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A Study of Scales for Growth and Age Determination in *Tor tor*

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Abstract: Age and growth determination of fish are very formal and fundamental components and have a great significance for not only in fisheries biology but it is equally important for providing information about stock management, age of maturity, life span, yield and production also. The proper knowledge on the age and growth of the fish is a prerequisite for studying population dynamics and maintaining sustainable yields in aquaculture (Campana and Thorrold, 2001). The Fish age wise growth rate is species specific, as higher weight increment is shown by few fishes than others at the same length of time, whereas some attain more length than others. Even in the same species, the growth rate differs between both sexes and also with the different seasons of the year which is related to environmental conditions especially water temperature (Akamine, 1993). The main objective to study age and growth of the fish is to assess the maximum level of production of a species in relation to a particular culture period.

Age of the fish can be determined by counting the annuli, and fish lengths at each year can be calculated by measuring the linear distance from the 'focus' of the scale, to each annulus. From these back calculations of length at different years, growth rates can be calculated. In this study scale studies were made for Mahseer to ascertain the growth rings for age determination. Mahseer fish specimens from the Bhopal fish market were collected during years 2000-2002 for age studies. It was found that the mean length of specimens aged between 1 year to 5 years ranged from 208 mm to 545 mm. Further studies are needed to confirm and expand upon these initial findings, but this study represents a significant step forward in our understanding of the mahseer fish.

Keywords: Age determination, Growth determination, Scales, Conservation, Annuli, *Tor tor*

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Introduction

The rate of growth varies to a large extent among fishes, as these are cold blooded. It varies from species to species or may vary for the same fish from different localities, or for the same individual at different seasons, for the rate of growth is easily influenced by many physical factors (temperature

etc.). Also different parts of the body or even different organs have different rates of growth. Except for the males of poecilids (which have determinate growth), fishes continue to grow practically throughout their life (indeterminate growth). However, in extreme old age fish's

growth is extremely slow. Thus, for many fishes, the growth curve at first rises up slowly with an increasing slope, representing an increasing rate of growth (Shrivastava. 1985).

A good number of scientific information is available on age and growth rate studies of fishes. Determination of age and growth of the fish has still continued to be one of the most important actions by fisheries professionals (Jackson, 2007). Analysis of life history parameters of natural populations of fish could help us to understand environmental impacts. Growth, survival rate and reproductive successes in natural populations are likely to be adversely affected by long-term contaminant stress. Age structure analysis could be a helpful tool in detecting contaminant related stress in fish populations.

Tor tor, also known as the Indian mahseer, is a freshwater fish species found in the rivers and streams of the Indian subcontinent and Southeast Asia. The species is highly valued for its size, strength, and fighting ability, making it a popular target for sport fishing.

The age of fish is determined by scales on the basis that successive rings are formed as the fish grows in age. During summer and autumn, plenty of food is available and the fish grows at a faster rate so that the rings formed in this period are widely spaced. During winter, the food supply is limited and growth is restricted so that the rings are tightly packed, giving an appearance of alternate light and dark bands. These two bands are together considered to have been formed in one year and are called the annuli. The number of annuli on the scale gives the age of the fish. Circuli are the actual sites of heavy deposition of bone material, and annuli represent the period of slow growth in a year. Sometimes false annuli also appear in some fishes due to slowing or fluctuation in temperature, and must be distinguished from real annuli. Generally a true annulus runs all along the surface of the scale, and is formed at the same time each year, but a false annulus does not run all along the scale and can be formed at any time due to various factors.

Knowledge of scale structure and its development is very useful in the interpretation of the growth zones. A scale presents a certain pattern of sculpturing on its surface, which can be easily studied under a dissecting microscope. The following markings are discernible; focus, circuli, grooves, radii and annuli. In most cycloid scales a nuclear, central zone is recognizable. This zone may properly be called the focus of the scale. Focus is the central, small, clear area; it may be displaced from the centre of the scale due to unequal growth of the anterior and a posterior part of the scale. Circuli are concentric marks around the focus. These appear as ridges running parallel to each other and at more or less regular intervals or gaps. Grooves alternate with ridges of circuli and are responsible for the regular spacing between them. Radii are grooves disposed radially i.e. running from focus to the margin of the scale. Radii cut the circuli as these fall in their path. Annuli appear in ageing fish, as wide circular troughs, their number depending upon the age in years of the individual. In this study scale studies were made for Mahseer to ascertain the growth rings for age determination.

