CHAPTER - 18

SUMMARY

The Golden Mahseer, *Tor putitora* (Hamilton) is well renowned as a splendid, riverine game fish and constitutes a group of large sized carps. *Tor putitora* were found to dwell in all the spring-fed and snow-fed rivers and streams. Being a fish of the rocks, rapids, pools and the hills, it has been providing sport to many enthusiastic anglers in India. Besides providing recreation to many naturalists. It is a good source of food to innumerable fishermen and tribals living in the long stretches of rivers and reservoirs. In commercial fisheries too, it could therefore, occupy an important position when its qualities are better known and appreciated and proper steps for its conservation are taken.

In large rivers, the fish can attain large size and weight, while the tributaries harbour the small and young fishes. During the spawning season mahseer migrates upstream for breeding purposes and travel long distances. The spawning activity of mahseer takes place at the confluence of the tributaries to the main stream or at the creek, where water is well oxygenated and has moderate velocity. The present study is highly confined to the stream fishery. The extensive survey was undertaken to locate the fish occurring sites and their breeding groups. During the course of survey, following sites were visited frequently to collect the data on the breeding biology of golden mahseer, *Tor putitora* (Hamilton).

1. Dehar Stream
2. Gaj Stream
3. Baner Stream
4. Ghatti Stream
5. Kahn Stream

These are the tributaries of the river Beas. The river Beas originates in southern face of Rohtang pass at an elevation of 4062m above msl. The river receives a number of tributaries, the principal one i.e. Dehar, Gaj and Baner feeding the river Beas at the Pong dam reservoir and the other two viz., Ghatti
and Kahn feeding the river Beas bypassing the Pong dam reservoir as shown in Fig. 3.2.

The fair population of Golden mahseer has been recorded from Dehar, Gaj and Baner during the course of sample collection from August, 1998 to January, 2000. The occurrence of Golden Mahseer has not been recorded from Ghatti and Kahn. So only one year data of these streams have been collected.

The streams under report belong to two categories viz., ‘B’ and ‘C’ types. The stream Dehar, Gaj and Baner fall into ‘B’ type. ‘B’ type streams are dominant by cobbles and gravel followed by small and large boulders. These streams are rapid and riffle dominated that infrequently produces spaced and score pools. They are primarily moderately steep. The landform made up of colluvial-alluvial deposits and valley side slopes that tend to result in narrow valleys. These streams are moderately entrenched, have a cross section with/depth ratio is greater than 12. The stream Ghatti and Kahn falls into ‘C’ type. The ‘C’ type streams are located in narrow to wide valleys, constructed from alluvial deposition. Runs, rapids, glides and riffles characterize these streams. These are slightly entrenched with wide flood plain. The shape and form of ‘C’ stream type are indicated by cross- sectional width/depth ratios generally greater than 12 and sinusitis exceeding 1.4. The channels are with meander geometry. Channels of the ‘C’ stream type can be significantly altered and rapidly de-stabilized when the effect of imposed changes in bank stability, watershed condition or flow regime are combined to cause an exceedance of a channel stability threshold.

The streams Dehar, Gaj and Baner originate from the Dhaouladhar hills and join the river Beas at Pong reservoir. These are the perennial streams and their bed consists of small boulders, cobbles, gravels, sand, silt and organic matter. The stream habitat comprised rapids, ripples, run and pools. The gradient of all streams is moderately steep. The vegetation along the streams is scattered. The presence of mahseer fingerlings confirmed that these streams are the breeding grounds of the mahseer. Maximum fish biodiversity is present in the Baner stream. It is called sanctuary of fishes with mahseer as a dominant fish. Besides mahseer, other fish species have also been recorded viz., Barilius
bendelisis, Barilius vagra, Cirrhinus reba, Labeo bata, Labeo dero, Puntius phutunio, Puntius sarana sarana, Puntius ticto ticto, Tor putitora, Crossocheilus latius diplocheilus, Schistura neilgheriensis, Aorichthys seenghala, Xenentodon cancila, Channa punctatus, Channa marulius, Mastacembelus armatus, Garra gotyla gotyla and Bachydanio rerio. Abundance of fish diversity in any water body is a good indicator of the health and status of the ecosystem. Dehar stream having 7 fish species, Gaj having 11 fish species, Baner having 16 fish species, Ghatti and Kahn having 4 fish species each. The Ghatti and Kahn have little substratum, shallow water and abode less number of fish species.

