COURSE CODE:	FIS313
COURSE TITLE:	Fish Farming Techniques and Hatchery Management
NUMBER OF UNITS:	3 Units
COURSE DURATION:	Three hours per week

COURSE DETAILS:

Course Coordinator: Dr. (Mrs.) O.T. Agbebi
Email: agbebi20@yahoo.com

Office Location: Room D204, COLERM
Other Lecturers: Dr. A.A. Idowu and Prof. G.N.O. Ezeri

COURSE CONTENT:

Artisanal and commercial fishing methods and different types of fish culture techniques, monoculture, polyculture, selected breeding, intensive and extensive culture inland land brackish water, in rice field, in floating cages and rafts. Spawning methods; artificial fertilization, incubation, rearing, harvesting and transportation of fry and fingerlings. Selection and care of breeders; larvae and fingerlings. Control of weed parasites and diseases in the hatchery, control of physicochemical properties of water.

COURSE REQUIREMENTS:

This is a compulsory course for all students in Departments of Aquaculture & Fisheries Management and Forestry & Wildlife Management. In view of this, students are expected to participate in all the course activities and have minimum of 75% attendance to be eligible to write the final examination.
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READING LIST:

LECTURE NOTES

ARTIFICIAL FERTILIZATION

Artificial production of fish seed involves human intervention in the natural propagation processes. This may be achieved by creating appropriate environmental conditions which are conducive to the spawning of the species. More commonly, the fish may be artificially induced to ovulate and spawn through injection of natural and synthetic reproductive hormones. Artificial production of fish seed is beneficial to the fish farmers in that the juveniles of the required species can be produced as when required, irrespective of the quantity and the time of the year. It

also makes possible the production of seed from good quantity stock and hybrids of desired species. The processes of artificial production of fish seed are carried out in enclosures known as hatcheries which may be an indoor or outdoor facility and require various inputs like brood stock adequate water supply and suitable feed. The sequence of steps involved in artificial production of seed is as follows:

Transfer of mature spawners to spawning ponds
Selection and segregation of
potential spawners
Brood stock maintenance
for maturation
Selection of gravis spawners
during breeding period
Hypophysation or hormone
treatment
Stripping of fish
Artificial fertilization
of eggs
Incubation of
fertilized eggs
Hatching
Natural spawning
Removal of
brood stock
Harvesting of
seed

Sequence of steps in the artificial rearing of fish seed

INDUCED OVULATION AND SPAWNING

In culture conditions, most fishes need to be induced before yielding their gametes during sexual reproduction. Two techniques can be used:

(1) Induced Spawning by Stimulation of Appropriate Environmental Conditions

Provision of natural nesting materials such as grasses in the littorals and slowly rising water level will stimulate nest building and subsequent spawning in *Heterotis* and *Gymnarchus.* The most frequently used artificial spawning substrate used for common carp, *cypnnus carpo* and the mudfish, clarias species, are known as "kakabans". These are mat-like structures made of polythene fibers, pine tree branches or similar, materials each measuring up to several square meters in area. They are spread on the pond floors and anchored with sticks or suspended about 20 – 30cm below water surface. Small drums, cut bamboo stems and PVC pipes cut in one meter length and sealed at one end are required to act as spawning receptacles for brooders such as chryichthys species in ponds.

(2) Inducing Ovulation and for Spawning by Hypophysation

In meter, ovulation in a fish is regulated and brought about by the gonadotrophic hormone produced and stored by the fish's pituitary gland**.** The stored hormone is released into the blood when all requisite external and internal conditions become favourable. In hypophysation technique, gonadtrophic hormones extracted from the pituitary gland of another fish called the donor, is administered to the brooder. At appropriate dosage, this may bring about the ripening of the fish gonads and trigger spawning activities. Hypophysation can also be achieved by using artificial preparations containing human chorionic gonadotopin (HCG) or synthetic cortico-steriods e.g. decontrasterone acctate (DOCA) dissolved in glycerine.

