FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

ADVANCEMENT OF BREEDING STRATEGY FOR CONSERVATION OF MALE CATFISH BROODSTOCK: MY ROLE.

By

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To God be thy Glory, To God be thy Glory, To God be thy Glory.

Mr. Vice Chancellor sir, it is a great honour and indeed a rare privilege to stand before you and this distinguished audience this afternoon to deliver my Inaugural Lecture in this noble University. It is with a deep sense of humility and gratitude to the Almighty God that I appear before you this day as the sixth presenter from the Department of Water Resources, Aquaculture and Fisheries Technology and the 21st from the School of Agriculture and Agricultural Technology.

1.0 Introduction

1.1 What is Fish?

Fish is an aquatic vertebrate with some unique features such as gills used for breathing and fins for locomotion in water which is its medium of life. Fish is a distinct group of aquatic vertebrates and is ectothermic in nature having backbone, gills and fins. They are aquatic craniate vertebrates that include the jawed (bony cartilaginous) fishes and jawless fishes. Fish generally are exploited by man because of tremendous benefits derived from it. According to Lagler (1977) fishes are the most numerous vertebrates having between 20,000-40,000 species. So fish is among the precious given resource by God himself and was created on the fifth day of creation because He saw that it was good and beneficial to mankind. And God said, "Let the waters swarm with fish and other life. Let the skies be filled with birds of every kind". So God created great sea creatures and every sort of fish and every kind of bird. And God saw that it was good (Genesis 1vs 20).

1.2. An Overview of Global Fish Production

Global fish production is estimated to have reached about 179 million tonnes in 2018. Of the overall total, 156 million tonnes

were used for human consumption, equivalent to an estimated annual supply of 20.5 kg per capita. Aquaculture accounted for 46 % of the total production and 52 % of fish for human consumption (FAO, 2020).

1.3. **World Capture Fisheries and Aquaculture Production**

In 2018, total global capture fisheries production reached the highest level ever recorded at 96.4 million tonnes – an increase of 5.4 % from the average of the previous three years. The increase in 2018 was mostly driven by marine capture fisheries whose production increased to 84.4 million tonnes in 2018. The top seven capture fisheries producers are China, Indonesia, Peru, India, the Russian Federation, the United States of America and Vietnam accounted for almost 50 % of total global capture production FAO (2020). It also stated that capture fisheries production stood at 55 % while that of aquaculture production was 45 % but projected that by 2030 aquaculture production will overtake capture fisheries production and will be 53 % and 47 % respectively. However, because of Covid-19 pandemic it was not possible to get the records of the year 2019 and 2020 fish global production.

1.4. **Fishers and Fish Farmers**

In 2018, an estimated 59.51 million people were engaged in the primary sector of fisheries and aquaculture, 14 % of them women. In total about 20-53 million people were employed in aquaculture and 38.98 million in fisheries, a slight increase from 2016. Overall, the world highest number of fishers and aquaculture workers (85 %)) are in Asia. Globally, the proportion of women in aquaculture workforce (19%) is larger than that are in fisheries (12%). Overall, women play a crucial role through the fish value chain, providing labour in both commercial and culture fisheries. Where appropriate techniques and capital are at their disposal, they also act as small-scale

entrepreneurs particularly in household-level cottage operations (FAO, 2020). Also, Table 1 below shows world employment for fishers and fish farmers according to regions between 1995 -2018. Asia is on top in terms of employment of people on fisheries and aquaculture while Africa is among the least regions.

Table 1: World Employment for Fishers and Fish Farmers, by Region

	1995	2000	2005	2010	2015	2018
			(thousands)			
Fisheries and aquaculture						
Africa	2 812	3 348	3 925	4 483	5 067	5 407
Americas	2 072	2 239	2 254	2 898	3 193	2 843
Asia	31 632	40 434	44 716	49 427	49 969	50 385
Europe	476	783	658	648	453	402
Oceania	466	459	466	473	479	473
Total	37 456	47 263	52 019	57 930	59 161	59 509
Fisheries						
Africa	2 743	3 247	3 736	4 228	4 712	5 021
Americas	1 793	1 982	2 013	2 562	2 816	2 455
Asia	24 205	28 079	29 890	31 517	30 436	30 768
Europe	378	679	558	530	338	272
Oceania	460	451	458	467	469	460
Total	29 579	34 439	36 655	39 305	38 771	38 976
Aquaculture						
Africa	69	100	189	255	355	386
Americas	279	257	241	336	377	388
Asia	7 426	12 355	14 826	17 910	19 533	19 617
Europe	98	104	100	118	115	129
Oceania	6	8	8	6	10	12
Total	7 878	12 825	15 364	18 625	20 390	20 533

Source: (FAO, 2020)

1.5. Reasons for Global Focus on Fisheries and Aquaculture

1. Fish is animal source food (protein) with the fastest growing production in the world. In low income food deficit countries, it is also often the most affordable and most accessible animal source food for low income consumers.
2. Fish has the highest feed conversion efficiency among all farmed animals. It is also the only food animal that can be produced in salt water, offering unique advantages for climate resilient production.
3. Fisheries and aquaculture contribute to the livelihoods of about 800 million people in the fisheries sector, 90 percent of these are in small-scale fisheries and 97 percent live in developing countries hence provide employment for teeming populace.
4. Sustainable intensification of production-including integrated fish and farming systems along with nutrition sensitive processing and trade, offer direct opportunities to build the income and assets of women and youth.
5. Fish consumption has a critical role to play in boosting dietary diversity and reducing the number of people who suffer from micro nutrient deficiencies, with lifelong benefits for health and productivity.

Fish constitutes about 41% of the total animal protein intake by average Nigerian, hence there is great demand for fish in the country. According to a report by Aquaculture Transformation Action Plan (ATAP), Agricultural Transformation Agenda (ATA), Federal Ministry of Agriculture and Rural Development (FMARD) (2011) Nigeria requires about 2.66 million tons of fish annually to satisfy the dietary requirement of its over 150 million citizens then. Regrettably, the total aggregate domestic fish supply from all sources (capture and culture fisheries) is less than 0.7 million tons per annum. Nigeria has to import about 0.7 million tons of fish valued at about 500 million dollars

annually to augment the short fall. This massive importation of frozen fish has made Nigeria the largest importer of frozen fish in Africa as reported by FMARD (2011).

The fish value chain has essentially three sub category- Production, Processing and Ancillary. Fish fingerling hatcheries, fish production, fish feed production and fish farm supplies are some of the activities which make up the production category. Unfortunately, despite the abundant water resources in the country Nigeria is yet to meet her domestic fish demand as we still experience fish short supply as shown in Table 2 below:

Table 2: Fish Supply and Demand in Nigeria (2000-2018).

YEAR	FISH DEMAND (MMT)	DOMESTIC FISH PRODUCTION (MMT)	FISH SUPPLY GAP DEFICIT (MMT)
2000	1,430,000	467,098	962,902
2001	1,470,000	480,164	989,836
2002	1,512,000	507,928	1,00,572
2003	1,555,000	522,627	1,032,373
2004	1,600,000	536,918	1,063,082
2005	1,643,000	552,433	1,091,317
2006	1,691,000	567,949	1,123,301
2007	1,738,750	583,872	1,154,878
2008	1,787,500	600,613	1,186,887
2009	1,838,750	617,353	1,221,397
2010	1,890,000	634,560	1,255,440
2011	1,943,750	652,606	1,292,143
2012	2,000,000	671,492	1,328,508
2013	2,055,000	689,958	1,365,042
2014	2,113,750	709,683	1,404,067
2015	2,175,000	730,248	1,444,752
2016	3,650,000	1,012,000	2,638,000
2017	3,760,000	1,010,000	2,750,000
2018	3,061,000	1,111,000	1,950,000

Source: (FDF, 2011and FMARD, 2018).

