Age and growth

Most fish continue to grow throughout their lives. Consequently, growth has been one of the most intensively studied aspects of fish biology because it is a good indicator of the health of individual and population. The information about the age and growth rate is considered useful to great extent in the field of fisheries management, in addition to their great biological importance.

The study of age and growth has practical application in many aspects such as:

1- In what age the fish reach the sexual maturity and what is the time required for small fishes to start reproduction.
2- In what age a definite species of fish reaches the legal size of catch. This subject has special importance in the arrangement of fishing laws,
3- The age estimation of fishes in a definite environment may help in detecting the unsuitable environmental conditions found in it.
4- Comparison the growth rate in different body waters help partially in identification the good and bad environmental conditions and put the future plan to correct the bad one.

* Growth can be defined as *the change in size (length, weight) over time.*

The methods used in studying age and growth:

1- The method of known age (raise in controlled environment)

The method depends on putting early hatched fishes (of known age) in a tank, small pond or cage in a large water body. Its length or body weight is measured at time intervals for growth rate calculations, but this method does not give a true picture about the normal growth of fishes. It is better to release the fish in the natural water.

2- Mark and recapture method

A fish is marked (or tagged) and released when an initial measurement of size is made. The fish is recaptured at future date and measured again. The growth rate is calculated from the change in size over the time period the marked animal spent in its habitat. It should be established that the marking method does not significantly alter the behavior, feeding rate… .etc. Marks may consists of clipped fin rays, pigmented epidermis from high pressure spray painting or fluorescent rings on bones or scales from incorporation of tetracycline in the diet. Tags may also vary considerably from externally attached discs, plates and streamers to small implantable metal rods detectable in a magnetic field. The chief value of this method lies in checking the scale method, as marking or tagging fish often becomes a costly and time consuming operation considering the low percentage of return.

3- **Length frequency distribution (Petersen method)**

This method is based on the fact that the length of fish of one age tends to form a normal distribution. The idea of this method is that most fishes lay eggs during definite season may extend to month or some months and wait the next year to repeat the same operation. This method has been often adequate for the first 2 to 4 years of life, but has failed to separate reliably the older age groups, because of increasing overlaps in length distribution. Other major disadvantages of this method are:

1- Fishes of a size tend to school together. (2) Hatching may occur at irregular times yielding size groupings not indicative of year classes. (3) Parts of a given year class may develop under variable conditions resulting in groupings of different size but of the same age , (4) one or more of of the year classes may be poorly represented or lacking in the sample.

3- Age determination using the hard parts of fish

The most important hard structures used in age determination are scales, otoliths (ear stone), vertebrae, operculum and spines. The interpretation and counting of growth zones which appear on the hard parts of fishes is the most frequently used method of age determination. Those that are considered to be formed annually are called annual rings or annuli. These are formed during alternate periods of faster and slower growth (or no growth at all), and reflect various environmental or internal influences. In temperate regions, the period of poor growth or no growth takes place only once a year, and the two seasons, summer, the period of faster growth, and winter, the period of slower growth (or no growth) have sharp differences of temperature. Thus readings of age determination based on annuli are, therefore, most reliable for temperate fish species. In general, the greater the seasonal temperature differences, the clearer are the annual marks.

a-Age determination from scales

Cycloid and ctenoid scales are the types most commonly used in age determinations and growth calculations. The most obvious distinction between these two types is the presence of the ctenii, small spines, on the posterior of the ctenoid scales. Cycloid scales are characteristic of soft-rayed teleosts and modern lobe finned fishes whears ctenoid scales are present in spiny fishes. Both cycloid and ctenoid scales may occurs in the same fish e.g Pleuronectus. In this fish, ctenoid scales are present on the pigmented dorsal surface while the cycloid scales are present on the lower side. The scales are arranged in an overlapping fashion, like the tiles on a roof of a house.

There are certain structures common to both types of scales:

*__The focus__ : is a small clear area near the centre of the scale and is the first part to develop.

*__Circuli__ : These are a series of concentric bony ridges around the focus, also called lines of growth. The circuli are continuous and homogeneous with the general bony surface.

