EFFECT OF BROODSTOCK SIZE ON THE SURVIVAL AND GROWTH OF HYBRID CATFISH (Clarias gariepinus ♀ and Heterobranchus longifilis ♂) FRY

BY

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A THESIS

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CERTIFICATION

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DEDICATION

This research work is specially dedicated to

GOD ALMIGHTY

(ALL KNOWING, ALL POWERFUL AND EVER PRESENT)

who made it possible for me despite all odds to successfully

complete this Masters Degree programme.

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ABSTRACT

Investigation on the effect of broodstock size on fry survival and growth during the primary rearing phase (14 days) of the hybrid of female Clarias gariepinus and male Heterobranchus longifilis in glass aquaria was carried out. The use of small size-range broodstock (≤ 250g) resulted in higher percentages fertilization than broodstocks of medium size-range (300 - 650g) and large size-range (700 - 950g). The percentage egg hatching and fry survival were not significantly ($P > 0.05$) influenced by the weight and size of the broodstock.

During the secondary rearing phase (56 days duration) growth and survival of the fingerlings of the same group of fish in hapa net cages were studied. Fingerlings from large size-range broodstock had the greatest average daily growth but fingerlings from medium size-range had the best specific growth rate and was significantly different ($P < 0.05$) from the other treatments. The percentage fingerling survival for the treatments were similar.

Cost-benefit analysis of production revealed that it is most profitable to use broodstocks of medium size-range (300 - 650g) than smaller or larger broodstocks for optimum fingerlings production.

CHAPTER ONE

1.0 INTRODUCTION

A very important yard-stick to measure the economic development of any country is freedom from hunger or low death rate. No nation can claim to be developing while a reasonable amount of the population is experiencing gradual death from malnutrition. Malnutrition causes retardation of physical growth and development. A country whose population is increasing every day like Nigeria is expected to have the demand of food on the increase as well. It is a generally acceptable fact that the quantity of protein 62g daily in the diet of Nigerians is quite inadequate to 70g daily which is the world standard body protein requirement (Oyatoye, 1982). The author also noted that small proportion of this amount is from animal source while large proportion of the protein is of plant origin which is of low quality.

As the drought in the sahel savanna region of Nigeria is increasing due to desert encroachment, cattle production which is the traditional source of animal protein for Nigerians (Ladipo et al., 1982) is decreasing while the importance of fish in the diet of Nigerians is rapidly increasing. Fish is important not only for its energy value but also as an important animal protein. Moreover, Fatunla et al. (1982) stated that some Nigerians derive their livelihood directly from activities related to fish procurement, distribution and consumption. As a major source of animal protein, Adesimi and Aderinola (1983) reported that the authors of the fourth National Development Plan (1980 - 85) estimated that 40.0% of animal protein consumed by average Nigerians comes from fish. From market price survey in Ondo State, Nigeria the average retail price of fish for 1991 - 93 was ₦80/kg as compared with ₦120/kg for beef and ₦150/kg for chicken. The relatively higher per caput consumption of fish per day was attributable to the easy availability of fish at comparatively cheaper prices than other

livestock production. Thus, it is quite obvious that any serious attempt to raise the animal protein consumption of Nigerians should necessarily give fish production top priority.

Tobor (1990) reported that Nigeria needs approximate 1.2 million tonnes of fish annually to satisfy her fish demand but her annual domestic production is less than 0.45 million tonnes. From inland fisheries alone, Nigeria has a potential to produce between 0.65 - 1.2 million tonnes of fish annually while she produces only 20,000 - 24,000 tonnes (Tobor 1990). This signifies a far under utilization of the aquaculture potential. The author also reported that in 1975, 300,000 metric tonnes of fish were imported and the nation spent approximately ₦99 million in foreign exchange in the fisheries sector alone that year. However, in recent years aquaculture or fish farming is gaining more popularity in Nigeria than it was twenty years ago. This is possibly due to the increase in demand for some freshwater and brackishwater fish species compared to the more abundant marine species imported into the country or due to the restriction placed by the Federal Government on the importation of fish either fresh or frozen which has invariably shifted focus to fish culture in order to augment the required fish supply and conserve foreign exchange.

In order to adequately provide fish in such quantities as to make it available at a reasonable price to Nigerians, there is need for adequate information on fish culture. Aquaculture has been accepted the world over as a means for increasing fish production and a tropical country like Nigeria with her immense water resources offers tremendous possibilities for fish culture (Dada and Gnanadoss, 1983). This has led to the culture of many desirable fish species in the country. The cichlid family that is, tilapias has been under culture in Nigeria for quite some time but due to the production

of more table sized fish to meet up with the consumers need, this species does not seem to offer much prospects due to its prolific breeding habit under culture system leading to production of stunted fish sizes thereby resulting in low yield. As a result of this behaviour of the cichlids, many other desirable fresh water fish species both locally available and imported have been tried. Recently the catfishes started to gain prominence in aquaculture in Nigeria. The catfishes Clariidae are found to show fast growth rate and are hardy. Due to these qualities there is an increasing awareness on their culture even to produce their hybrids for culture. The hybrids are expected to have more valuable characteristics like early maturity than their parent stock. This will enhance the production of table-sized fish and thus increasing both the quality and quantity of the fish protein required in the diet of the consumer.

Catfish family Clariidae is very popular in Nigeria. Two of it's genera namely Clarias and Heterobranchus are more important. The two genera have many species but of more importance are C. gariepinus, H. longifilis and H. bidorsalis. C. gariepinus is the most popularly cultured because of its ability to tolerate extreme environmental conditions, fast growth rate reaching up to 1kg under eight months in ponds, it is an efficient air breather and resistance to diseases. Hogendoorn 1981, Hecht and Lublinkhof 1985, Viveen et al., 1985).

In Nigeria Nwadukwe (1993) reported that the demand for H. longifilis far exceeds that for C. gariepinus which attains earlier sexual maturity. H. longifilis is popular because of its faster growth rate and usually attains a larger size than C. gariepinus. As a result of the difficulties in obtaining H. longifilis fingerlings in commercial quantities, a readily available catfish has been sought with a combination of the favourable culture characteristics of the two species (Nwadukwe 1995) that is,

adaptability and fast growth rate. This has led to the need to crossbreed the two species to produce a hybrid.

Ayinla and Nwadukwe (1988) found that there are variations in the sizes of fingerlings produced from the same clariids broodstock at the same time and that the variations in sizes of the fingerlings might be related to the variations in sizes of their eggs. Due to the cannibalistic behaviour of clariid fishes it is not economically feasible to stock the large sized fingerlings with the small ones. Oladosu et al (1993) reported that the small sized fingerlings are not desirable for stocking because they were found to be very slow growing. The large-sized fingerlings in these catfishes constituted less than 20% of the fingerlings population from each spawning (Ayinla and Nwadukwe, 1988) which is quite inadequate for any viable hatchery.

The ultimate goal of an aquaculturist is to produce fish that meets both the needs of fish farmers and the market demand of the consumers. It is therefore imperative to develop a method by which means the population of the large-sized fingerlings from any spawning can be improved in order to produce enough number of fingerlings for stocking. This will go a long way in reducing cannibalism and with a very fast growth rate. Ufodike (1987) noted that the largest mature C. lazera would usually give the best spawn weight in induced breeding but no mention in any literature available as to whether the fish with the best spawn would equally give the best fry survival and best growth performance.

This study was therefore designed to investigate the effect of broodstock size on the survival and growth of the hybrid between female Clarias gariepinus and the male Heterobranchus longifilis. It was postulated that probably the use of bigger-sized

broodstock might lead to increased survival rate of fry and faster growth rate of fingerlings.

1.1 OBJECTIVES

(a) To determine the effect of broodstock size on the survival of fry of hybrid catfish during primary and secondary rearing phases of fingerlings production.

(b) To determine the growth performance of the fry obtained from different broodstock size-ranges.

(c) To evaluate the economics of the effect of broodstock size on hybrid catfish fingerling production.

CHAPTER TWO

LITERATURE REVIEW

2.1 DESCRIPTION OF Clarias gariepinus

Clarias gariepinus (Burchell, 1822) belongs to the family Clariidae. It has a scaleless slimy skin. The upper and lateral parts of the body are darkly pigmented while the ventral part is slightly white. During stress they will show a mosaic-like pattern of dark and light spots (Viveen et al, 1985). The fish has a long body with dorso-ventrally flattened bony head with a large mouth. The mouth circumference of this gape-limited predator is about one fourth of its total length ((Viveen et al, 1985). Surrounding the large mouth are four pairs of barbels, these are the nasal, maxillary, outer mandibular and inner mandibular. The maxillary barbel which is the largest is attached to the side edges of the upper lips and can be moved independently of the mouth. The inner part of the mouth both the jaws and the roof is equipped with numerous small teeth arranged in bands. The character of these bands of teeth is the most reliable means for identifying this species (Reed et al, 1967). There are two pairs of nostrils which are far apart. The anterior one is tubular while the posterior one is attached with a barbel. The barbels serve as tentacles because the fish and all other catfishes recognise their food mainly by touch and smell particularly when feeding at night and in highly turbid or muddy waters when visibility is of less importance (Viveen et al., 1985). Clarias gariepinus is equipped with two types of fins, the median fins and the paired fins. The median fins consist of a dorsal, a caudal and an anal fin, while the paired fins consist of the pectoral and ventral fins. Both the dorsal and anal fins are without spines and are very long, reaching almost to the caudal fin which is rounded (Reed et al, 1967). The pectoral fins have strong spines which have locomotory and protective functions.

Under the operculum or gill cover is found the gills and the arborescent organs over the five branchial arches (Viveen et al, 1985). The gills are used for gaseous exchange.

Oxygen in water diffuses into the fish muscles via the gill filaments while carbondioxide from the fish muscles diffuses out in the same way. When the fish is out of water or in water depleted of oxygen content, Viveen et al, 1985 stated that air is periodically gulped in the mouth and gaseous exchange takes place via the arborescent organs in air-chambers above the gills.