1.6. Importance of Fish to:

i. **Children:** Increases Intelligent Quotient (IQ) and help in the proper development of infants.

ii. **Pregnant women:** Good source of Sulphur and essential amino acids; good source of thiamine; rich source of omega - 3poly saturated fatty acids. It aids in the proper development of the foetus.

iii. **Aged people:** Lowering of blood cholesterol level; lowering of high blood pressure; lower the risk age related muscular degenerations and vision impairment; reduces the risk of sudden death from heart attack and rheumatoid arthritis.

2.0. The African Catfish

Globally, one of the fish families that has been most adapted for culture is the family *Claridae* particularly the Genus *Clarias* and *Heterobranchus*. They both belong to the group of fishes called catfish. Both are commonly called names such as air breathing catfish, walking catfish, broad head catfish, sharp tooth, saw tooth and mud fish catfish. Other families include *Lacantunidae*, *Plutosidae* and *Ariidae*.

All catfishes are scale less and possess certain unique features such as barbells (external breathing accessory organs) which resembles the whiskers of cats and mousses, hence the name catfish. The barbells are mostly used for breathing whenever the fish is out of water hence the fish is able to live for long time when out of water. All catfish species belong to order: *Siluriformess*.

2.1. *Clarias* and *Heterobranchus* Genus

2.1.1. Genus *Clarias*

This Genus has no adipose fin between the rayed dorsal and caudal fin. We have ten species in Nigeria with some on the verge of extinction.

2.1.1.1. *Clarias gariepinus* (Burchell,1822). Its maximum growth size is 1 m. It has long and thin gill rakers on the first branchial arch, head length is 30.8% of standard length. The distance between extreme end of dorsal fin and origin of caudal fin is small (Plate I).

2.1.1.2. *Clarias anguillaris* (Linn, 1758). It has maximum size of 1m, they possess short gill rakers on the first branchial arch; head length 31.2% of standard length.

2.1.1.3. *Clarias lazara* (Valenciennes, 1840), it is synonymous with *Clarias gariepinus* (Burchell, 1822). Other species include *Clarias jaensis* (Boulenger, 1909), *Clarias macromystax* (Gunther, 1864), *Clarias albopunctatus* (Nicholas and La Monte,1953), *Clarias agboyiensis* (Sydenham, 1980), *Clarias buthupogon* (Sauvage, 1879), *Clarias ebriensis* (Pellegrin, 1920), *Clarias pachyneme* (Boulenger, 1903) and *Clarias camerunensis* (Lonmberg, 1895).

2.1.2. Genus *Heterobranchus*

The *Genus Heterobranchus* possess well developed adipose fin present between the rayed dorsal and caudal fins. They also possess premaxilliary and vomerine teeth. We have three (3) species in Nigeria

2.1.2.1 *Heterobranchus bidorsalis* (Geoffrey Saint-Hilaire, 1809). Maximum size is 800 mm, dorsal fin length 37-42 % of standard length and there are no serrations on the anterior part of the pectoral spine (Plate II).

2.1.2.2.*Heterobranchus longifilis* (Valenciennnes,1840) Their maximum size is 600 mm. They possess volumerine teeth with width 25-32% of head length; premaxillary width 29-36.9%

head length; posterior part of the adipose fin is blackish. It has caudal fin with a clearly marked transverse band.

2.1.2.3. *Heterobranchus isopterus* (Blecker, 1863). Maximum size is 500 mm, vomerine width 20.8-25% head length, no black spot on the posterior part of the adipose fin; caudal fin is uniformly dark.

Plate I: The African Catfish, *Clarias gariepinus (*Burchell, 1822).

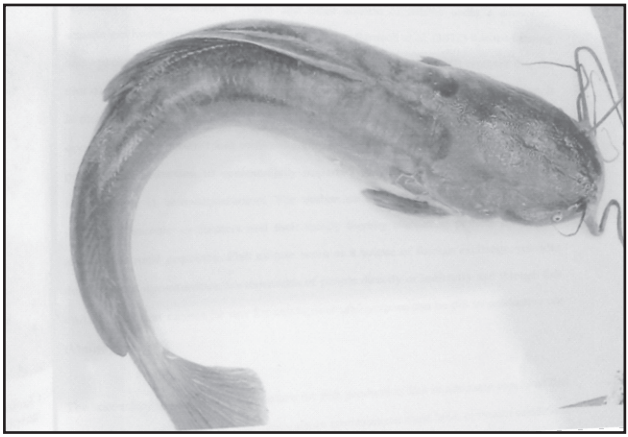

Plate II: The African Catfish, *Heterobranchus bidorsalis* (Geoffrey Saint -Hilaire, 1809).

2.2. **The Life History of *Clarius gariepinus* and *Heterobranchus bidorsalis* and its Implications for Aquaculture.**

African catfish is one of the highly priced food fish in Nigeria and many parts of the world. They are widely cultured in Nigeria owing to their high market value, fast growth rate and ability to withstand adverse pond conditions especially low oxygen content. In Nigeria, catfish of the family *Claridae* comprise the most commonly cultivated fish. Inspite of the adaptability of some of the catfishes to cultivation, commercial importance attached to catfish culture has developed slowly in Nigeria (Oresegun *et al*., 2007). It has been observed that in the 60's, the only fresh water fish sold in the markets were caught in the wild. However, in the 90's to date most of the *Clariid* catfishes offered for sale are produced from fish farms. The steady rise of catfish culture cannot be separated from the growth of aquaculture in Nigeria. They are endemic to Africa and have wide geographical distribution from Middle East in the North to Orange river in South Africa and Northern Africa (Tengels, 1984). Due to their hardiness and adaptability, they thrive well in variety of climatic conditions including Europe, Netherlands, Germany and Belgium. *Clariids* are potamodromous migrating within streams and rivers.

One of the constraints to expand *Clariid* culture in Nigeria was inadequate quality fish seed. The sharp tooth catfish is an efficient opportunistic omnivore, well equipped to exploit whatever resources are available (Appelbaum and Van Damme,1988). Catfishes are able to adjust their life by adopting alternative strategies in accordance with the requirements of the environment in which they live. This makes the species ani d e a l candidate for aquaculture as observed by Neushual (1989).

2.3. **Global Production of *Clariid* and *Heterobranchus* Catfish Species.**

According to Hecht (1996), the principal *Clariid* species which make up the bulk of the production is *Clarias gariepinus* as well as *Heterobranchus* species such as *Heterobranchus bidorsalis* and *Heterobranchus longifillis*. Culturable fish with high demand for fingerlings in Nigeria are the African catfish (*Clarias spp* and *Heterobranchus spp*). *Clariid* constitute about 80 % of fish produced in Nigeria with Tilapia 20 % (FDF, 2020).

2.4. **Distribution, Habitat Preference and Environmental Tolerance of Catfish.**

The African catfish, *Clarias gariepinus* natural geographic range as presently recognized, ranges from Southern Natal and the Orange River in South Africa and North wards through Central, West and North Africa, through the middle East and into Eastern Europe (Britz and Hecht 1989). The catfish is the species with the widest latitudinal range in the world. The fish is eurytropic and inhabits a very wide range of inland waters, including streams, rivers, swamps, underground sink holes, shallow and deep lakes as well as impoundments. The environmental tolerances of African catfish are:

i. Water temperature: 8° C-35°C breeding (>18° C).
ii. Water temperature for egg hatching:17°C-32°C.
iii. Optimal temperature for growth:28° C-30° C.
iv. salinity: 0 to 12 ppt, 0 to 2.5 ppt is optimal (96 hLC $50=11g1^{-1}$)
v. Oxygen: 0 to 100% saturation. *Clarias gariepinus* is an efficient and obligate air breather using the epibranchial organ, epibranchial epithelium, gills fans and possibly the skin on the dorsum which when active drowns if denied access to air.
vi. Desiccation: strong resistance to desiccation as a result of their air-breathing ability. When the gills collapse or are

clogged with mud, the catfish secrete mucus to keep the skin moist, or dig hole and burrow into it, but they cannot aestivate in a cocoon like the lung fish.

vii. pH: wide tolerances and viii. Turbidity: wide tolerances

The African catfish is widely distributed throughout Africa (Figure 1). According to Viveen *et al.* (1986) it inhabits tropical swamps, lakes, and rivers, some of which are subject to seasonal drying. In the Northern and Central part of Africa it has been described as *Clarias lazara*, in the Eastern part as *Clarias senegalensis*, in the Western part as *Clarias mossambicus* and in the Southern part as *Clarias gariepinus*.

