COURSE CODE:	FIS501
COURSE TITLE:	Fisheries Production and Management
NUMBER OF UNITS:	3 Units
COURSE DURATION:	Three hours per week

COURSE DETAILS:

Course Coordinator: Dr. O.J. Olaoye

Email: olaoyejacob@yahoo.co.nz

Office Location: Room D205, AMREC

Other Lecturers: Dr. (Mrs.) O.T. Agbebi, Dr. I.T. Omoniyi and Dr. O.J. Olaoye

COURSE CONTENT:

Practical aspects of handling and care of fish, breeding of fish. Production of fingerling and fry; management of brooders; growers and other types of fish and marine products; Building of equipments needed in fish farms; Procurement of feed and system of feeding. Harvesting and marketing. Appraisal of management structure and effectiveness of fisheries management policies. Preparation of management plan in fisheries projects

COURSE REQUIREMENTS:

This is a compulsory course for all students in Department of Aquaculture & Fisheries 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.

.

READING LIST:

LECTURE NOTES

1: Practical handling and care of fish
2: Breeding of fish (Natural and Artificial breeding)
3: Management of fish seed (fry and fingerling)
4: Management of fish brooders and growers
5: Building of equipment needed in fish farm
6: Procurement of feeds
7: Types of feeding system

8: Harvesting and marketing
9: Problems of fisheries management
10: Management plan in fisheries projects

By way of introduction, students should understand the broad spectrum of the course as Pisciculture which is defined as an aspect of Aquaculture. It entails the husbandry of fin fish at densities greater than would normally occur under natural conditions purposely to enhance production for human consumption.

In Nigeria today, there is need to increase fish production because beef cost is exorbitant; ban on importation of frozen fish and stock fish for source of protein:- to auguement fish stocks in natural waters. Fish production in Nigeria is from 3 main sources:

a. By artisanal fisheries - These are local fishermen and women who fish either on parttime or full time basis employing all sorts of gears and techniques. Some of the methods are destructive e.g. use of poisons-crushed fruits of *Raphiahookeri*(Rafia palm). The common feature of these approaches is that almost all the fishes irrespective of size are captured.

b. By industrial/commercial trawlers - Industrial fishing in in-shore and offshore water of the seas. The UN law of the sea allows Nigeria the exclusive right to fish in zone up to 200 nautical miles (320km) from her coast. This zone is known as the Exclusive Economic Zone (EEZ). The establishment of national jurisdiction in this zone offers each country the chance to exploit the benefits of the zone for its country. Intense and uncontrolled exploitation of the fishes in the EEZ has resulted in dwindling catches and remarkable reduction in the catches of some species e.g. the tongue sole. *Cynoglossussenegalensis*in Nigeria coast (Fagade, 1992).

c. By fish farming - Fin and shell fishes can be produced in some systems e.g. ponds, cages, pens, raceways etc as a result of over-exploitation from the wild. Any over-exploited species can be hatchery raised/reared and restock into the natural waters. In Nigeria, the technique is expensive and has been so far neglected.

Therefore, practical handling and care of fish is crucial in fish production to achieve the goal of providing enough quantity of fish for consumption especially through pisciculture.

Practical handling and care of fish

This is the very first step in fish production especially through aquaculture source because there cannot be harvest without recruitment. It entails all the precautionary steps and techniques to protect the fish especially from the seed stage to adult stage when it appears on the table for consumption. The fish seeds (fry and fingerling) are usually 'nursed' rather than reared to ensure proper recruitment or else the harvest will be low. All processes e.g. the contact materials with fish (fish seed), water treatments, fastness during operations etc are referred to as the practical handling and care of fish to ensure the success of each venture into fisheries management.

For example, as a rule, gear that is used for collecting fish especially fish seed is constructed of fine mesh (<10mm) netting materials and should inflict minimal physical injury on the body.