2.2 DESCRIPTION OF Heterobranchus longifilis

Heterobranchus longifilis (Valenciennes 1840) belongs to the family Clariidae. Other members of the genus are H. bidorsalis and H. isopterus. The species is very similar to Clarias gariepinus. One general morphological feature that differentiates members of the genus Heterobranchus from the genus Clarias is their possession of two distinct dorsal fins different from the single dorsal fin of the Clarias. H. longifilis has a long body with scaleless and slimy skin. The upper and lateral parts are brownish olive while the ventral or belly part is white. Hecht and Lublinkhof (1985) stated that one of the dorsal fins is rayed with 29 - 34 rays and the other towards the tail is fleshy adipose fin which is not as high as rayed dorsal with its base being 0.8 times the length of the rayed dorsal fin, (Reed et al, 1967). The head is flat, bony and strongly depressed and the upper surface granulated. The mouth is wide and slightly subterminal and with a circumference of about one fourth of its total body length. It also has four pairs of barbels surrounding the mouth namely: nasal, maxillary, outer mandibular and inner mandibular barbels. The maxillary barbel is the longest and it is attached to the edges of the upper lips. The barbels of H. longifilis are much longer than that of C. gariepinus and they are known to grow faster and larger than C. gariepinus. The inner part of the mouth is equipped with numerous small teeth arranged in bands on the roof of the mouth and jaw (Reed et al, 1967).

H. longifilis also has two types of fins, the median or unpaired fins which are dorsal, caudal and anal. The other type comprises the paired fins which are pectoral and ventral fins. The pectoral have strong spines which are locomotory and protective in function. The gills and the arborescent organs are under the gill-cover on the head. These are used for gaseous exchange, the gills are used for oxygen and carbon dioxide diffusion in and out between the water and the muscles of the fish when in water rich in oxygen when oxygen content of the water is very low or the fish is outside water the arborescent organ is used for gaseous exchange.

2.3 GEOGRAPHICAL DISTRIBUTION OF CLARIID FISHES

Clarias gariepinus is the only freshwater species with the widest latitudinal range in the world (Hecht et al, 1988). It is widely distributed through out Africa, Israel and South East Asia. It is found in all tropical regions of the world inhabiting tropical swamps, lakes and rivers some of which are subject to seasonal drying (Viveen et al, 1985). C. gariepinus of which C. lazera is a junior synonym (Teugels, 1982) occurs from the Orange river in South Africa to the Nile and up into eastern Turkey. Viveen et al (1985) stated that C. gariepinus is described with different names in different parts of Africa, in the northern and central part as C. lazera, in the eastern part as C. senegalensis, in the western part as C. mossambicus and in the southern part as C. gariepinus.

Unlike C. gariepinus which is circumtropical (Teugels, 1984) Heterobranchus longifilis is epidemic to tropical Africa (Teugels et al, 1990) being reported from the Nile, the Zaire basin, West African rivers and southwards to the middle Zambezi system. This species is however absent from lake Malawi and east coast rivers to the North of Zambezi (Bruton et al 1982). Clay (1977) estimates that clariid catfishes contribute approximately 20% to the total fish yield from Africa.

2.4 WATER QUALITY REQUIREMENT OF CLARIID CATFISHES

Water is the habitat of fish, therefore for the achievement of optimum or maximum fish production the water quality requirements of a particular fish proposed for culture is of paramount importance. The water quality requirement of the African catfish for optimal production are not fully known (Viveen et al 1985) but the water quality factors affecting the survival and growth of fish generally include temperature, dissolved oxygen, salinity, pH, nitrates, nitrites and heavy metals present. It is not only necessary to ensure that there is a proper range of these factors, but also that they be properly managed and regulated on a continuous basis so that they are within a desirable range for survival and growth of the fish particularly at the primary nursing phase. Viveen et al (1985) stated some water quality requirements for the African catfish which is also applicable to other clariid catfishes based on results from practical experience in hatcheries.

Parameters	Egg	Larval to fry	Fingerling to Adult
- Oxygen	Close to saturation	> 3 p.p.m	> 3 p.p.m
- Optimum Temp	27°C	27°C	25°C
- Temperature range	20° - 30°C		
- pH	6.5 - 8		
- N_2	< 102% saturation (subject to temp. changes)		
- CO_2	< 15 p.p.m		
- NH_3	< 0.05 p.p.m		
- NH_4	< 0.80 p.p.m at pH 7		
- NO_2	< 0.25 p.p.m		
- NO_3	< 250 p.p.m		
- Cu	< 0.1 p.p.m		
- Zn	< 0.1 p.p.m		

- Cd < 0.0006 p.p.m
- Salinity < 15000 p.p.m

They however reported that catfish have the ability to tolerate high concentration of CO_2 up to 40 - 45 p.p.m since its solubility increases with decreasing temperature. Catfish with full grown arborescent organs can survive low concentration of dissolved oxygen as low as 0 -3ppm.

2.5 FOOD AND FEEDING HABITS OF CLARIID CATFISHES

Clarias gariepinus and Heterobranchus longifilis are predatory (Hacht and Lubhinkhof 1985). Ayinla (1988) reported that C. gariepinus is an omnivore with preference for plankton diet. It also feeds on other types of food items such as insect and insect larvae and pupae, fish and fish remains and other unidentified food items, it shows a preference for feeding on diatoms and flagellates over all the other food items. Heterobranchus longifilis is omnivorous (Micha 1973) reported in Legendre (1986). Both C. gariepinus and H. longifilis are bottom dwellers. Olatunde (1983) reported that the bulk of food found in the stomach of C. gariepinus consisted mainly adult and immature insects, fish and bottom deposits probably due to the fact that the fish is a bottom dweller. The same is also expected of H. longifilis being a bottom dweller as well. The author also reported that over 25% of the population of fish sampled consumed fish and about 40% fed on bottom deposits while other food items include molluscs, plant debris including diatoms and crustaceans. Fagade and Olaniyan (1972) reported that larger fish are able to feed on relatively larger food items. Therefore, bigger C. gariepinus and H. longifilis have better ability to seizing and gulping prey because they posses better developed jaws than fingerlings but at any stage of development, either fingerlings, juvenile or adult stage all have the ability for filter feeding as was observed that phytoplankton was equally important in their diets.

2.6 HYBRIDIZATION IN CLARIID CATFISHES

Fish hybridization seems to achieve optimum culture character from different species as a result of heterosis (Nwadukwe, 1995). Fish hybridization both interspecific and intergeneric is an innovation that has been conducted for many years (Salami and Fagbenro, 1993) and it is aimed at evolving a strain or hybrid of superior quality to that of parent species (Borode, 1995). Only recently has this technique been recognised as a potential means for stock improvement and management (Chevassus 1983, Salami and Fagbenro, 1993).

Investigations on the hybridisation of cultured fish families abound in literature but comparable work on the potential of clariid catfish hybrids for commercial aquaculture is limited (Hecht and Lublinkhof 1985, Legendre et al 1992, Salami and Fagbenro 1993). Hybridization sometimes results in the production of monosex or sterile hybrids which are of great importance in controlling the problem of overpopulation in certain prolific breeding fishes and sterile hybrids are found to grow faster as they do not spend energy for gonadal development. Green and Smitherman (1954) worked on the hybridization of the big head carp and the silver carp and reported that the hybrid grows faster than the parent stocks and more easily harvested by seine than silver carp which is very agile. On the hybridization between the Isreali mirror carp "Dor 70" male and the local female carp, Sin (1982) reported that the hybrid was similar to the local race in scale cover, body shape and colour reaching an average weight of 815g in 6 months, double the growth rate of the local race, and was easier to seine, and matures within one year to reproduce under favourable environment.

Kowtal and Gupta (1985) produced hybrids between Mrigal (Cirrhinus mrigala) and common carp (Cyprinus carpio) and found that the hybrid showed a pattern of early

embryonic and larval development similar to that of the parent species, high rates of fertilization but during embryonic and larval development about 40% mortality took place among the hybrids with many of the hatchlings deformed in the caudal region. The authors also reported that only a few hybrids could be reared to adult size 242mm (120g) in 14 months and did not show signs of maturity at the end of 14 months of rearing while the parent species mature in ponds 6 months (common carp) or 12 months (mrigal). Dunham et al (1982) reported that the male parent of interspecific crosses between blue catfish Ictalurus furcatus and channel catfish Ictalurus punctatus had controlling influence on several growth patterns, that is the external appearance of the channel (female) x blue (male) hybrid and of the blue and channel are more similar to the male parent than to the female parent. In their work on the hybrids of clariid catfishes Clarias gariepinus and Heterobranchus bidorsalis Salami and Fagbenro (1993) reported that the average fry production was higher in male H. bidorsalis x female C. gariepinus hybrids than in the reciprocal cross male C. gariepinus female H. bidorsalis. Also, the highest growth rates and largest body sizes were attained by the hybrids followed by the offspring of the parental crosses. The hybrids male H. bidorsalis and female C. gariepinus have considerable potential as commercial food fish because they grow at a very fast rate. Nwadukwe (1995) reported that C. gariepinus and H. longifilis could readily be artificially hybridized to produce fertile F_1 progeny that would be further crossed to produce F_2 and backcross generations. The author also reported that the fertilization and hatching rate obtained for C. gariepinus (female) x H. longifilis (male) crosses was higher in the F_1 crosses while backcrosses from C. gariepinus paternal parent had the highest mean fertilization rate and the best early survival rates were obtained among the backcrosses from H. longifilis paternal parent but generally fry production showed that mean hatching rates among F_1 hybrids were about three times those obtained among F_2 and backcrosses. Hecht and Lublinkhof

(1985), crossbreed C. gariepinus (female) with H. longifilis (male) and reported that the hybrid larvae hatched at the same level of development as the control C. gariepinus larvae but the hybrid larvae were slightly larger than the C. gariepinus larvae and the yolk sac more elongate approximately 1 ½ times the size of the C. gariepinus yolk sac. The authors also reported that 98 days after hatching, the hybrids had reached an average total length of 108.9 ± 19.0mm while the control group of C. gariepinus under identical environmental conditions reached an average length of only 74 ± 18.8mm.