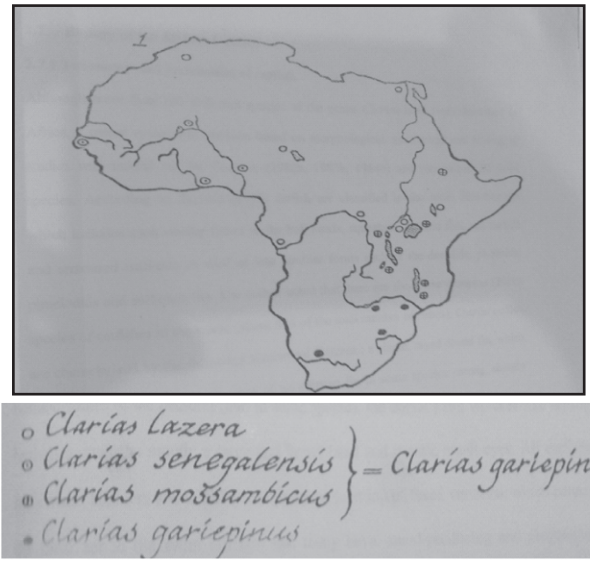

Figure 1: The Geographical Distribution of the African Catfish, *Clarias*.
Source: (Viveen *et al.*, 1986)

2.5. **Natural Fish Breeding/Reproduction in the Wild.**

The reproductive cycle of the catfish starts in most African countries at the beginning of the rainy season Viveen *et al*. (1986). They observed that the final stimulus to spawn appears

to be associated with a rise in water level and inundation of marginal areas. They stated that spawning takes place in large shoals of adult males and females in water which is between 30-50 cm deep and situated at the edges of lakes and pools. *Clarriid* catfishes have in common the natural breeding season which begins with the onset of the rainy season triggered by a combination of environmental factors such as a rise in water level and changes in the chemical composition of the water. The African catfish spawns in captivity on a variety of substrates including sisal fibres, palm leaves and stones during rainy season.

During courtship which can last several hours the female catfish lays her eggs in several batches. The partner (male) fertilizes at the same time each batch of eggs by releasing a cloud of sperm on top of the eggs. Within some seconds the female distributes the fertilized eggs over a wide area by wiping them with her tail. The eggs will finally adhere to the flooded vegetation. After spawning the shoal of catfish migrates back to deeper water. There is no parental tending of eggs. After a few weeks another batch of eggs mature in catfish ready for spawning. It has been reported that a second spawning can be induced by rainfall or by in flow of water from an upstream source, so in this way several spawning per year can take place. Depending on the water temperature, the eggs will hatch after 24-36 hours. These so-called larvae hide under the vegetation. However, due to a high mortality rate among the eggs and larvae in nature, fry and fingerlings from the African catfish are difficult to find. The fish culturist therefore, have to rear eggs and fry in a hatchery.

Naturally, many fish species tend to follow seasonal pattern of reproduction which usually occurs during the rainy season. The seasonal spawning does not permit year-round breeding and intensive cultivation of fish in culture system, seasonal reproduction in fish, like in other animals, is influenced by some factors such as climatic conditions especially temperature and

photoperiod (Purdom, 1993). The author noted that temperature is the most important environmental factor controlling sexual maturation and spawning in Cyprinid fishes, but photoperiod (light and day length) is the most in salmonids and marine species. These factors are more pronounced in temperate regions but in the tropics where there is less temperature variation during the year, these constraints have limited effects.

Some Problems associated with natural breeding technique includes:

i. Many species fish seed may not be available as and when needed or required. Hence, there is shortage of fingerling for stocking leading to low fish production.
ii. Thrash fish and fish enemies e.g (Anisoptera) dragon fly larvae, water bugs which may feed on eggs or attack the fry or compete for the fish food may also be collected with the fish seed.
iii. Fish parasites e.g leeches and other diseased fish are collected along with healthy fish seed from the wild and introduced in advertently into the rearing ponds.
iv. Difficulty in identification of the fry/fingerling stages of certain species which results in the desired species being stocked with undesired stunted species e.g as observed in catfish with Barbus.
v. There is high mortality during catch/collection and at transportation.
vi. May be uneconomical e.g cost of going to the wild, pay workers to gain access to the spawning sites through trial and error methods.
vii. Catch from the wild may not be genetically proven and viable hence may not guarantee fast growth and high survival rate.
viii. There is no room to improve quality of seed since crossing of two different species (hybridization) is not possible.

ix. Uncertainty of the species, it is difficult to identify the fry of wanted and unwanted species.
x. Seed collection is highly seasonal. It is only when the fish reproduce at the beginning or end of rainy season that seeds can be collected.
xi. There is the risk of capturing predators such as *Corixa* (water boat man), *Ranatra* (water scorpion) and bringing them into the culture system.
xii. There is also the risk of bringing parasites or diseased fish into the culture system.
xiii. It is time consuming and labourous. You may have to cover long distance to collect fry from different stations.

2.6. Reproduction under Captivity.

2.6.1. Hatchery Management in Aquaculture.

Hatchery management in aquaculture is the skillful mass production of fish fingerlings through controlled reproduction and effective utilization of available resources (Madu, 1989). It involves breeding activities which result in mass production of fish seeds under controlled environmental conditions (Viveen *et al*., 1986). Hatchery management is however based on the principle of induced breeding that is the techniques of stimulating fish to reproduce in confinement at the convenience and control of the fish culturist. It involves successive induced spawning and fertilization, controlled incubation and hatching of eggs and the nursing of hatchlings to fry and fingerling stages. Induced breeding techniques ensure production of fish seed all year round and at required quantity. There are three major operations in fish hatchery management, they are: selection and care of brood stocks, induced spawning and hatching of eggs and rearing of fry.

2.6.2. Ideal Hatchery Environment for Catfish.

Catfishes generally reproduce over a wide range of temperature and time (April to October) and may spawn 5-11 times per year or per season. Spawning period may last between 15-35 days. Good water quality with optimum temperature, pH and dissolved oxygen should be maintained in the hatchery. Direct sunlight on incubators or ponds should be avoided. The best temperature range for hatching is between 23-33^0 C Zheng (1988).

According to Vinke (1988), fish generally spawn at low temperature (18-25^0 C). Thus, a rise in temperature level can stimulate fish to spawn. Temperature can be controlled in pond by either adding cool water or increasing water quantity to reduce temperature or stop inflow of water to build up temperature (Vinke, 1988) or using thermo-regulated water heater. Also, ideal hatchery environment for catfish production must meet the following criteria:

good spawning ground with presence of nest or receptacles or spawning surfaces according to species habit, water current /inundation, reproductive partner and absence of predators that may prey on eggs.

3.0. Artificial Breeding

Artificial breeding is the process of producing fish from a matured breeder in a controlled environment outside their natural habitat. It involves induce breeding which is the technique of stimulating fish to reproduce in confinement at the convenience and control of the culturists. Induce breeding also involve activities which result in mass production of fingerlings under controlled environmental condition.

