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Fish Hatchery Management in Nigeria

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Abstract: Fish hatchery management is efficient tool in intensive fish culture. The vital requirements of fish hatchery, hatchery construction, concrete tank construction, nursery, rearing and production ponds, fish seed hatchery, hormone in fish spawning, hypophysation, compounds used for induced breeding, hormone administration, spawning and rearing, steps in artificial propagation, hatchery management, nursery management are basic elements in effective hatchery management. The article reviews these vital elements to re-awaken fish farmers, Fisheries students private and public sectors in the formulation of fisheries policies.

Key words: Brood stock, fish hatchery, hormones, management, hypophysation, nursery, spawning

INTRODUCTION

The steadily growing importance of fish farming has compelled improvements in the technologies necessary for securing the initial and basic requirements for productive aquaculture; namely the production of fish seed for stocking. Fish culture today is hardly possible without the artificial propagation of fish seeds of preferred cultivable fish species. The need for the production of quality fish seed for stocking the fish ponds and natural water bodies has indeed increased steadily (Brain and Army, 1980). Artificial propagation methods constitute the major practicable means of providing enough quality seed for rearing in confined fish enclosure waters such a fish ponds, reservoirs and lakes (Charo and Oirere, 2000).

The production of marketable fish fingerlings or juveniles into rearing environment that assures optimum and rapid growth to allow harvest in the shortest possible time. The fish farmer has to obtain adequate number of young fish to meet his production goals. The possibilities of obtaining fish seed in adequate numbers from natural source is rather limited. Even the spawners which, reproduces successfully n confined enclosures are propagated artificially.

Apart from being able to obtain quality seed, the artificial propagation technique can also be used to develop strains superior to their ancestors by the methods of selective breeding and hybridization. Depending on the perfection of the system, at least 65% of the eggs produced can be raised to viable fingerlings as against less than 1% survival rate in natural spawning. It is through this method that out of season supplies of fingerlings are achieved.

The Food and Agricultural Organization of the United Nations (FAO, 2006) stated that Nigeria is a protein deficient country. The protein deficiency in the diets can be primarily remedied through the consumption of either protein-rich plants or animal food stuffs.

Protein from animal sources is in short supply in Nigeria due to the rapid increase in human population annually a well as the decrease in livestock population du to several factors including diseases, deforestation and drought, scarcity and high cost of quality feeds, poor genetic qualities and limited supply of indigenous breeds and avian flu disease which brought about mass mortality of poultry. These factors combined have raised the cost of animal protein to a level that is almost beyond the reach of the ordinary citizen. This situation has therefore given rise to a considerable increase in the demand for fish to supplement the needed animal protein intake.

This study reviews the vital requirements of fish hatchery, hatchery construction, concrete tank construction, nursery, rearing and production ponds, fish seed hatchery, hormone in fish spawning, hypophysation, compounds used for induced breeding, hormone administration, spawning and rearing, steps in artificial propagation, hatchery management, nursery management to re-awaken fish farmers, Fisheries students private and public sectors in the formulation of fisheries policies.

REQUIREMENTS FOR FISH HATCHERY

Intensive fish culture seldom exists without an efficient fish hatchery management (Adekoya *et al*., 2006). It

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involves a long range of breeding activities ranging from the collection, selection and manipulation of breeders for spawning or stripping of eggs up to the nursing hatchlings to a minimum of one month old. Proper site selection plays an important role in any successful fish hatchery. The vital requirements of fish hatchery include:

- Adequate supply of plenty quality water
- Sufficient land for hatchery tanks, buildings and other assets.
- Electricity
- Transportation facilities; and
- Manpower

In addition, the following factors need be considered on the site.

Ecological factors: These factors consider the relationship between the abiotic and biotic factors existing in the site. For example:

Water supply: There must be a reliable source of water, which needs proper analysis for discharge, yield, flood and elevations. Sources of water supply for hatchery include rivers, reservoirs, springs, creeks, lakes and bore holes or deep wells. Springs and boreholes that are relatively free from pollution are preferable. It is essential that water for hatchery should be free from pollution. Dissolved oxygen of at least 5 ppm is required. Water could be supplied to the hatchery through feeder channel, pipe or gravity. Gravity method is preferable because it saves cost. A small waterfall from the supply tank is needed. This provides pressure for the devices. The required pressure ranges from 1.0-1.5 m fall. Stronger pressure is not necessary because it would harm the delicate eggs and larvae. When the water contains gases such as methane, hydrogen sulphide and limited dissolved oxygen, simple oxygenation filter can make it suitable for the hatchery.

