EFFECTS OF DIFFERENT SALINITY FOR SURVIVAL AND GROWTH ON AFRICAN CATFISH *Clarias gariepinus* JUVENILE

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THIS DISSERTATION IS SUBMITTED AS A PARTIAL FULLFILMENT OF THE REQUIREMENT TO GRADUATE AS A BACHELOR OF SCIENCE WITH HONOURS

AQUACULTURE PROGRAMS
FACULTY OF SCIENCE AND HUMAN RESOURCES
UNIVERSITI MALAYSIA SABAH

2015

262810

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UNIVERSITI MALAYSIA SABAH

BORANG PENGESAHAN STATUS TESIS

JUDUL: ~~HANIS~~ THE EFFECT OF SALINITY ON SURVIVAL ~~AND~~ AND GROWTH FOR AFRICAN CATFISH *Clarias gariepinus* Juvenile

IJAZAH: SARJANA MUDA SAINS DENGAN KEPUJIAN (AKUAKULTUR)

SAYA: HANIS BINTI ABD MOHMIN (HURUF BESAR) SESI PENGAJIAN: 2012/2015

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ACKNOWLEDGEMENT

The supreme thanks belong to ALLAH SWT, the Almighty, the Creatures and Sustainer of the Universe. Who have given me so many grants and off course the chance joining the study and finishing the dissertation. I really believe all of those occurred because of His Great kindness and Great Loves.

Firstly, I wish to express my sincerest thanks and gratitude to the person and institutions, who in one way or another, have contributed to make the realization of this study possible and stood by me in quest for educational advancement and enhancement.

I would like to acknowledge with gratitude and indebtedness to my supervisor Prof. Dr Shigeharu Senoo for his helpful suggestions, constant encouragement and hospitality to me that relevant to the thesis and other requirements for finishing the degree.

I extend my thanks to all the teaching staffs, lecturers and administration staffs of Borneo Marine Research Institute for their cooperation. Not to forget to all staffs and research assistant of Marine Fish Hatchery, Borneo Marine Institute for their valuable advice, constructive suggestion, sincere concern and understanding. Grateful thanks are extended to my colleagues for their technical support, irreplaceable assistance and kindly helpful during my experiment.

Finally, I would like to thanks to my family for the moral support. To them, this piece of work is humbly dedicated. To everyone in this list and to all, whom in one way or another, have contributed in making this work possible, I wish to recapitulate my heartfelt expression of gratitude, appreciation and indebtedness.

ABSTRACT

The study was conducted to determine the possibility for culturing African catfish *Clarias gariepinus* juvenile in low saline water and to determine the optimum level of salinity for survival and growth. The study was carried out with six treatments from 0 (as a control), 1, 2, 3, 4 and 5ppt of water media with three replicate in each level. African catfish juvenile with an initial length of 0.26 and 0.29 gram were stocked at 20 tails per 7 liter no recirculating aquarium tank in each treatment. Prior to the experiment juvenile were acclimated by a gradually increased the salinity per hour for each treatment. Juvenile were fed by using marine sinking pellet until satiation twice a day at 8.30 am to 3.30 pm. Furthermore, survival and growth performance were evaluated. After three weeks of experiment, there are no significant different in survival result. Survival was almost similar at all levels of salinity. The best growth (final weight (g), weight gain (%) and SGR(g/%)) was perform in 1ppt are 2.679±0.02, 371.254, 5.565 respectively and the poorest was at 5ppt where the growth performance are 1.824±0.15, 259.799, 4.578, respectively. Overall, the optimum level of salinity for culturing juvenile was suggested at 1ppt due to the best growth performance.