*__Radii__ : These are the grooves that radiate from focus towards the margin of scales. It represents the lines of flexibility in the scales.

*__Annuli__ : These are annual (yearly) growth marks.

Irregularities

In examining a series of scales irregularities are frequently observed. The most common irregularity is regenerated scales in which the clear , well-defined focus is replaced by an expanded central area, devoid of circuli, rough or granular in appearance and irregular in outline.The regenerated scale is not an original one and are not suitable for age estimation because it represents fewer annuli than normal scales. When a scale is dropped from a fish for any reason, another scale is formed instead of it, but the growth rings do not appear on it until its size become similar to the size of the others.

Another irregularity arise when more than one annulus are laid down in one year. The additional rings are referred "supplementary rings" or "false annuli" or accessory year marks, and may occur as the result of changes in the rate of growth during the spawning period, seasonal variation in amount of food, extremes of climatic conditions, periods of floods, or times of drought.

b- Age determination from otoliths

Otoliths, commonly known as "ear stone", are hard, calcium carbonate structures located directly behind the brain of bony fishes. Three are three three types of otoliths, all of which aid fish in balance and hearing:

1- Sagitta: The largest of the three pairs of otoliths, sagitta is involved in the detection of sound and the process of hearing, or converting sound waves into electrical signals.
2- Asteriscus: This type of otolith is involved in the detection of sound and the process of hearing
3- Lapillus: This type of otolith is involved in the detection of gravitational force and sound.

Otoliths grow continuously throughout the life time of a fish by laying down calcium carbonate on the surface at different rates throughout the year. Growth is slower in the winter and faster in the summer months. The different rates of growth give a different appearance to the material laid down: in winter it looks milky white and opaque, in summer the material is much clearer and translucent. The result is a banding pattern on the otolith, alternating between the milky opaque bands (inter) and translucent bands (summer). Each set of bands represents one year of growth. By counting the number of opaque bands on an otolith, the age of the fish can be determined.

Otoliths are considered to provide more reliable indication of age than scales (Sinha and jone,1967). According to frost (1945a), the time of formation of the scales depends on length rather than age, and scales from the same area of the body may show different numbers of annual rings. Opuszynski(1965) stated that the appearance of the scales was related to reaching a definite body size by the individual.

Many techniques are used in the preparation of otoliths for age determination. These techniques are divided into four types:

1- Grinding or sliceing

The otolith is placed, concave side up, inside a small, both sides- opened, plastic tube on a microscope slide. Two or three drops of a resin are put inside the tube. The resin becomes hard

after several seconds forming a column which is removed from the slide.The otolith(inside the resin column) is then ground on a wetgrinding paper(600, 800 and 1000 grit) with a constant supply of water. The otolith is periodically washed by distilled water during grinding and examined with a microscope using reflected light to check the appearance of rings. When the rings show up clearly, the polished surface is cleaned with distilled water, dried and decalcified with 5% solution of EDTA for 5 minutes, washed with distilled water, dried and stained with 1% solution of toluidine blue. After staining, the resin column is stuck to a microscope slide with plastic liquid with the polished surface upward, and covered with a layer of plastic layer to protect the surface of the otolith. Otoliths slices (average thickness 0.2 mm) are cut from otoliths embedded in polyster resin along the longitudinal axis passing through the focus. Cutting of otoliths are done using a low speed circular saw covered with diamond dust as used in metallurgy.

2- Burning and cracking

The otolith is placed on a blade of heavy scalpel in a Bunsen flame for 30 to 60 seconds or in a flame from an alcohol burner.