2.7 EARLY LIFE HISTORY AND MORPHOLOGY OF CLARIID CATFISH HYBRIDS

Hecht and Lublinkhof (1985) worked on hybridization of Clarias gariepinus and Heterobranchus longifilis and reported that embryogenetic development was completed at 50hr when hatching took place and ascribed this long incubation period to the relatively low water temperature during the incubation while Salami et al (1992) worked on hybridization of C. gariepinus and H. bidorsalis at temperature between 22°C - 29°C and reported that hatching took place at between 24 - 28h after fertilization. It is therefore worthy of note that temperature has a lot of influence on the development and hatching is faster in warm waters but if too warm the unsynchronized development and enzyme production may cause premature hatching of weak larvae (Borode 1995).

At hatching the young larvae are 5 - 7mm in size and weigh about 1.2 - 3.0mg for catfish, they look like tiny needles each with a green lobe that is, the yolk sac (Viveen et al, 1985). The hatched fish larvae is very different from the adult fish , it has no mouth, gut, vent, gills and air bladder, the yolks sac provides the materials and energy for growth and development. The yolk is a high quality reserve food donated by the

mother fish. The presence of the yolk at this stage serves to ensure survival since it is difficult for the larvae to find suitable external food for sometime. The yolk is about 80% absorbed after 3 - 4 days of hatching and at this stage larvae weigh 2-3mg and they become feeding and free swimming fry (Ayinla 1991). Once the yolk sac is fully absorbed the fry must find its own food adequate both qualitatively and quantitatively (Janseen, 1987) to ensure proper development otherwise the fry become weakened beyond recovery and this will make them susceptible to cannibalism.

Early fry (7-10 days) must be fed ad-libitum six times, that is, every 3 - 4 hrs interval a day between 6.00am and 8.00am with live or frozen 300 plankton, naupli of brine shrimp. Artemia salina and decapsulated Artemia eggs (Janssen 1987, Ayinla 1991). Ayinla (1991) also reported that the experience at ARAC/NIOMR has shown that fry of catfish fed mixed culture of zooplankton (Daphnia sp, Rotifer and Moina sp) had better growth performance than those fed nauplii of A. salina or pure strain of Moina sp. Advanced fry (10 - 18 days) starts when the development of the main organs are completed and the metamorphosis had ended, the accessory air breathing organ had developed, the catfish fry is seen frequently rising to the surface of the water to breathe air. Greater depth of water should be avoided in order to conserve swimming energy which otherwise would be expended on the regular swimming to the surface to obtain air. The advanced fry have become real small fish, less delicate compared to early fry. From this stage young fish about 50mg body weight accept and grow well on artificial dry feeds. The feed must have the correct particle size (0.35 - 0.50mm for fry ranging between 50 - 100mg; 0.50 - 0.75mm for 100 - 250mg; 0.75mm - 1.25mm for 250mg - 1g) and the fry must be able to recognise the feed chemically and optically (Janssen, 1987). He also reported that particles must be

water - stable to restrict nutrient leaching, must have low moisture content (< 10%) to allow storage and must be a balanced diet.

Legendre et al (1991) while working on C. gariepinus and H. longifilis reported that the hybrid specimen displayed an intermediate external morphology with an adipose fin about half the size of that found in H. longifilis which indicates that the products of that hybridization were true hybrids resulting from fusion of the genetic material of both parents. Dunham et al, (1991) reported the same on the hybrids of channel and Blue catfish where the two reciprocal hybrids were found to possess intermediate combination of morphological features of the two parent stocks. However, Salami et al, (1992) reported significant over dominance of Heterobranchus in both hybrid crosses because there are distinctive differences genetically between Clarias and Heterobranchus.

2.8 REPRODUCTIVE BIOLOGY AND BEHAVIOURAL PROBLEMS OF CLARIIDS

Fish breeders aim at bringing to pass artificially what happens in nature. This being the situation,they need to thoroughly understand what happens naturally in order to mimic it. A thorough knowledge of the reproductive cycle in nature is an essential pre-requisite for the artificial breeding and development of improved techniques for the culture of a particular species (Barua et al, (1985). In most African countries the reproduction cycle of catfishes starts at the beginning of the rainy season when the water level is high with the inundation of the marginal areas (Reed et al 1967, Olatunde 1977, Viveen et al 1985). Under natural conditions mass spawning of the African catfish C. gariepinus takes place in shallow inundated vegetated areas (Micha 1973, Richter 1976). Rainfall and the inflow of water are cues for the spawning process. Spawning takes place in large shoals of adult males and females in water

which is often less than 10cm deep (Viveen et al 1985). The interval between external stimulation and readiness of spawn is short (8 - 36hrs) (Richter 1976) and requires a good synchronization of sexual activities. As spawning takes place in turbid water on stones, sisal, fibres and palm leaves mostly during the night, chemical communication by pheromones is likely to play a major role (Stacey et al, 1986). During courtship which can last several hours the female catfish lays her eggs in several batches while the male fertilizes the eggs by releasing a cloud of sperm on top simultaneously. The female distributes the eggs over wide areas by wiping them with her tail and the eggs finally adhere to the flooded vegetation. The clariids with no parental care of eggs or young ones produces large number of eggs in a way to ensure that some at least will survive to adulthood. Few weeks later after spawning the African catfish will often have developed new batch of eggs, and is ready to spawn again. After 24-36 hrs after fertilization depending on water temperature the eggs will hatch, then the yolk-sac larvae will hide underneath the vegetation.

In nature however, it is difficult to find fry and fingerlings of clariid catfishes probably due to some behavioural problems which cause high mortality rate among the eggs and larvae (Viveen et al,1985). Clariids are cannibalistic, territorial (Haylor 1991) and omnivorous predator (Hecht and Lublinkhof 1985). The cannibalistic and territorial attributes of clariids are the two major behavioural problems that has been shown to cause losses of healthy fry under culture conditions even in good quality water condition and if uncontrolled can result into severe losses which can devastate a population (Haylor 1991).

Two types of cannibalism have been identified as Type 1 and 2 as described by Hecht and Appelbaum (1988). Type 1 cannibalism takes place when foraging fish identifies

the tail of a sibling as food, it therefore attacks the prey from the tail region, consumes the body and discards the head, few days after the start of exogenous feeding from about 8mm to 80mm this can start. Type 2 cannibalism is just the opposite of type 1 in this case the prey is swallowed head first and whole. This happens in a population when the size variation is such that the head size of some siblings is smaller than the mouth of other large siblings in the same population. Although, type 2 cannibalism is more common in a population of both fry and older fish but if type 1 cannibalism is uncontrolled early enough among the larvae it can result into type 2. This is because the siblings that cannibalizes another will tend to grow faster than others thus gaining more access to cannibalise on more.

Territorialism is often observed among young catfish. Hecht and Appelbaum (1988) described it as head to head contact between two siblings within the territory of one resulting in a brief but violent barbel biting encounter followed by a short chase in the general direction of the intruder. It was as a result of fish swimming into the territory of another followed by a brief chase and some body biting. Marks of territoriality is usually the presence of one or two dead fish at the bottom of the rearing receptacle.

2.9 SEXUAL MATURITY IN CLARIID CATFISHES

The size of fish at first maturity in various clariid populations shows a remarkable variations. Richter et al (1982) observed that at least 50% of the females of C.gariepinus had ripe ovaries after 6 months while H. longifilis females reached sexual maturity much later usually at about 12 - 14 months of age. Legendre et al (1991) reported that C. gariepinus reached a mean weight of 200g in 180 days from 1.0g fingerlings when fed with 35% pelleted feed and reared in pond monoculture at 10 fish per m^2 and under optimal condition of intensive culture. It was also reported by the

authors that sexual maturity was achieved after 5-7 months of age and reach approximately 400g after 233 - 258 days of age depending on feeding level. The hybrids of C. gariepinus and H. bidorsalis were normally viable (Legendre et al 1991). Hecht and Lublinkhof (1985) while working on C. gariepinus and H. longifilis reported that the hybridization of the two species has been successful and may possibly hint at hybrid vigour going by the growth data in which under identical environmental conditions the hybrids after 98 days of hatching had reached an average length of 108.9 ± 9.0mm while the control group of sharptooth catfish only reached an average length of 74.3 ± 18.8mm. Mollah and Tan (1983) while working on induced spawning of the catfish Clarias macrocephalus (Gunter) observed that males at first maturity are 20.0cm and 100g while female are 18.0cm and 85.0g. They also reported that the males were always smaller than the females of the same age in average length and weight. In contrast, Barua et al (1985) reported on Clarias batrachus that the smallest male specimen at maturity was found to be ripe at total length of 18.1cm and 51.2g body weight whereas the smallest ripe female was 17.2cm in total length and weighing 52.3g. Sagua and Gubio (1979) reported that Clarias gariepinus from Lake Chad attained sexual maturity at 24cm females while males at 20cm. Ufodike (1987) while working on gonadal histogenesis in Clarias lazera reported that in an earlier work, he observed that total length and weight of African catfish and also weight of the ovary were observed to have a direct relationship with fecundity (Ufodike et al 1986). It was therefore concluded that the largest mature Clarias lazera would usually give the highest spawn in induced breeding.

2.10 USE OF HORMONES IN CLARIID HYBRID PRODUCTION

Final maturation followed by ovulation can easily be induced in clariid catfishes. Janseen (1987) reported that a large number of oocytes which have completed the

yolk accumulation also called post-vitellogenic oocytes or oocytes in the "dormant" phase is a prerequisite for successful induced breeding. In Clarias gariepinus the post-vitellogenic oocytes (diameter ≥ 1.0mm) constitute about 80 -90% on weight basis of the ovary. The success of the artificial propagation (number of ovulated eggs obtained after stripping) depends on the number of post-vitellogenic oocytes in the ovary e.g. the size of the female gonad and/or gonadal maturity.