ABSTRAK

Kajian ini dijalankan untuk menentukan kebarangkalian untuk menternak ikan keli Afrika *Clarias gariepinus* juvenil di dalam saliniti rendah dan menentukan tahap optimum kemasinan untuk kemandirian dan tumbesaran. Kajian ini telah dijalankan dengan menggunakan enam rawatan iaitu 0 (sebagai kawalan), 1, 2, 3, 4 dan 5ppt untuk media air dengan tiga replika di setiap rawatan. Keli Afrika juvenil dengan berat 0.26 dan 0.29 gram dengan kepadatan stok sebanyak 20 ekor setial 7 liter tangki akuarium untuk setiap rawatan. Sebelum juvenil eksperimen disesuaikan dengan rawatan saliniti, rawatan air ditingkatkan secara beransur-ansur per jam untuk setiap rawatan. Juvenil diberi makan dengan menggunakan pelet tenggelam jenama Cargill sehingga kekenyangan dua kali sehari pada 8:30 am dan 3:30 pm. Tambahan pula, kemandirian dan prestasi pertumbuhan telah dinilai. Selepas tiga minggu menjalankan eksperimen, kemandirian bagi setiap rawatan ini menunjukkan tiada perezaan signifikasi dan kesemua kemandirian bagi kesemua rawatan hampir sama di semua peringkat kemasinan. Tumbesaran terbaik (berat akhir (g), berat badan (%) dan SGR (g /%)) dapat di lihat melalui rawatan 1ppt iaitu 2.679 ± 0.02, 371.254, 5.565 dan tumbesaran yang rendah adalah di 5ppt dimana prestasi pertumbuhan adalah 1.824 ± 0.15 , 259.799, 4.578. Secara keseluruhan, tahap optimum kemasinan untuk pengkulturan remaja dicadangkan di rawatan 1ppt disebabkan oleh prestasi pertumbuhan yang terbaik.

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LIST OF ABBREVIATION

pH	= puissance negative de H
g	= grams
ppt	=part per thousands
ppm	=part per millions
mg	=milligram
L	=liter
d	=days
S.D	=standard deviation

LIST OF SYMBOLS

%	= percentage
°C	=degree Celsius

CHAPTER 1

INTRODUCTION

1.1 General Introduction

The African catfish *Clarias gariepinus* is appreciated by consumers for the quality of its meat (Pruszyński, 2003) and is mostly smoked and used in soups. It is recognized by its long dorsal and anal fins, which give it a rather eel-like appearance. The catfish has a slender body, a flat bony head, and a broad, terminal mouth with four pairs of barbells. Its prominent barbells give it the image of cat-like whiskers. The fish is mostly cultured in earthen ponds. In the wild and riverine systems, the fish reproduces naturally but considerable effort is required to induce spawning under culture conditions. The African catfish is an excellent species for aquaculture as it is omnivorous, grows fast, and tolerates relatively poor water quality (Rad *et. al.*, 2003).

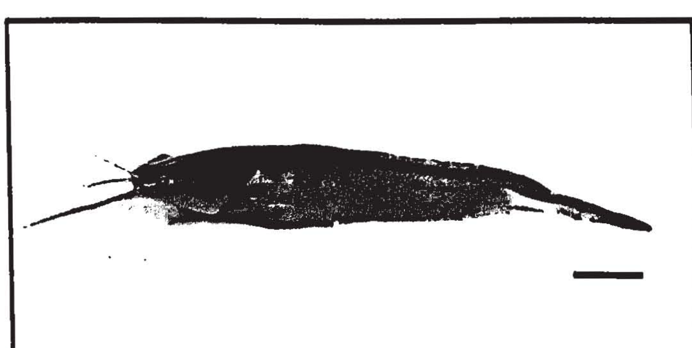

Photo 1.1 The targeted species were use in this experiment which are African catfish juvenile, scientifically known as *Clarias gariepinus* and locally name as Keli Afrika

1.2 Current Status for Culturing African Catfish Juvenile in Sabah

Due to articles in the public arena about the advantages of farming African Catfish, many aquaculture and fish farmers turned to stocking the Catfish. There were many new farmers want to culture this species. In Sabah, especially the farmers at the sea side, they are having a hard time to find freshwater, when they digging the water source from the ground, low salinity water were coming. Due to this problem, an experiment to culture African catfish juvenile in low saline water were conducted, if African Catfish can be culture with this range of salinity and successful, it can give positive advantages for the farmers to promote aquaculture production.

