CHAPTER VII

AGE AND GROWTH

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Introduction

Age is the lifespan of a fish, and growth is defined as the addition of material to that which is already organized into a living pattern. The age and growth of fish are important in the estimation of fish production in terms of quantity in a body of water in relation to time. Determination of age of a fish is perhaps the most complicated and controversial matter in the field of fishery biology, because ageing of tropical fishes is complicated by a lower seasonal variability and protracted breeding seasons. Age determination form the basis for calculations leading to the knowledge of the growth, mortality, recruitment and other fundamental parameters of fish population. According to Nikolsky (1963) count of age of a fish is important in the solution of biological problems, related with the size, growth and age of the fishes in the field of fisheries and has provided a large amount of information in this field and there are many investigations which are interesting from a technical point of view. Chugunova, 1959, carried out a review of the methods of determining the age and growth in fishes.

The growth of fish results from the consumption of food, its assimilation, and the construction from it of the organism's body (Vasnetsov, 1953). The growth process is specific for each species of fish as for any other organism. Growth is a specific adaptive property, ensured by the unity of the species and its environment (Nikolsky, 1963). It is interesting to noted that the age of a fish is not alike throughout its life and even throughout the year. The growth of fish is rapid in certain parts of year and slower or ceases in other parts of the year. Nikolsky (1963) pointed out that the fluctuating periodicity of fast and slow growth in fish expresses itself annually on the skeletal parts of the fish as a periodic structure of fast growing (i.e, wide) and slow growing (i.e, narrow zones). The period reflected on the hard parts in the form of rings or stripes, which are pale in reflected light, and controversly, the period of fast growth is characterized on the scale and skeleton by wide fields or rings, which are dark in reflected light and pale in indirect light.

Many ichthyologists emphasized that these rhythms of growth are seasonal and pointed out that there is a very close relationship between the periodic structure of the skeletal parts and the growth of the fish. But, there are contradictions among fish biologist's opinions regarding the causative factors that are responsible for the formation of growth checks or annual rings are evident from a review of previous studies. The fishery biologists who reported the role of temperature in the formation of growth checks/ rings are Fulton, 1904; Lea, 1911; Cutter, 1918; Thompson, 1926; Graham, 1929; Van Somern, 1950; Holden, 1955; Bishai and Gideri, 1965; Balon, 1971; Hopson, 1972; Kato, 1977 and emphasized that seasonal variations of temperature are responsible for the formation of growth checks / annual rings among fishes. On the other hand, the workers who stressed the intensity of feeding responsible for the formation of checks / rings are Thomson (1904), Hardy (1924), Kesteven (1942), Nair (1949), Bhimachar and George (1952), Pillay (1954), Qasim(1957), Radhakrishnan (1957), Jhingran (1959), Natrajan and Jhingran (1963), De Bont (1967), Lakshmanan *et al.* (1971), Khan and Siddiqui (1973), Rangaswami (1973), and Chattejee *et al.* (1979). Fully developed gonad almost completely occupies the abdominal cavity leaving little space for gut and resulting the low rate of feeding. This period of starvation coincided with the spawning act is also known as spawing fast and are repoted by many fish biologist Hardy, 1924; Hickling, 1933; Menon, 1954; Chacko and Krishnamurthi, 1951; Frost, 1954; Garrod, 1959; Buss, 1961; Major and Craddok, 1962; Lowe- McConnel, 1963; Lowler, 1965; Natrajan and Jhingran, 1963; Bilton, 1974; Payne,. 1976. Hora and Nair (1940);Johnels (1952) and Olatunde (1979) reported that sudden rise of water level coupled with high turbidity particularly during monsoon are responsible for the annual rings formation in the fishes. The formation of rings within the hard parts of the fishes are due to annual physiological changes in the internal environment suggested by Schneider (1910), Hickling (1933), Brown (1946), Molander (1947), Menon (1954), Swift (1955), Hoar (1957), Simkiss (1974) and Payne (1976).

Age and growth of different other fishes was carried out many other workers like Khan and Siddiqui (1973), Rangaswami (1973), Chatterjee *et al.* (1979), Lai *et al.* (1979), Chen *et al.*(1984), Edwards (1985), Guetreuter (1987), Sainsbury *et al.* (1989), McPherson *et al.* (1992) and Arvindkishan and Jena (1995), Rani Dhanze and Dhanze (1997). But no published information is available on age and growth of *Mastacembelus pancals*. Therefore, an attempt was made here to carry out the age and growth of this freshwater spiny eel.