Temperature: Most warm water fishes need water temperatures ranging from 20 to 30ºC for their propagation. Extreme cold or warm temperatures inhibit final gonad development. The eggs and larvae are very fragile. Therefore, the water must be analyzed to provide information on its physical, chemical, biological and microbiological properties. Emphasis should be on the following:

- Physical properties such as temperature, turbidity, transparency and odor.
- Chemical properties such as pH, dissolved oxygen, free carbon (iv) oxide, salinity and ammonia. The levels at which these substances, are useful and toxic must be considered. The extent of pollutants from agricultural or industrial origin should also be investigated.
- Biological properties include the quantity and density of plankton; and
- Microbiological properties include the species and type of parasites

Economic and social factors: This involves the cost involved and reactions of people in the area of operation. The economic and social factors necessary for consideration in site selection include:

- Development plan for the project area
- Ownership, availability of land and cost of land
- Proximity to all
- Availability of equipment, service and supplies needed for running the project
- Availability of construction materials
- Availability of supplementary feeds
- Location of markets for the produce and determination of demand
- Cost of equipment, materials and feeds
- Availability of suitable transport facilities
- Availability of staff with adequate hatchery management skills
- Availability of skilled and semi-skilled labor
- Information on local financing methods or credits
- Political realities

Biological and operational factors:
These include:

- Species to be cultured
- Resources and availability of brood stock
- Type of project (small scale or large scale)
- Operational target
- Estimated size of area required

Negligence of these factors before choosing any fish hatchery site would lead to a failure of the project.

HATCHERY CONSTRUCTION

A modern hatchery and fish seed distribution center is composed of four different units.

- Brood fishpond
- The hatchery
- Nursery
- Fingerling rearing cum production ponds.

Brood fishponds: The brood fish provides several products for starting new generations of fish. It must be given adequate care. Smaller ponds are recommended for the harvesting and selection of brooders. Pond size

ranging from 200-1000 m^2 is adequate. Let the number, size and variety of species of brooders guide the pond size.

Brood fishponds should be a minimum of five meters deep and be supplied with sufficient water. Replenish the water lost by evaporation or leakage carefully. Store brood fish in an area with adequate security and easily accessible. Rectangular shaped ponds of (75x20) m^2 or (80x25) m^2 are adequate.

Hatchery: The hatchery is very important and needs water with good quality during the propagation season. Spent water from the hatchery can be diverted into other units in the center if properly treated. The hatchery includes tanks or containers where ripe brooders for induced spawning are kept. Ward basin tanks are used for the injected brood fish. The bottom of these basins has a gentle slope towards the drain. They can be completely drained easily. A turn down pipe serves for regulating the water level. The chain and peg is required to lock the turn down pipe in position. This prevents back flow of water from ward tank to the drain (Aluko *et al*., 2003).

Injected fish are stripped in 20-25cm deep and 50cm wide ditch along the longitudinal areas of the basin. This is because the fish could easily be taken from the basin for stripping without obstruction. The recommended sizes of basins are (2.5x1.5x1.0) m^3 for 4-10 breeders and (4x2x1) m^3 for more. Larger ward tanks should be avoided, especially for fish induced to spawn. Fertilized eggs obtained through stripping or induced spawning are incubated. The hatched larvae are reared to fry feeding stage in the hatchery. The tanks for a hatchery could be concrete, plastic, wooden, fibre-glass or hollow blocks, but water tight. Although concrete tanks are more durable, hollow block tanks could be used for temporal measures.

Concrete tank construction: The materials required for the construction of concrete tanks are sand, chipping stones of 9.2 mm size, cement, re-enforcement rods of sizes 8 and 10 mm, binding wire, nails, wood and plumbing materials. The wood and plumbing materials are for the inlets and outlets of the tanks.

The required personnel include carpenter, Manson, plumber, filter, unskilled labor and a fish culture engineer or an experienced fish culturist. The latter would guide in the construction of the facilities. A house to shelter these tanks for security and enhanced working condition is necessary.

Moderately heavy textured soils are good because weights of the whole structure rest on it. Soft soils are strengthened with gravel and sand. The mixture of the first base is 1:4:8; while the second base is 1:2:4. The first base is bigger than the tank. This balances the weight.

The entire walls, bases and tanks are re-enforced with re-enforcement rods and bundles. The re-enforcement materials at the base have continuity with that of the wall. The thickness of the wall depends on the size of the tanks. Tanks containing 16-20 m^3 water volume have diameters ranging from 10-15 cm thicknesses. The walls mixtures are 1:2:4. These are properly compacted during casting. The use of waterproof cement enhances the efficiency of waterproof tanks. The tanks are plastered inside. Plastering provides smooth surfaces. The right-angled joints are "rounded off". This makes easy clearing and reduced algal, bacterial and protozoan growth. Concrete pouring work is continuous. This prevents the concrete from drying out. Failure to do this would result in cracks and leaks at the joints. All tanks require a good drainage. A turn down pipe requires a gentle slope on the floor towards drainage. It is essential to "age" new tanks before usage. Filling the tanks with waters to remove any soluble toxic materials in the tank could do this. This could be carried out weekly for a period of one month.

Nursery, rearing and production ponds: The numbers of nursery, rearing and production ponds for a hatchery depend on the number of fry and fingerlings expected from the hatchery (Ayinla and Nwadukwe, 1988). The sizes depend on the following factors:

- Species bred
- Fecundity of the species
- Number of brooders
- Number of hatch able eggs
- Number of surviving fry to fingerlings

Nursery ponds could range from 200-500 m^2, while rearing and production ponds could range from 500-2000 m^2. The management of these ponds depends on the ability of the fish culturist. They could be rectangular in shape, but better when the width is half the length. This facilitates easy seining during partial harvesting. Proper drainage system in these ponds in necessary. The bottom measures 2.0-2.5 m from either side towards the middle measuring 2-3 m. A wide ditch of 0.5 m deeper than the flat surface of the bottom is constructed to provide refuge for the fish. The soil for these ponds should have a good percentage of clay that is watertight. The desired water levels in ponds are maintained during rearing at any season of the year (Brain and Army 1980).