Janseen (1987) stated hormones that have been successfully used to induce artificial propagation with Clarias gariepinus.

- Acetone dried carp pituitary, 4mg/kg body weight (Hogendoorn and Vismans 1980).
- Acetone dried or fresh Clarias pituitary, 1 pituitary/female (Hogendoorn and Vismans 1980).
- Human chorionic gonadotrophin (HCG), 4.0 I.U/g body weight (Eding et al, 1982).
- Deoxycorticosterone acetate (DOCA) (Richter and Van den Hurk, 1982).
  - (a) In water solvent, 5mg/100g body weight
  - (b) In oil solvent, 2.5mg/100g body weight
- 5mg pimozide + 0.05mg LHRHa per kg body weight (De-Leeuw et al, 1985).
- 17α- hydroxy-progesterone, 8μg/g body weight (Richter et al 1985).

Artificial reproduction using acetone-dried carp hypophysis to induce maturation and ovulation of the eggs of C. lazera was first carried out successfully in Cameroon in 1975 (Hogendoorn 1979). Hypophysation (Induced ovulation and spawning achieved through gonadotrophins either pituitaries or isolated gonado-trophins) using commercially available carp pituitary glands is presently the most commonly used

technique for artificial propagation of C. gariepinus. Acetone dried carp pituitary extract has been successfully used to induce ovulation in C. gariepinus, H. longifilis and H. bidorsalis at the rate of 4mg/kg, 6mg/kg and 6mg/kg body weight respectively (Ayinla 1988, Nwadukwe 1992, Oladosu et al, 1993, Ayinla and Nwadukwe 1993. The use of deoxycorticosterone acetate (DOCA) is not recommended since this compound only induces pre-ovulation or final maturation, ovulation (rupture of follicle and accumulation of ripe eggs in the ovary) does not occur. The eggs are "ovulated" mechanically through stripping (Janssen 1987). Legendre (1986) reported the use of Human chorionic gonadotrophin (HCG) as a good ovulating agent because its activity is well standardized, easy to preserve in tropical climates and has the advantage of being more readily available in developing countries. Human chorionic gonadotrophin has been successfully used to induce ovulation in Heterobranchus longifilis with a doze of 2.5 I.U/g body weight (Legendre, 1986). Induced breeding of C. gariepinus have been undertaken using various hormones (Salami et al 1992) amongst these are carp pituitary suspension, human chorionic gonadotrophin, 17α-hydroxy-progesterone and fish pituitary glands using both the homoplastic and heteroplastic pituitary method. Thus, induced breeding trials have centred mostly on the use of both synthetic and piscine sourced pituitary. However, this poses a constraint on fish seed development especially in developing countries where the non-availability of synthetic inducement agents such as deoxycorticosterone acetate and analogues coupled with the cost of foreign exchange has made the use of the synthetic hormones unpracticable at least at production level. In Nigeria, most fish hatcheries depend on piscine pituitary sources because of its relative ease of procurement (Ebietomiye and Ojo, 1982). Although, treatment with locally available catfish pituitary extract is less expensive but certainly more laborious and the content of active hormone i.e gonadotropin(s) of pituitary glands varies during different seasons and different life stages of the donor.

Catfish pituitary glands from wild or pond-reared donors must be collected when the gonadotropin level is at its highest that is, during the beginning of the rainy season when sexually mature fishes have reached or nearly reached their optimum gonadal development. The hormone dosage required may vary according to the "readiness" to spawn of the females which depends on season, age, size, sensitivity, farming conditions and many other factors. It was found that a dosage of 1/4 of the recommended dosages of carp pituitary gland induces ovulation during the peak of breeding season of pond-reared breeders.

The high cost of hatchery facilities also imposes a limit on the farmer who in his search to reduce cost finds it cheaper to utilize non-piscine pituitary (Fagbenro et al 1991). Ayinla et al (1991) reported that toad pituitary extract failed to effect oocyte maturation but induced ovulation even at 3mg/kg body weight. However, the recent work on effective dose of amphibian pituitary extract for the induced spawning of the clariid cat fish by Salami et al (1996) revealed the successful use of frog pituitary extract (FPE) and Toad pituitary extract (TPE) at a threshold dose of 6mg dry gland/kg catfish and optimal dose of 9mg dry gland/kg catfish as spawning inducement agents in catfish.

The most commonly adopted technique to administer the hormone solution, is injecting intra-muscular into the dorsal muscles above the lateral line, just below the anterior part of the dorsal fin using a graduated syringe (2 - 5ml) but in the seventies the technique was intra-peritoneal into the body cavity.

CHAPTER THREE

MATERIALS AND METHODS

The studies were carried out between March and September 1996 using the hatchery and fish pond facilities of the Ondo State Agricultural Development Project at Alagbaka Fish Farm, Akure, Ondo State, Nigeria.

3.1 BROODSTOCK SOURCE AND MAINTENANCE

Clarias gariepinus broodstock were obtained from domesticated stock from a private fish farm at Oka Akoko while those of Heterobranchus longifilis were procured from a private fish farm at Akure. Sexually mature broodstock of both fish species were selected based on external morphological features as described by Viveen et al (1985) and Legendre (1986). A total of eighty nine live broodstock ranging from 180g - 910g were selected. All the broodstock both C. gariepinus and H. longifilis were held in one pond which was fertilized weekly with chicken manure. Supplementary pelleted feed of 35% crude protein was used for feeding. The fish were fed once daily at the rate of 3% of their total biomass. Oreochromis niloticus juveniles were also stocked in the pond to serve as natural diet for the broodstock.

3.2 HORMONE SOURCE AND GLAND COLLECTION

In this experiment, pituitary hormone extracts from C. gariepinus and H.longifilis were used to induce ovulation and spawning of the broodstock. All the pituitaries were collected from both male and female fishes with ripe gonads and broodstocks that have just been spawned.

3.2.1 Gland Collection

Collection of pituitary was done by first recording the weight of the donor after which the head was decapitated. The head was put upside down and the lower jaw together with the gills was cut away. The palate of the mouth was opened with a pair of pincers. The skull was forced opened to expose the brain. The pituitary gland a pinky-white globule like organ found situated on top of the brain was removed with a pair of tweezers. It was preserved in acetone.

3.2.2 Preparations of Hormone

The pituitary gland was placed in a porcelain mortar and crushed into fine powder. 2.0cm^3 of 0.9% physiological salt solution (prepared by dissolving 9g uniodized common salt in 1.0 litre distilled water and mixed). The quantity of hormone to be administered was calculated based on a body weight ratio 2:3 (recipient: donor fish).

3.3 INDUCED BREEDING AND LARVAL REARING

3.3.1 Selection of Spawners

The fish were seined out 24 - 36 hrs before hormone administration from the broodstock pond. Ripe female C. gariepinus were selected for induced spawning trials on the basis of external morphological features (Viveen et al, 1985) and fish that were in ripe condition, equivalent to stage IV (Ufodike, 1987). The broodstocks were categorized into three size-ranges namely, Small ≤ 250g, Medium 300- 650g and Large 700 - 950g representing treatments 1, 2 and 3 respectively. Ripe male Heterobranchus longifilis with vascularised genital papillae often with reddish tint on the papillae were selected. They were kept individually in separate plastic bowls, aerated and starved for 24 hours before inducement.

3.3.2 Inducement

The pituitary homogenate was carefully drawn into a 5ml syringe and injected intramuscularly at an angle of 30-45°. The injected area was gently rubbed with the finger to ensure even distribution of the hormone throughout the dorsal muscles. The broodstocks were then gently placed individually into plastic bowls and covered with a lid for some hours until the completion of ovulation.

3.3.3 Male Gonad Collection and Preservation

The male H. longifilis was killed by knocking hard the head just below the skull with heavy hand pestle. The fish was then put on its back and the body cavity opened with a pair of scissors. This was carefully done to avoid contact of the testes with water as the milt looses its potency 30 - 60 seconds after coming in contact with water (Viveen et al, 1985). The intestine were pulled aside to expose the two cream-coloured testes lying close to the back muscle of the fish. The two testes were removed and dried with a dry tissue paper. Both preserved and fresh milt were used in this experiment. To preserve, the testes were dissected with a blade by making small incisions on the lobes and the milt was squeezed out into $5cm^3$ of 0.9% physiological salt solution in a small specimen bottle. This was gently shaken and stored immediately at 4°C in a refrigerator,but not exceeding 48 hours before use.

3.3.4 Stripping, Egg Fertilization and Incubation

At the end of ovulation, the female was caught with a hand net, both the head and tail regions were covered with a wet towel and held tightly at these ends by two persons. The fish was then stripped by gentle strokes applied on the abdomen to obtain the quantity of eggs needed from each treatment. Artificial wet fertilization method was employed. One male was used to fertilize egg mass from each treatment. Freshly

collected testes was incised at the lobes and the milt squeezed out evenly on the egg masses. Clean aerated water was added and mixed with the sperm by gently moving the bowl. After 30 seconds more water was added to resuspend the excess milt and wash it away. The fertilized eggs were incubated in glass aquaria tanks (1.0m x 0.33m x 0.33m). The eggs were gently poured and spread in a monolayer in the incubation tanks. After ten hours, a flow through water system was installed to constantly change the water inside the incubators. Hatching occured after 24 hours.

3.3.5 Percentage Fertilization and Percentage Hatchability

3.3.5.1 Estimation of Percentage Fertilization (% fertilization)

Three batches of 100 eggs were randomly counted from each size range (small, medium, large) broodstock into each of three petri dishes. Along side was placed a set of three petri dishes containing 100 eggs from each size-range not treated with milt to serve as control. The time taken for all the control eggs to become opaque (dead eggs) were noted, after which the transparent (live) eggs in the test petri dishes were termed fertilized eggs. Percentage fertilization in the test petri dishes was calculated.

3.3.5.2 Estimate of Percentage hatchibility (% hatchability)

On completion of hatching, 36 hours after the start of incubation. Percentage hatching from each size range were determined.