4.0 Methods of Fish Seed Production

Clarias gariepinus, and *Heterobranchus bidorsalis* reproduce naturally. However, they can be artificially propagated. The two species have similar methods of artificial propagation except the dosage of the hormone to be injected.

4.1. Artificial Fish Seed Production

There are three important methods of artificial fish seed production.

1. Induced spawning without hormonal treatment by simulating natural conditions in ponds or tanks.
2. Induced spawning by injections of hormones after which the fish spawn naturally in ponds or tanks.
3. Artificial spawning with or without hormonal treatment by manually stripping out eggs and milt from mature broodstocks.

4.1.1. Induced Spawning without Hormonal Treatment

Many culturable fish may not breed in captivity even though the gonad may be ripe. As reproduction is supposed to interplay with both internal and external environmental conditions in ponds or tanks. In general fish can be made to reproduce naturally in ponds only if conditions similar to its natural spawning conditions can be simulated. If otherwise, the fish culturist will resort to artificial induced spawning in the hatchery. These include provision of good spawning ground with presence of nest or receptacles or holes, spawning surfaces according to species habit and kakabarns, inundation or rising water level; control of temperature, day length or photo period, and provision of reproductive partner, absence of predators that may prey on eggs. Stocking ratio or sex combination ratio of breeders is very important in induced natural spawning. If the males are

more they will fight due to mating aggression and on the other hand if the females are more, some would be isolated and would not participate in mating and breeding. Based on these reasons optimum sex ratio is important for efficiency of induced breeding without hormone treatment. The optimum sex ratio or sex combination may vary from one specie to another but in most species, it is observed to be either 1: 2 or 1:3 (one male to two or three females). Under normal environmental conditions, good water quality and sex ratio courtship would occur and spawning and fertilization would take place naturally.

4.1.2. Induced Spawning with Hormonal Treatment

4.1.2.1. The Action of Hormone in Fish Reproduction

The use of hormone is to manipulate the internal environment of fish to induce breeding. This is referred to as 'hormone injection technique` or `internal stimulus technique` (Harvey and Hoar, 1979; Woynarovich and Hovarth, 1980). This is done by administration of chemical compounds or hormones to stimulate gonad maturation, ovulation in females and spermiation in males. The chemicals can also go further to stimulate spawning of eggs or milt. These chemicals are either natural hormones or chemicals artificially synthesized from the natural hormones. The natural hormones are regarded as first-generation compounds while those synthesized from them are regarded as second-generation compounds. When any of these are injected into fish they trigger off actions of endocrine reactions.

This method is effective during the dormant phase of gonad development when the level of gonadotropin hormone in fish blood is low. The level is increased by artificially injecting the fish with hormone. The increased hormone level speed up ovulation

and spawning. This is a faster technique of inducing fish to breed if the gonads are fully ripe and ready. If the gonads are not ripe, the technique may fail (Harvey and Hoar, 1979). Hormone injection can also be used to induce maturation of ova or gonads development (Delince *et al.*, 1987).

The hormonal control of reproduction in fish is achieved by successive excretion of hormones from various endocrine centres of the fish (Decline *et al.*, 1987). The process begins by the environmental stimuli being received by the brain. The brain transmits the impulse to the hypothalamus which by action of leutining hormone releasing hormone (LHRH) releases the Leutining hormone. This goes to the pituitary and cause synthesis of various steroids which include estrogen steroids C-19 and C-21. Estrogen C-21 induce maturation of ova. Estrogens are also involved in the first stage of egg development (vitellogenesis). However, vitellogenesis begins by synthesis of glycophospho protiens in the liver which are then deposited in the oocytes. The action is supported by estrogens. Estrogens are also responsible for secondary sexual characteristics. The gonadotropins act on the follicle tissue of the ovary to produce ovarian steroid prostaglandins and catecholamines which stimulate maturation of eggs and ovulation. Ovulation has also been induced by injection of progesterone and 17 hydroxy-20B-dihydroprogesterone. However, 17-hydroxy-20B-dihydroprogesterone has been found to be effective only at the final stage of maturity of oocyte. It is therefore restricted in use for ovulation.

4.2. Artificial Spawning with or without Hormonal Treatment

Hypophysation (use of pituitary extract from fish) technique encourage maturation, ovulation or spermiation but may not stimulate spawning. Where this occurs, stripping method is

adapted. This is an artificial way of obtaining ripe eggs from ovulated fish or milt from mature male.The fish is taken out of water for stripping. It should be made comfortable, so it is held with wet towel or anaethesized. The belly is pressed by applying gentle pressure with hand over the abdomen towards the genitalia. The ovulated eggs readily pass out even with slight pressure. The eggs are collected preferably in a plastic container. For males the abdominal pressure may not yield enough milt, so an alternative method is to suck out the milt using rubber tube or blunt syringe. In catfishes the body anatomy may not allow enough milt to pass out with normal abdominal pressure, the fish may therefore be killed to bring out the testis a current technique that is been practice by many fish breeders. Milt is then squeezed out, (Decline *et al.,* 1987).

Stripping techniques is however dangerous to some species so it is only carried out where normal spawning does not occur. It is also important to note that if eggs or milt are not easily passed out by stripping, it may be that the fish is not ripe to breed. The fish may then be treated with hormone for eggs to mature.

Induced spawning with hormonal treatment is easily practiced in catfish *Clarias gariepinus*. This is done by using the hormone De Oxy Cortitesterone Acetate (DOCA) at a dose of 50 mg/kg body weight or carp pituitary extractor *Clarias* pituitary extract at a dose of 4 mg/kg body weight, the female is injected in the morning during low temperature and left in the tank until night. The male partners are chosen by themselves and in the evening the couples are placed in a separate tank with bottom covered with grasses or any loose substrate. The tank is filled gradually with running water. The couple spawn overnight and the brooders are removed the following morning. The fertilized eggs stick to the grasses/vegetation and hatch within 24 hours, (Decline *et al.*, 1987).

5.0. Artificial Propagation through Hypophysation

The hypophysation technique which uses the pituitary gland (the hypophysis) to induce spawning in fish can be carried out at any time of the year and under any environmental conditions. The technique ensures fish seed availability at all times of the year and under any environmental conditions. For instance, using this technique a single common carp (*Cyprinus carpio*) has been induced to spawn five times within a year at intervals between successive spawning, even though carps breed naturally only once a year. Artificial propagation was first described in 1765, but was neglected until 1842. A number of experiments were carried out and by 1937 artificial propagation at commercial level was attained. By 1964, it has spread to many parts of Europe, America, Japan, China, Israel but to date there are increased trials in Nigeria with varying degrees of success. It was first reported in Panyan fish farm and Agodi fish farm where carp propagation was successful. Some private owned fish farms have tried hypophysation using catfishes e.g *Clarias gariepinus*, *Heterbranchus bidaorsalis*. Some advantages of artificial propagation include fish seed is guaranteed all the year round, fish seed is obtained outside the natural environment of fish, it increases the survival rate of the fry, it improves quality by crossing two different species (i.e. hybridization) can be obtained, better rates of fertilization and hatching, protection against enemies and unfavorable environmental conditions, better conditions for growth and survival and all conditions are controlled among others.

However, some disadvantages are that the male donor catfish has to be sacrificed to obtain milt to fertilize egg hence loss of male brood fish, the whole process is laborious and highly technical, may be expensive in that it requires adequate facilities, construction of tanks, installation of jars in a close circulatory system. It should be noted that artificial (i.e naturally induced or through hypophysation) production of fish seed are carried out

in enclosures known as hatcheries which may be an indoor or outdoor facility and they require inputs such as brood stock, adequate water supply and suitable feed.

6.0. Steps in Artificial Propagation

The artificial propagation of catfish is a chain of activities. The various activities involved in the process of artificial propagation of the African catfish are: selection and management of brood stock, inducing final maturation and ovulation with hormone administration, procurement of ripe eggs by stripping, procurement of milt by dissection of a male donor (current common practice), artificial fertilization by maceration of testes over stripped eggs and rearing of larvae and fry.