Knowledge of specific fish population dynamics is essential to assess the racial structure. The morphometric and meristic characters of Tor putitora were taken into consideration and scatter diagrams were drawn between the independent and dependent variables. Regression lines were fitted by the method of least squares. It has been observed that all the characters show high degree of correlation indicating that all the morphological characters increase in direct proportion with each other. 18 characters have been studied in the percentage of total length from which 15 characters have been observed genetically controlled, 1 character with intermediate and 2 characters were environmentally controlled. Out of all these characters, SL shows most significant correlated body part in the sample and least correlated body parts are length of caudal peduncle, head depth, depth of dorsal fin, length of anal fin and minimum body depth.

Regarding the food and feeding habits of the fish, it is designated as "carni-omnivore". During the course of the study 163 fish have been examined for the food and feeding habits. Different sized fish have been procured from the Baner stream. The fish were divided into three major groups on the basis of their length.

1. 7.2 cm – 10 cm (19 Nos.)
2. 10.0 cm – 20.0 cm (111 Nos.)
3. 20.0 cm – 35.5 cm (33 Nos.)

The gut contents of Tor putitora have been grouped into 12 broad groups i.e. 1) Undigested muscle of insects, 2) Chitinous parts of insects, 3) ...
Algae, 4) Crustacean, 5) Protozoans and Rotifers, 6) Plants (Water and Periphytons), 7) Detritus, 8) Fish bones and scales, 9) Gastropods, 10) Parasites, 11) Sand particles and 12) Miscellaneous (wood parts and plant seed etc.). The fry and fingerlings of *Tor putitora* fed mostly on phytoplankton and zooplankton. But the adult fed on a large variety of food including insects larvae, higher algae and diatoms etc. and large sized fish fed on small fishes, gastropods, molluscs and sometimes amphibians also.

A majority of fishes all over the world are seasonal spawners, but in the Indian subcontinent a vast majority of the freshwater fishes spawn during the rainy season. The samples procured from the Baner stream were dissected in the laboratory to examine the ovary and the testes. The fish studied were immature. The ovaries were thread like having nucleated ova. The occurrence of ova were in three groups because the mahseer lay eggs in batches. The ova diameters range from 0.20--0.30 mm (25%), 0.30-0.40 mm (50%) and 0.40-0.45 mm (25%). The males mature earlier than the females. It has been inferred that 10.0 cm – 20.0 cm range of one year old males were mature and found in oozing condition.

The length-weight relationship of fishes generally indicates that an increase in length is accompanied by a much conversion of one measurement into another. For study of the length-weight relationship of *Tor putitora* the fish were brought from the field, were first measured and then the excessive moisture was removed from each fish by pressing the latter in between two blotting papers and weights were noted down for individual fish. The observed values of length and weights were transformed to logarithmic values and equation were calculated by the method of least squares. Males and females have been treated collectively because of small size. The length–weight relationship of the data was analysed by regression which is as follows.

\[
\log W = -1.821 + 2.831 \times \log L^{2.831}
\]

or

\[
W = 0.0115 \times L^{2.831}
\]
The value of ‘n’ generally lies between 2.5-4.0. In the present study it is 2.831. So it is considered that growth of mahseer is almost isometric.

The sex ratio of fishes, theoretically should be 1:1 males to females. But during the present investigations, it is inferred that sex ratio between female and male is 1:1.77. It was found that for 1.77 males there was 1 females. Hence for practical purpose it can be stated male-female ratio is 2:1.

