been described all over the world. The different species (*C. lazera, C .senegalensis, C. massambicus and C .gariepinus*) can be found in different part of Africa. This catfish has many local names in countries where it is distributed which are Malaysia we call "Keli Afrika". African catfish also known as walking catfish because of their ability to use their modified pectoral fins to essentially "elbow" to across the land, often from pond to pond (Stickney, 2002).

2.1.1 Distribution

Clarias gariepinus locally called African Catfish is an indigenous species in Africa where it is widely distributed. They can be found in streams, ditches, ponds and lagoons (Blakely and Hrusa, 1989). In recent years the species has been introduced in Europe, Asia and South-America. The species easily adapts to environments, where the water temperature is higher than 20° C.

2.1.2 Morphology

de Graff and Janssen (1996) have been described the genus Clarias. Catfish have long elongated cylindrical body which consists of a dorsal, a caudal and an anal fin, while the paired fins consist of the pectoral and ventral fins (Figure 2.1). The pectoral fins have developed strong spines (Figure 2.1) which have locomotory and protective functions. Their head is flattened skull boned forming a casqued and the body is covered with smooth and scale less skin, darkly pigmented in the dorsal and lateral parts of the body (Viveen *et al.,* 1985). Besides that, they have a large head, depressed and heavily boned.

This species could reach a maximum size up to 1.7 meters including the tail in total length and can weight up to 60 kg when fully grown. They have 8 barbels (Figure 2.2) which can distinguished as nasal, maxillary, outer mandibular and inner mandibular. Close to the nasal barbels, two olfactory organs are located. Viveen *et al.,* (1985) mentioned main function of barbells for prey detection by touch and smell which is relevance during feeding at night and in highly turbid or muddy water.

REFERENCES

Austin, C. M., Jones, P. L., Stagniti, F., Mitchell, B. D., 1997. Response of the yabby, Cherax destructor, Clark, to natural and artificial diets; phenotype variation in juvenile growth. *Aquaculture* **149**, 39-46.

Appelbaum, S. and Kamler, E., 2000. Survival, growth, metabolism and behaviour of Clarias gariepinus early stages under different light conditions. *Aquaculture* **22**, 269-287.

Baidya, A. P. and Senoo, S., 2002. Observation of Oocyte Final Maturation and Eggs on African Catfish, *Clarias gariepinus* under Artificial Rearing Conditions. *Suisanzoshoku* **50** (4), 415-422.

Bardach, J. E., 1997. *Sustainable Aquaculture: Fish as Food and the Case for Aquaculture*. John Wiley & Sons, New York.

Baras, E., Kestemont, P. and Melard, C., 2003. Effect of stocking density on the dynamics of cannibalism in sibling larvae of Perca fluviatilis under controlled conditions. *Aquaculture* **219** (1), 241-255.

Blakely, D. R. and Hrusa, C. T., 1989. *Inland Aquaculture Development HandBook*. Fishing News Books, Great Britain.

Boyd, C. E., 1982. *Water Quality Management for Pond Fish Culture*. Elservier, Amsterdam.

Burgess, W. E., 1991. *The World of Catfishes*. TFT Publications, New Jersey.

Davenport, J., Black, K., Burnell, G., Cross, T., Culloty, S., Ekaratne, S., Furness, B., Mulcahy, M. and Thetmeyer., 2003. *Aquaculture: the ecological issue*. Blackwell Publishing Company, Germany.

De Graff, G. J. and Janssen, H., 1996. *Artificial reproduction and pond rearing of the African catfish, Clarias gariepinus in sub-Saharan African,* A handbook. FAO Fisheries Technical Paper. No. 362. Rome.

Dou, S., Seikai, T. and Tsukamoto, K., 2002. Cannibalism in Japanese flounder juveniles, *Paralichthys olivaceus*, reared under controlled conditions. *Aquaculture* **182** (1), 149-159.