FISH SEED HATCHERY

The source and means of procuring fish seed directly influence the production of fish from fish culture. Regular supply of fish fingerlings increases regular fish production. The cost of fingerling varies and is an important factor in determining the production cost. The production of eggs, larvae and fingerlings in a hatchery depends on the number of hatch able eggs, survival and growth rates of the larvae (Charo and Oirere, 2000).

In commercial fingerling production, certain investment in equipment, infrastructure and trained personnel are inevitable. These costs can be considered as part of the production cost of marketable fish.

For certain fish species, it is difficult to understand and control the stages of reproduction. Fish culturists depend on natural supply. For example, *Gymnarchus niloticus* and *Heterotis niloticus.* Fish reproduces in the hatchery when the conditions are similar to the natural spawning conditions.

There are various forms of controlled reproduction, but all achieve the same thing (fertilized fish eggs). In some cases, the adult fish are captured from the wild. In other cases, the fish is obtained from the fish farm itself. The various activities in hatchery fish seed production are:

- Brood stock management
- Hatchery management proper
- Nursery management

Brood stock management: Brood stock management involves caring of the brooders from the time the fish was captured and brought for breeding to the time of spawning, stripping and returned. Brooders could be obtained from the wild or fishpond. Wild brood fish can be easily captured during:

- The breeding season when mature fish aggregates or migrate towards shallow spawning grounds; or
- The dry season, when they are relatively concentrated at the shallow areas of their natural habitats.

Handling and transportation of brood fish from the wild is carefully done. Brood fish from the wild are disinfected and parasite removed with a formal dehyde bath (15 ppm for 6 h) together with a fungicide (Malachite green 0.2 ppm) and bactericide (furaltadone or furazolidone, 10 ppm for 1 h). This can be applied daily for four days after transportation. This prevents disease out break; though, infections from the injuries incurred during the handling and transportation Richter and Van Der Hurk, 1982).

Brood fish from the wild are reared in special ponds for the maturation of gonads, and are prepared for spawning. Sexual maturation of the fish is facilitated by the external factors:

- Temperature
- Photoperiod
- Water volume
- Salinity
- pH

With a corresponding internal change resulting from hormonal activity, adequate feeding before spawning occurs can ensure health care for brood fish. Sexing of fish prior to spawning is inevitable. Fishes such as *Clarias* spp., *Heterobranchus* spp and the tilapias are sexually dimorphic. There is no difficulty in sexing these fishes. Mature brooders of carp and *Heterotis spp* release eggs/milt when pressed gently on the abdomen. Most inland fresh water fish breed during the rainy season except the tilapias and carp which breed all year round (Ezeri *et al*., 2009).

Maturation of gonads needs certain amount of temperature referred to as “hour grades” or “day grade”. Length of photoperiod is also important but excludes equatorial fish species. In the equatorial region, a change in length of days with the solar year is minimal. The intensity of light in the breeding environment can also play an important role. Some species breed in daylight. Others breed in the dark. The physical and chemical parameters of the water are optimal. Stocking densities are low. This avoids stress and facilitates the maturation of the gonads.

Feeding of brood stock is important. If adequate feed is not administered to the brood stock, cellular modifications in the hypophysis and a reduction of secretions in gonadotropins occur. There is therefore the need for proper feeding prior to breeding. The feeds are composed of different feed ingredients devoid of an unknown deficiency. Fish fed with the ingredients: protein, lipids, calcium and phosphate are sufficient for egg yolk production.

The rearing of fingerlings to mature fish in fishponds is alternative to capturing brood fish from the spawning grounds. At harvest, mature fish are selected and transferred to holding units in the hatchery or a special fishpond. Brood fish of weight ranging from 0.5-1.0 kg are preferable. They have substantial quantities of eggs and are easy to manipulate. The period of indoor rearing of fry to fingerling size of 1g varies from six to eight weeks. However, this depends on the water temperature and feed quality. It implies that artificial propagation can be carried out every six to eight weeks. If the fingerlings are raised in ponds, artificial breeding can be carried out once or twice every month in order to meet the annual production of fish fingerlings.

Rearing of brood fish: Both intensive and extensive fish culture require adequate sexual products as pre-requisites for artificial propagation. Therefore, sexually mature and healthy brooder kept in suitable environmental conditions with adequate food supply are mandatory. Optimal hatchery management is required to maintain brood fish under optimal conditions.

The brood fish maintained in the hatchery can be captured with a rectangular hand net after reducing the water level in the tanks. A seine net can be used in the capture of brood fish from fishponds. Mature female fish are chosen based on the criteria:

- Well-rounded and soft abdomen extended anteriority from the pectoral fin to the urogenital papilla.
- Mature eggs with clear nucleus at the center obtained easily by slight pressure on the abdomen.
- The genital opening is swollen and reddish or rose in color.

There are seldom-external characteristics peculiar to the mature male fish. A more elongated swollen urogenital papilla describes the "ready to spawn" males.