These gears include drag net, lift net, cast net, clap net and traps. When using nets or traps to take fingerlings or adult fish out of ponds, care must be taken during seining since muddy water can stress the fish. To reduce mortality due to muddy seining, fish could be attracted with crumbles of feeds, light source or dewatering. Other practical handling and care of fish can be hinted as

- Always use wet hand/ contact materials e.g. nets
- Handle the fish gently
- Keep fish in water while counting
- Avoid overcrowding the fish in containers
- Avoid standing fish in the sunlight and for a long time
- Fill containers for transport with pond water
- Transport fish during cool weather
- Work fast and travel quickly
- Avoid squeezing, throwing or dropping fish
- Always check temperature and temper fish

Tempering is a pre-stocking treatment of especially fish seed. It involves homogenizing the water in which the seeds are transported with the water in the pond/system into which they are stocked. It is a crucial step in handling and care of fish to avoid high mortality.

FISH BREEDING

Fish breeding is synonymous to fish propagation which simply means multiplication. Breeding entails all the various techniques or methods which can be used or at least maintain a fish stock (i.e. methods of fish seed production).

This concept in fish production is important when an increase demand for fish and for culture is

considered. Also, in tropical world, many fish species breed only once a year. Therefore, a
continuous demand for fish seed makes fish propagation sine-qua-non. There are various
techniques which differ from different parts of the world depending on local conditions and
available local facilities. For instance, in developing world where facilities are not available, fish
seeds are obtained from the wild while in advanced countries where there are facilities,
propagation is completely artificial.

Basically there are 3 types of fish breeding/propagation

- Natural propagation/breeding techniques
- Naturally induced breeding/pond or enclosure propagation
- Artificial propagation through hypophysation.

Natural breeding technique: is a technique whereby fish are allowed to breed in their natural
environment and their eggs, larvae, fry and fingerling are collected for pond stocking. The fry
and fingerling (fish seeds) of Cichlids, *Clarias, Chrysicthys*as well as mullets (*Mugilsp*) are
available in Nigerians waters fairly in large quantities all the year round. *Heterotisniloticus*is
seasonal in abundance and can be obtained within a short period in a year usually at about the
beginning of the rainy season. Many other species are known to be available during the rains
(April to September) in the flood plains-inundated river banks and the estuaries. However, much
is still desired to be studied in Nigeria concerning the season and nursery grounds of other
species. Accurate statistics of fish seeds obtained from the wild is not available in Nigeria.

The collection of fish seed is carried out with no physical damage to the seeds which entails the
elimination of gill-nets and hooks as used gears. Gears for collection include the hand net; lift
net, drag/seine nets, cash nets. Light is used to attract them at night, pieces of feeds, GNC can
also be used to attract them to avoid mudding during seining. Special traps especially in streams
and river could be used. Before transportation, the collected fry are fingerling are kept in Happa,
net or pots and starve overnight in clean water to avoid defaecation which can utilize O_2 during
transit. The collected fry and transported in well aerated, cool water to the pond for stocking.

Problems associated with natural breeding technique include:

・For many species, the seed may not be available as and when needed or required. Hence,
there is shortage of fingerling for stocking leading to low fish production.
・Weed fishes and fish enemies e.g. Dragonfly 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.
Fish parasites e.g. leeches are collected with fish seed from the wild and introduced inadvertently
into the rearing ponds.
・Difficulty of accurate identification of the fry/fingerling stages of certain species which
results in the desired species being stocked with undesirable stunted species. e.g.
observed in catfish with *Barbus*.
・There is high mortality during catch/collection and at transportation.
・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.
However, natural breeding technique needs little or no skill which is an advantage.

Ponds or enclosure propagation

Essentially it is a naturally induced breeding technique that involves introduction of broodfishes
or brooders into specially constructed ponds or tanks and allow them to breed. It is a common
practice to leave the brooders breeding repeatedly. This is not ideal in terms of quality and is
anti-selective since the age and parentage of the fish cannot be determined after some time.
Therefore, a proper and systematic pond propagation technique that would ensure production of
fry of known age is recommended. Usually, ponds used for propagation are small, about 0.1ha or
100m^2 and shallow usually less than 1m. Cement/concrete tanks with measurements of 5x3x1m
have been successfully used for pond propagation of Tilapias in Nigeria. Some fishes which
reproduce easily in ponds are Tilapia, *Oreochromis, Sarotherodon, Lates, Heterotis, Clarias*,
Carps and *Gymnarchus*breed in special ponds. Intensive efforts are going on to propagate
*Chrysichthys*in ponds. For example, the propagation of tilapias in ponds does best in shallow
waters and the pond must have sandy bottom. If tank is used, the floor of tank is usually covered
with a layer of sand for making their nests (spawning area). The eggs hatch within 1-2days after