One to two milliliters of the extract is carefully injected into the dorsal muscle or the abdominal cavity of the fish. Extracts from the pituitary glands or ripe fish of the same species with matching weight are known to be most effective, though carp pituitary extracts are effective on several other especially salmonids and catfish.

CARE OF BROOD STOCK

Sexually ripe and healthy fish are the pre-requisite for any kind of artificial or semiartificial propagation. They can be obtained from natural waters just prior to the spawning ground or by fish raised on farms.

TREATMENT OF STRIPPED EGGS ANND MILT

Spawning male and female are removed from the holding tank and dried with a towel.

The genital area is lightly pressed to remove faeces from the lower gut and any interstitial tissue which may contaminate the gonad product.

The eggs of ovulating females and ripe males are stripped into plastic bowls and mixed by swirling or stripping with a feather or plastic spoon. Stripping is carried out by applying moderate pressure on the flank of the spawner which results in the release of the gonad products. If heavy pressure is required or blood is exuded the fish should not be used as it is probably not ready for spawning. Distilled water is then added to the mixture of eggs and milt. This solution temporarily reduces the stickiness of the eggs and prolongs the fertilizing capacity of sperm.

INCUBATION AND HATCHING

The fertilized eggs can be incubated in a large inverted bottle until the flat bottom cut off. This bottle is called a zougar jar. A slow flow of well aerated, 25^{o}C water is introduced at the bottom of the jar sufficient to just keep the eggs afloat. The water is allowed to overflow over the top of the jar.

At this stage, no difference can be seen between fertilized and unfertilized eggs and all must be incubated. However, 6-7 hours after incubation, unfertilized eggs become white and opaque and discontinue development. Because theses eggs are prone to fungal or bacterial infections, which may be transmitted to the healthy fertilized eggs, they must be removed, usually by siphoning with a rubber tube.

The fertilized eggs are retained in this jar until they hatch. The yolk sac hatchling are transferred into shallow rearing troughs and trays where they grow until their yolk sacs are absorbed.

CARE OF THE LARVAE

After absorption of their yolk sac, hatchlings are better fed with pure cultures of phytoplankton for about 2 to 5 days, depending on the species. As the larvae get large they are fed with zooplankton organisms such as Artemia larvae. Larvae clarias can be on formulated diet containing 37-40% crude protein. The feed is powdered through sieves of mesh sizes 55-65m and fed to the larvae twice daily. Larvae grow rapidly to the fingerling stage and these can be transferred to fingerling ponds after 3-4 weeks.

PRACTICAL

INDUCED BREEDING

The most common technique employed to induce final maturation and ovulation in African catfish is to inject the female with hormones or pituitary gland materials. The required quantity of powdered acetone dried pituitary material or the required number of whole pituitaries are pulversed in a porcelain mortar, mixed with the required quantity of physiological salt solution (9g of common salt/liter of water). A syringe is filled with the suspension and the injection can be given.

Note: Fill the syringe, insert the needle and supply the syringe again into the mortar, when this is possible you can start injecting the fish. This procedure has to be followed always, as the needle often gets blocked if the pituitary material is not completely crushed and it is unpleasant for the fish and annoying for the operator to resolve this problem once the needle is inserted into the fish.

The most common method of administering the hormone solution is by intra-muscular into the dorsal muscle.

Note: Cover the head of the breeder with a wet towel in order to keep it quiet during injection. In general, fish keep still if their eyes are covered.

MATURATION PROCESS AND STRIPPING OF EGGS

The process of final maturation (migration of the nucleus fusion of the yolk, breakdown of the germinal vesicle meiotic division) and ovulation (rupture of the follicles and accumulation of ripe eggs in the ovary cavity) cannot be stopped or reversed after administration of the correct hormone dosage. Once these processes start, the egg can be spawned or stripped.

