A Preliminary study on Habitat Ecology of Mahseer (Tot tor Hamilton) in Western Zone of Narmada River and its Tributaries

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Abstract **- Tor-tor (Mahseer), the deep bodied Mahseer represent an iconic genus of large-bodied species of the Cyprinidae family and is a native of river Narmada. A preliminary study was conducted for a period of four months stretched from August 2018-November 2018 on Narmada River and its tributaries to analyze the characteristic features of the Mahseer habitat. The physio-chemical parameters of water along with physical characteristic/substrate types have been studied spot wise at different gradient zones. During the study it was observed that mahseer adults inhabit in lowland river and then migrate upstream in torrential monsoon condition to reach suitable spawning ground. The fish prefer to inhabit deep and clean water with high velocity (rheophilic), good, dissolved oxygen content (>5 mgL-1), optimum temperature (200C – 280C), optimum pH (6.5-8.5). The study further concluded that increasing anthropogenic pressure including dam construction across river, habitat fragmentation, deforestation, untreated sewage influx in river, and massive collection of fry and fingerlings of Mahseer by local fisherman during downward migration are some notable reasons behind sharp decline of Mahseer population and have brought Mahseer (Tor tor) to the state of near threatened species as per the reports of IUCN (2015). The study recommends immediate conservation measures to protect the majestic fish from population extinction.**

Index Terms **- Mahseer, Narmada River, habitat, water quality, conservation.**

INTRODUCTION

Freshwater resources of world comprise a diverse fish fauna encompassing close to 16,000 species (about 47% of all fishes and 25% of all vertebrates), with around 250 new species defined each year. This diversity is, however, concentrated into restricted areas (less than 1% of the Earth's surface) that are extensively exploited and modified for societal requirements (Pinder et al. 2019). A high percentage of fish diversity 'hot-spots' occur within countries with fast developing economies where protection of vulnerable habitats is of relatively less importance (Dudgeon et al. 2006; Sarkar et al. 2008; Reid et al. 2018). These hotspots include freshwater bodies within South and Southeast Asia (Nautiyal, 2014: Pinder et al. 2019). India is one among the Mega biodiversity countries in the world and occupies ninth position in terms of freshwater mega biodiversity. In India, there are 2500 species of fishes, of which 930 inhabited in fresh water (Malik, 2011). Among the diverse groups of fishes, the Mahseer fishes (Tor sp.) represent an iconic genus of large-bodied species of the Cyprinidae family, characterized by their very large body and big scales (Pinder et al. 2019). Out of the 47 species of Mahseer that exist in the world, India is home to fifteen species. This genus currently comprises 16 valid species, all of which are considered to exhibit highly potamodromous behavior, with upstream spawning migrations, often over 'considerable' distances, reported as being necessary to facilitate successful reproduction (Nautiyal et al. 2001, 2008; Pinder et al. 2019).

Thomas (1873) and Lacy and Cretin (1905) have reported that etymologically, the name 'mahseer' is perhaps derived from the Hindustani word maha (meaning great) and sir (pronounced as seer meaning head). A friend of Thomas, a great angler and eminent Persian scholar, wrote to him that the name 'mahseer' was derived from two Persian words, mahi (meaning fish) and sher (meaning lion), in appreciation of its gameness. A third derivation is from 'mahasaula' (means big-scaled) because mahseer has bigger scales than any other freshwater fish in India. A fourth

derivation is from 'matsya', which is the Sanskrit word for 'fish' and has been used in the Vedas. As mahseer is a sacred fish, preserved and protected near many Hindu temples, Brahmans call it 'mahsia', (meaning a fish of excellence). However, it has also been stated that the word 'mahseer' has no phonetic or etymological resemblance to the Sanskrit word 'matsya' and that mahseer is not a big-headed fish. The most probable derivation is that the word 'mahseer' is the corruption of the Persian 'mahisher', referring to its fighting and sporting character.