1.3 Literature Review

1.3.1 Habitats and Habits

Being a freshwater fish it is often found in rivers, dams, weirs, lakes, swamps, muddy waters, floodplains and other water bodies. They can be found at depths between 4 and 80m.

It is able to bury itself in the river bed when there is a decrease in water or drought is occurring. They have been known to stay in muddy ground of ponds gulping air directly using their accessory breathing organ instead of their gills. They are unlikely to survive in ground that has dried completely.

They have been known to 'walk' over land when there are damp conditions or to look for food and they can survive extreme conditions and harsh environments. It can survive low oxygen concentrations in water of temperature extremes from 8 - 35°C with salinity levels between 0 and 10% as well as a wide tolerance of pH range.

1.3.2 Feeding Behavior

These fish are voracious predator and eat almost anything. Literature includes insects, crabs, plankton, snails, fish, young birds, amphibians, reptiles, rotting flesh, plants and fruit in the diet. It is normally an individual bottom feeder; however they are known to be extremely adaptable to conditions and feed in groups at the water surface.

They hunt socially, swimming in formations on the water surface or in a claw like formation to the shore. The pack herd cichlid prey towards the shallows where they are easily caught by these fish that use their pectoral spines to 'walk' out of the water to engage prey.

The mouth is wide, sub terminal, traverse and capable of opening extremely wide for engulfing prey items or sucking in large amounts of water which is flushed through the gills for filter feeding. Once the prey is in the mouth, the jaws snap closed and the broad bands of sharp teeth on both the upper and lower jaws prevent the prey from wriggling free. The prey is swallowed whole. The esophagus is short, muscular and dilatable. It opens into a distended stomach typical of creatures capable of carnivore. The four types of feeding described by Bruton (1977) are:

I. Individual foraging (general solitary searching for food through the water column)
II. Individual shoveling (moving detritus and debris on the river floor and eating hidden organisms)
III. Surface feeding (moving water through the mouth and gills to capture organisms on the surface)
IV. Formation feeding (includes social hunting, pack formation and feeding frenzies)

Catfish are opportunistic feeders and will take any fish species which is abundant. They respond quickly to newly available food sources and will change their feeding patterns to match organisms freely available. Young fish feed mostly on small invertebrates in shallow inshore areas.

Factors which restrict the food niche of these fish are interspecific competition; predation pressure, constant low supply levels of food and harsh physic-chemical conditions. Interspecific competition and predation pressure are buffered by the large body size of the catfish, the shape and protection of the head, pectoral spines and piscivorous habits. The versatility of their physical adaptations enable them to survive almost all conditions (De Moor & Bruton, 1988; Bruton, 1977).

In 2004, a study was undertaken by Linden Rhoda at Zandvlei Estuary Nature Reserve to ascertain what these fish were eating. The results showed that the most dominant food sources utilized by these fish were crabs (two species), bloodworms, earthworms, fish and frogs. Less dominant food types consumed included plant material, prawns and snails. This will more than likely change with the available food and during breeding season may be dominated by bird's eggs and chicks as well as tadpoles or young frogs. They tend to remain in the deeper waters during the day and move to the shallows at night.

1.3.3 Market Demands of African catfish

This species is a nutritious food source in Africa and there is contention between various sources on its viability as an aquaculture species. It can be housed in higher densities than most fish species, is a hardy, quick growing and tasty fish. Market research and trials have shown in some areas that this species is not economically viable for aquaculture due to their high food intake requirements (Marr, Pers Comm., 2009). It is marketed fresh and frozen in Africa and is eaten boiled, fried and baked by members of the community (De Moor and Bruton 1988). Fourie states that between 65 and 100 tons of fish can be produced annually. In the Vaalhurts Dam, *Clarias gariepinus* is an endemic species and would therefore be a more suitable species for aquaculture in a catchment where the species is not alien. There are various methods of marketing the fish, however no formal established market exists in South Africa (Fourie, 2006).