The Analysis of Variance test was used to determine significant differences ($P = 0.05$) in percentage fertilization and percentage hatchability among treatments and the Tukey-HSD multiple range test was used to compare treatment means.

3.3.6 Primary Rearing Phase

3.3.6.1 Care of Newly Hatched Larvae

On hatching the yolk-sac larvae moved away from the source of light to the darker part over which a flat wood was placed to provide shade. This facilitated the cleaning out of decaying eggs, egg shells and deformed larvae.

The yolk-sac larvae was carefully siphoned out into well aerated spring water. The tanks were washed thoroughly with clean water and refilled with fresh aerated water. The yolk-sac larvae were re-stocked into the glass troughs with flow-through system.

On the fourth day when the yolk-sac have been fully absorbed, 100 fry were siphoned into each one of three replicates of the nine glass troughs (1.0m x 0.33m x 0.33m) and fish fed intensively on Daphnia sp for 10 days.

3.3.6.2 Fry Survival

On day 18, percentage survival of fry were determined. After 10 days of intensive feeding on Daphnia sp 30 fry were assigned to each one of three replicates of the three broodstock size-range. The treatments were randomly allocated to nine hapas (0.45m x 0.33m x 0.33m) suspended in concrete tanks of size 1.0m x 1.0m x 1.0m. Prior to stocking, quickline was applied to the tank bottom at 150g/m^2 to eliminate parasites and invertebrates predators. Ten days later, the tanks were filled with fresh water from the reservoir. Source of water used was pond water which had been sieved using improvised sieving cloths.

3.4 SECONDARY REARING PHASE

3.4.1 Growth Performance of Hybrid (Clarias gariepinus female and Heterobranchus longifilis male)

Fry in each hapa were gradually weaned over a 5-day period unto pelleted artificial diet (52% crude protein). Feeding was done twice daily at 5% of their body weight at 0900 hours and 1700 hours for a period of 56 days making a total of 70 days rearing. The mean fry size (weight and total length) for each treatment and its replicates were measured every 7 days. The Average daily growth (ADG) and specific growth rate (SGR) for each treatment were also calculated. One way Analysis of variance test was used to determine significant differences ($P = 0.05$) in growth performances among treatments and the TUKEY-HSD multiple range test was used to compare treatment means.

3.4.2 Survival of Fingerlings

At harvest, the fish were removed from each treatments and replicates, counted and weighed. Deaths were recorded and removed twice daily during cleaning and feeding. A distinction was drawn between cannibalistic and non-cannibalistic causes of death. The latter was identified by the presence of dead unmutilated fry lying at the bottom of the hapa, if left over night corpses were sometimes found with the abdomen removed and uneaten. Percentage survival were determined. The Analysis of variance test was used to determine significant difference ($P = 0.05$) in survival after 70 days.

3.5 COST - BENEFIT ANALYSIS

At the end of 70 days of rearing, the hybrid fingerlings raised from each treatment and replicates were sold at ₦5.00/fingerling. The gross profit for each treatment were calculated as:

Gross Profit = Value of fingerlings - [Cost of (broodstock + feed + labour)]

The incidence of cost and profit index of each treatment were determined as follows:

$$\text{Incidence of Cost} = \frac{\text{Cost of feed}}{\text{Kg of fish produced}}$$

$$\text{Profit Index} = \frac{\text{Value of Fish}}{\text{Cost of feed or fertilizer}}$$

3.6 WATER ANALYSIS

The water quality was investigated twice daily at 0800 hours and at 1600 hours from March to September 1996. The parameters monitored were water temperature, pH and dissolved oxygen content (DO_2). Temperature determination was done using mercury-in-glass thermometer, pH was done with pH meter and DO_2 was done with water test kit. The water in the tank was replaced on weekly basis.

3.7 DATA ANALYSIS

All data were subjected to one way ANOVA and TUKEY test to compare treatment means.

CHAPTER FOUR

RESULT

4.1 INDUCED BREEDING AND LARVAL REARING

Fresh Clarias gariepinus and Heterobranchus longifilis pituitary hormones were used for the eleven spawning trials. The dosage of hormone at ratio 2:3 (recipient : donor) by weight successfully induced spawning and hybridization of female C. gariepinus and male H. longifilis. The colour of the eggs successfully fertilized were either green or greenish-brown. The egg size range between 1.0mm and 1.25mm. The mean length of hatchlings produced at day 1 were 3.5mm, 4.5mm and 5.0mm from treatments 1, 2 and 3 respectively.

4.1.1 Percentage Fertilization, Hatchability and Fry Survival

The percentage fertilization, percentage hatching and percentage fry survival at 14 days (Post-yolk absorption) were shown in table 1.

4.2 GROWTH PERFORMANCE OF HYBRID FINGERLINGS

4.2.1 Growth Performance in Weight

Figure 1 displays the growth performance in weight over 70 days of hybrid (C. gariepinus male and H. longifilis female) fingerlings raised from three broodstock size ranges. In all treatments fish increased rapidly in weight with each successive 14-day as evidenced in the graph.

4.2.2 Average Daily Growth and Specific Growth Rate

Table 2 displays mean body weight, average daily growth (A.D.G) and specific growth rate (S.G.R) of the fingerlings. The highest average daily growth was obtained in broodstock with the largest size. Fingerlings produced from large size broodstock

gained significantly ($P < 0.05$) more weight over each 7-day period than those produced from lower size-range broodstock. Differences in average daily growth was significant ($P < 0.05$) from those of medium size, it was also significantly different from those of small size range at 5% level.

Fingerlings produced from medium size-range have significantly higher growth rate than fingerlings from large size-range and small size-range broodstocks as evidenced by the specific growth rate (S.G.R) values.

4.3 SURVIVAL OF FINGERLING

4.3.1 Percentage Fingerling Survival

Figure 2 presents the percentage fingerling survival for each successive 7-day period for each treatment between day 15 and day 70. At harvest percentage fingerlings survival was highest in medium-sized broodstock than the other two categories as evidenced in figure 2 and table 1. However, these differences were not significant ($P > 0.05$). Mean survival was in excess of 60% in all treatments over the 70 days rearing period.

4.3.2 Percentage Mortality

Deaths resulted due to handling stress during weighing rather than due to fluctuations in the physico-chemical parameters. Deaths due to territorialism was also observed in all the treatments. Type I cannibalism was observed but no type II cannibalism (consumption of whole siblings) took place. Figure 3 presents the mean percent causes of deaths (Cannibalistic and Non-cannibalistic) in all the treatments.

4.4 COST-BENEFIT ANALYSIS

Table 3 presents the production figures of hybrid (C. gariepinus female and H. longifilis male) fingerlings raised from three broodstock size-ranges.

Fingerling production from small size-range broodstock has the highest incidence of cost, lowest gross profit and profit index while fingerling production from medium size-range broodstock has the lowest incidence of cost but the highest profit index.

4.5 WATER ANALYSIS

Table 4 presents the values of the physico-chemical parameters of water used.

Table 1: Artificial Propagation of Hybrid (C. gariepinus female and H. longifilis male) from three broodstock size-ranges.

Parameter	Treatments			Level of Significance (0.05)
	1	2	3	
Mean fecundity	10.5	35.0	42.0	-
% Fertilization	57.0 ± 1.0[b]	45.0 ± 2.9[ab]	40.0 ± 4.3[a]	*
% Hatching	73.3 ± 1.8	67.7 ± 1.5	67.7 ± 2.9	NS
% Fry survival	86.0 ± 3.0	88.7 ± 3.3	90.7 ± 0.7	NS
% Fingerling Survival	69.3 ± 4.8	79.7 ± 3.8	79.0 ± 1.5	NS

KEY

* = Significant at 5% probability and figures followed by different alphabet differ.

N.S = Not significant at ($P > 0.05$)

1 = Small Broodstock ($\leq$ 250g)

2 = Medium Broodstock (300g - 650g)

3 = Large Broodstock (700g - 950g)

Table 2: Mean Body Weight, Average Daily Growth (A.D.G), Specific growth rate (S.G.R) of Hybrid (C. gariepinus and H. longifilis) fingerlings reared for 56 days.

Parameter	TRT 1	TRT 2	TRT 3	Level of Significance (0.05)
Initial Mean Weight (mg) at day 14	2.47 ± 0.09	2.97 ± 0.09	3.80 ± 0.12	
Final Mean weight (mg) at day 70	20.27 ± 0.12	32.00 ± 0	34.83 ± 0.60	
Mean weight gain (mg)	17.80 ± 0.03	29.03 ± 0.09	31.03 ± 0.48	
A.D.G	0.32 ± 0.1[a]	0.52[b]	0.55 ± 0.1[c]	*
S.G.R	1.63 ± 0.1[a]	1.84 ± 0.1[b]	1.72 ± 0.1[a]	*

KEY

* = Significant at 5% probability and figures followed by different alphabet differ.