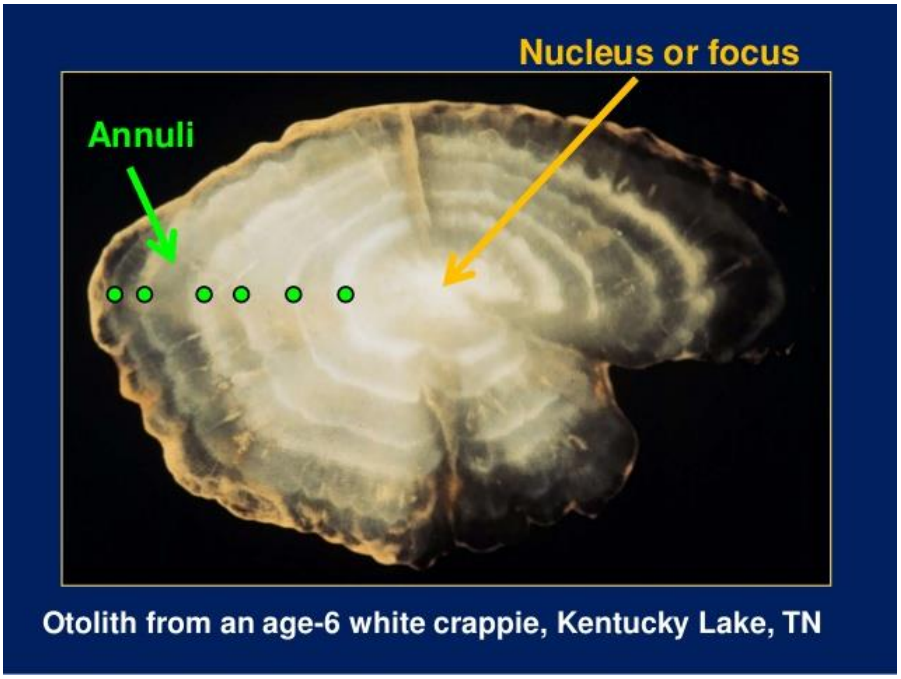
3- Whole otoliths

Before ageing, the otoliths are cleared for 18-24 hours in 96% ethanol. They are read using reflected light against dark background.

c- Age determination from vertebrae

The centrum of vertebrae contains also annual rings which are used in age determination especially cartilaginous fish. The method includes direct observation of growth rings from the face of the centrum. Tissues adhering to the centra were removed by a digestive solution made

up of 0.7% pepsin in 0.2% hydrochloric acid. Centrum may be stained by alizarin red and silver nitrate to clear the annual rings.



Factors affecting the growth rate of fish

1- population density:This is one of the effective factors in the fish growth. It is observed in the aggregation of population that the relation between the growth of individual and their number is reversal. The increase of stocking density is accompanied by a decrease in growth rate.
2- water temperature :The effect of water temperature on fish growth during the season of growth is important. The optimum temperature for fish growth differs in different fish species. The growth rate of a fish species decreases, when water temperature rises above its optimum temperature of growth. The effect of temperature on growth seems to be due to its effect on feeding and biochemical activities. A strong relationship was found

between temperature, biochemical activities, quantity of food consumption and the rate of live material formation in the body.

3- Level of dissolved oxygen :Oxygen is very important for fish growth especially youngs. High levels of oxygen promote growth of young, while low level of it lead to decrease and may stop growth. Fish differ in their needs to dissolved oxygen by the difference in its species, activities and ages.
4- Food supply: The quantity and quality of natural or artificial food have direct and great effect on growth rate.
5- Photoperiod: The fish growth rate increase with the increase of photoperiod, and decrease when photoperiod shortens. This explains why the growth rate of some fish increase during spring and summer, the maximum growth rate appear during these seasons, while this rate decrease during Autumn and winter when the hours of photoperiod decreases.
6- Ammonia: is the primary excretory product of fishes, but if it is present in high concentrations, it will slow growth rates. Obviously, this information has important application in fish culture . Culture system designed to maximize growth rate must have either high flow of fresh water to carry excreted ammonia away or ammonia –removal system such as green plants or biological filters utilizing appropriate bacteria.
7- Age and maturity: are usually the best predictors of relative growth rates in fishes, although the absolute growth rates are strongly influenced by environmental factors. Thus , fish typically grow very rapidly in length in the first few months or years of life, until maturation. Then increasing amounts of energy are diverted from growth of somatic tissue to growth of

gonadal tissues. As a consequence, growth rates of mature fish are much slower than those of immature fish.

8- Genetic composition

Little is known about the genotype of most fish species with the exception of carp. Growth must be correlated with fish strain.