external fertilization. These hatchlings/larvae are usually carried by one of the two parents until
they are free to go or fend on their own. The fry move in shoals (school) along the edges of the
water from where they can be collected. Discuss the newly designed special receptacle for
propagating tilapias.
Also, discuss pond breeding of *Heterotis, Gymnarchus*which require some stimuli to effect
breeding in enclosures. These species would not breed in ponds without submerged higher plants
e.g. grasses. In case of *Clarias*, it requires moving water and hence an artificial water current of
the water must be created. Carp requires a special pond called Hoffer or Dubisch pond and it
must have a large bottom with grasses and it is shallow. Temperature and dissolved Oxygen are
crucially and optimally required in the ponds. In addition, the water must be free of other fishes
especially the carnivorous ones e.g. *Hemichromis*. Also, mention the success story so far about
*Chrysichthys*breeding in an enclosure.
The above techniques are simple and inexpensive in addition to achieving the best possible
survival rate, good growth and health for the fish. The techniques require no sophisticated
installations or tools and without difficulties and risks involved in artificial fertilization.

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. For instance,
using this technique a single common carp (*Cyprinuscarpio*) has been induced to spawn five
times within a year at intervals of 60,62,41 and 186 days between successive spawning, even
though carp breeds naturally only once a year.
Artificial propagation was first described in 1765, but was neglected until 1842 when it was
described again. 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. Other privately owned fish farms have tried hypophysation using catfishes e.g.
Clarias gariepinus, Heterobranchusbidaorsalis.
For the purpose of easy description and discussion, artificial propagation can be divided into 6
stages as:
・Selection of brooders
・Maturation of the brooders
・Stripping i.e. obtaining eggs and sperms (milt) from the brooders
・Fertilization
・Incubation of fertilized eggs to ensure that they hatch
・Rearing of the larvae/fry up to fingerling stage.
Discuss each stage with good illustrations and examples with the students.
On the whole, more fry can be obtained from an individual fish through artificial propagation
involving stripping after hypophysation when compared to what is obtained through other
propagation techniques.

ADVANTAGES
・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.

DISADVANTAGES
・The donor fish has to be sacrificed in most cases and hence of loss of fish.
・The whole process is laborious and highly technical.
・Very expensive in that it requires proper housing, constructions 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 facilities and they require inputs such as brood stock, adequate water supply and suitable feed.
The sequence of steps involved in artificial production of seed can be schemed as:
Selection and segregation of potential
Brooders/spawners
Brood stock maintenance
for maturation
Selection of gravid
Brooders during breeding period
Hypophysation or hormone treatment Transfer of mature brooders to the spawning ponds/enclosures

Stripping of fish Natural spawning
Artificial fertilization of eggs Removal of broad stocks
Incubation of fertilized eggs harvesting of seeds
Hatching Rearing of seeds
Collection of seed (fry)
Rearing of fry to fingerling (seed)