In areas of the Western Cape, reports have reached conservation authorities of recreational fishermen having their lives threatened by informal settlement dwellers unless they can produce sale stock of these fish. These people are willing to pay up to

R60 for a fair sized fish. The selling price in 2008 was R5 per kilo (Pers. Comm., van Der Westhuizen, 2008).

1.3.4 Environmental influences on Salinity

Climate affects markedly the balance between precipitation and evaporation and thus the salinity concentrations of the surface waters. This effect has been discussed already in global terms. At a more local level, climatic effects are manifested in a general increase in salinity with decreasing elevation of rivers and lakes. This correlation is because most of the salinity of rain and particulate fallout is deposited at lower elevations.

The salinity of pond waters of closed drainage basins is governed not only by inputs of dissolved ions from runoff but by the fate of these materials upon evaporation (Hutchinson, 1957). Most closed lakes occur in regions with long term (several years) fluctuating climate and are often exposed to periods of severe aridity. Commonly very shallow, these lakes may evaporate completely or sufficiently to expose large expanses of sediments. Diversions of river inputs by human activities, as in the tragedy of the Aral Sea (Williams and Aladin, 1991), can also lead to the exposure of large areas of sediments of saline lakes. Loss of salts then can occur by wind deflation.

Saline lakes are generally categorized on the basis of dominating anionic concentrations into carbonate, chloride, or sulfate waters (Hammer, 1986; Williams, 1994, 1996). The range of salinity in these lakes is extraordinary, from several hundred to over 200,000 mg l-1 in the Great Salt Lake of Utah and the Dead Sea (Moss and Moss, 1969; Kalk *et al.*, 1979; Hammer, 1986).

Other significant climatic factors influencing salinity are temperature and wind. Temperature influences the rate of rock weathering. Tropical waters, for example, which drain strongly weathered soils, are usually poor in electrolytes, and a large part of their total composition consists of silica. Wind direction and speed may affect the chemical composition of atmospheric salinity and sites of deposition inland. Losses of atmospheric salinity are greater in low elevation, turbulent air masses. The type of vegetation growing on the drainage basin and its requirements for major ions are also influenced by climate. Mineral cycling in tropical perennial forests of dense vegetative cover, for major ions are also influenced by climate. Mineral cycling in tropical perennial forest of dense vegetative cover, for example, differs greatly in higher rates of utilization and leaching of soil nutrients as compared to nutrients cycling in deciduous vegetation of temperate regions.

1.3.5 Seawater Intrusion

Seawater intrusion is the movement of seawater into fresh water aquifers due to natural processes or human activities. Seawater intrusion is caused by decreases in groundwater levels or by rises in seawater levels. When you pump out fresh water rapidly, you lower the height of the freshwater in the aquifer forming a cone of depression. The salt water rises 40 feet for every 1 foot of freshwater depression and forms a cone of ascension. Intrusion can affect the quality of water not only at the pumping well sites, but also at other well sites, and undeveloped portions of the aquifer.

The first physical formulations of seawater intrusion were made by W. Badon-Ghijben (1888, 1889) and A. Herzberg (1901), thus called the Ghyben-Herzberg relation. They derived analytical solutions to approximate the intrusion behavior, which are based on a number of assumptions that do not hold in all field cases.