Mahseer species, the national heritage of India has been provided the status of state fish by various states of India. Among the various states of India, Madhya Pradesh, centrally located state in India is famous for rich diversity of fishes. A great array of rivers flow in state but river Narmada originating from Amarkantak Hill (Madhya Pradesh) is regarded as "Life line of Madhya Pradesh". This river is the natural abode of wide variety of fish fauna. Tor tor (state fish of Madhya Pradesh) the deep-bodied Mahseer, locally known as "Badas" is one of the largest freshwater cyprinid and a native of river Narmada (Sharma et al. 2015). This fish is famous for its fighting character during angling to such an extent that some used to call it "Majestic Goddess" (Sarkar et al. 2015). Because of the high nutritive value of Tor mahseer (Day 1876), their ability to provide food security in regions with high poverty levels (Pinder et al. 2019) and its delicacy as food; it is ranked on the top of all commercial catches of river Narmada. Besides this mahseer has been labelled as biological indicator of ecosystem health (Nautiyal et al. 2013). Despite of such a tremendous economic, cultural, aesthetic, ecological and religious significance, it is quite unfortunate that due to undesirably increasing anthropogenic stress Tor tor is getting depleted rapidly in river Narmada and other fresh water bodies and has been declared as Near-Threatened species by IUCN (Sarkar et al. 2015; Sharma et al. 2015; Pinder et al. 2019).

OBJECTIVE OF STUDY

Keeping in view the economic, cultural, aesthetic, ecological and religious significance of Mahseer (Tor tor), the current study was undertaken to study the habitat features of mahseer so that efficient strategies could be implemented towards the protection of this iconic fish species particularly in Narmada River

MATERIALS AND METHODS

The current study was conducted on River Narmada and its various tributaries (Choral River) in Barwaha forest division (Khargone District) Madhya Pradesh, India located at a latitude 22°15'26.71"N and longitude 76°03'04.04"E. Narmada River which is considered as "life line" to millions of inhabitants of central India particularly Madhya Pradesh and Gujrat due to its huge contribution to the states. It is one among the largest river (1312 km) of country which has its origin from Maikala highlands near Amrkantak, district Shahdol of Madhya Pradesh and culminates into Arabian Sea in Bharuch district of Gujrat. Narmada is of the rivers in peninsular India which flows from east to west along with River Tapi and Mahi and enter the state of Madhya Pradesh (1077 km), Maharastra (74 km), and Gujrat (161 km). A series of dams have been constructed along the Narmada River basin under comprehensive river valley project program, contributing to reservoir fishery resources and an increase in inland fish production of India (Bhaumik et al. 2017; Bhaumik et al. 2018; Bhakta et al. 2020). Among the huge diversity of fish fauna inhabiting Narmada River mahseer (Tor tor) is considered as highly significant with respect to its nutritive, economic, aesthetic, religious, cultural and ecological significance. However, it is quite unfortunate that due to undesirably increasing anthropogenic stress Tor tor is getting depleted rapidly in river Narmada (Sharma et al. 2015). Tremendous amount of research have been carried out on aquatic ecosystems of India particularly Narnada River with respect to their biological diversity, however the scientific investigations towards analyzing habitat conditions of Mahseer (Tor tor) have always gained less priority, as a result of which Mahseer population have greatly reduced to near threatened level.