Management/Maintenance of Broodstocks

Maintenance or management of broodstocks on a breeding farm is very necessary
because it permits the build-up and selection of healthy, high quality brooders for stock
improvement. In ponds for keeping broodstocks, they need to be simulated to that of the fish's preferred habitats in terms of O_2 content, temp, pH, tranquility, size and depth of the water, stocking density and quality and enough food.
Sharp fluctuations in the physico-chemical parameters of the water in the enclosures or ponds
must be prevented especially temperature and O_2 as these are known to inhibit gonadal
development. Overcrowding in the pond conditions must be avoided because it constitutes
negative stress on the stock, though many cultured species are able to tolerate some degrees of crowded pond situations. For example, brooders of catfish (*Clarias*) are held at a stocking
density of one fish in 2.-5.0m^2 of pond area with the depth of 1.0-1.5m.
Frequent disturbances also interfere with normal gonadal development and therefore care must be taken to restrict seeing or netting of the fish to the minimum. For example *Clarias* being hardy can withstand being netted out of water two or thrice a week, other fish species should not be seined more than once a week.
Provision of suitable and adequate quantity of food is equally of great importance. It has been
known that brooders reared or maintained on adequate natural food and/or protein-rich artificial feed have a higher fecundity of larger eggs and thus yield best results.
To prevent outbreak of diseases in the stock used for breeding or subsequent transmission of any diseases to the offspring, brooders should be routinely treated and bathed in a 25% NaCl or 150ppm formalin solution for 10-30minutes. Malachite green can also be used.
Maintenance or management of brood stocks kept depends on the species, their size and the noof eggs per Kg per female, the survival from fertilized egg stage to the fry stocking phase and the demands for the fish from the grow-out units.On principles of brood stock management solve the following problem with the students.
Problem as:
As a fishery consultant, you have to supply one million Clarias gariepinus fry for restocking a
Government farm.

i. How many eggs of this species will you require to produce the fry assuming that the
average female brooder produces 5600eggs per kilogram body weight and that only 90%
of eggs spawned are viable and of these, 86% will be successfully fertilized and out of
these, only 78% would hatch?
ii. The average weight of each female *Clarias* as at the time of this contract was 3kg.
Calculate the number of female brood stock to be maintained that would produce the
above eggs to supply the required numbers of fry.
iii. If the sex ratio of male to female to effect the breeding was 2:3, how many male would
be required, assuming each weighed 2.4kg to effect the above fry production?
iv. For proper management, at least thrice the required brood stocks must be maintained in a
brood stock pond at a density of 600kg per hectare. Calculate the surface area of the pond
required to maintain the brooders that would ensure the above fry supply.

Management of Fish seeds (Fry and Fingerling)

In fish life history, egg(fertilized) Larva fry fingerling sub-adult/juvenile
adult. The larval stage ends when it fills up its air bladder with air, begins swimming in a
fish-like manner and starts to eat external food that it becomes to fry. In addition to needing
all the essential requirements of the larva e.g. adequate O_2, suitable temperature, removal of
waste matter etc, the fry also requires external food which should be adequate both
qualitatively and quantitatively. The early fry may still have a part of the yolk left and can
draw on it for sustenance from 1-4days depending on the species. The fry spends this period
and learns to find its own food. Fry are said to require a more precise and careful nursing to
ensure their survival and proper growth. Authors have remarked that lack of suitable food
caused high fry mortality. Fingerling is bigger than fry e.g. 5-10cm and it is the stage that is
usually stocked. Management of these developmental stages is based on their fragility and
difference in sizes in terms of their habitats, stocking density, feeding and control of their
infections and diseases. These stages are crucial because there cannot be harvest without
recruitment. Hence, these stages are called fish seed or recruits.

Fry are nursed in small earthen ponds which vary from 100-200m2 for about 3-4 weeks to attain fingerling stage. Fingerlings are reared rather than nursed in bigger earthen ponds. The pond is usually prepared to have a standing crop of rotifers and must be checked to exclude cyclopoid copepods which are natural enemies of fry. Food is crucial for growth which must be observed daily. Fry have two sources of food during the initial stage - yolk and external food to ensure better survival. Maintain these. It is part of the management that mixing of different age groups of same species should be avoided and it is advisable to use amonoculture of fishseed.

The most commonly provided artificial feed is finely ground and sieved through 100-150μm mesh called starter food. After two weeks, the size of feed particles is increased. Cutting the grasses on the dyke and throwing them around the shallow part of pond helps to increase natural food production in the pond. After about one month, the young fingerling have to be removed from the small nursing pond and stock in a large pond. The artificial feeding continues but the size of food changes due to changes in the size of mouth. It is necessary to thin out the stock in order to provide sufficient space, O_2, food to the fast growing fingerling.

Enemies of these stages must be managed too. These enemies change with the age of the fish.