Age and growth assessment of fish from their calcified structures can be a vital components of our present day fisheries management decisions. To understand age and growth, fish scales and opercular bones were taken. Linear relationship with a high correlation coefficient between total fish length and scale radius/opercular length was observed. The regression line in case of scales cuts the X-axis at 0.72 mm and this value has been considered as the correction factor for back-calculated length, whereas no such correction factor has been observed in case of opercular bones.

During the present studies 163 specimens have been employed for age and growth studies. The specimens ranging from 7.2 cm to 35.5 cm total length were studied belonging to age classes 1\textsuperscript{st} to 5\textsuperscript{th} years. The maximum number of specimens belonged to age class 2 followed by age classes 3 and 4. It has been observed that the linear growth rate decreased with the increase in age. The high rates of growth has been observed between 1\textsuperscript{st} to 2\textsuperscript{nd} years and it slows with increase in age. Many interspersed small streaks are also observed which represent false ring which may be due to feeding fluctuations or any other unfavourable condition.

The maximum annual increment has been observed in the age class of 1 to 2\textsuperscript{nd} year. The phenomenon of growth compensation occurred in the age class of four.

The specific rate of linear growth decreased with the increasing age of the fish except in fourth year. The growth characteristics did not show specific period and different periods cannot be demarcated. When a particular population is under stress or leading an abnormal life, the population loses this characteristic.
The value of specific linear growth shows a decreasing trend with increase in age whereas those of specific rate of weight increase. The average growth constant of first, second and third period are 0.3695, 0.5966 and 0.1865. On the basis of above data it is concluded that *Tor putitora* attain full sexual maturity at the age of 4th year.

The condition factor (K) increases with increase in length and weight up to 2nd year of fish and suddenly drops in the third year and again start increasing upto 5th year of the fish. With the increase of age the size also increases and competition for survival occurred which leads to slow rate in gaining weight and length.

Many physico-chemical factors influence the composition of river water, causing variation from place to place. Most rivers and streams contain much more suspended and dissolved material, originate from dissolution of earth’s rocks. The following parameters were studied form the streams under report viz., air temperature and water temperature which were recorded maximum during summer months and minimum during winter months. Water current has been recorded maximum during monsoon and minimum during summer months and winter months. Humidity has been recorded maximum during rainy season and minimum during summer months. The trend of conductivity is highly variable, it has been recorded maximum during winter months from Dehar, Gaj and Baner streams and minimum during monsoon months. Conductivity recorded from Ghatti and Kahn was almost reverse as compared to above streams. Difference in conductivity results mainly from the concentration of the charged ions in the stream water. Ghatti and Kahn may bring more ions during the monsoon season.

The value of turbidity has been recorded maximum during rainy season and minimum during winter season. Total dissolved solids have been recorded maximum during winter season and minimum during summer and monsoon months. pH has been recorded maximum during summer and minimum during monsoon season. Chlorides have been recorded maximum during winter months and minimum during monsoon months. Chloride is useful as trace element. Total alkalinity has been recorded maximum during the winter,
summer season and minimum during the monsoon season. The value of alkalinity fluctuates due to the presence of \( \text{CO}_2 \) dissolved in soil and ground water which form the bicarbonate. \( \text{CO}_2 \) is produced by bacterial decomposition of organic matter, and derives in turn from the photosynthetic fixation of atmospheric \( \text{CO}_2 \). Total hardness has been recorded maximum during winter season and minimum during monsoon. Total hardness is determined by cations which form insoluble compounds like calcium and magnesium salts. Ca and Mg occur mainly in combination with bicarbonates, sulphates and chlorides. When there was less volume of water and the high values of total hardness have been recorded. The large volume may dilute the concentration. The dissolved oxygen has been recorded maximum during winter months and minimum during summer and monsoon months. Photosynthesis and respiration are the two important biological processes that alter the concentration of oxygen. During the winter months the abundance of algae in the stream water has been found to be the sole reason to elevate concentration of oxygen in the stream water.