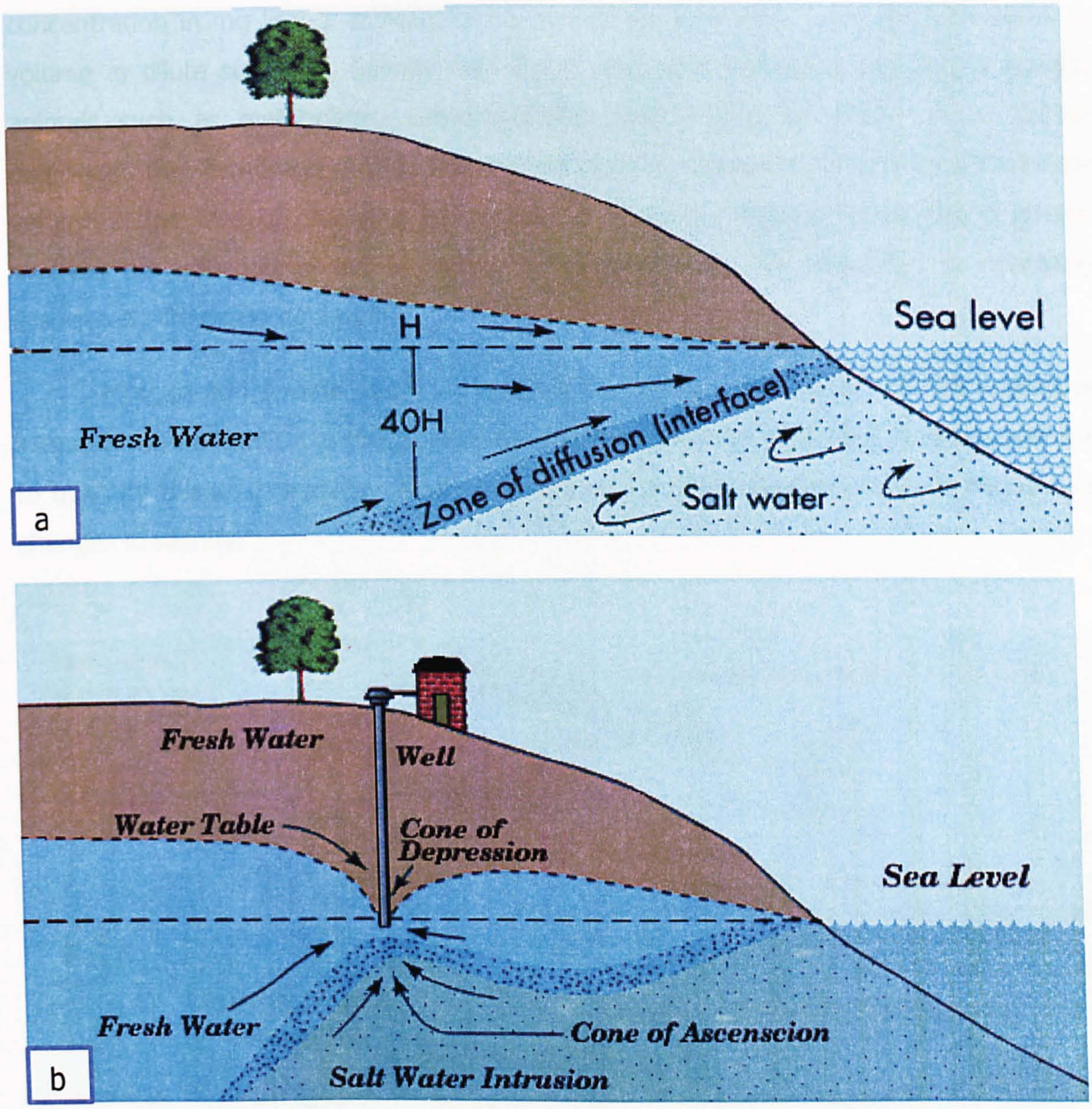

Figure 1.1 The sea water intrusion (a) natural system (b) sea water intrusion cause by human activity

Source: http://www.lenntech.com/groundwater/seawater-intrusions.htm

1.3.6 Effect of Salinity on Freshwater fish

Salinity is the correct chemical term for the sum concentration of all ionic constituents dissolved in inland waters, both fresh and saline. Salinity is best expressed as total ion concentration in mg liter-1 or meq liter-1, which are essentially equivalent as mass or volume in dilute solutions. Salinity can affect various physiological process in aquatic animals such as metabolism, osmoregulation and biorhythm. Evan *et al.* (1999) mentioned that osmoregulation is the maintenance of consistent blood and intracellular volume in the face of changing environmental osmolity. Since osmoregulation always involves the transport of ion across epithelial membrane, ion regulation is intimately associated with osmoregulation.