These are categorized as (i) enemies of fry (ii) enemies of advanced fry and (iii) of fingerlings.

Identify these enemies and treat adequately. For example enemies of fry include carnivorous Cyclops, insect and insect larvae (e.g. dragonfly), which predate largely on the fry. It has been stated that Cyclops are responsible for the highest mortality of fry at this stage next only to that caused by hunger. The advanced fry is less prone to predation by Cyclops since it is more agile and its skin in thicker and stronger. It is the insect larvae that pose greater danger at this stage followed by hunger if there is acute food shortage. O_2 deficiency may kill in heavilymanured ponds. Abrupt changes in temperature and extreme cold may exterminate the fry population.

Enemies of the fingerling - Besides hunger, O_2 deficiency, sudden change in temperature,

white spot disease caused by *Ichthyophthirius, Trichodina*and gill worm infections could exterminate the entire stock within a brief period in fingerling ponds. Consult your note on Pathology for effective treatments. Preventive and control methods of these infections would be discussed during class interactions. Infection of a pond with any protozoan or bacteria or fungus can be diagnosed through certain indicative signs such as: (i) swimming of fry/fingerling in large school near the surface (ii) their accumulation below the water inlet (iii) the occurrence of dark specimens (iv) sudden occurrence of dead fish on the surface. It should pointed out that fish that die because of parasitic infection only float on the surface while those that die due to dietary factors remain at the bottom.

Procurement of feed and system of feeding

Intensive fish culture involves a high/heavy stocking of water impoundments/enclosures and the use of artificial/formula feeds to improve production. Fish feed provide nutrients for optimal growth and this rapid growth achieved implies that fish feeds are essential for the economic use of time. Through shortened grow-out periods, a fish farmer can effect two croppings within a year. The increased number of croppings of table-sized fish imply that more profit can be generated by the fish farmer. Therefore, feed of adequate nutritional value is the foundation on which fish farming is built. Good and high quality feeds improve the quality of the edible portion of fish, enhances high protein retention and gives the flesh a firm consistency and delicate flavor.

Types of foods: Based on the source of origin, there are natural food and artificial feeds.

Natural fish food can be of animal origin which include zooplankton e.g. rotifers, protozoans, cladocerans, copepods, larger zooplankton (arrow worms, crustaceans etc, benthic invertebrates e.g. polychaetes, molluscs, insect larvae e.g. Chironomids and Chaoborids, forage fish and aquatic insects.

Natural food could be of plant origin as an phytoplankton e.g. diatoms, desmids, blue-green algae, unicellular, filamentous and colonial algae and aquatic macrophytes. Dead plants and animals (i.e. decaying organic matter called detritus) also constitute an important natural food

source.

Artificial feeds: Under commercial culture condition involving high stocking densities of fish, natural foods become limiting. It is the artificial or supplementary diets that fill the shortcoming of natural foods.

Early efforts to provide supplementary diets for cultured fish were based on attempts to duplicate composition of natural foods. This was labour-intensive involving the growing of earthworm and insects, harvesting small fish or tadpoles or by processing agricultural slaughter house by-products not readily consumed by man. Such diets had a number of drawbacks e.g. poor growth and nutritional diseases which led to the development of dry or semi-moist feeds commonly used nowadays. Artificial feeds are available in

Type I - meals, pastes or cakes

Type II - pellets

Type III - semi-moist feed

Type I is for plankton feeders, algae grazers, fry, small fingerling. They may be prepared as dry meal, colloidal suspension or soft cakes. Fish consume them by direct capture or by filtering water.

Type II - This type is convenient for storage, transportation and dispensing in automatic feeder or self feeder. Many fish feeds are prepared in pellet forms which can be hard (sinking), expanded (floating-encapsulated) or soft pelleted. Hard pellets may be used for fish with a mouth size capable of ingesting them, the stomach capacity to store them and the peristaltic action and enzymatic ability to digest them. Uneaten pellets disintegrate slowly in water and hence cause less water pollution. To discuss the merits and demerits in class.

Floating or expanded feeds enable the fish farmer to observe fish feeding at the pond surface.