In practice, it is convenient to select the breeders in the morning and administer the hormone in the evening. Selected breeders are kept in a plastic pool or basin filled with well-oxygenated clear water, covered with a board to prevent the escape of the fish. Careful handling with hand net and wet towels is necessary for the proper health care for breeders during artificial reproduction. The selected breeders are starved prior to stripping.

SPAWNING METHODS

Several spawning methods can be used in fish culture for the production of fry and fingerlings:

- Natural spawning without hormonal treatments. This is through the simulation of natural spawning conditions in ponds or tanks.
- Natural spawning with hormones. The final maturation of gametes is achieved through the administration of hormones. The fish spawn naturally in the pond or tank after hormone administration.
- Artificial spawning with or without hormone treatment. Sexually matured brood fish are obtained through the administration of hormones. The eggs are stripped from the female brood fish manually. Fertilization is also done manually. The eggs are incubated for hatching.

Hormone in fish spawning: Hormone action is particularly concerned with metabolic activities that is anabolic (building up processes) and catabolic (breaking down processes) in the cytoplasm. By altering the balance of these, hormones are able to coordinate such long-term changes as growth and maturation, which are less suited to nervous control. Both nervous and endocrine mechanisms use basic properties of the living cell, such as secretion and the propagation of impulses. It is not possible to decide which type of coordination came first in evolution and both methods are closely connected. The hypothalamus in vertebrates contains certain neuron-secretary cells specialized for the production of hormones. In many cases neurons secrete a hormone for synaptic transmission (Fagbenro *et al*., 1991).

The build-up of gonad hormones in the female during maturation of the ovum suppresses the secretion of pituitary gonad tropic hormone. During the lifetime of the animal, the balance of hormones, sometimes called the hormone spectrum, is continuously changing and controlling the direction of its activities. Certain prolonged conditions such as exposure to stress or cold may led to increase in the size of the endocrine concerned, in this case the adrenals which is an adaptive change analogous to learning.

The mediator between the environment and the animal, that is, the nervous system and especially by the hypothalamus, is in close proximity to the pituitary. This is described as the "master gland", and is situated below the fore brain. It can be stimulated directly by external environmental change. The working of the pituitary is also related to the hypothalamus, which integrates so many of the visceral activities (Hogendoorn, 1981).

In fish, hormonal control of reproduction is secreted and relayed by the secretion of successive hormones by various organs. The environmental stimulus is received by the brain, which transmits the information to the hypothalamus and subsequently to the pituitary. The stimulus is transmitted from the gonads, which produce the sexual hormone. The control of the activities is at three levels:

- Hypothalamic
- Pituitary
- Gonad level

Final maturation precedes ovulation and can be easily induced in *clarias gariepinus*. The success of artificial propagation depends on the number of post vitellogenic ovocytes in the ovary. These are the size of the female gonad and gonad maturity. Roundness of the abdomen and the number of post vitellogenic eggs from the ovary are signs of gonad maturity. The number of post vitellogenic eggs can be obtained by inserting a crannule of inner diameter ranging from 1-1.5 mm into the urogenital orifice and carefully sucking out some eggs. The diameter of the eggs can be measured with a binocular, using a micrometer or millimeter paper. This sample represents the egg development of the ovary because maturity of different parts of gonads is similar.

Hypophysation: This is the process of inducing fish to spawn through the use of hormones. The pituitary gland provides one of such hormones. The pituitary gland is extracted and preserved in alcohol or cerine. The whole pituitary gland can be used fresh or dried. It is ground, placed in a suitable solvent and centrifuged. The extract is administered to female fish or both sexes.

Other hormones used are Human chronic gonadotropin (HCG), Leutinizing hormone (LH) and Follicle stimulating hormone (FSH). Both pituitary extract and these hormones are widely used. The dose

used varies with fish breeders since no standard dose exist for all fish species. However, the recommended dose of 2 to 6 mg/kg of body weight for pituitary extract is adequate (Nwadukwe *et al*., 1991).

The use of hormones to induce maturation, spawning and sex reversal of captive fish is one of the most important and exciting areas of Aquaculture research. Fish that are already in breeding condition and have matured eggs in which the germinal vesicle has migrated can easily be induced to spawn by injection of naturally occurring reproductive hormones or their synthetic analogs.

Numerous hormones have been used to induce reproduction:

LHRHa: Leutinizing hormone releasing hormone is the name of a mammalian hormone that has been employed successfully to induce reproductive hormonal cascade. Argent laboratories, USA, manufacture its analogue referred to as LHRHa. It is many times stronger than naturally occurring one. Fish because they are pure and are not rapidly metabolizes this; they remain active for longer periods. Research has shown this to be the most potent maturation and spawning hormone. LHRHa is not specific to any particular species and should be applicable universally to all species. When dopamine is present in the fish, even LHRHa will have only limited success. A dopamine antagonist is used to limit the effects of dopamine. When, LHRHa and a dopamine antagonist such as Pimozide (PIM) are used together, reproductive success increases.