Morgan and Iwama (1991) also reported that energetic cost of ionic regulation increases with alteration of the salinity away from isoosmotic conditions, but any attempt to quantify this cost probably affected by other metabolic processes which respond to changes in salinity.

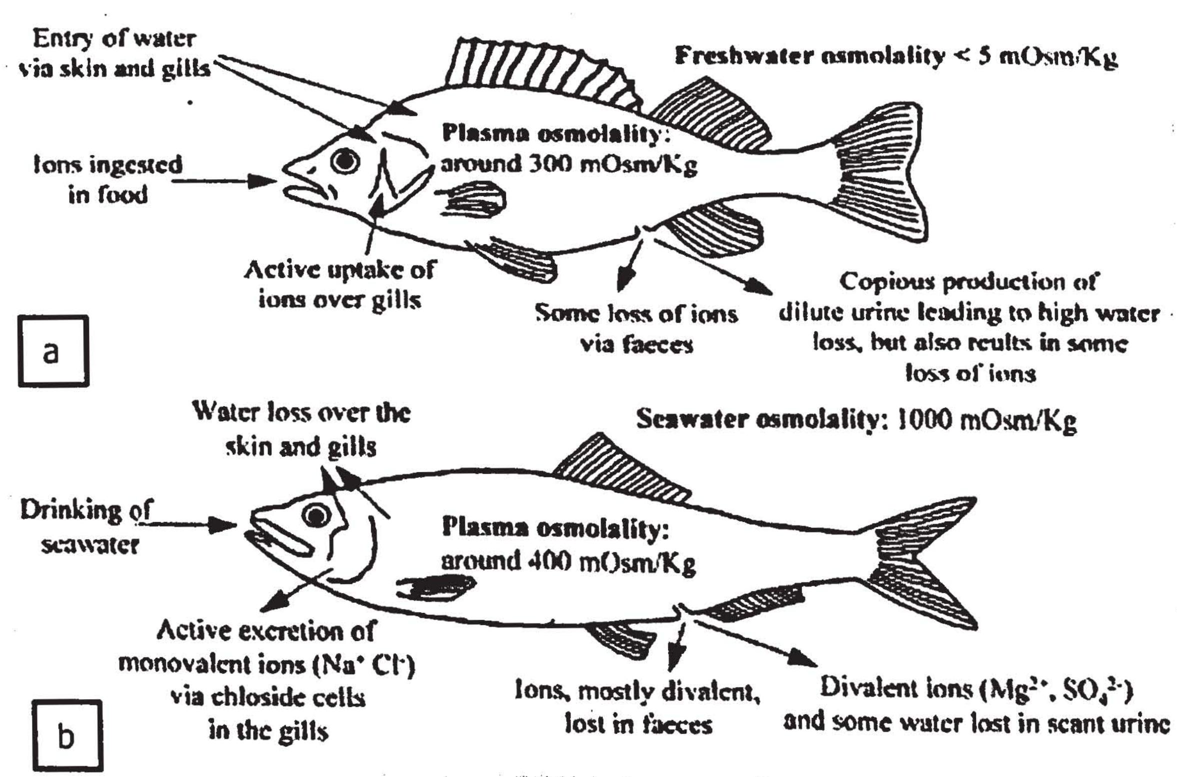

Figure 1.2 Osmoregulation in Teleost fish (a) freshwater osmolality (b) sea osmolality. Source : Werdemeyer (1996).In the process of water absorption, ions are actively taken into the body through the gut and water follows passively. Branchial chloride cells are principal excretion sites for excess ions in adult fish.

The ion pump in chloride cells, a Na+, K + -activated phase, is located on the cytoplasmic side of the extensive tubular system (Imsland *et al*, 2002) that is an extension of the basolateral plasma membrane. Reduced need for ion pumping at salinities lower than full strength seawater could lead to reduced numbers of activity chloride cells and hence reduced activity of the enzyme Na+, K+ -ATPase (Imsland *et al.*, 2002).