Floating feeds are acceptable to most surface-water feeders as well as catfish. Floating feeds are more expensive than hard pellets because they require extra energy in extrusion process and increased drying time. Soft pellets have water content between 8-20% and are preferred by fish which strike for their food.

Type III - Semi-moist have water content in the range of 37-40% and are prepared from

frozen or fresh, wet ingredients. They are the most expensive feeds available hence fish
farmers are not interested in using them.

Feeding systems or techniques

A feeding programme is successful when the required amount of nutritionally adequate feed
is consumed. The feeding plan and techniques are affected by fish species and size, time of
the year and the type of production system. The best guide for the fish farmer is to place the
feed where it can be obtained by the fish, offer it so that the fish will receive their
share/rations. Floating feeds can be broadcast mechanically from specially designed feeding
troughs or from mechanical feeders. For small ponds, the feed can be distributed by hand
(self feeder). Feeding of fry and small fingerling poses different challenges. The experienced
fingerling producer knows where the young fish are located in the pond. He may use
containers or shelters to attract or hold the newly-stocked fry in an area. Note that feed
placed in wrong location will not be eaten and will reduce overall water quality.

Mechanical feeders include the demand type which is activated by the fish and the automatic
type which is activated by a time clock. Both have serious limitations, one of which is the
tendency to less frequent observation of the culture system. The demand feeder is useful in
extensive systems where fish do not have to be observed closely e.g. in lakes, reservoirs. The
automatic feeder is designed to offer a measured amount of feed at predetermined time of the
day.

Relationships between feeding and production will be discussed in class.

Test-cropping and Grading

Before harvesting, there is the need for test cropping and/or grading for at least once a month
after stocking of the fish into the production ponds. A farmer needs to make direct
assessment of the status of his fish stocks over the growth period because there are some
species especially the carnivorous species e.g. *Clarias* which exhibit hierarchical dominance
in its feeding behavior. As a result, the more aggressive will be at an advantage to receive
more food than others bringing about marked differences in sizes of individual fish. Not only

this, test cropping allows to monitor the health status and adjustments in the feeding rates to account for growth especially if artificial feeding is practised.

The test cropping involves capturing a few number of fish using cast net or seine net early in the morning of a cool day and a bowl/bucket of water is kept nearby to keep or hold the fish during examination. The fish is held in a wet cloth or foam and any surface with which the live fish makes contact during the examination must be thoroughly moistened / wetted. If large variations in size among individual fish are observed, the stock should be graded into appropriate size groups and probably restocked into different ponds if not ready for harvesting.

Grading can be carried out by eye or where large numbers of fish are to be sorted out for harvesting, a box with a bottom that consists of a series of bars or slots appropriately spaced to segregate the specific size range of fish can be used.

Grading also functions to produce equal-sized fish for the market at the time of harvesting.

However, it should be noted that test cropping and/or grading during production period should not be more than once a month because it is stressful to the fish and they tend to go off their food for a few days.

References or relevant textbooks would be recommended during the introductory lecture.

Inter-net lectures are incomplete for your excellent performance in my examination.

Therefore, attend my classes punctually and regularly for your own good.

THE BIOLOGY OF HEREDITY

Transmission of biological characters from parents to offspring through genes is a kind of inheritance known as *heredity*. Living organisms have hereditary characters, as every individual is an offspring of other individual of a similar kind. In spite of this we have observed that variations exist between organisms even of the same species. The characters that can be transmitted are those that are controlled by the genes. As a discrete unit of inheritance, the gene controls the appearance of a character by directing the development of one or more proteins, which leads to the manifestation of the character.

All genes inherited by an offspring, constitute its genetic make-up or genotype. This is distinct from the phenotype, which is the outward or physical appearance of the inherited characters or traits in an individual. However a sudden change in the structure of genes may occur and this is referred to as mutation. A gene mutation can be transmitted from parent to offspring, if the mutation occurs in gametes, gamete – producing cells or on the zygote. Such a mutation is then inherited by subsequent generations of the off–spring. The body or somatic cells of animals and the sporophyte stages of plants have a characteristic number of chromosomes fixed for a particular species, they are referred to as the diploid or 2n number.