Possible combinations:

0.05 mg LHRHa+1 mg PIM/kg body wt
0.05 mg LHRHa + 5 mg PIM/kg body wt

WOVA - FHTM: Wova-FH is manufactured by WOCKHARDT, one of the largest pharmaceutical companies in India. WOVA-FHTM can be used for induced breeding in carp and catfish. The trade name is WOVA-FHTM-Synthetic Gonadotropin analogue (WoVA-FHTM-SnGnRH). Performance of WOVA-FHTM has been assessed in some of the government and private hatcheries in Andra Pradesh, West Bengal, Orissa and other places. Results proved that WOVA-FHTM is very effective synthetic fish hormone for induced breeding.

Advantages:

- High fertilization and hatching rate
- Single dose administration
- No stress to the brood stock
- Easy inject ability
- Cost effective
- Stable at room temperature and long shelf life
- Easily available and ready to use

Dosage:

Species	Sex	MI/kg body weight
Rohu	Male	0.1-0.30
	Female	0.3-0.5
Catla	Male	0.1-0.30
	Female	0.3-0.50
Mrigal	Male	0.1-0.30
	Female	0.3-0.50
Cross carp	Male	0.01-0.30
	Female	0.4-0.80
Silver carp	Male	0.1-0.30
	Female	0.4-0.80
Catfishes	Male	0.2-0.40
	Female	0.6-0.90

- Dosage of WOVA-FH can be adjusted depending on the brood stock, weather and agro climatic conditions.

STORAGE: Store below or at 25ºC.

OVAPRIM: Domperdone in combination with Salmon gonadotropin - releasing hormone SnGnRHa is packaged in one preparation (Trade name: OVAPRIM). Syndel laboratories, Canada, manufacture Ovaprim. Ova prim contains 0.02 mg SnGnRHa and 10 mg of domperidone. Domperidone is adopamine antagonist. Ova prim is popularly used in inducing ovulation and spawning in freshwater fishes (Makinde, 2001).

The company recommended dosage of ova prim is 0.5 mL/kg. However, Mrigal, Rohu carps and African catfishes have been induced with single intramuscular infection of lower dose of ova prim.

Human Choronic gonadotropin (HCG): Less specific method of inducing spawning is to augment serum gonad tropic levels by injection of HCG. HCG is a cost effective method of inducing spawning but it is primarily used on ripe fish to ensure completeness of spawning as well as maximum output.

HCG is perhaps the oldest agent commercially used in induced spawning. Each vial of GCH contains 10,000 i.u units (international unit) of Human Chorionic Gonadotropin with a separate 10 c. c vial of sterile diluents water. HCG is often used as a primer with pituitary extracts of salmon or Carp as well as with Synthetic hormones like (LH-RH). Doses vary from 45 i.u/kg to 12500 u/kg depending on species and maturity of the recipient fish. However, 4.0 i.u/g body weights was recommended in inducing *Clarias gariepinus* to spawn (Richter and Van Der Hurk, 1982).

Carp pituitary extract (CPE): Argent Chemical Ltd. U.S.A manufactures acetone-dried carp pituitary extract. It is a very effective agent extracted from carp fish pituitary. Sodium Chloride solution, 0.6-0.7% (Physiological salt solution) is used as solvent for pituitary gland solution. This solution can be obtained by

dissolving six to seven grammes clean common salt, free from iodine, in one liter distilled, or boiled tap water. Addition of 10% glycerin to the solvent is recommended to increase the viscosity of the solution, which will reduce wastage of the solution by retracting after injection.

Preparation of pituitary gland solution: The quantity of pituitary extract as well as the quantity of solvent required for each propagation can be calculated from the estimated total body weight of the females to be treated as illustrated in Table 1.

Estimated of hormone solution to be injected:

- Concentration of pituitary gland solution 20 mg/10 mL = 2 mg/L
- Weight of female = 500 g

- Required quantity of pituitary gland (4 mg/kg x 0.500 kg) = 2 mg

- Required quantity of hormoneSolution (2.0 mg/2 mL)

The recommended dosage is 6 mg/L, for induction of *Heterobranchus species*.

Deoxycorticosteroid acetate (DOCA): Oocyte maturation can be induced with DOCA, but ovulation will need to be evoked mechanically. The use of DOCA is not usually recommended since this compound only induces pre-ovulation or final maturation.

In induction of *Clarias gariepinus*, Deoxycorticosteriod acetate doses are as follows:

- In water solvent, 5 mg/100g body weight
- In oil solvent, 2.5 mg/100g body weight

Fresh pituitary: Acetones dried of fresh fish pituitary are used in one pituitary to one female fish ratio. The hormone is administered in a single injection and spawn the fish within 8 to 24 h. The dosage used and frequency of spawning depends on the quality of the pituitary extract and the stage of the female fish maturity. However, it is necessary to determine the proper dosage in each case. The doses for human choronic gonadotropin vary from 45 to 12500 ui/kg, depending on the fish specie.