Salinity considered as one of the important factors exerting a selective on aquatic organisms. Salinity defined as the measures of amount of dissolved particles in the water (State Water Resources Control Broad, 2010). In addition, aquatic animals can be either stenohaline or euryhaline, which shows the osmotic tolerance. Stenohaline species only tolerate narrow ranges of salinity such as African catfish, while euryhaline species like seabass are able to tolerate wide range of salinity, for instance they are able to move between freshwater and salt water and it is leading to many differences adaptation for different species to survive in different osmotic pressure.

Besides, it is an energy demanding process, certain ambient salinities might help to maximize growth or reproduction by decreasing osmoregulatory energy expenditure (Sampaio and Banchini, 2002).The metabolic cost would be expected to be minimized during the cultured in isotonic condition, thus it can minimize the cannibalistic behavior indirectly improve the survival and growth performance of Afican catfish juvenile.

a. Effects of Salinity in Survival

Salinity is an important factor affecting the survival, metabolism and distribution of fish species (Holliday, 1969). The salinity of the sea water, water temperature, age and size of the fish and developmental stage can all affect the survival of salmonnids when transferred into seawater (Franklin *et al.*, 1992). Stickney (1979) mentioned that the effect of salinity on the survival depending two factors which are (a) the ability of body fluid for tolerate changes of osmolality and ion concentration and (b) the osmoregulation of body fluid in fish and controlling osmotic pressure on normal condition. The sudden changes of salinity of fish when they transferred for hypersaline or on the fluctuating of the salinity due the fish to survive by osmoregulatory mechanism (Bone *et al.*, 1995, Evans *et al.*, 1999).

b. Effects of Salinity in Growth

Growth is a specific physiological function in fish which differs from that observed in birds and mammals. Fish show regular changes in length, resulting in an asymptotic curve as they grow older because smaller fish often grow faster in length compared to larger fish. Furthermore, growth is used as an indicator of success because a fish in relatively good condition will show higher growth rates, higher survival and more potential on reproduction then a fish that is not in good condition in the same environment (James,2004).

Jobling (1994) mentioned that the osmotic and ionic concentration of fish body fluids differ from those of surrounding medium, so the fish is required to expend a certain amount energy in order to meet the metabolic cost of ionic and osmotic regulation. Metabolic cost would be expected to be minimized when fish are held in isotonic and isoosmotic media (Brett, 1979; Jobling, 1994), and it has been hypothesized that growth and food conversion might be improved in an isosmotic environment (Foss *et al.*, 2001).

Usually, the energy of fish will be accomplished on metabolism, osmoregulation, and activity first, then the remaining energy will be used for growth. The differences in energy budget will be resulted in the differences of growth.

c. Effects of Salinity on Related Species

There are a number of researchers that investigate the relationship between salinity and catfish basically on survival and growth, hatching rate and feed intake. Britz and Hecht (1989) examined the effect of salinity on survival of African Catfish larvae. The result showed that there was no significant differences in survival and growth rate was decrease and the larvae in 10 ppt died within 48 hours. According to Glolubo and Erondu

REFERENCES

Arunachalam, S. and S.R. Reddy. 1979. *Food intake, growth, food conversion and body composition of catfish exposed to different salinities.* Aquaculture, 16: 163- 171 ms.

Boeuf, G., and P. Payan, 2001. *How salinity influence fish growth.* Comp. Biochem. Physiology, 130 C: 411 – 423 ms.

Brett, J.R. 1979. *Enviromental Factors for Growth.* In W.S. Hoar, D.J.

Bruton, M. N., 1977. *The biology of Clarias gariepinus (Burchell, 1822) in Lake Sibaya, Kwazulu with emphasis on the role as a predator.* Department of Zoology Institute for Freshwater Studies, Rhodes University.

Bruton, M. N. & van As, J. 1986. *Faunal invasions of aquatic ecosystems in southern Africa, with suggestions for their management.* Oxford University Press, Cape Town.