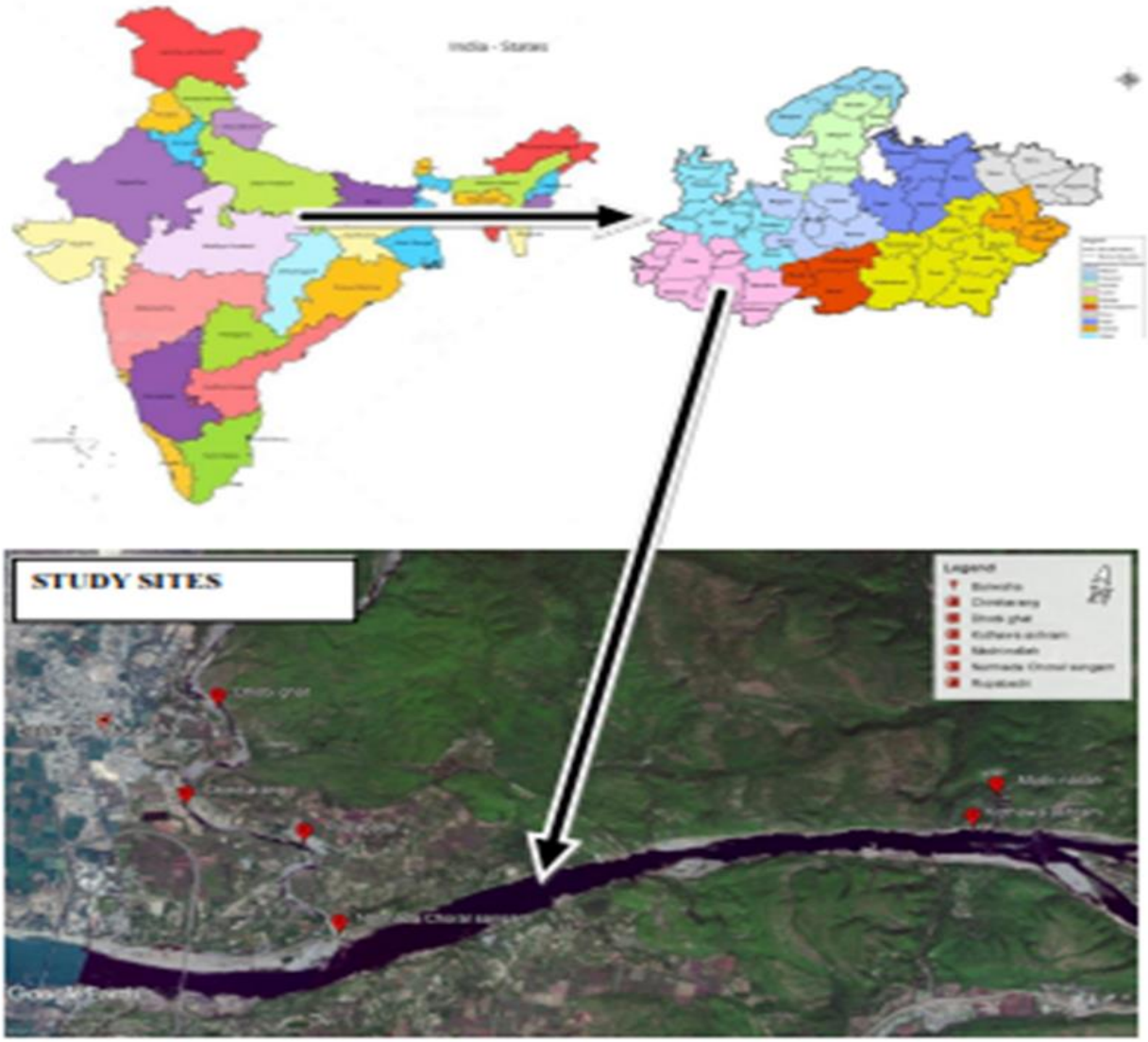

Fig. 1 : Geographical view of all study stations.

BRIEF DESCRIPTION OF SAMPLING SITES

1. Chidiyabhadak (S1):

This site is located on the Choral River (Tributary of river narmada),at a distance of near about 15km from the guest house between geographical coordinates of 22°21'44.86"N 76.02'50.34"E. Chidiyabhadak is a deep pool place having a presence of stagnant water.

2. Dabri Gufa (S2):

It is a tributary of river Narmada, located near about 12 km from Forest guest house. The location is the interior part of forest. This river is Sangam of Choral and Dabri rivers.this region built mainly for the mahseer conservation. The water flow of this region approximately slow but in monsoon season water flow is high.The dimension of this region is 15ft in lenght and 7ft in dept.