Compounds used for induced breeding: The compounds commonly used for induced artificial propagation include

- Acetone dried carp pituitary at 4 mg/kg body weight
- Acetone dried or fresh pituitary of 4 mg/kg body weight
- Human choronic gonadotropin (HCG) at 4.0 iu/g. body weight

Table 1: Preparation of pituitary gland solution

Species	*C.gariepinus*
Number of females	10
Average weight of females	500 g (0.5 kg)
Dosage	4 mg/kg
Total weight of females	5 kg
Quantity of pituitary powder (5kg x 4 mg/kg)	20 mg
Quantity of solvent 1 mL/500 g body weight	10 mL

Ayinla and Nwdukwe (2003)

- Deoxycorticosterone acetate (DOCA) in water solvent (5 mg/100 g body weight and in oil solvent, 2.5 mg/ 100 g body weight)

Hypophysation with frog pituitary extract induces final maturation and ovulation in *Clarias anguilaries*. The hormone dosage required varies with "readiness" to spawn of the female fish. The "readiness" to spawn of the female fish depends on the season, age, size sensitivity and farming conditions. It is easier to use whole glands of approximately the same size of fish than pulverized glands. The use of pulverized glands require a microbalance for weight measurement, because, only some milligrams are needed for each propagation. The pulverized glands can be easily contaminated with adulterated brain tissue. The hormone is administered by a single decisive dose to the female fish (Richter and Van Der Hurk, 1982).

Pituitary gland solution preparation: Physiological saline can be used as solvent for pituitary gland solution. Ten percent glycerin can be added to increase the viscosity of the solution. This reduces injected hormone wastage by retraction after injection. Adequate quantity of hormone solution should be used. A mL pituitary gland solution per 500 g body weight is adequate.

The required fresh pituitary gland from the donor fish is extracted, defattened and dehydrated in acetone or alcohol. This is placed in physiological saline, macerated and allowed to settle. The supernatant is administered to the female fish. Pulverized acetone dried pituitary gland is weighed and placed in a small dry porcelain mortar. The measured quantity of glycerin is initially added to facilitate pulverization of the powder or glands preceding the salt solution (Richter and Van Der Hurk, 1982).

Hormone administration: Brooder female fish of approximately equal sizes are selected for hormone administration. All female fish can be injected with the same quantity of pituitary gland solution. Otherwise each female fish be weighed and the quantity of useable hormone solution estimated. Intramuscular injection into the dorsal muscles above the lateral line below the anterior part of the dorsal fin is the commonly used technique. This can be done using a graduated syringe ranging from 2 to 5 mL.

It is preferable to administer hormones in the evening. However, the injection time depends on the water temperature and desired time of stripping. Handling of brooders should be done with care, using a wet towel. The females are gently kept in covered containers after hormone administration (Richter and Van Der Hurk, 1982).

Spawning and rearing: In the mass production of fry and fingerlings, semi-natural or hormone-induced propagation of fish species in ponds or tanks is not a reliable method. This is the case with the mass production of *Clarias gariepinus* fingerlings. Therefore, artificial propagation in a hatchery under controlled environmental conditions is necessary to ensure production *en masse* of fry and fingerlings. The advantages of artificial propagation resulting from artificial fertilization, fertilized eggs incubation and subsequent rearing to fingerlings are:

- Better fertilization rate and hatching
- Protection from predators and unfavorable environmental conditions.
- Better growth and survival conditions.

Steps in artificial propagation: The artificial propagation of fin fishes involves a chain of activities similar to natural production. For example, the process involved in the artificial propagation of *Clarias gariepinus* is:

- Brood fish selection from nature or fish ponds
- Brood fish rearing
- Inducing final maturation and ovulation with hormone treatment.
- Treatment of the male and milt collection
- Stripping of the female and egg collection
- Artificial fertilization
- Incubation and hatching of eggs; and
- Larvae and fry rearing.

HATCHERY MANAGEMENT

This involves the collection of male and female gametes for artificial fertilization or the collection of fertilized eggs from spawning mats, heaps and spawning receptacles; incubation of fertilized eggs, hatching and maintenance of hatchling (Nwadukwe *et al*., 1991).

Procurement of ripe eggs: Pre-ovulation is continuous after the administration of the correct hormone dosage. The eggs must be spawned or stripped once, these processes, start. The physical effects of induced pre-ovulation on the ovocytes are:

- Increasing diameter due to hydration
- Changing of color from transparent green to brownish green; and
- Flattering (hollowing)

It is obvious that only post-vitellogenic or dormant ovocytes respond to the hormones treatment. Only the transparent ovocytes in which pre-ovulation occurred would be discharged into the ovaries and fertilized. Early stripping results in incomplete ovulation. Late stripping results in overripe ovulated eggs and subsequent resorption. The incubation of unripe or overripe eggs result in relatively low hatching rates. Therefore, it is essential to strip females as soon as the main bulk of the eggs are ovulated. Majority of eggs mature and ovulate simultaneously. The required time for pre-ovulation and ovulation (latency time) varies with the water temperature. Latency time is inversely proportional to the water temperature. When HCG is used, the latency time is slightly extended compared to when fresh pituitary gland is used. The latency time at 25ºC is 13 h for fresh pituitary gland and 14-16 h for HCG (Nwadukwe *et al*., 1991).

The ovulated female fish is carefully caught with a hand net and held with head pressed by two persons using wet towels. One person presses the abdomen of brood fish gently with the thumb from the anterior pectoral fin to the genital papilla. A second person holds the tail strongly. If the spawner female responds positively to the hormone treatment, ovulated eggs easily flow out in a thick jet from the genital papilla. The eggs are collected into a dry plastic or enamel bowl. When stripping is complete, only few eggs flow out. Most often, the appearance of some blood with non-transparent eggs is an indication that almost all the ovulated eggs have been released. The spawner female fish is now called “spent”.