A.D.G. = Final weight - initial weight/rearing period

S.G.R. = (Log final weight - log initial weight /rearing period) x 100

TRT1 = Small Broodstock (≤ 250g)

TRT2 = Medium Broodstock (300g - 650g)

TRT3 = Large Broodstock (700g - 950g)

Table 3: Cost-benefit analysis of Hybrid (C. gariepinus ♀ and H. longifilis ♂)

	TRT 1	TRT 2	TRT 3
Cost of Procurement of Broodstock at ₦200/kg	₦ 600.00	₦ 1,500.00	₦2,400.00
Cost of Procurement of donors at ₦180/kg	₦ 540.00	₦ 1,350.00	₦2,160.00
Cost of feed per kg	₦ 56.00	₦ 56.00	₦ 56.00
Cost of feed input	₦ 950.00*	₦ 1,920.00	₦2,805.00
Number of fingerlings produced at day 70	3007	7991	9416
Weight (kg) of fingerlings at day 70	7.56	27.18	32.96
Value of fingerlings at ₦5.00 per fingerlings	₦15,035.00	₦39,955.00	₦47,080.00
Cost of labour	₦10,800.00	₦10,800.00	₦10,800.00
Gross Profit	₦ 2,210.00	₦24,385.00	₦28,541.00
Incidence of Cost	125.66	70.64	85.10
Profit Index	15.82	20.80	16.78

KEY:

Gross Profit = Value of fingerlings (₦) - (Cost of broodstock + Cost of feed + Cost of Labour)

Incidence of Cost = $\frac{\text{Cost of feed}}{\text{Kg of fish produced}}$ (Vincke, 1969)

Profit Index = $\frac{\text{Value of fish}}{\text{Cost of feed or fertilizer}}$ (Faturoti and Lawal, 1986)

TRT 1 = Small broodstock (≤ 250g)

TRT 2 = Medium broodstock (300g - 650g)

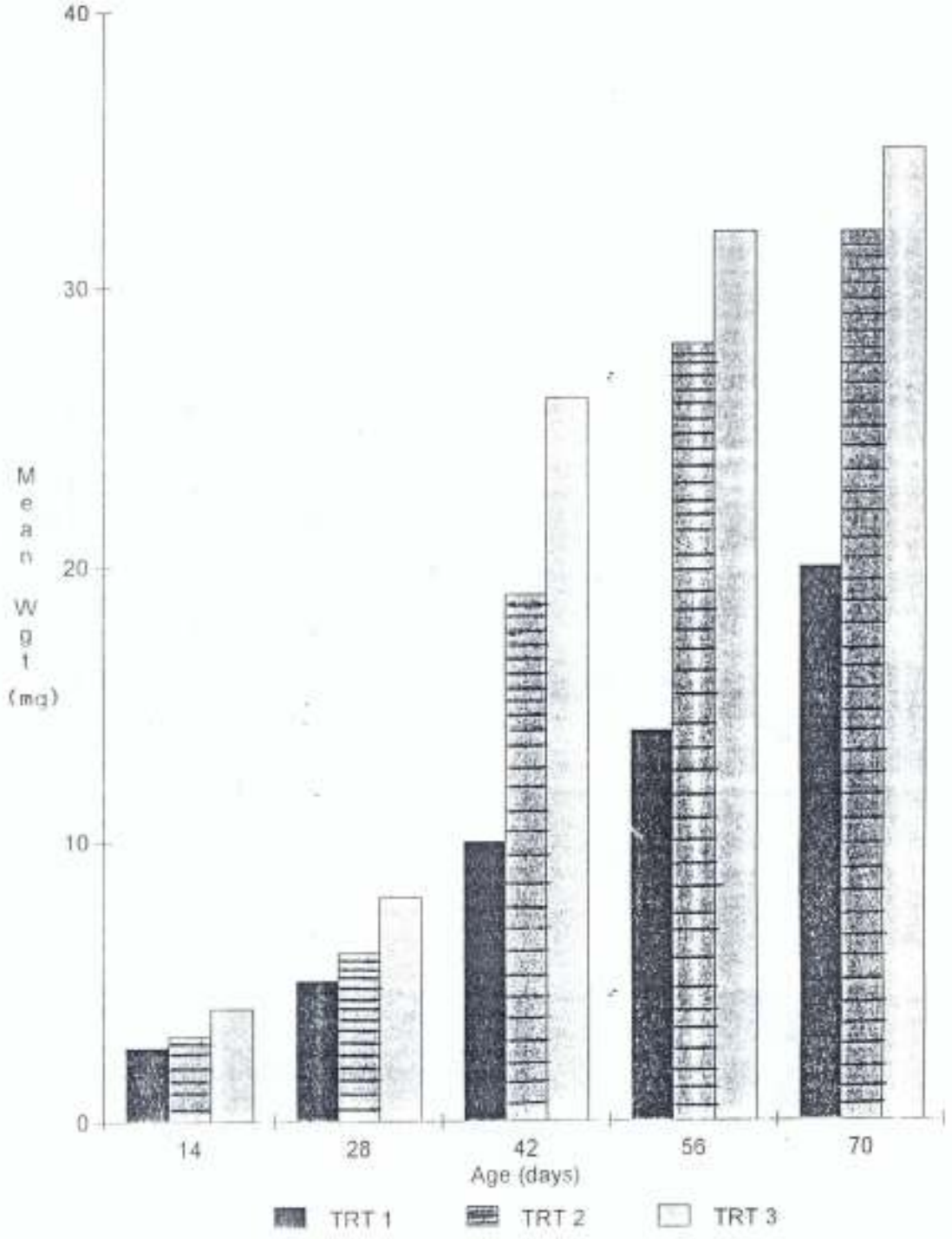
TRT 3 = Large broodstock (700 - 950g)

TABLE 4: The Mean Values of the Physico-chemical Parameters of Tank water

Tank	Temperature (°C)			Dissolved Oxygen (ppm)			pH		
	Morning	After-noon	Mean	Morning	After-noon	Mean	Morning	After-noon	Mean
1	27.50	28.50	28.00	5.30	7.50	6.40	7.09	7.60	7.35
2	27.50	28.55	28.03	5.30	7.60	6.45	7.10	7.60	7.35
3	27.50	28.50	28.00	5.35	7.55	6.45	7.10	7.60	7.35
4	27.40	28.60	28.00	5.40	7.40	6.40	7.00	7.10	7.05
5	27.00	28.40	27.70	5.50	7.60	6.55	7.00	7.05	7.03
6	27.20	28.00	27.70	5.50	7.60	6.55	7.00	7.00	7.00
7	27.40	28.50	27.90	5.40	7.55	6.48	7.10	7.30	7.20
8	27.50	28.55	28.03	5.30	7.64	6.47	7.10	7.50	7.30
9	27.55	28.60	28.08	5.35	7.55	6.45	7.00	7.40	7.20

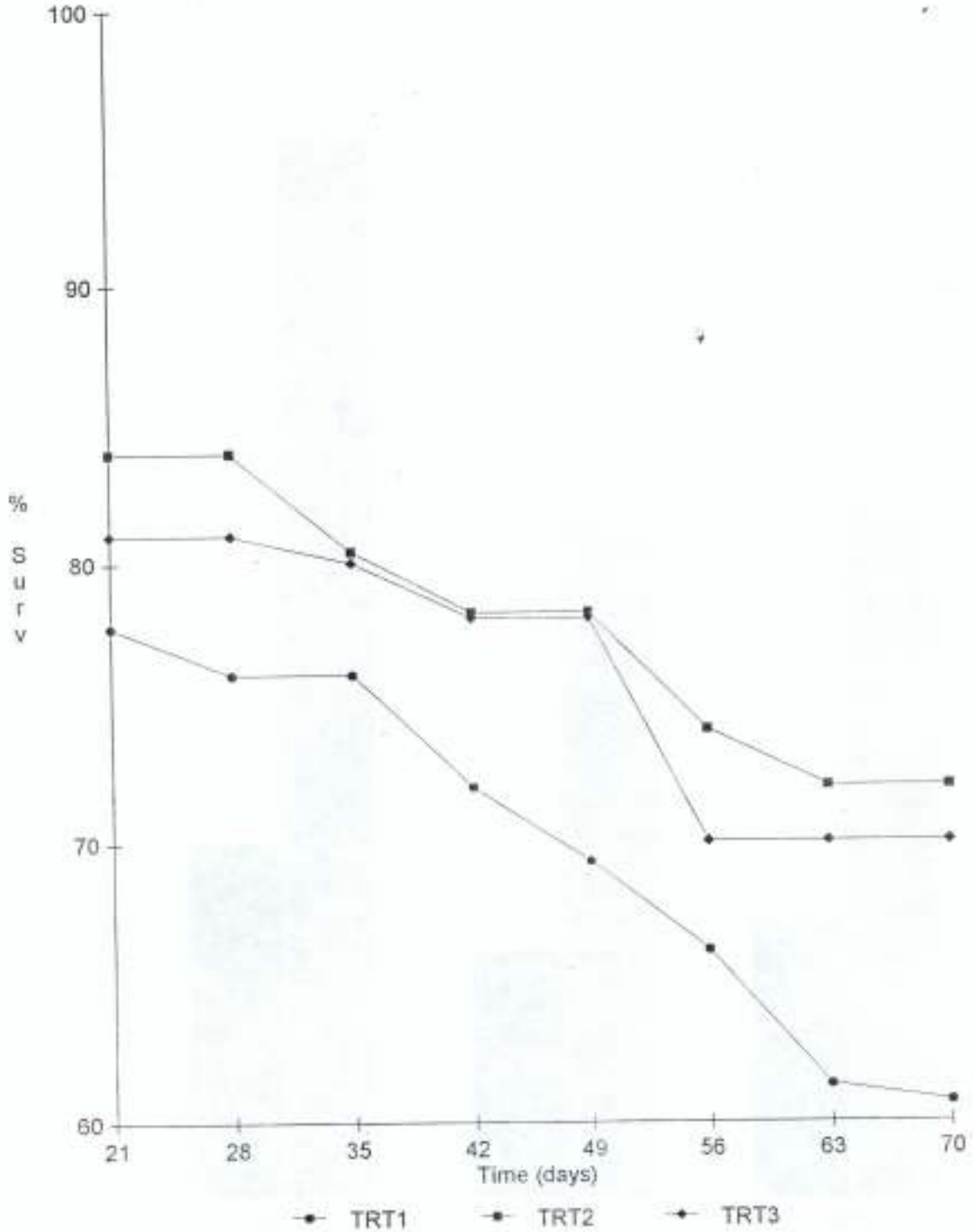
Table 5: Proximate Analysis of Fish Feed fed to the fish

Nutrient	% Composition
Moisture	6.02
Crude Protein	52.00
Fat and Oil	8.57
Crude Fibre	2.40
Ash	9.40
N.F.E	21.04