Materials and Methods

Generally scales are used for age determination of fish. This is the simplest and most accurate method; on the basis of experience annuli on the scales can be easily counted. About 10 scales were taken from the fish, usually from below the origin of the dorsal fin just above the lateral line. These are called 'key scales' (Khanna, 1997). To remove adhering- tissues the scales were cleaned in 5% KOH solution and finally washed in distilled water. The scales were then pressed while drying so as to avoid their curling and were examined under a dissecting microscope for easy and accurate counting of growth rings. Thus, age of the fish can be determined by counting the annuli, and fish lengths at each year can be back calculated by measuring the linear distance from the 'focus' of the scale, to each annulus.

Results and Discussion

Scale studies were made to ascertain the growth

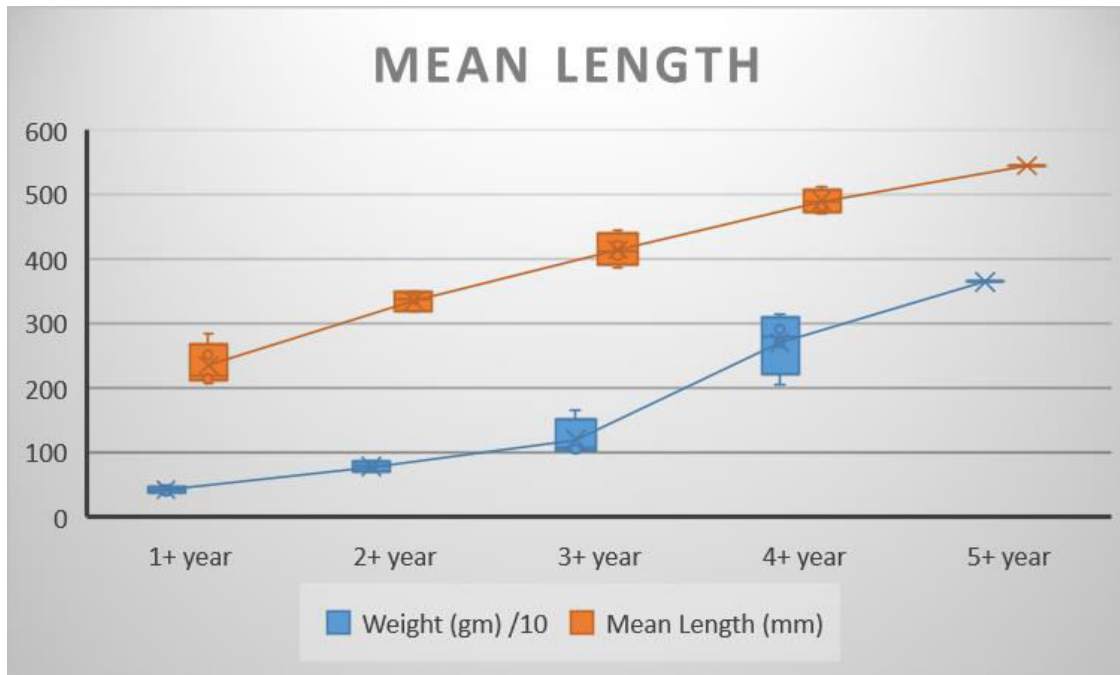


Fig. 1: Mean length and weight in relation to age of the mahseer, *Tor tor*.