Procurement of Milt: The spermatozoa from a male spawner fish are obtained an hour to stripping. It is difficult to strip the male for milt. This is probably due to the anatomical structure of the seminal vesicles. Therefore, milt is obtained by sacrificing a spawner male fish. Its testes are dissected and small incisions are made into the cream colored lobes of the testes.

The milt can easily be squeezed out and collected into a vital or small bottle. This process can obtain several droplets of milt. Milt can be diluted with physiological saline solution. Contact with water should be avoided. Otherwise, the spermatozoa lose its ability to fertilize mature fish eggs. Milt solution can be stored in a refrigerator for one or two days without affecting its activity (Nwadukwe *et al*., 1991).

Fertilization: The union of the male’s spermatozoa and the female’s mature eggs to form a zygote is referred to as fertilization. In fish, the fertilization period is limited. This is because; fish eggs swell immediately when in contact with water, resulting in the micropyle closure. For common carp, the fertilization period is within 45-60 sec. In most other fish species, it is limited to few minutes.

Special precaution must therefore be taken to the application of water during artificial fertilization. Three methods are commonly adopted in the artificial fertilization.

- The wet method: Sexual products are stripped simultaneously into a receptacle containing a small quantity of water
- The dry method: Sexual products are stripped into a dry receptacle, mixed properly before the addition of water
- Super dry method: Eggs are stripped into a sieve to eliminate the egg fluid before the application of dry fertilization method

The most popular method used is the dry method. In this method, one or more female spawners are stripped. Few drops of milt solution are poured on the eggs. The sexual products are mixed by gently shaking the bowl. Adding few drops of physiological saline solution can facilitate mixing. An equal volume of clean water can be added. The water and egg mass are thoroughly mixed by gently shaking the bowl. The spermatozoa seize to fertilize any egg after 60 sec. The micropyle also closes which makes further fertilization impossible (Nwadukwe *et al*., 1991).

Incubation and hatching: Fertilized eggs are incubated in stagnant or running water in incubation troughs containing small trays or boxes. These trays have a perforated bottom made up of mosquito netting. The incubator is filled with clean, well-oxygenated water, free from plank tonic organism. The eggs are spread homogenously in one single layer in the incubation tray. These trays are made in such a way that the eggs are continuously oxygenated by induced water current. Fertilized eggs swell and become sticker when in contact with water. His stickiness is strongest within 30-60 min interval but disappears with time at the end of the incubation period. Therefore, incubation is carried out promptly after fertilization. It should not be more than 60 sec after mixing egg mass and water. Incubation period changes with increasing temperature. At a temperature of 25ºC hatching takes place in 28-32 h after fertilization. It is 22-24 h at 30ºC. The hatching percentage is 80-90% when small quantities of eggs are incubated. The total of 70% of healthy larvae can be obtained through this method of incubation.

The fertilized eggs develop normally if the incubation conditions mentioned earlier are provided. However, it is not mortality free. Three to five percent of the eggs die a few hours after incubation and a relatively higher percentage during hatching. Higher mortalities are abnormal and can be caused by:

- Wrong latency period
- Over stressing of female spawners during latency period
- Incubation of more than one layer of eggs per incubation tray
- Poor incubation conditions

NURSERY MANAGEMENT

Nursery management starts from the hatching stage to free swimming feeding fry stage. However, in most breeding centers, activities in the hatching unit overlap with those of the nursery. These two stages are regarded as the most delicate aspects of fish breeding. Hatching and its survival depend largely on the efficient management of these stages. The management processes of the nursery unit are centered on adequate supply of good quality water, quality food acceptable to the fish and maintenance of good environmental sanitation.

Newly hatched larva depends entirely on the yolk sac for energy, growth and development. When the yolk sac is virtually desorbed, the fish feeds on exogenous food. Food selectivity and acceptability are very crucial factors in the survival and development of “fry” and fingerlings. Fingerlings are four or more weeks old fry.

Larva separation from eggshell and spoiled eggs: The yolk sac contains high quality food reserve for growth and development of the lava. The hatchling weighs 1.0-1.5 mg and measures 4 mm. They assemble in dark places on the trough bottom. The separation of healthy larva from egg ruminants and spoiled eggs is automatic when incubation is done in perforated trays. The trays can be removed as soon as hatching is complete and fish larva is assembled under the incubation trays. Eggshells, dead eggs, and deformed larva are removed by siphoning (Ayinla and Nwadukwe, 1988).

Larval rearing: The technology employed for mass rearing of larva and fry in in-door facilities is the flow-through technique. This technique is based on the following principles:

- In-flowing water ensures water quality requirements
- In-flowing water permanently replaces used water
- Out-flowing water removes the accumulated metabolic wastes and feed ruminants
- Fish assemble in small easily controllable areas

The device employed for egg incubation is similar to that of larval rearing. The difference is the absence of incubation trays in the latter. Water level in the larval rearing tank can be adjusted by changing the stand or turn down pipe position. A fine mesh (1.00 mm) screen is placed diagonally anterior to the water outlet. The screen

should be cleaned several times a day to prevent an over flow of water from the rearing device and subsequent loss of young fish. The recommended water level in the larval rearing device ranges from 12 to 15 cm.