De Moor, I. J & Bruton, M. N., 1988. *Atlas of alien and translocated indigenous aquatic animals in southern Africa.* South African National Scientific Programmes Report 114, South Africa.

De Silva, S.S., and A.T. Anderson. 1995. *Fish Nutrition in Aquaculture.* School of Aquatic Science and Natural Resources Management, Deakin University, Australia. Chapman and Hall.

Evans, D.H., 1993. Osmotic and Ionic Regulation. In The Physiology of Fishes. CRC Press, USA.

Fourie, J. J., 2006. *A Practical investigation into Catfish (Clarias gariepinus) farming in the Vaalharts Irrigation Scheme.* Dissertation for Magistar Scientiae Faculty of Natural Agricultural Sciences, Department of Zoology and Entomology, University of the Free State.

Foss,A.,T.H. Evensen,A.K. Imsland and V. Oeistad, 2001. *Effects of reduced salinities on growth, food conversion efficiency and osmoregulatory status inthe spotted wolfish.* Journal of Fish Biology. 59 : 416-426 ms.

Franklin, C.E., M.E. Forster and W. Davison. 1992. *Plasma cortisol and osmoregulatory changes in sockeye salmon transferred to seawater: Comparison between successful and unsuccessful adaptation*. Journal of Fish Biology. 41: 113-122 ms.

Holliday,F.G.T. 1969. *The effects of Salinity on Eggs and Larvae of Teleost*. In W.S. Hoar and D.J. Randall, eds. Fish Physiology, Vol. 1 : Excretion, Ionic Regulation and Metabolism. Academic Press, New York.

Hutchinson, G. E. (1957), *A Treatise on Limnology, vol. 1*. Geography, Physics and Chemistry. John Wiley. New York.

Imsland,A.B., S.Gunnarson, A.Foss, S.O. Stefansson. 2002. Gill Na+, K+- ATPase activity, plasma chloride and osmolalilty in juvenile turbot (Scophthalmus maximus) reared at different temperatures and salinities. Aquaculture. 2139 :1-13 ms.

Jobling, M., 1994. *Environmental Tolerances and* Preferences In Fish Bioenergetics. Chapman & Hall, London.

Morgan, J.D. and G.K. Iwana, 1991. *Effects of Salinity on Growth, Metabolism, and Ion Regulation in Juvenile Rainbow and Steelhead Trout (Oncorhynchus mykiss) and Fall Chinook Salmon (Oncorhynchus tshawytscha)*. Journal Fisheries Aquatic Science. 48: 2083 – 2093 ms.

Pruszyński, T. 2003. *Effects of feeding on ammonium excretion and growth of the African catfish (Clarias gariepinus) fry*. Czech J. Anim. Sci., 48 (3): 106–112 ms.

Randall and J.R. Brett. *Effects of spatially localized and dispersed patterns of feed distribution on the growth, size dispersion and feed conversion ratio of the African Catfish (Clarias gariepinus).* Fish Physiology Vol. *8.* Academic Press, London. Rad, F., Kurt, GI. and Bozaoủlu, AS. 2003 Turk J Vet Anim Sci 28, 851-856 ms.

Rhoda, L., 2007. *An assessment of the stomach contents of the invasive fish Clarias gariepinus on the estuarine fauna of Zandvlei Estuary, Muizenberg.* Cape Peninsula University of Technology, Cape Town.

Sampaio, L.A., and A.Bianchini. 2002. *Salinity effects on Osmoregulation and Growth of the Euryhaline flounder Paralichthys orbigyanus*. Journal of Experimental Marine Biology and Ecology, 269: 187-196 ms.

S.K. Sahoo, S.S. Giri, C. Maharathi And A.K. Sahu *Effect of salinity on survival, feed intake and growth of Clarias batrachus (Linn.) fingerlings*, Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar - 751 002, India

Stickney, R.R. 1979. *Principle of Warms Water Aquaculture*, 375 p. John Willey and Sons, USA