6.1. Selection and Care of Brood stocks

Broodstock should be obtained from a reliable source or fish farm without any history of disease. They should be well fed with at least 40 % crude protein and good water quality management. The broodstocks should be selected and checked for signs of maturity, ovulation and spermiation. Gravid females show distended and swollen belly if filled with eggs, the genital papilla becomes reddish infused with blood. When gentle pressure is applied on the belly the ovulated eggs ooze out through the genital papilla (Plate III).

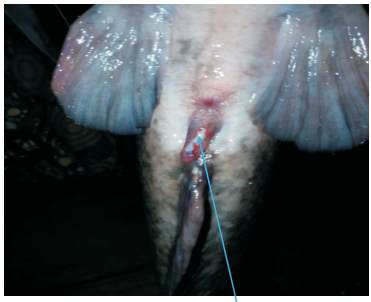

Plate III: Ripe and mature male *Clarias gariepinus* with turgid genital papilla

Gravid female *Clarias gariepinus* with distended belly

Plate III: Display of mature male and gravid female *Clarias gariepinus*.

Normally, ripe and mature eggs are greenish yellow or golden brown in colour. In case of males, the genital papilla is turgid when touched particularly at the tip, reddish and vascularized.

6.2. Hormone Administration

The weight of all the female fish are recorded just after collection from the pond. The quantity of hormone solution to be injected is calculated based on the weight and level of maturity of the broodstock. Ovaprim, one of the common synthetic hormones use in fish breeding is injected at the dose of 0.5 mg/kg body weight using graduated syringe and needle (Plate IV). Two methods of injection are employed. These are intramuscular and intraperitoneal hormone. The intramuscular is done via the muscle at the dorsal lateral part of the body just below the dorsal fin.

Plate IV: Female catfish been injected intramuscularly.

This should be done with caution to avoid any damage to the bone or organ. Intraperitoneal method of injection is done by raising the pectoral fin and inserting the needle into the peritoneal cavity of the fish and release the hormone into the cavity. Also, care should be taken in order not to injure the internal organ of the fish. In both methods the hormone enters the blood stream via absorption.

6.3. Latency Period

The period during which ovulation takes place is referred to as latency period (Table 3). The follicle cell of the egg breaks open to release the ovum into the lumen of the ovary. The fish breeder should be watchful to know accurate measure of temperature and check the broodfish regularly in order to avoid release of eggs into the water. In order to avoid the contamination of stripped eggs with content of digestive system and excreta, the broodfish should not be fed during latency period.

Table 3: The relationship between water temperature and latency period.

Water temp. (^{0}C)	20	21	22	23	24	25	26	27	28	29	30
Latency Time (hrs)	21	18	15.5	13.3	12	11	10	9	8	7.5	7

Source: FAO (1996).

The table shows that as the temperature increases, the latency period decreases. Also, Oyelese (2006) stressed the importance of the water temperature as a determinant of fertilization and hatchability rates in artificially induced breeding of *Clarias gariepinus*.

6.4. **Procurement of Ripe Eggs (Stripping)**

The fish is brought out of brooder tank and ensure that water or moisture is wiped out of its body. The fish should be held by 2 persons using towel. The main operator who holds the spawner's head with one hand presses gently the abdomen with the thumb of his other hand from the anterior of the pectoral fin to the genital pore or orifice.

A second operator holds the tail of the female. If the female has responded well to the hormone treatment, ovulated eggs will easily flow out in a thick jet from the genital pore. The eggs are collected into a dry plastic bowl (Plate V).

Stripping of Eggs in Action

Plate V: Stripping of eggs

Stop stripping when blood start coming out of genital pore. Water or blood should not be allowed to touch eggs before fertilization is done.

6.5. **Procurement of Milt**

It has not been possible to strip milt from male catfish due to anatomical structure of the testis, their milt is obtained by sacrificing the male and dissecting the testes (Plate VI).

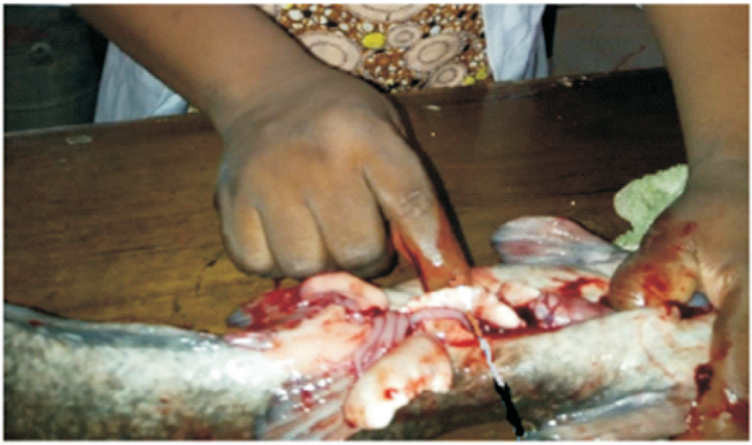

Plate VI: Display of Testis from Sacrificed Male Catfish, *Clarias gariepinus*

In catfishes the body anatomy may not allow enough milt to pass out with normal abdominal pressure, the fish may therefore be killed to bring out the testis. Milt is then squeezed out to fertilize eggs. The technique whereby valuable male brood fish have to be sacrificed is wasteful and a major obstacle in breeding. When pressure is exerted on the gonads, it releases the milt into the lobes at the seminal vesicles and not directly through the analpore as it is the common practice with common carp species. Also, seminal vesicle and internal organs block the flow of milt and convulated vas deferens. Some of the disadvantages and challenges of sacrificing male catfish brood stock include reduces the number of males in the population. It also brings about shortage of male for further breeding and hinders genetic improvement studies. *(http://cdserver2.ru.ac.za/cd/catfish/catfish/cat223a.htm 1/1/2002).*

7.0 My Contribution/Role.

The procedure and strategy I developed during the course of my research to obtain milt from male catfish which was the main focus of my research differs from the method highlighted above and is as explained below:

This new strategy and technology ensure that all male brood stocks especially viable ones with good vigor and disease free and disease resistance strain, fast growth rate and big size that are capable of producing healthy progeny are maintained, save and conserve.

After careful selection and management of ripe and mature male broodstocks according to the method of Blythe *et al*. (1984) surgical operation was carried out on the matured male fish on the dorsoventral part of abdominal cavity where testes are situated (Plate VII). To reduce stress during the surgical operation, each fish was injected intraperitoneally using 2 ml size syringe and needle with general anaethesia Ketamine HCL according to fish size and weight (0.1 ml/kg body weight) before operation. Each fish became inactive and unconscious within 30 seconds and remained so until after 25-30 minutes. The fish were placed dorsally on a wet disinfected white cloth spread on clean table with the head covered with a piece of wet clean towel. The surface of the abdomen was disinfected with methylated spirit (40%) before an incision was made on the ventral side of the abdomen.

Plate VII: Display of incision point on the body of male broodfish *Clarias gariepinus*.

Key: IP = Incision Point

The incision was extended towards the head with sterilized surgical scissors 3-5 cm long for all replicates and assisted by a person to expose the internal organs including the testes which remained intact. The digestive tracts were pushed aside to reveal the testes. Milt was extracted from the testes using sterilized 2 ml size syringe and needle (Plate VIII).