FAO, 1995. *Code of conduct for responsible fisheries*. Food and Agriculture Organization of the United Nations. Fisheries Department, Italy.

Hengsawat, K., Wardb, F. J. and Jaruratjamorna, P., 1997. The effect of stocking denstity on yield, growth and mortality of African catfish (*Clarias gariepinus*) cultured in cages. *Aquaculture* **152** (1), 67-76.

Hetch, T., and Pienaar, A. G., 1993. *A review of cannibalism and its implication in fish larviculture. World Aquaculture Society* **24**, 241-246.

Hogendoorn, H. and Vismans, M. M., 1980. Controlled propagation of the African catfish, *Clarias lazera*. II. Artificial reproduction. *Aquaculture* **21**, 39-53.

Hossain, M. A. R., Beveridge, M. C. M. and Haylor G. S., 1998. The effect of density, light and shelter on the growth and survival of African catfish (*Clarias gariepinus*) fingerlings. *Aquaculture* **160** (3), 251-258.

Howgate, P., Bunting, S., Beveridge, M. and Reilly, A., 2002. *Public, Animals, and Environment Aquaculture Health Issues: Aquaculture Associated Public, Animals,*

and Environmental Health Issues in Nonindustrialized Countries. John Wiley & Sons, Canada.

Kestemont, P., Jourdan, S., Houbart, M., Melard, C., Paspatis, M., Fontaine, P., Cuviera, A., Kentouri, M. and Baras, E., 2003. Size heterogeneity, cannibalism and competition in cultured predatory fish larvae: biotic and abiotic influences. *Aquaculture* **227** (1), 333-356.

Kristiansen, T. S., Ferno, A., Holm, J. C., Privitera, L., Bakke, S. and Fosseindengen, J. E., 2003. Swimming behaviors as an indicator of low growth rate and impaired welfare in Atlantic halibut (Hippoglossus hippoglossus L.) reared at three stocking densities. *Aquaculture* **250** (1), 137-151.

Le Cren, E. D., 1962. *The Efficiency of reproduction and recruitment in freshwater fish.* Blackwell Scientific, UK.

Nash, C. E., 1995. *Production of Aquatic Animals, Fishes: Introduction to the Production of Fishes*. Elsevier Science, Netherlands.

Nga, B. T., Lurling, M., Peeters, E. T. H. M., Roijackers, R., Scheffer, M. and Nghia, T. T., 2005. Chemical and physical effects of crowding on growth and survival of Penaeus monodon Fabricius post-larvae. *Aquaculture* **259** (1), 183-191.

Parker, N. C. and Nash, E. N., 1995. *Production of Aquatic Animals, Fishes: The Catfishes*. Elsevier Science, Netherlands.

Pillay, T. V. R., 1990. *Aquaculture, Principle and Practices*. Fishing New Books, UK.

Stickney, R. R., 1994. *Principle of Aquaculture*. John Wiley & Sons, New York.

Stickney, R. R., 2002. *Encylopedia of Aquaculture*. John Wiley & Sons, US.

Tucker, C.S. and Robinson, E. H., 1990. *Channel Catfish Farming Handbook.* Van Nostrand Reinhold, New York.

Teugels, G. G. (1986). *Clariidae. In check list of the fresh water fishes of Africa* (J. Daget, J. P. Gosse, and D. F. E. Thys van den Audenaerde, Eds), CLOFFA II, Orstom, Paris.

Viveen, W. J. A. R., Richter, C. J. J., van Oordt, P. G. W. J., Janssen , J. A. L. and Huisman, E. A. (1985). *Practical Manual for the culture of the African catfish (Clarias gariepinus).* Directorate General International Cooperation of the Ministry of Foreign Affairs, The Hague, Netherlands.

http://animaldiversity.ummz.edu/site/accounts/information/Clarias_gariepinus.htm1

http://www.Fao.Org/docrep/field/003/ac578e/ac578e 11.htm