Fish lava need well oxygenates water saturated with air. The minimum required dissolved oxygen level is 5 mg and the optimum temperature for rearing ranges from 22 to 30ºC.

Larva nursing: Fish larvae become a feeding fry in 3-4 days interval when 70% of the yolk is absorbed. This can be observed when the larvae begin vigorous swimming in a fish like manner, searching for external food. The presence of yolk at this stage ensures its survival because the fry need time to learn the processes of finding its food. The fry finds adequate food quantitatively and qualitatively to ensure its proper development, once the yolk sac is fully absorbed. Otherwise, they are weakened beyond recovery, which can stimulate cannibalism.

The development of major organs and completed metamorphosis after 10-18 days marks the end of the early fry stage. During this time, the necessary air-breathing organs have developed and the fry frequently rise to the surface to breathe atmospheric air. This is the beginning of advanced fry stage (Ayinla and Nwadukwe, 1988).

Two nursing techniques are:

- Nursing in indoor facilities commonly referred to as hatchery nursing; and
- Nursing in out-door facilities commonly referred to as pond nursing.

Hatchery Nursing: This involves the processes in nursing from the early fry to advanced fry.

Early fry Nursing: This stage is very sensitive and delicate, requiring a more precise and conscientious care. Lack of suitable food and improper hygiene are main causes of fish fry mortality. Feeding fry are kept in the incubator or larval rearing troughs. The farming condition of early fry is similar to those for larvae.

Clarias gariepinus fry can be nursed successfully with the following feeds:

- Live zooplankton moina
- Live or frozen nauplic
- Decapsulated artemia eggs

A variety of artificial dry feeds are used for the primary nursing of *Clarias gariepinus*. Feeding the fry with zooplankton from neighbouring fresh water fishponds seem to be the most reliable technique in Nigeria. This is because the importation of *Artemia* eggs is difficult. A moderate hatchery needs a minimum of 0.1 ha pond to produce the required quantity of zooplankton. Large quantities of zooplankton can be collected daily with mesh plant net ranging from 100-150 mm mesh size.

Artificial feed seem to be good for fry rearing. But, its use requires constant cleaning of the concrete hatchery troughs. Early fry must be fed six times a day between 6.00 am and 8.00 pm. Feeding the fry in every 3-4 h a day is better. Mortality during the early fry stage is negligible under optimum nursery management (Ayinla and Nwadukwe, 1988).

Advanced fry nursing: The early fry becomes advanced fry when metamorphosis is complete. The supra-branchial air chamber is filled with air. Young fish accepts and grows well on artificial dry feeds. The advanced fry are then transferred to nursery troughs. The transfer of advanced fry to the nursery trough is a delicate procedure and must be done carefully by siphoning into a bucket. The content of this bucket can then, be gently released in the nursery device. The recommended dissolved oxygen level for advanced fry nursing is 3 mg/L.

The feed must have the correct particle size (0.35-0.50 mm for fry ranging from 50-100 mg; 0.50-0.75 mm for 100-250 mg and 0.75-1.25 mm for 250 mg-1.0 g). It should be easily recognized chemically and optically by the fish fry. The feed particle must be water stable to reduce nutrient leaching. It should have a low moisture content to allow adequate storage. The complete range of nutrients required for fish fry should be present in each particle.

The fish fry accepts artificial diets from 10-18 days after hatching. This change from live food items to artificial dry feed is a major turning point in the life of a nursed fish. The change can be gradual to enable the fish adapt, recognize and accept artificial feeds. Therefore, the quality of artificial feed can be increased gradually during the first week of artificial feeding. During this time, the live food feeding can be proportionally reduced and finally stopped. The advanced fry weighs a minimum, of 1g after 5 to 8 weeks. At this weight, they can be harvest and transferred to grow-out or fattening ponds. A survival rate of 70 to 80% can be obtained under optimum management.

Fry nursing in earthen ponds: Fry can be nursed to the fingerling stage for the period of one month. The number of ponds required depends on the productivity of the ponds and the quantity of fingerlings to be produced. A moderate fish seed production center aiming at an annual production of one million fish fingerlings needs of 800 m^2 of earthen nursery ponds is based on an estimated average production of 12,500 fingerlings per 100 m^2 per year.

The size of the pond can vary from 200 to 1000m^2. Rectangular ponds ranging from 19 m×20 m to 25 m×40 m are good because this can facilitate seining.

These ponds should have a water level of 50 to 100 cm. Higher depths should be avoided in order to conserve energy the fish would have used for swimming (Ayinla and Nwadukwe, 1988).

CONCLUSION

The vital requirements of fish hatchery, hatchery construction, concrete tank construction, nursery, rearing and production ponds, fish seed hatchery, hormone in fish spawning, hypophysation, compounds used for induced breeding, hormone administration, spawning and rearing, steps in artificial propagation, hatchery management, nursery management are vital tools in effective hatchery management and need to be adequately addressed in fish culture.

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