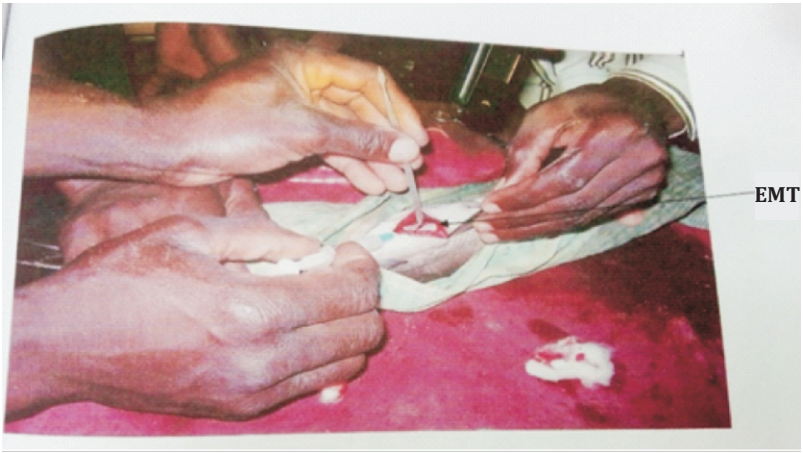

Plate VIII: Extracting milt from ripe and mature testis of male broodfish of *Heterobranchus bidorsalis* using 2 ml size syringe and needle

Key: EMT = Extracting Milt from Testis.

A sample of milt was weighed and then observed under Binocular Olympus microscope to determine their motility while the rest was used to fertilize the eggs (Plate IX).

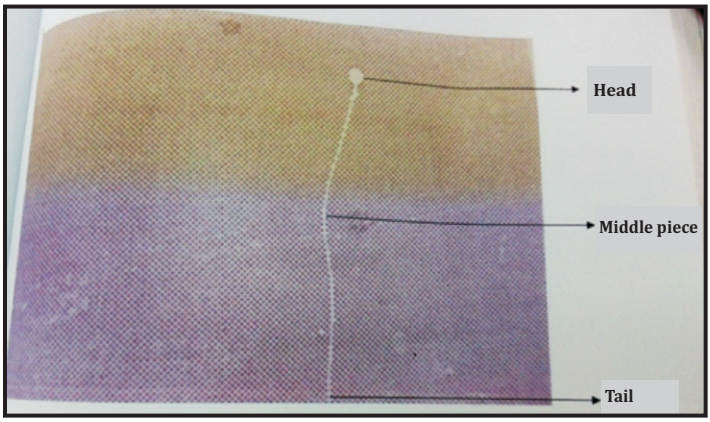

Plate IX: *Clarias gariepinus* sperm (milt) Mg x200).

The incisions were sutured using simple interrupted suture pattern with catgut chromic 2/0 stitch (Plate X a and X b).

Plate X a: The researcher aided by an assistant stitching the incision point on the body of male broodfish *Clarias gariepinus.*

Key: SIP = Stitching the Incision Point with catgut chromic 2/0.

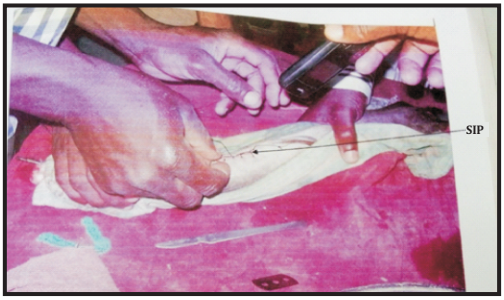

Plate X b: Stitching the incision point on the body of male broodfish of *Heterobranchus bidorsalis*.

Key: SIP = Stitching the Incision Point with catgut chromic 2/0.
The surgery on each fish lasted for 25-30 minutes. Each incised fish was placed in a plastic trough with well aerated fresh water to enable them recover and recuperate. After recovery from the anaethesia, each fish was placed into separate concrete tank (2 m x 2 m x 1 m) containing broad spectrum antibiotic (Dav-Biotic) at a dosage of 5 g/L of water for 8 days without food under intensive care and monitored for recuperation, recovery and reuse time (Plate XI a and XI b). Sterile procedure and aseptic technique was observed to avoid infection. The economical recovery and reuse time was determined by regularly examining the genital papilla for ripeness, rigid and reddish infusion as well as progressive monitoring of healing process (Plates XII-XIX).

Plate XI a: The stitched incision point on the body of male

broodfish of *Clarias gariepinus* (immediately after stitching).
Key: TSIP = The Stitched Incision Point

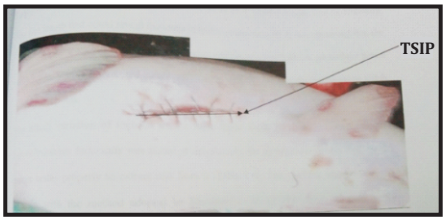

Plate XI b: The stitched incision point on the body of male broodfish *Heterobranchus bidorsalis* (immediately after stitching).
Key: TSIP = The Stitched Incision Point.

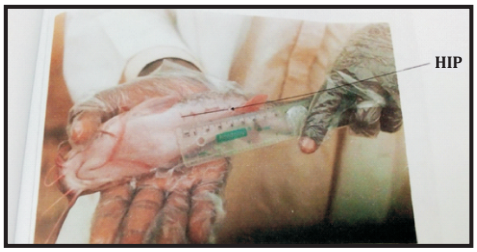

Plate XII: The measurement of length of stitched incision point on the body of male broodfish *Clarias gariepinus* (3.40 cm) 4 weeks after.
Key: HIP = Healed Incision Point.

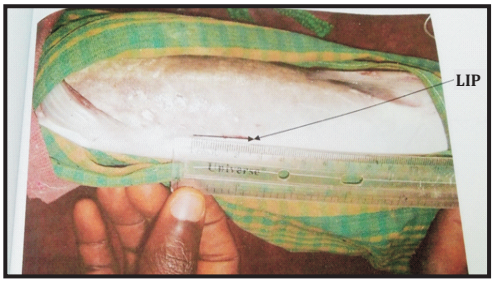

Plate XIII a: The measurement of length of stitched incision point on the body of male brood fish *Heterobranchus bidorsalis* (2.50 cm)

Key: HIP = Length of Incision Point.

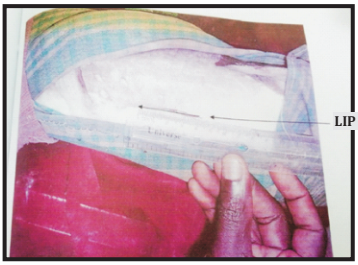

Plate XIII b: The measurement of length of stitched incision point on the body of male broodfish *Heterobranchus bidorsalis* (4.00 cm)
Key: HIP = Length of Incision Point.

Plate IVX: The stitched incision point on the body of dead male broodfish *Heterobranchus bidorsalis* (Died after 3 days).
Key: TSIP = The Stitched Incision Point.

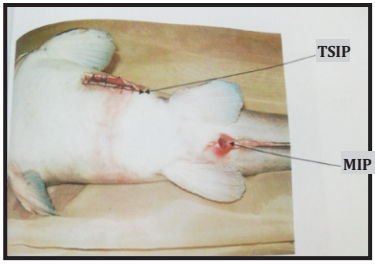

Plate XV: The stitched incision point on the body of dead male broodfish *Heterobranchus bidorsalis* (Died after 6 days).
Key: TSIP = The Stitched Incision Point, MIP = Microbial Infection Point.

Plate XVI: The stitched incision point on the body of survived male broodfish *Heterobranchus bidorsalis* (8 days after).
Key: TSIP = The Stitched Incision Point.

Plate XVII: The healed stitched incision point on the body of survived male broodfish *Clarias gariepinus* (3 weeks after).
Key: HSIP = Healed Stitched Incision Point.

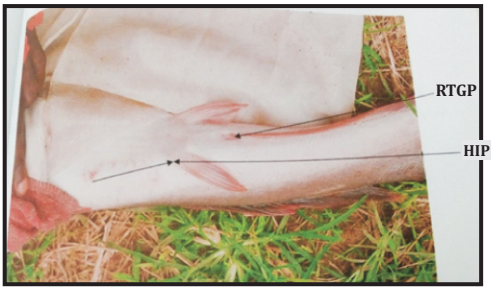

Plate XVIII: The healed stitched incision point on the body of survived male broodfish *Heterobranchus bidorsalis* (50 days after).
Key: HSIP = Healed Incision Point, RTGP = Reddish and Turgid Genital Papilla.