Materials and Methods

For the present study, individuals of *Mastacembelus pancalus* of different size groups were collected from ponds, rivers and canals in and around of Sant Ravidas Nagar–Bhadohi district of eastern Uttar Pradesh. Weight of each fish was recorded by using a single pan balance sensitive to 0.001g; length was measured nearest to 0.1mm with the help of fish measuring board.

Usually, the age of a fish is determined by two ways: (i) direct or knowledge method; and (ii) indirect method. In direct method, the time when the fish is born or initial age should be known. Generally, fish spawns are reared in controlled environment and the growth of the samples in terms of length (linear growth) and weight (dimensional growth) is measured at certain intervals. As the direct method takes long time and has limited scope. So, biologists are more concerned with indirect method. In indirect method, the age of fish is determined by the annual growth marks that are formed in certain hard (skeletal) parts of the fish like scales, otoliths, spines, operculi and vertebrae. However, the indirect method was followed in the present study.

Scale method

Scales are the most widely used for age determination, because they are easy to collect and read. In most cases scales are directly viewed under microscope. Very large scales are readable without any aid, but small scale required for proper mounting. At the time of mounting of scales to keep convex side up. Cleaned scales are held flat between glass slides, which are pressed at the ends with the help of rubber bands, and left to dry. The scales may stick directly to the albumen, once they have dried, but if necessary either a spot of albumen or a mixture of glycerin and gelatin may be used for very thick scales.

Otolith method

In this method the whole fish are boiled in 2-5% potassium hydroxide solution. The head bone is then dissected and the otoliths are removed using a pair of fine tweezers and are preserved dry in paper envelopes or in suitable vials. To brighten the otoliths and to accentuate the appearance of growth rings, glycerin, xylol, cedarwood oil or cresol may be used.

Before observing the otoliths under a microscope, they first cleaned and polished. For large otoliths, cross sections are obtained through the nucleus using a fine knife. A graphite stone or grinding and polishing machines are often employed for polishing the otoliths. As in the case of fish scales, the growth rings or annuali present in the otoliths are counted and the age of the fish assessed.

Opercular bones, spines and vertebrae

For the purpose of age determination the operculum was cut from the body, cleaned and dried properly. The rings are then studied under reflected light. The scales or any other body parts used for age determination should increase along with the length of the fish. If the growth is constant and uniform, the relationship between these two parameters can be calculated by using the following formula (Lee, 1920):

$$\mathbf{Li = L\ Si\ /\ S}$$

where,

Li = length of the fish at the time of ring formation
L = length of the fish at the time of capture
S = radius of scale, etc.
Si = distance of each datum is taken out which is considered as the mean length attained at particular age.

Length-frequency distribution of Peterson method

Each fish was measured and grouped into different size classes with an interval of 5 mm or 10 mm. The monthly percentage frequencies are then calculated and their growth rates are subsequently traced by plotting. However, the opercular bone was used along with the method of length–frequency distribution as given by Peterson for the determination of age and growth in *M. pancalus*.

Results

Age of *Mastacembelus pancalus* was determined by using the operculum (Figs.1-3). The youngest among the collected individuals of *M. pancalus* was below one year old and the body size was 3 cm in length, whereas, the oldest among the sampled individuals of this fish was three years old and maximum body length of this group of fish was 16 cm and its body weight was 14g.

Determination of age from examination of the hard parts requires two operations, the reliable detection of bands with hard parts, and the determination of time scale associated with this banding, or validation (Williams and Bedford, 1974).

Reliable detection of operculum bands

Total 175 individuals of *M. pancalus* were observed for age determination, which showed different age groups. Among them fourty six fish's operculum was found completely opaque without showing any check formation. These fishes designated by O^+, and were 26.29% of the total fish. The operculum were contained only one ring in thirty eight individuals of this fish, which grouped in one year old fish (yearling) and designated by 1 in Table-1 and was 21.17% of the total fish. The specimens which contain one complete ring plus another incomplete were twenty three in numbers. These were grouped as less than two years old fish and their size being ranged 106 – 126 mm in length. The operculum of twenty-five individuals of this fish containing two bands was in size range of 127 to 142 mm in length. Individuals of size range 153 – 160 mm were recorded to contain three growth checks and these were classified as three years old fish (Table-1).

