Length – Weight Relationship
Studies pertaining to reproduction in relation to ecology and habitat of fishes are extremely useful in fishery management. Majority of fishes all over the world are seasonal spawners and in the northern Indian a vast majority of the freshwater fishes spawn during south-west monsoon. According to Karmchadani et al. (1967) *Tor tor* of the Narbada river has a prolonged breeding season which commences in July-August and continues up to December with peak breeding from July to September. The other studies on the breeding of the *Tor* species from regions are those of Khan (1939), Qasim and Qayyum (1962) and Sehgal et al. (1971) who described that *Tor* species spawn two to three or more times in a year. Badola and Singh (1980b) showed that *Tor tor* and *Tor putitora* of Garhwal hills spawn once a year, during from April to July. Johal et al. (2000) pointed out that the breeding act is completed before the month of August in Gobind Sagar population.

Maturity is a term profusely used for expressing the attainment of reproductive capacity, whereas ‘maturation’ refers to the period prior to it when the gonads undergo morphological changes. In the present study fishes having the size of 7.2cm to 35.5cm total fish length of fish have been subjected to the present study. The samples were collected from Baner stream, dissected in the laboratory to examine the ovary and the testes. Most of 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 diameter ranged from 0.20-0.30mm (25%), 0.30-0.40mm (50%) and 0.40-0.45mm (25%).

During the course of study hardly any mature fish was found. Nautiyal and Lal (1985a) recorded 2.80mm ova diameter in ripe fish. Bhatt et al. (1998a) described that the mature size of the fish ranged from 46.0 – 64.0cm.

The earlier studies have indicated that the males mature earlier than the females. It has been inferred that 10.0cm-20.0cm size range of one year old
males were mature and found in oozing condition. The quantity of milt was less. Ogale (2000) recorded similar observations and categorically stated that males mature in the first year of their life and with little pressure is exerted on their belly, the milt oozes out.

Golden mahseer from Baner spawns during the monsoon period. The level of water of the stream at this time is very high or they are usually flooded. The large sized fish to live in deep water. Thus, to procure large-sized fish from the flooded streams was very tough.

**Classification of maturity stages of *Tor putitora* (Ham.)**

It is not possible to give an exact account of the maturity after as fishes of all lengths and all stages could not be procured inspite of best efforts. The available female fish from Baner was always in an immature state and perhaps less than three years old. However, the following classification of maturity stage based on the work of Johal *et al.* (2000) from Gobindsagar and collections made from Pong Dam is given.

**Reproduction of *Tor putitora* (Ham.) described by Johal *et al.* (2000)**

Whether different types of ova are homogeneously distributed throughout the ovary or not, the samples were taken from anterior, middle and posterior regions of the ovary. In stages III and IV these were following three categories of ova in mature fish.

1. White coloured (in preserved form), opaque, with ova diameter 0.83-1.33 mm.
2. Light yellow coloured (in preserved form), opaque, with ova diameter 1.66-2.00 mm.
3. Dark Yellow coloured (in preserved form), opaque and ova diameter ranged from 2.16-2.66 mm.

**a) Classification of maturity stages:**

**Stage-I (Immature):** Ovaries occupy one half of the body cavity, thick ribbon shaped light pink in colour, opaque. Ova not visible to the naked eyes.

**Stage-II (Maturing):** Ovaries occupy one half of the body cavity but broader than stage-I, thick ribbon shaped with dark pink or red colour and granular appearance.
Stage-III (Maturing): Ovaries occupy three fourth of the body cavity, much broader than stage-I and II, shape rounded, colour dark orange with conspicuous superficial blood vessels. Ova large translucent and visible to the naked eyes.

Stage-IV (Mature): Ovaries occupies the body cavity fully Eggs fully laden with yolk and orange coloured.

Stage-V (Spawning): Not observed.

Stage-VI (Spent): Not observed.

Stage-VII (Spent recovering): Not observed (Resemblances likely stage-II)

The absence of spawning spent and spent recovering females in the collection is attributed to the upstream migratory nature of the fish. It is likely that the fish moves downstream after spawning when the process of spent recovering has already begin.

b) Seasonal progression of ova: In order to determine the spawning season on the basis of ova diameter and gonado-somatic index of each month, the observations are recorded. On the basis of these observations there is only one breeding season of *Tor putitora* from Gobindsagar. In August the higher value of gonado-somatic index was recorded. Similarly, from the ova diameter of each month it is observed that throughout the year the ova diameter is same but, during the month of August it was maximum. It is therefore, concluded that the breeding season of *Tor putitora* falls during the month of August. The pattern of ova development as evident by plotting of ova diameter in different months indicates that for most part of the year fish remains in an inactive stage of maturity. The progression of ova indicates mature ovaries only in the months of August. It is therefore

c) Size at first maturity: The diameter of 100 ova from each ovary was recorded by an ocular micrometer fitted to stereoscopic binocular. To determine when the ovaries mature, eggs are released in atleast 3 batches in the month of August.

d) Spawning season: In order to determine the spawning season, ova diameter during each month was recorded. On the basis of these observations there is no clear indication of the spawning season of *Tor putitora* from Gobindsagar. From the ova diameter of each month it is observed that
throughout the year ova diameter show three stages of eggs, but peak values were observed during the months of May and August. It is therefore concluded that the spawning season of *Tor putitora* is during the months of May to August. Moreover, the mahseer releases eggs in batches.