Biotic factors are the important components to regulate the stream ecology in relation to fishes. Phytoplankton, zooplankton and benthos have been studied in the present context. The phytoplankton occurrence has been recorded form all the streams under report i.e. Cyanophyceae including *Chroococcus* spp., *Oscillatoria* spp., *Nostoc* spp., *Anabaena* spp., *Merismopedia* spp. and *Microcystis* spp. Maximum abundance of Cyanophyceae has been recorded during the summer months and decreasing towards winter and minimum during the monsoon season. Chlorophyceae comprises of *Chlorella* spp., *Pediastrum* spp., *Ulothrix* spp., *Microspora* spp., *Ulva* spp, *Oedogonium* spp., *Cladophora* spp., *Zygynema* spp., *Spirogyra* spp., *Closterium* spp., *Cosmarium* spp., *Scenedesmus* spp., *Oocystis* spp, *Closteriopsis* spp. and *Stigeoclonium* spp. The maximum occurrence of Chlorophyceae has been recorded during the winter season and almost negligible during the summer season. Bacillariophyceae consists of *Melosira* spp., *Cyclotella* spp., *Tabellaria* spp., *Meridion* spp., *Diatoma* spp., *Fragillaria* spp., *Synedra* spp., *Acanthess* spp., *Eucocconeis* spp., *Caloneis* spp., *Navicula* spp., *Eucocconeis* spp., *Caloneis* spp., *Navicula*
spp., Gyrosigma spp., Pinnularia spp., Stauroneis spp., Cymbella spp., Gomphonema spp., Gomphoneis spp., Nitzschia spp. and Surirella spp. Maximum abundance has been recorded during winter season decreasing towards summer season and almost negligible during the monsoon season. Euglenophyceae represented with two members i.e. Chlamydomonas spp. and Volvox spp. Their presence were also recorded maximum during winter and minimum during summer and again increases during the monsoon season. Chlorophyceae, Bacillariophyceae and Euglenophyceae members require low temperature to flourish. The presence of substratum and medium flow of water also pertain to the abundance.

Zooplankton were represented by Protozoa i.e Diffugia spp., Vorticella spp., Arcella spp., Nebella spp., Thecamoeba spp. and Sexangularia spp., Rotifer i.e. Keratella spp., Brachionus spp., Asplanchna spp. and Filina spp., Cladocerans i.e. Daphnia spp. and Moina spp., Ostracods i.e. Cypris spp. The occurrence of zooplankton was recorded throughout the year except during monsoon season.

The benthos were abundant in Dehar, Gaj and Baner stream, but low values of benthos have been observed in Ghatti and Kahn stream. The benthos included of ephemeroptera insects i.e. Cloen spp., Ephemera spp., Ephemera doris, Ephemera aleghoniensis, Heptagenia spp., Rithrogenia spp. and Baetis spp., Plecoptera includes Isoperla spp. and Perla spp., Hemiptera comprises Gerris spp. only, Diptera includes Chironomus spp., Antocha spp. and Culex spp., Trichoptera includes Rhyancophila spp. and Hydropsyche spp., Coleoptere i.e. Gyrinus spp. and Dytiscus spp., Odonata is represented by Macromia spp. only, Oligochaeta includes Pheretima posthuma, Annelida comprises Glossiphonia spp. and Gastropoda consists of Lymnea spp. Maximum occurrence of benthos have been recorded during the winter and almost nil during summer and monsoon.

The present status of the fish is threatened because it has been observed that the population of this fish is declining gradually. During the present course of studies it has been observed that following essential steps should be taken to conserve the mahseer population in natural water:
1. Removal of bed material from the stream bed should be strictly banned.
2. Illegal poaching in the form of dynamiting, hunting and poisoning should be checked.
3. Close season should be strictly observed.
4. Population should be seriously dealt to safeguard the interest not only of fishes but also of humanity in general.
5. Lakes, rivers and streams should be designated as sanctuaries, where occurrence of mahseer is abundant.
6. Mass awareness programs should be launched in the form of workshops, seminars and symposiums.
7. To maintain the golden mahseer population in the natural water bodies, construction of flow through fish hatcheries should be constructed for artificial rearing of this fish.

Various aspects presented in the thesis pertain to the productivity of streams with particular reference to the golden mahseer, *Tor putitora* (Ham.).