Validity of hard parts

The growth zones found in hard parts, although formed periodically may not be always annual in nature. Before, interpreting the growth zones on hard parts, it is necessary to provide corroborative evidences that these rings are really annual in nature, the following are the tests which confirmed the validity of hard parts (operculum) used as age indicator.

In order to study the time of the formation of the ring, the outer margin of the skeletal parts (operculum) of fish caught in different months were examined. Growth of the hard parts was found to be proportional to the growth of the fish. A good agreement was found between the estimates of length at age by Petersen method and opercular method.

Growth and production

After a period of twelve months, the growth in length and weight in between one year old and less than one year old of *M. pancalus* was 75 mm and 4g respectively. The monthly and per day rates of increment of body length were computed which are 6.25 mm / month and

0.21mm /day in the individuals of fish of one or less than one year old. Weight wise body increments recorded in this group of *M.pancalus* were 0.33g/ month and 0.11g/ day. In between one year old and two years old individuals of this fish the increment was 5.5mm/ month (0.18mm / day) in body length and 0.25g/month (0.008 g / day) in the body weight. However, in three years old specimens, the rate of body length increment was 2.75mm / month and 0.09 mm/day whereas, 0.20g/month and 0.006 g /day body weight increment was recorded in the same group of individuals of this fish.

Discussion

In the present investigation the age of *M. pancalus* was determined on the basis of annual rings present in the operculum. The growth of the fish was studied on the basis of the weight or length gained by the fish during the formation of annual ring. It was observed that no bands were appeared in the individuals of *M.pancalus* which were less than one year old, and operculum were completely opaque. The annuli appeared after the completion of year, probably, during the period March through May, which is the peak feeding period of this fish. Lai and Liu (1979) demonstrated a time of annulus formation in *Lutjanus sanguineus* from the North West Shelf in 1973 –1975 between October and December, while Chen *et al.*(1984) observed a check formation during May–September for *L. malabaricus* from the same area in 1983-84.

The result indicated that the growth in length and weight of adults *M. pancalus* was low in comparison to young ones. Nikolsky(1963) suggested the several factors for high rate of growth in younger individuals and emphasized that during the period to the attainment of maturity of the fish is closely related to the food supply, feeding intensity and food conversion ratio. Moreover, after the attainment of maturity the main part of food consumed by the fish is used not for the linear growth but also for the ripening of the gonads and the accumulation of fat for over wintering. The ratio of maintenance and growth, food changes in the direction of an increase in the amount of maintenance food. During the period of old age relative growth practically ceases, the value of the growth sharply reduced because most of the food is used for maintenance and only occasionally for accumulation, particularly in over wintering fishes. However, ageing of tropical fishes is complicated by a lower seasonal variability and protracted breeding season signal both in the hard parts and population length / frequency (Brothers, 1971; Sainsbury *et al.,* 1989). During the course of this study, it has been observed that growth in adult individuals was ceases during winter and spawning season. The growth of fish not alike throughout the year. There are several external factors, which affect the growth of fish. For example, the temperature, which affects the character of the growth in fishes. Nikolsky (1963) reported that in a number of cases the temperature acts a "signal factor". A reduction of the temperature below a certain level to a cessation of protein growth and the commencement of the fat accumulation processes. This was noted for young carp by Kirpichinkov (1958) and also holds for a number of other species. In this case the reorganization of the metabolism in relation to the change in temperature is and adaptive reaction, which ensured the necessary preparation of the organism for over wintering. Several other workers reported similar results in different fishes. Chen *et al.* (1984) considered that the differential growth in weight of *L. malabaricus* was due to the reproductive burden imposed on females. Ralston and Miyamoto (1983) a significant effect of maturation on the growth of male and female *Pristopomoides filamentosus* (Lutjanidae). Growth rate of the both sexes declined after the length at maturation.

Table 1: Annuli and age groups in *M. pancalus*

Size (mm)	No. of fish	No. of annual rings	Designation	Age groups
30-75	46	Nill	0^+	Less than one year old
76-105	38	One	1	One year old (yearling)
106-126	23	One	1^+	Less than two years old
127-142	25	Two	2	Two years old
143-156	28	Two	2^+	Less than three year sold
153-160	15	Three	3	Three years old

+ = The plus sign signifies the start of the following year's growth.