Note: normally, the females are injected in the afternoon and are kept (separated from the males) in holding facilities. The holding facility can be a concrete basin inside a hatchery, a happa inside pond or even a simple plastic bucket or a half drum will do. Of a major importance is that the breeders can be caught easily the morning after injection to avoid spoilage of eggs.

The speed of the process is dependent upon water temperature, the higher the temperature, the quicker the eggs ovulate. The relationship between temperature and the time taken for eggs to ovulate is given below:

The time taken between injection and stripping of female Catfish in relation to water temperature

Note: Sometimes with fluctuating water temperature, and in particular with higher temperature during the day, it is difficult to establish the actual mean water temperature. This can result in eggs being stripped too early with consequently very low hatching rate (5-19%). Eggs which are stripped too early tend to have a tready consistency. It is always much safer to strip the eggs later rather than earlier. If you are too early you will lose all your eggs, if you are too late you will lose some eggs. The eggs ooze out very easily if stripped at the right time.

Stripping of the female spawners is carried out by gently pressing their abdomen from the pectoral fin towards the genital papilla. Ovulated eggs will flow out easily in a thick jet from the genital vent and are usually collected into a dry plastic container. The ovulated eggs are more or less transparent, flattened and1g contained approximately 600 eggs. Under normal conditions a "ripe" female ovulates a quantity of eggs which equal 15.20% of her own body weight. If the fish is stripped too early the eggs come out with difficulty, whereas they have a "flushy" appearance if they are stripped too late.

The males of the African catfish cannot be stripped and consequently the sperm can only be obtained by sacrificing a male. The male is killed and the body surface thoroughly dried after which the testis is disserted and placed in a mortar or a teacup. The testis is rapidly cut into small pieces using a scissor and finally the milt is pressed out with a pestle or a teaspoon.

Water Temperature	**Time between injection and stripping (Hours)**
20	21
21	18
22	15.5
23	13.5
24	12
25	11
26	10
27	9
28	8
29	7.5
30	7

HYPOPHYSATION

Hypophysation is presently the most commonly used technique for the propagation of fish. It is employed not only in propagation experiments, but also in the commercial production of million fish.

Induced ovulation and spawning achieved through hypophysation amount to a short cut of the natural process. In nature, ovulation in a fish is regulated and brought about by its own gonadtropic hormone produced and stored by the pituitary gland. The stored hormone is released into the blood when all the requisite conditions become favourable. But in the hyphysation technique, gonadtropic hormone extracted from the pituitary of some other fish (donor) is injected into the breeder and this brings about the final ovulation.

Like all other techniques, this technique too has its own limitations. Some of the sensitive fish such as the pike-perch cannot tolerate the treatment, while others may ovulate only irregularly. Then again, the breeders whose ovaries have not yet reached the adequately ripe stage fail to respond to hypophysation. It is a fundamental rule that hypophysation will be effective only when the eggs in the ovary have reached the resting or dormant phase after the completion of *vitellogenesis.* The eggs are then materially ready for further development to be triggered by gonadtropic.

Different types of fish culture techniques, monoculture, polyculture, selected breeding, intensive and extensive culture, inland and brackish water in rice field, in floating cages and rafts.

Different types of fish culture techniques

Fish culture techniques can be described from different perspectives. They can be described on the bases of biological, economical and social factors. The type of rearing facilities, technology of production, number of species cultured, type of fish, cultivation stage, geographical origin of cultured species and target market.