Plate XIX: The researcher pointing to the healed stitched incision point on the body of survived male broodfish *Clarias gariepinus* (45 days after).

Key: THSIP = The Healed Stitched Incision Point.

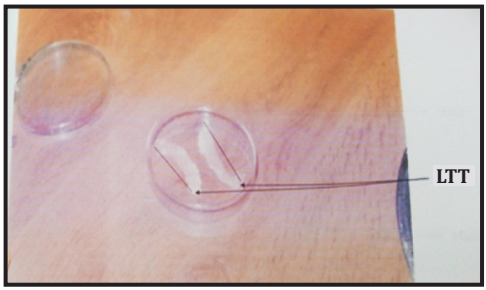

Plate XX: Lobes of serrated testis tissue of *Clarias gariepinus*.
Key: LTT = Lobes of Testis Tissue.

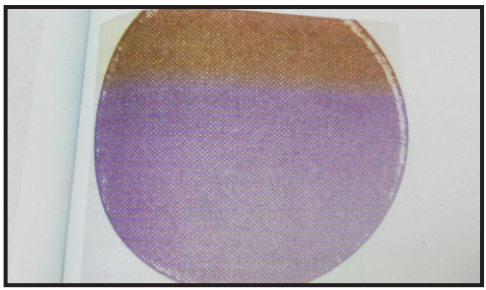

Plate XXI: *Clarias gariepinus* egg (0.2 mm).

7.1. Artificial Fertilization of Eggs

After stripping the eggs and extraction of milt, fertilization is done by mixing them together. This should be done within few minutes of extraction. Two techniques of artificial fertilization widely used are wet technique and dry technique. In the wet technique the eggs and milt are stripped into separate plastic containers containing water. Water serves as the medium of fertilization. The eggs and milt are then mixed together and stirred with plastic spoon. The water medium prevents the sticky substance on the eggs from trapping the sperm. The sperm is then able to penetrate the egg easily.

In the dry techniques the eggs and milt are not stripped into water medium separately, they are mixed directly with each other. They are stripped into containers before water is added and mixed thoroughly using soft dry material such as feather or hair brush. This method is preferred than wet method because sperm cells remain fertile for longer time when not diluted. Secondly the eggs membrane swells when in contact with water and make sperm penetration difficult. As water activate the sticky substances of the eggs and cause them to stick together thereby interfering with fertilization, the use of fertilization solution or anti sticking agent such as saline solution is prefer (Plate XXII). Saline solution serves as anti -sticking agent and also prolong the life span of milt.

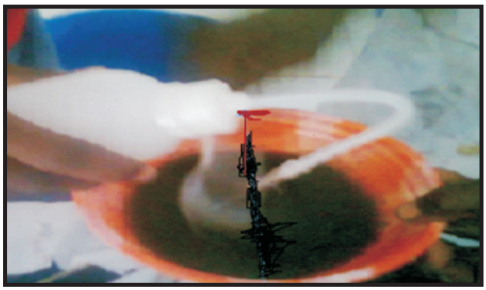

Plate XXII: Plastic Container with Saline solution

After fertilization the eggs are transferred to the incubator for hatching.

7.2. Incubation and Hatching

Various types of incubators are used as receptacles for hatching of eggs. These include plastic tanks, glass or fiber aquarium tanks, zong jars aspersion chambers etc. However, it is important to ensure that eggs are immersed in shallow water and eggs should be spread in a monolayer pattern for efficient hatching (Plate XXIIIa).

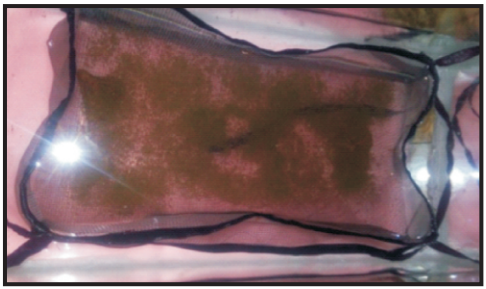

Plate XXIII a: Fertilized eggs spread in monolayer pattern on the kakabarn in the incubation tank.

Substrate materials that could be use and serve as kakabarns include mosquito nets, sack sponge, water lettuce and water lily leaves. They have proved to be effective.

Plate XXIII b: Water Lily Leaves

Plate XXIII c: Water Lettuce Leaves

Use of optimum temperature increase hatching rates. The temperature requirement for hatching is between 27-32^{0}C, This is not a problem in the tropics. The temperature can be maintained with the aid of thermo-regulated water heater.

Fertilized eggs are incubated in flow through water system in incubation troughs or tanks. The incubation is filled with clean, well oxygenated water, free of planktonic organism. The rate of hatching of fertilized eggs is dependent on water temperature as shown in Table 4 below. They remain in the incubation unit for 3 to 4 days (depending on water temperature) until their yolk sacs become reabsorbed. It is important to note that the dead eggs during incubation will become whitish in color, this and unhatched eggs as well as egg shells should be siphoned out of the incubating system using net hapa. This is to avoid fungal and bacterial infections.

Table 4: The relationship between water temperature and incubation period.

Water Temp. (^{0}C)	20	21	22	23	24	25	26	27	28	29	30
Incubation period (hrs)	57	46	38	33	29	27	25	23	22	21	20

Source: Janssen (1987).

As the temperature increases the incubation and hatching period decreases.

As soon as the eggs are fertilized, embryonic development begins. The time needed for hatching varies among species but in all cases, they require warm temperature, good supply of well oxygenated and clean water. Temperature requirement is between 27-30^0 C. This is not a problem in the tropics and eggs hatch within 1-4 days. In temperate climate it takes several days to hatch. During development eggs are very susceptible to attack by predators, bacteria and fungi. Fertilized eggs should therefore be well protected in the incubators or hatcheries. They should be

protected from direct sunshine and shock.

Fry in Incubation Tank

Plate XXIV: Display of Fry in Incubation Tank

7.3. Management of Hatchling and Fry

Young hatchlings with yolk- sac before the first exogenous feeding are referred to as larvae (Delince *et al.*, 1987). Fry are very sensitive, delicate and fragile requiring a more precise and conscientious care (Plate XXIV). Larvae were reared in the same incubation trough with water flow through but incubation trays or net layers were removed. This is done after separation of larvae from egg shells and un hatched eggs. Water flow through system is the best rearing device because it ensures inflow of good quality water, replacement of used water, removal of accumulated metabolites and concentration of fish in a small-easy- to- manage area (Ritcher and Vandan Hork, 1987).

Normal larvae tend to love dark shallow water areas. Darkness should be maintained at the anterior 2/3 of the trough and the remaining posterior part should be illuminated. This separates normal and healthy larvae which cling to the dark area of the trough from the weak diseased larvae which remain in the illuminated area (Delince *et al.*, 1987). Water level can be maintained by drain pipe or turn down pipe with fine mesh

screen (about 1.0mm mesh) placed diagonally just anterior to the water outlet. The screen should be cleaned regularly to prevent blockage and overflow. Placing the air-stone under the screen can automatically clean the screen. The recommended water depth for larvae rearing is 12-15 cm deep (Delince *et al.*, 1987). Dissolved oxygen level required in larval rearing trough was not below 5 mg/L. This can be obtained by keeping water flow rate at 3-5 L/min (Delince *et al.,* 1987). The optimum temperature for rearing catfish larvae and young fish generally is about 30^0 C, low temperature (less than 22^0 C) and high temperature (greater than 36^0 C) retard larval development (Delince *et al.*, 1987). This was also maintained.