rings of the fish. It is evident from Figure 1 that the sampled fishes ranged from one year to five years in age. The cycloid scales of *Tor tor* were roughly rectangular in shape. The outer surface of scales is marked with bony ridges that alternate with valley-like depressions. The inner part of the scale is made up of layers of criss - crossing fibrous connective tissue. Small scales were soft and transparent but the degree of softness and transparency decreased with the increasing size and age. The samples with mean length ranged from 208 mm to 545 mm were assessed for age determination and it was found that fishes of 1+ year had weight ranged from 350 g to 500 g and mean length ranged from 208 mm to 285 mm. For fish samples of age 2+ years mean length ranged between 320 mm to 350 mm and average weight between 700 g to 860 g. For fishes of 3+ years weight ranged from 1020 g to 1650 g and mean length ranged from 386 mm to 445 mm. For fish samples of age 4+ years mean length was observed between 470 mm to 512 mm and average weight between 2050 g to 3150 g and for fishes with age 5+ years mean length was 545 mm and average weight of 3650 g.

Badpanda (1996) studied the growth of the scales of Mahanadi mahseer and observed in the scales of specimen up to 725 mm in length five complete circuli with numerous radii, David (1953) also observed that in the scales of specimen up to 261 mm length only one ring was found and in the scales of specimen up to 365-mm in length there were at least two rings in addition to a third ring which was not distinct.

In determining growth and reproductive characteristics of fish, age is considered to have an important role to play (Weatherley, 1987; Mayank *et al.*, 2018). The studies related to fish growth are important to understand many aspects like fisheries sustainability, its life history including its reproductive biology and population dynamics (Rizvi *et al.*, 2010; Dwivedi and Nautiyal, 2012; Vilizzi *et al.*, 2017).

In the lotic ecosystems factors like technique used for fishing, size of nets and the quality of water have a significant role in decreasing size and age classes of the fishes (Dwivedi and Nautiyal, 2012; Tripathi *et al.*, 2017). Though fishes grow well both in the lentic and lotic

ecosystem still it is considered that they exhibit better growth in the lotic environment.

The growth and age determination of *Tor tor*, a freshwater fish species also known as the mahseer, has been studied extensively using scales as a method of analysis. Otoliths are bony structures found in the inner ear of fish that are used for balance and hearing. They also provide valuable information on the growth and age of a fish species. The mean length of fish collected was 208 mm to 545 mm for an age group of 1 year to 5 years of age which seems to be satisfactory (Nautiyal and Dwivedi, 2020). Desai (2003) reported the mean length of *Tor tor* in the Narmada river using the scale method as 21.4 cm, 28.9 cm, 36.2 cm, 42.9 cm, 49.0 cm, 53.8 cm, and 57.2 cm for ages 1 to 7 years. On the other hand, Karamchandani *et al.* (1967) observed mean length of *Tor tor* in Narmada river as 249 mm, 320 mm, 380 mm, 440 mm, 490 mm, 533 mm, and 580 mm for ages 1 to 7 years, using scales and opercular bones. Furthermore, age and growth of *Tor tor* from Lake Bhimtal were also studied by using scales and opercular bones (Pathani, 1986-87).

Overall, the study of scales has proven to be a valuable tool in determining the growth and age of *Tor tor* populations. This information is important for understanding the biology and ecology of the species, as well as for management and conservation efforts.

Conclusion

The result discussed here is of initial observations of satisfactory growth of the fish but of utmost importance as such this type of studies have not been done on this fish earlier. Looking at the present declining trend of Mahseer, the study of scales can be an efficient method to study the growth rate of endangered fish mahseer.

Furthermore, the results of this study can also be used to develop conservation strategies for the protection and management of Mahseer populations. This information can then be used to

develop appropriate conservation measures to ensure the long-term survival of this endangered species.

Additionally, the scale analysis technique can also be used to study the impact of human activities on Mahseer populations. For example, the growth rates of Mahseer in areas that are heavily impacted by human activities, such as pollution or overfishing, can be compared to those in less impacted areas. This can provide valuable insights into the impact of human activities on Mahseer populations and can be used to develop conservation strategies to mitigate these impacts.

The results of this study can be used to develop conservation strategies for the protection and management of Mahseer populations and to study the impact of human activities on these populations. Further research using this technique is needed to fully understand the dynamics of Mahseer populations and to develop effective conservation measures for this endangered species.

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