A **Fish culture technique based on rearing facilities**

1. Fish culture in earthen ponds.
2. Fish culture in concrete tanks.
3. Fish culture in reinforced plastic tanks
4. Fish culture in plastic tanks
5. Fish culture in wooden troughs or vats
6. Fish culture in rearing cages

B. **Fish culture techniques based on technology of production**

1. Extensive culture system – characterised by low stocking density, no input and output of less than 1000 kg/ha/year.
2. Semi-intensive culture system – characterised by moderately high density, addition of input (fertiliser and feed) Yield around 10,000 kg/ha/year
3. Intensive culture system – characterised by high stocking density, addition of high input (fertiliser and nutritionally balanced diet), cost of production is generally high with yield above 10,000 kg/ha/year

C. **Fish culture technique based on number of species cultured**

1. **Monoculture** – This is the culture of single species of fish in a pond or tank. The culture of *Clarias* only or *Oreochromis niloticus* or Heterotis or Gymnarchus are typical examples of monoculture. The advantage of this method of culture is that it enables the farmer to make feed that will meet the requirement of his fish especially in intensive culture system. Fish of different ages can be stocked thereby enhancing selective harvesting.

Polyculture

This is the culture of two or more species of fish in a pond or tank. It is also a system that grows more than one species of fish from the same trophic level.

Integrated Multi-trophic Aquaculture (IMTA)

Integrated multi-trophic aquaculture systems mimic natural ecosystems. Here organisms (fish) are present from more than one trophic level and waste products are recycled. An example is cultivating sea weed near mariculture fish pens. Nutrients in the fish waste fertilize algae, which in turn improve water quality for fish.

Mariculture

In mariculture, fish are grown in pens or mesh cages in habours or sea.

Aquaponics

It is a combination of aquaculture and hydroponics, two systems that are not new, but share a common problem and concern, TOXIC WATER BUILDUP!! In aquaculture, it is the fish emulsion, with hydroponics, it is the fertilizer water. This toxic water is not good for the fish or the plants. This water must be cleaned from time to time and it cannot be dumped any place in our environment without causing damage.

Aquaculture and hydroponics are systems that compliment each other as a single unit, not as separate units. The fish water is pumped to a greenhouse, which is evenly distributed. The fish water feeds the plants, such as lettuce and tomato's, then filters through a porous material (volcanic cinders in Hawaii) and returns to the fish tank by gravity. Both systems are in a controlled environment, meaning light and temperature are controlled. The primary crop is the vegetable and the fish are secondary, meaning commercially, there is more money and turn around with the vegetables.

The aquaculture is suitable for ornamental fish, prawns, tilapia, catfish bass and escargot snails. We also grow the Hawaiian taro plant in cement pots that are placed in with the fish. Watercress can also be used. What is amazing is the stable and balanced pH and crystal clear water.

The water is basically recycled, with a small amount of water added weekly for

evaporation. This is a balanced, self-contained eco system that works!! Solar powers the water pump and no chemical are added what so ever, it is totally organic. Chameleons control any insects that might get into the house. Earthworms are raised to feed the fish and the earthworm compost is used in the garden or planter box gardens. (http://www.bromes.com/aquaponics.htm).

Fish rearing in cages

A fish cage is an enclosure made with net where fish are raised in free flowing water especially in lagoon waters, rivers, lakes and large reservoirs. Cages are made of four parts: 1. Solid frame 2. Nets 3. Floats 4. Anchor.

A cage can be floating type or fixed type.

Floating type if the cage is submerged

Fixed type if it is attached to a stake fixed to the bottom. Cages have high potential to improve the status of the local fish supply. Major disadvantages are:

1. Water pollution 2. Poaching 3. Conflicts in the use of water with other users.

Management include routine check, provision of adequate security and good supply of quality feed to ensure faster growth.

Fish culture in pens

Pens are constructed from bamboo or wooden poles that are forced down into the lake or shore bottom. Nets are strung from pole to pole to form an enclosure. The nets are anchored into the lake bottom with weights or sinkers. They are stocked with fish. Pens with size of ponds are often placed in the fertile lakes to yield high biomass. No feeding, no extra feed input but if lakes are not fertile feeding may be required.

Disadvantages

1. Expensive to build 2. Last for 3 – 5 years 3. Poaching 4, Pollution