Growth is an irreversible or permanent increase in size of an organism as a result of formation of new cytoplasmic materials. Growth can be determined by increase in length, size or

by dry weight of organisms. At cellular level, the growth process is usually an increase in cell number by mitotic division. Mitosis is a simple cell division whereby a cell passes a copy of its genetic materials to each of the daughter cells. Mitosis is responsible for the processes of growth and the repair of tissues. Mitosis occurs in stages namely; Prophase, Metaphase, Anaphase, and

Telophase.

As each chromosome is made up of genes which are functional units of inheritance, chromosomes control the major features of heredity. Genes that occupy the same relative position or loci on the homologous chromosomes but separate during meiosis are referred to as alleles: the pair is known as allelic pair. Meiosis is a type of cell division in reproductive cells.

This cell division gives rise to haploid gametes which have half the number of chromosomes that are found in parent cells. Meiosis occurs only in reproductive organs. When two gametes unite through fertilization, there is fusion of gamete nuclei. It is important to note that the chromosome number in different organisms is constant.

Meiosis helps to maintain constancy in the chromosome number of a species. Meiotic division consists of two nuclear and cytoplasmic divisions, namely first and second divisions. The first meiotic division is reductive in nature while the second stage is mitotic. It is during meiosis that hereditary materials are interchanged between chromosomes resulting in variation within and between species.

From fertilization to hatching, embryogenesis proceeds from a single egg cell to the highly organized larvae. The eggs undergo cell division or cleavage. Cleavage is the division of cells early embryo.

Depending mostly on the amount of yolk in the egg, the cleavage can be holoblastic (total cleavage) or meroblastic (partial cleavage). The pole of the egg with the highest concentration of yolk is referred to the vegetal pole; while with low concentration is referred to the animal pole. Thus, one cell divides into two:

(a) The daughter cells called blastomers, and then cleave into four cells;

(b) These cleave into eight

(c) And soon reached by vertical cleavage. The mass then resolves itself into a layer of cells forming a hollow sphere, the blastula.

(d) The next stage is the formation of double-walled sac, the gastrula, the outer wall is called the endoderm and the inner wall is endoderm. The endoderm surrounds a new cavity known as the primitive gut. In some cases, these two layers are formed by delamination that is, pushing of a portion of the wall of the blastula. The endoderm produces specialized cells in the principal digestive glands and forms the lining of air passages and most of the alimentary canal. The mesoderm gives rise to blood and blood vessels, connective tissues, muscles, reproductive glands and the kidney.

(e) The embryonic axis is formed with optic vesicles.

(f) During the further development, the eye lens, optic vesicles, myomeres and brain appear.

(g) The tail grows and lifts off the yolk, eyes became pigmented.

(h) The embryo reaches the hatching stage.

The larvae phase begins with hatching and is a fundamental stage of early life history.

The innate behavior of newly hatched larvae differs widely among species. Pike larvae, for example remain rather inactive during the yolk sac period, trait larvae after hatching show a positive geotaxis and a negative photo taxis.

Morphological characteristics may vary over a certain range at time of hatching because hatching is not correlated with a definite morphological stage; for example body length, yolk sac size and the differentiation of head and trunk are variable features among newly-hatched larvae. However, temperature during incubation influences the larva's morphological stage at hatching. Within certain limits, development from fertilization to hatching is prolonged by low temperatures and accelerated by high temperature. Temperature to be the most important external factor because it has a direct influence on the timing of ontogenetic events.

Duration of egg Development from fertilization to Hatching In some cultured freshwater species.