**Reproduction of *Tor putitora* (Ham.) in Pong Reservoir**

a) **Classification of maturity stages**: The classification of maturity stages have been done on the basis of colour, shape and size of gonads in relation to body cavity and the diameter of unspawned eggs. For this purpose the gonads were subjected to macro and microscopic examinations. The maturity stages were classified according to Holden and Raitt (1974) for partial spawners with certain modifications. Based on the colour, shape and size of gonads and the diameter of the unspawned eggs, following five maturity stages in females have been ascertained with distinct possibility of sixth stage.

**Stage-I (Immature stage)**: Ovaries slender, thin, short light flesh coloured and ribbon like and occupy one half of the body cavity. Ova minute, transparent not visible to naked eye. Ova diameter ranges from 0.10 to 0.43 mm.

**Stage-II (Maturing-i)**: Ovaries slightly enlarged and becomes translucent, yolk deposition further progresses and ova become yolky, opaque, visible to naked eye ova diameter ranges form 0.17 to 0.77 mm.

**Maturing-ii**: Ovaries turn fleshy in colour, become thick from all sides and occupy 3/4th of the body cavity with conspicuous superficial blood vessels. Ova have granular appearance and visible to the naked eye, transparent and translucent and opaque egg are noticed, ova diameter ranges from 0.43 to 0.94 mm.

**Maturing-iii**: Ovaries greatly enlarged with large mature eggs, eggs uniformly distributed and blood vessels were not prominently visible. Large yolky ova from anterior, middle and posterior regions of the ovary was recorded by an ocular micrometer fitted to stereoscopic binocular. In order to find out the distribution and pattern of ova between the right and left ovary, ova from right and left ovaries were examined. The distribution of ova was found to be uniform within and between the ovaries. Percentage frequency of ova in different parts of ovary has also been recorded.
From the above data it is clear that stage-1 i.e. immature ova are transparent and have diameter which ranges from 0.10-0.43 mm, with very clear distinct nucleus. In maturing; stage there are two types of ova, transparent and the other translucent, having ova diameter ranging from 0.17 to 0.77 mm. In the case of maturity ii, these types of egg were noticed i.e. transparent, translucent and a few large opaque ova. The diameter ranges from 0.43 to 0.94 mm. In maturing iii, all the there types of eggs i.e. transparent, translucent and opaque were noticed. The percentage of opaque eggs is more as compared to other. The ova diameter ranges from 0.60 to 1.46mm to the mature ova are yellow in colour and uniform in their distribution. The ova diameter ranges from 2.73 to 3.05 mm.

From the above data it is concluded that in the case of Tor putitora differed stages of maturity were noticed almost every month so it is difficult to pin point a definite season of maturity.

c) Size at first maturity: For determining the size at first maturity of female fish, the percentage of immature maturing and mature ovaries were calculated separately. According to the analysis 42.5 percentage of fish mature at 67.54 cm, 21 percentage at 58.97 cm, 36.0 at 55.8 cm from Pong reservoir population. Thus fish attains first maturity in the size ranges of 58.6-83.0 cm. Nautiyal (1984) reported that the maturing individuals, the iii stage of maturity “ripening” appears for the first time in the 471-600 mm size group. Since the percentage of mature individuals in this group was observed to be very low (17%) as compared to 33% in 671-870 range, the average length i.e. 770.5 mm of the latter was considered to be the size at first maturity. Desai (2000) also calculated the size at first maturity of female. According to him 5 percent of fish were mature at 280 mm, 50 percent at 360 mm, 90 percent at 440 mm and practically all over 500 mm. Observations indicated that fish attains first maturity in the size range of 340-380 mm (50 percent mature ovaries).

d) Spawning season: In order to determine the spawning season, ova diameter during each month was recorded. On the basis of these observations there is no clear indication of the spawning season of Tor putitora from Pong reservoir. From the ova diameter of each month it is observed that throughout the year ova diameter show three stages of eggs, but peak values were
observed in the months of May and August. It is therefore concluded that the spawning season of *Tor putitora* is in the months of May to August. Moreover, the mahseer releases eggs in batches.

**e) Relationship between the weight of fish and ovaries:** During this study only two mature female specimens ranging from 77.5 cm to 80.5 cm total length and weighing between 4095 gm to 4495 gm could be collected from the Pong reservoir. Lack of specimen due to close season during June-July. There is not much differences the length and weight of left and right ovary, so the average of two were taken for the calculation of fecundity. On the basis of average of left and right ovaries of two specimens the fecundity is recorded as 15504.872. For calculating fecundity, counting of mature eggs have an ova diameter of more than 0.75 mm was considered. In the absence of sufficient number of specimens no attempt has been made to find out the relationship between total length and weight of fish and fecundity. The fecundity given above is the actual count of mature eggs.

**e) Fecundity:** On the basis of average of left and right ovaries of two specimens, the fecundity is recorded as 15504.872. For calculating fecundity, counting of mature eggs have an ova diameter of more than 0.75 mm was considered.

From the present and earlier observations it can be concluded that maturity of gonads and spawning activity of *Tor putitora* (Hamilton) is influenced by the environmental conditions of the water, hence, show variations as far as size and season are concerned. For the artificial breeding of golden mahseer, the local conditions must be kept in mind.