7.4. Stocking Density of Fry

Fish larvae can be stocked at the rate of 45,000 to 70,000 larvae per 100 to 120 L of water or 375-700/L for a period of 2 months (Delince *et al.*, 1987). Stocking density could be 5,000-10,000 fry/m^2, to be reduced by 1/3 after one-week rearing. In plastic tanks, density could be increased between 10,000 to 15,000 fry/m^2 and water depth should be 15-30 cm deep (Zheng, 1988).

7.5. Feeding of Fry

After absorption of yolk sac, the fry now goes for exogenous food, their survival now depends on food selectivity and acceptability. Protein requirement is highest in initial feeding of fry and decreases as the fish grow in size. Fry was fed to satiation, feeding at least every 3-4 hours is found to be better. It is advisable that for maximum growth, fry must have diet in which almost half of the digestible ingredients are protein. Catfishes can be fed with zooplankton before transiting to other feeds and were therefore considered as one of the species in which fry rearing require a phase of feeding with natural live food (zooplankton) before artificial food.

8.0 Other Areas of my Contribution in Research

1. Study on effects of Incision Variation Length (IVL) on *Heterobranchus bidorsalis* male spawners to extract milt for induced breeding was carried out. It was discovered that IVL 3.40 cm among other lengths 2.50 cm and 4.00 cm made on abdominal region (gonad position) of *Heterobranchus bidorsalis* male brood stocks exposed testes good enough to extract milt to fertilize egg without adverse effect on fish hence enhance fingerlings production.
2. Study on effect of nematode infection on the breeding potential of *Clarias gariepinus* was conducted. It was revealed that *Eustronglylides africans* worms found under the skin and visceral cavity of brood fish do not completely hinder reproduction/breeding, although the result in terms of survival and growth rate was not as good as compared with uninfected brood fish.
3. Micro-organisms hinders the fertilization, hatching, survival and growth of eggs and hatchlings. Therefore, study was carried out to determine the effects of some disinfectants and anti-sticking agent (Dettol, formalin and izal) on African catfish (*Clarias gariepinus*) eggs, survival and growth performance of the hatchlings.

Results showed that *Clarias gariepinus* eggs treated with 0.01 ml concentration of Dettol had the highest survival of hatchlings, while 0.00 ml was the least. Eggs treated with 0.20 ml and 0.30 ml diluted Dettol concentration post fertilization for 60 seconds before incubation were most effective in terms of fertilization and hatching. Also, eggs treated with 1.00 ml diluted formalin concentration for 60 seconds in terms of fertilization, hatching, survival and growth performance was most effective. Similarly, eggs treated with 1.00 ml diluted izal concentration for 60 seconds in terms of fertilization, hatching, survival and growth performance was most effective as compared to other treatments (0.00 ml and 0.05 ml).

9.0. Conclusion

African catfish (*Clarias gariepinus* and *Heterobranchus bidorsalis*) are aquaculture candidate, highly priced and of high preference to the consumers. They easily adapt to African climate because of their unique characteristics such as hardy, fast growth rate, large size, air breathing ability, omnivorous feeding habit and farmed in its pure form or as a hybrid. In view of the above features of these species, this strategy and technology to save and conserve the male catfish for re-use and for further genetic studies was developed. This will advance the course of fish production in order to alleviate poverty, create job opportunity and ensure food security in the country.

There is a growing decline in wild fish populations as a result of over fishing and effect of climate change hence the need to focus and expand our aquaculture practice. One of the ways to achieve this is through aggressive hatchery practice and management where mass production of reliable, genetic improved, and disease free and fast grow fingerlings is ensured for stocking production ponds.

The importance of these two species (*Clarias gariepinus* and *Heterobranchus bidorsalis*) in terms of supply and demand has necessitated the development of this breeding strategy and technology where the life of African male catfish broodstock is saved and conserved for future use after breeding against the traditional practice of killing and termination of their lives.

The technology also offers the fish breeders /hatchery managers the opportunity to re-use several times the male African catfish broodstock for purpose of breeding and later sell the male spent spawner's to boost their economic life.

10.0. Recommendations

There is the need to further advance the technological benefits of this breeding strategy in such a way that there may be no need to

make abdominal incision on the fish but rather a scanning machine would be used to determine the distance and position of testes from outside (skin surface) with the view to extract milt using syringe and needle without incision into the body cavity.

Credit facilities, loans, and empowerments should be made available through financial institutions to genuine fish farmers, hatchery managers/fish breeders with low interest rate. Government at all levels should subsidize agricultural inputs to vulnerable rural fish farmers to expand their hatchery production. Administrative bottle necks should be removed for easy access to obtain the loan facilities.

Deliberate efforts should be taken by Government in such a way that the loans are not hijacked by highly placed individuals who are not genuinely committed to fish farming and hatchery production.

Extension workers/agents should be strengthened and motivated in order to disseminate new farming techniques and technologies to farmers especially in the rural areas.

11.0. Acknowledgments

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13.0 Brief Profile of the Inaugural Lecturer

Professor Ananias Tswanya Yisa was born on 13th December, 1968 to the family of Mr Barnabas Yisa (Ndatswanya) and Mrs Comfort Yisa in Edati-Eshata, Edati Local Government Area of Niger State, Nigeria. He attended LEA Primary School, Katamba Bologi and completed in 1979. Thereafter he proceeded to Government Science Teachers College (G.ST.C.), Bida where he obtained Teachers Grade II Certificate in 1985. He went to Advanced Teachers College, Zaria in 1987 to study Biology/Chemistry as his teaching subject combination and graduated in 1990. In the same year he gained admission to Ahmadu Bello University, Zaria to study B Sc. (Ed) Biology which he successfully completed in 1994. Between 1994-1995 he served the one-year mandatory National Youth Service Corps (NYSC) in Kogi State.

After the NYSC, he took appointment with Niger State Government as Education Officer and was posted to Government Science College, New-Bussa as a class room teacher to teach Biology and was later transferred to G.ST.C, Bida in 1999. The same year he enrolled for his Master degree in Fisheries Technology at Federal University of Technology, Minna and graduated in 2003. He later secured employment with F.U.T. Minna, Department of Water Resources, Aquaculture and Fisheries Technology in August 2005 as Assistant Lecturer. He did his PhD in the area of Fish Breeding and Genetics in the same University and finished in 2012.

Through sheer scholarship and hard work, he rose through the ranks to become a Professor of Water Resources, Aquaculture

and Fisheries Technology on 1st October, 2019. He has published more than 60 papers in Journals and conference proceedings and has attended several International and National conferences and workshops. He is a member of several associations/societies including Fisheries Society of Nigeria (FISON) and Association of Nigeria Fisheries Scientists (ANIFS). He is a reviewer to some National and International Journals.

Professor Ananias Tswanya Yisa has supervised several undergraduate, PGD, M Tech. and PhD students and is still supervising. He has also served in several committees. He was Assistant Departmental Examination Officer between 2005-2007 and became Examination Officer of the Department in 2007-2011and Post Graduate Coordinator for many years. He was Deputy Director, Center for Climate Change and Freshwater Resources (CCCFR). His current research focuses on genetic characterization of wild and hatchery-raised of some catfish populations using microsatellites and single nucleotide polymorphisms (SNPs) DNA MARKERS and improvement of growth and survival of some catfish species through marker-assisted selection and Quantitative Trait Loci (QTL). Treatment of some catfish eggs with selected disinfectants to reduce micro-organisms infection and enhances fertilization, hatchability and survival of hatchlings and ultimately better growth performance as well as area of Biotechnology. Prof. A. T. Yisa has been external examiner for postgraduate students in a number of Universities, also Assessor of many academic staff members seeking promotion to professorial rank. He is happily married to Mrs Lois Yisa and the marriage is blessed with four (4) children and one (1) foster child.