S/N	Species	Hours	Temperature	Author
1	Heterobbranchus bidorsalis	23	26^{o}C	Agbebi et al 2005
2	Clarias gariepinues	21	26^{o}C	Aluko et al 2001

3	Heterobranchuscoryyyfillis	23.1	25oC	Olufeagba 1999
4	Pseudoplatystomacoruscan	19	24oC	Cardoso et al 1995
5	Ictaluruspunctatus	23	24oC	Makeeva and Emel'yanova 1993

EMBRYOGENESIS IN RELATION TO GENETIC IMPROVEMENT

The timing for the occurrence of morphplogical changes in the developing embryo revealed much about the life cycle of different fish. The accurate timing for the first cleavage opens the window into genetic improvement of the species. Most problems encountered such as un-hatched eggs even though fertilized, abnormality in embryo and the difficulties associated with hatchery management, embryogenesis has been able to give reasons for this occurrence. Embryological studies provide some basic information of embryonic and larva development. It further provides a better understanding of early embryonic, larva stages and their behavior. Embryological stages helps in determining the species frequencies, the implication of chromosome engineering research and to know the various stages involves from fertilizer egg to hatching.

Embryology is a key factor in chromosome manipulation in that apart from the type of manipulation involved, the exact timing and duration of the shock relative to both meiosis (extrusion of the second polar body) and mitosis (first cleavage when zygote divides to become an x-called embryo determines the success of triploid production (chromosome manipulation).

TAXONOMIC CHARACTERS

Character is any attribute of any organism that we can detect and describe. A Taxonomic character must be easily observable and vary from one taxomy to another. Therefore, good characters must be genetically, rather than environmentally determined. For instance, fish that live in impoverished waters may have relatively large heads and bodies because they are undernourished.

In this situation, one might mistake emaciated fish with big heads for a separate species simply because the fish were starving due to environmental conditions. Nonetheless, differences in head size and body shape are often determined genetically and as such can be used as good characters.

Most good characters used in fish taxonomy are morphological that is, they are attributes of body form and structures because such attributes are the easiest to observe. Morphological characters may be divided into those that are directly measurable and those that are not. Measurable or quantitative, characters include those like length of body parts which can be measured with a millimeter or centimeter scale (morphometric) and those like number of fin rays (menstic) which can be counted. Statistically, morphometric characters are continous variables. This means that, theoretically, any number of values exists between one measurement of say head length and another depending on the degree of accuracy. Menstic characters are discontinuous or discrete variable. There might be 9 or 10 rays counted in a fin, but there will not be 9.5.

QUALITATIVE CHARACTERS

Values of qualitative characters are not easily expressed as numbers are. Such attributes ascolour or shape are usually described in words such as red or fusiform. But with the technological advances, more and more qualitative characters have the potential to become qualitative. Photographic image analysis by computer can render differences in tints and outline in digital terms. More simply, qualitative characters can be scored subjectively. For example, body shape might be scored to 1 (slender) to 5 (robust) or body colour shade from 1 (light) to 5 (dark).

Non-morphological characters

Taxonomic characters needs not always be morphological even though morphological characters are often easiest to observe and measure. Characters can also be functional (physiological), behavioural, distributional, cytological or bi-chemical.

Every kind of taxonomic characters is potentially important and should be used of it proves valuable in identifying fish taxonomy and if the resources are available.

CHARACTER COMBINATION

If a single character does not efficiently separate individual of two different populations or species, a group of characters whose values are combined mathematically into a discriminate function may do so. Thus, usually by computerized correlative procedure "virtual" characters are created as combination of real (direct observable characters).

SUGGESTED DATA SHEET FOR RECORDING

Your Name: …….
Species: …….....
Specimen Number: ……...

Counts

1. Dorsal fin spines
2. Dorsal soft rays
3. Anal spines
4. Anal sift rays
5. Total spectoral rays
6. Scales along lateral line
7. Scales above lateral line
8. Scales below lateral line
9. Scales around caudal pendunle
10. Scales around caudal penduncle
11. Branchiostegal rays
12. Pyloriacacea
13. Total gill rakers on first arch
14. Total vertebrae

Measurements

1. Standard length
2. Body depth
3. Caudal peduncle depth
4. Caudal peduncle length
5. Pre-Dorsal length
6. Length of dorsal base
7. Length of anal base
8. Height of dorsal fin
9. Height of anal fin
10. Length of pectoral fin
11. Length of pelvic fin
12. Length of longest dorsal spine
13. Head length
14. Head width
15. Snout length
16. Suborbital width
17. Orbit to pre-opercle angle
18. Eye diameter
19. Upper-jaw length
20. Gape width