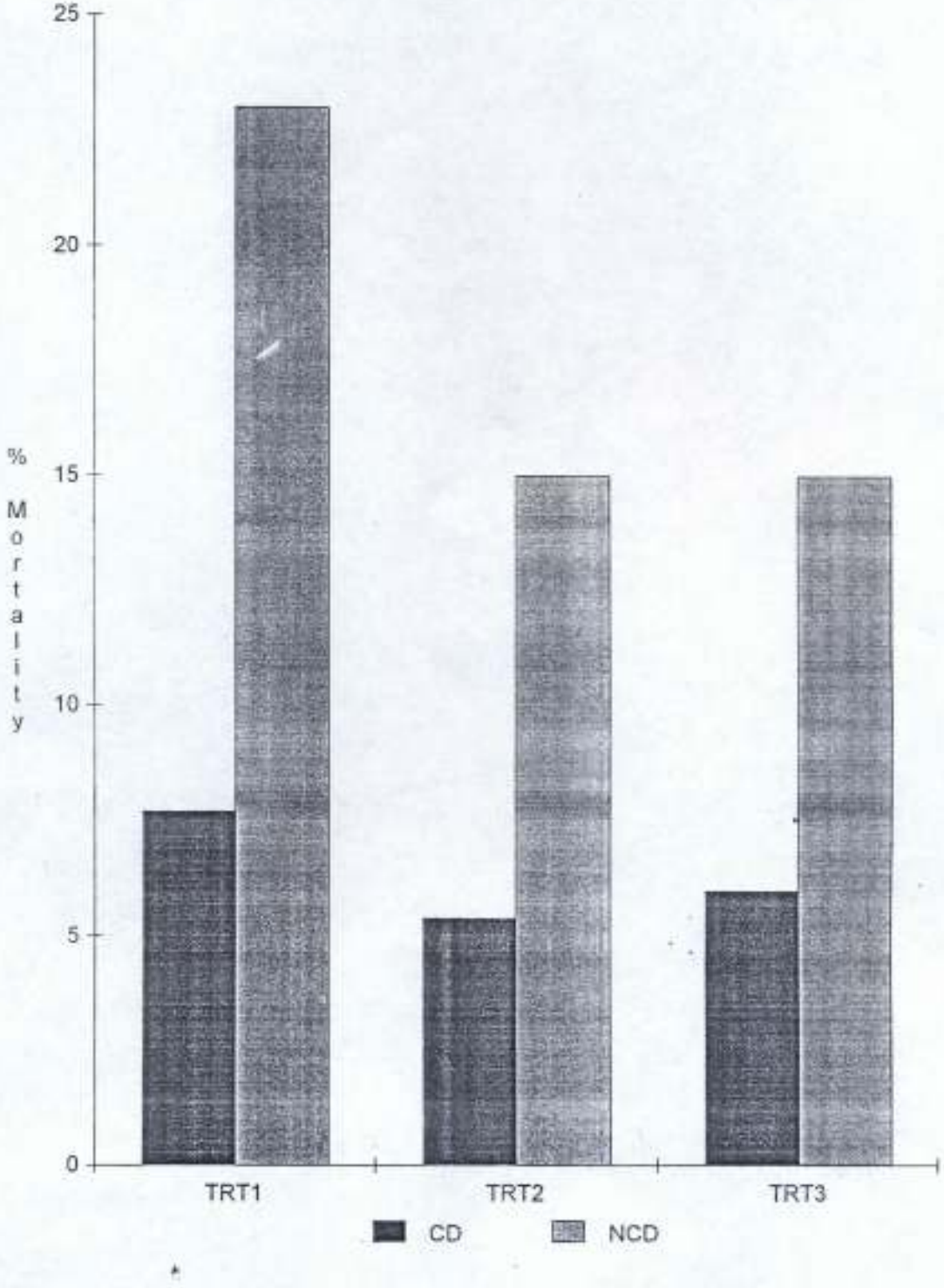
TRT 1: Small Sized Broodstock ≤ 250g
TRT 2: Medium Sized Broodstock (300 - 650g)
TRT 3: Large Sized Broodstock (700 - 950g)

Fig: 1: Growth Performance in Weight over 70 days of hybrid (C. gariepinus female and H. longifilis male) fingerling raised from three broodstock size-range.



TRT 1: Small Sized Broodstock ≤ 250g
TRT 2: Medium Sized Broodstock (300 - 650g)
TRT 3: Large Sized Broodstock (700 - 950g)

Fig: 2: The change in percentage fingerlings survival over time of Hybrid (female C. gariepinus and male H. longifilis) from three broodstock size-range.



TRT 1: Small Sized Broodstock ≤ 250g
TRT 2: Medium Sized Broodstock (300 - 650g)
TRT 3: Large Sized Broodstock (700 - 950g)

CD: Mortality due to cannibalism
NCD: Mortality due to territorialism and Stress

Fig: 3: Percentage Mortality.

CHAPTER FIVE

DISCUSSIONS

A single dose injection of pituitary homogenate induced ovulation and spawning in 80% of treated C. gariepinus females. This result is in agreement with that of some earlier workers like Hecht and Lublinkhof (1985), Britz and Hecht (1987) and Borode (1995) who reported that single dose injection of pituitary extracts effectively induce ovulation and spawning in catfishes. There is a favourable comparison in the 80% ovulation and spawning in this experiment with the works of earlier authors (Hecht and Lublinkhof (1985). Carreon et al (1973) using the same ratio 2:3 (recipient : donor) to achieve 50 -100% ovulation and spawning response in C. gariepinus.

Fish weight and size have been found to affect weight and number of eggs, Ufodike et al (1986) reported that total length and weight of African catfish and also weight of ovary had a direct relationship with its fecundity. This also indicates that the higher the weight of the fish the more the number of eggs which is likely to be stripped. Similar result were obtained in this experiment, broodstock of large size-range produced the highest number of eggs while lowest number of eggs were produced by small sized-range broodstocks.

Percentage fertilization for the treatments were significantly different ($P < 0.05$). Generic variation could be suspected as being responsible for the difference since the quantity and quality of milt, period of fertilization and water quality parameters were same for all treatments. The range of percentage fertilization (40% - 57%) observed in this experiment was lower than > 90% recorded by Salami et al (1993) using human chorionic gonadotropin hormone and 65% - 72% recorded by Nwadukwe (1995) using powdered carp pituitary hormone. This difference could be attributed to

the effectiveness of hormones, strain of brooders used, difference in physico-chemical parameters of water used or could also be due to insufficient use of milt, as milt from one H. longifilis was used to fertilize a batch of 1g of eggs from each broodstock size range in this experiment.

Percentage hatching for small broodstock size-range was the highest though not significantly different from the other two treatments ($P < 0.05$). Successful hybridation of C. gariepinus and H. longifilis was carried out and established in this experiment through artificial fertilization as described by Hogendoorn and Vismans (1980) and Viveen et al (1985). Hatching time observed for the treatments were similar, therefore neither broodstock size nor hybridization could be said to affect hatching time. Report of Hecht and Lublinkhof (1985) on the hybridation of C. gariepinus and H. longifilis where both the hybrid and the parental crosses hatched at the same time that is, 50 hours further confirms that hybridization does not affect hatching time.

Viveen et al (1985) noted variations in the size of larvae of C. gariepinus but did not relate this to the size of broodstock from which the fingerlings were produced. Ayinla and Nwadukwe (1989) found that there are variations in the sizes of fingerlings produced from the same broodstock at the same time. In this experiment, at hatching the size of individual larvae was found to be a function of egg size which invariably is a function of broodstock size. The hatchlings from small broodstock size range were smaller than those from medium and large broodstock size-ranges. The findings of Blaxter (1969) and Hunter (1981) reported in Ayinla and Nwadukwe (1989) supported the results that the female size and egg size influence the size of the offsprings.

Salami et al (1992) reported 100% survival for the reciprocal hybrid of C. gariepinus and H. bidorsalis due to good water quality condition in their rearing system which is actually rare to accomplish in most hatcheries in Africa due to lack of facilities. Borode (1995) recorded 28.05% survival for hybrid female C. gariepinus and male H. bidorsalis 10.5% for hybrid female H. bidorsalis and male C. gariepinus due to lack of adequate facilities. At the end of primary rearing phase (1 - 18 days) in this experiment percentage fry survival was found to be 86.0%, 88.67% and 90.67% for treatments 1, 2 and 3 respectively. However, on statistical analysis this does not show any significant difference. Nwadukwe (1995) recorded 87.67% fry survival for hybrid C. gariepinus and H. longifilis which was similar to the result obtained in this experiment.

During the secondary rearing phase, the average daily growth performance of the fingerlings produced from the large broodstock size-range was significantly different from those from medium size-range and highly significantly different from those from small broodstock size-range. The significant differences in average daily growth of the fingerlings from the treatments observed in this experiment is ascribed to generic variance, since similar milt, diet, feeding regimes, hatchery conditions and techniques were provided. Histogram of growth performance over 70 days (Figure 1) of the fingerlings clearly shows this disparity. Fingerlings from bigger sized broodstocks has higher mean weight gain as evidenced in the graph. The growth performance of the fingerlings were also assessed based on specific growth rate values. Statistical analysis shows that there are significant difference in the specific growth rate of the treatments. Fingerlings produced from medium size-range broodstocks performed best and was significantly different from the other two (figure 3 and Appendix 5). Since specific growth rate measures growth performance over a long period of time as

against average daily growth which is a daily effect, specific growth rate would therefore be a better parameter to determine which size-range would be the best candidate for optimum production of fingerlings. Medium size-range C. gariepinus broodstock would be the best as the good growth performance was not an environmental effect but genetical. The result of this experiment agrees with that of Ayinla and Nwadukwe (1989). The authors recorded that when broodstocks of C. gariepinus average weight 664.5g were used highest percent of shooters were obtained. The weight relatively fall into the medium size-range in this experiment.

At day 70 when the experiment was terminated, percentage survival of fingerlings was highest for medium sized-range broodstock. The result was however not statistically significant. (Figure 2 and Appendix 6).

In the evaluation of the cost and benefit of the use of the three broodstock size-range small sized-range broodstock are the cheapest to procure and would seem to be most preferred for fingerlings production if price of broodstock alone are to be the determining factor. Also, the large sized-range broodstock would even be more attractive candidate because it has the largest number of fingerlings at day 70. This was due to its high fecundity and high rate of fry survival. However, Table 3 revealed that medium size-range broodstocks have the lowest incidence of cost but the highest profit index.

CONCLUSION

The outcome of this experiment revealed that the hybrid between female C. gariepinus and male H. longifilis are true hybrids with the morphology of Heterobranchus dominating. It also revealed that egg size is directly proportional to broodstock size and that percentage fertilization is highest in small size-range broodstocks. However, percentage hatching and fry survival is not significantly affected by size of broodstock.

Results of growth performance of the fingerlings revealed that fingerlings produced from small size-range broodstock had the least average daily growth and specific growth rate. Small size broodstocks also had the lowest number of fingerlings at the termination of the experiment due to its low fecundity. The fingerlings being relatively smaller are less attractive to customers therefore commanding less price. On the other hand, large size-range broodstocks had high fecundity, high survival rate and fast growing fingerlings but its relatively high cost for the procurement of broodstock overweighed the value of fingerlings realized. Therefore broodstocks not less than 250g and not greater than 700g would be recommended as the best size-range for the production of fingerlings for optimum result.

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APPENDIX 1

DATA ANALYSIS OF PERCENTAGE FERTILIZATION USING ONE WAY ANOVA AND TUKEY TEST

- - - - - - - - - - - O N E W A Y - - - - - - - - - - -

Variable PERFERT % FERTILIZATION

By Variable SIZE SMALL OR MEDIUM OR LARGE

Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	443.5556	221.7778	7.8893	.0209
Within Groups	6	168.6667	28.1111		
Total	8	612.2222			

- - - - - - - - - - - O N E W A Y - - - - - - - - - - -

Variable PERFERT % FERTILIZATION
By Variable SIZE SMALL OR MEDIUM OR LARGE

Multiple Range Test

Tukey-HSD Procedure
Ranges for the .050 level -

4.34 4.34

The ranges above are table ranges.
The value actually compared with Mean(J)-Mean(I) is..
3.7491 * Range * Sqrt(1/N(I) + 1/N(J))

(*) Denotes pairs of groups significantly different at the .050 level

*

	L	M	S
	A	E	M
	R	D	A
	G	I	L
	E	U	L
		M	

Mean Group

```
    40.3333     LARGE
    45.0000     MEDIUM
    57.0000     SMALL       *

Homogeneous Subsets  (Subsets of groups, whose highest and lowest means
                          do not differ by more than the shortest
                          significant range for a subset of that size)

SUBSET  1

Group          LARGE          MEDIUM
Mean         40.3333        45.0000
- - - - - - - - - - - - - - - - - - -

SUBSET  2

Group          MEDIUM         SMALL
Mean         45.0000        57.0000
- - - - - - - - - - - - - - - - - - -
------------------------------------------------------------------------

This procedure was completed at 14:35:00

7/16/97
```

APPENDIX 2

DATA ANALYSIS OF PERCENTAGE HATCHABILITY USING ONE WAY ANOVA AND TUKEY TEST

- - - - - - - - - - - O N E W A Y - - - - - - - - - - -

Variable PERHAT % HATCHING

By Variable SIZE SMALL OR MEDIUM OR LARGE

Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	64.2222	32.1111	2.4083	.1707
Within Groups	6	80.0000	13.3333		
Total	8	144.2222			

- - - - - - - - - - - O N E W A Y - - - - - - - - - - -

Variable PERHAT % HATCHLING

By Variable SIZE SMALL OR MEDIUM OR LARGE

Multiple Range Test

Tukey-HSD Procedure
Ranges for the .050 level -

4.34 4.34

The ranges above are table ranges.
The value actually compared with Mean(J)-Mean(I) is..
2.5820 * Range * Sqrt(1/N(I) + 1/N(J))

No two groups are significantly different at the .050 level

Homogeneous Subsets (Subsets of groups, whose highest and lowest means do not differ by more than the shortest significant range for a subset of that size)

SUBSET 1

Group	MEDIUM	LARGE	SMALL
Mean	67.6667	67.6667	73.3333

- -

APPENDIX 3

DATA ANALYSIS OF PERCENTAGE HATCHLINGS (FRY) SURVIVAL USING ONE WAY ANOVA AND TUKEY TEST

- - - - - - - - - - - O N E W A Y - - - - - - - - - - -

Variable PERHATSU % HATCHLING SURVIVAL

By Variable SIZE SMALL OR MEDIUM OR LARGE

Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	32.8889	16.4444	.7872	.4970
Within Groups	6	125.3333	20.8889		
Total	8	158.2222			

- - - - - - - - - - - O N E W A Y - - - - - - - - - - -

Variable PERHATSU % HATCHING SURVIVAL
By Variable SIZE SMALL OR MEDIUM OR LARGE

Multiple Range Test

Tukey-HSD Procedure
Ranges for the .050 level -

4.34 4.34

The ranges above are table ranges.
The value actually compared with Mean(J)-Mean(I) is..
3.2318 * Range * Sqrt(1/N(I) + 1/N(J))

No two groups are significantly different at the .050 level

Homogeneous Subsets (Subsets of groups, whose highest and lowest means do not differ by more than the shortest significant range for a subset of that size)

SUBSET 1

Group	SMALL	MEDIUM	LARGE
Mean	86.0000	88.6667	90.6667

- -

This procedure was completed at 14:35:00

APPENDIX 4

DATA ANALYSIS OF AVERAGE DAILY GROWTH RATE USING ONE WAY ANOVA AND TUKEY TEST

- - - - - - - - - - - O N E W A Y - - - - - - - - - - -

Variable ADG AVERAGE DAILY GROWTH

By Variable SIZE SMALL OR MEDIUM OR LARGE

Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	.0985	.0492	402.8182	.0000
Within Groups	6	.0007	.0001		
Total	8	.0992			

- - - - - - - - - - - O N E W A Y - - - - - - - - - - -

Variable ADG AVERAGE DAILY GROWTH
By Variable SIZE SMALL OR MEDIUM OR LARGE

Multiple Range Test

Tukey-HSD Procedure
Ranges for the .050 level -

4.34 4.34

The ranges above are table ranges.
The value actually compared with Mean(J)-Mean(I) is..
.0078 * Range * Sqrt(1/N(I) + 1/N(J))

(*) Denotes pairs of groups significantly different at the .050 level

Mean	Group	S M L M E A A D R L I G L U E M

```
      .3167    SMALL
      .5200    MEDIUM     *
      .5533    LARGE      * *

Homogeneous Subsets (Subsets of groups, whose highest and lowest means
                     do not differ by more than the shortest
                     significant range for a subset of that size)


SUBSET  1

Group         SMALL
Mean           .3167
- - - - - - - - - - -

SUBSET  2

Group         MEDIUM
Mean           .5200
- - - - - - - - - - -

SUBSET  3

Group         LARGE
Mean           .5533
- - - - - - - - - - -
------------------------------------------------------------------------
This procedure was completed at 14:34:59
```

APPENDIX 5

DATA ANALYSIS OF SPECIFIC GROWTH RATE USING ONE WAY ANOVA AND TUKEY TEST

- - - - - - - - - - - O N E W A Y - - - - - - - - - -

Variable SGR SPECIFIC GROWTH RATE

By Variable SIZE SMALL OR MEDIUM OR LARGE

Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	.0714	.0357	21.9932	.0017
Within Groups	6	.0097	.0016		
Total	8	.0811			

- - - - - - - - - - - O N E W A Y - - - - - - - - - -

Variable SGR SPECIFIC GROWTH RATE
By Variable SIZE SMALL OR MEDIUM OR LARGE

Multiple Range Test

Tukey-HSD Procedure
Ranges for the .050 level -

4.34 4.34

The ranges above are table ranges.
The value actually compared with Mean(J)-Mean(I) is..
.0285 * Range * Sqrt(1/N(I) + 1/N(J))

(*) Denotes pairs of groups significantly different at the .050 level

Mean	Group	S M A L L	L A R G E	M E D I U M

```
1.6300     SMALL
1.7167     LARGE
1.8467     MEDIUM      * *

Homogeneous Subsets (Subsets of groups, whose highest and lowest mean
                     do not differ by more than the shortest
                     significant range for a subset of that size)

SUBSET  1

Group       SMALL          LARGE
Mean        1.6300         1.7167
- - - - - - - - - - - - - - - - - -

SUBSET  2

Group       MEDIUM
Mean        1.8467
- - - - - - - - - -
--------------------------------------------------------------------------
This procedure was completed at 14:34:59
```

DATA ANALYSIS OF PERCENTAGE FINGERLINGS SURVIVAL AT DAY 70 USING ONE WAY ANOVA AND TUKEY TEST

- - - - - - - - - - - O N E W A Y - - - - - - - - - - -

Variable PERFING % FINGERLINGS SURVIVAL AT DAY 70

By Variable SIZE SMALL OR MEDIUM OR LARGE

Analysis of Variance

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	200.6667	100.3333	2.4945	.1628
Within Groups	6	241.3333	40.2222		
Total	8	442.0000			

SPSS/PC+ 7/16/97

- - - - - - - - - - - O N E W A Y - - - - - - - - - - -

Variable PERFING % FINGERLINGS SURVIVAL AT DAY 70
By Variable SIZE SMALL OR MEDIUM OR LARGE

Multiple Range Test

Tukey-HSD Procedur
Ranges for the 50 level -

4.34 4.34

The ranges above are table ranges.
The value actually compared with Mean(J)-Mean(I) is..
4.4845 * Range * Sqrt(1/N(I) + 1/N(J))

No two groups are significantly different at the .050 level

Homogeneous Subsets (Subsets of groups, whose highest and lowest means do not differ by more than the shortest significant range for a subset of that size)

SUBSET 1

Group	SMALL	LARGE	MEDIUM
Mean	69.3333	79.0000	79.6667

- -