3. Jayanti Mata (S3):

It is a tributary of river Narmada located near about 3 km away from the forest guest house.This location is the interior part of forest. Dlow of water in monsoon was high it is good sign of mahseer. After monsoon water depth is only 2 meter. We found all life stages of mahseer in monsoon.

4. Karbala (S4):

This site is about 1.20 km far from Narmada-Choral Sangam, located between the geographical coordinates of 22°14'31.67"N 76°03'49.62"E. This site is characterized by presence of abundant micro

and macro vegetation in abundant quantity and muddy and rocky bottom.

5. Rupabedi (S5)It is about 1.20 km far from Narmada choral sangam. Flow of water is normal. At monsoon time depth of water is about more than 3 meters. Bottom of the river was rocky.

6. Narmada choral sangam (S6):

This site is very important for Mahseer in monsoon season for breeding. All the life stages of Mahseer were found at the end of choral river.Narmada choral Sangam is far from (Kothawa ashram) where choral river drain into Narmada , meeting point of choral and Narmada.

PHYSICO-CHEMICAL ANALYSIS OF HABITAT

The study was conducted on monthly basis for a period of 6 months stretched from September2019, February 2019. Nature of habitat bottom was thoroughly studied. Water samples were collected in iodine treated polyethylene plastic bottles and were analyzed according to standard procedures of APHA, 2004. Air and water temperature, dissolved oxygen (DO), pH and free carbon dioxide were measured on spot during water sample collection while as total alkalinity and total hardness were analyzed in the laboratory.

Fish sample collection, preservation and identification

Fish samples were collected by the help of gill net and cast net of size 10 x 5 and 5 x 2.5 meters with mesh size of 8 – 10 cm respectively.. The fishes were taken to laboratory, photographed, preserved in 10% formalin solution and later identified and labelled to lowest possible taxonomic level according to standard taxonomic works of Sen and Jayaram (1982), Talwar and Jhingran (1991) and Day (2007).

RESULT AND DISCUSSION

During the study period, Narmada River beds and its tributaries mostly showed the presence of rocks, sand, pebbles and mud. It has been reported that Mahseer mostly prefer cold, clear and swift flowing waters with stony, pebbly or rocky bottoms and intermittent deep pools (Dinesh et al., 2010). According to Bhat et al (2015), substratum type comprising pebbles, rocks and sand are important variables in explaining distribution patterns of fish fauna. Muddy bottom typically possess high macrophytic growth which acts suitable hiding areas for fishes to escape from predators. The physical characterization of habitat and various study sites is presented in table. 1.

Table. 1: Physical characterization of study sites.

Physical characterization of Habitat

Physical characterization of Habitat						
Parameters	Study sites					
	S1	S2	S3	S4	S5	S6
Pools	✗	✗	✗	✓	✓	✓
Rapids	✓	✓	✓	✓	✓	✓
Rocks	✓	✗	✓	✓	✗	✗
Perennial streams	Modri nala	✗	Choral	✗	✗	✗
Substratum type	Smooth rocks and sandy bottom	Sand covered by smooth soil	Rocky, Smooth Stone Covered area	Smooth Soil with Rocky Bottom	Muddy bottom with Smooth Soil	Muddy with Smooth Pebbles.

WATER TEMPERATURE

The water temperature is one of the most important parameters that influence almost all the physical, chemical and biological properties of water. It plays an important role in the growth of plants and other living organisms in the water body. In present study, water temperature fluctuated from 26°C to 29°C. The highest water temperature was recorded 280C at site-S3(Jayanti mata) & S6 (Narmada choral sangam) in September , S3 &S6 (Jayanti mata &Narmada choral sangam) in October and S2(Dabri gufa), S5(Rupabedi) & S6 (Narmada Choral sangam) in November, S6(Narmada Choral sangam) in December, S5 (Rupabedi) in January and S6 in (Narmada choral sangam) in February while as the lowest water temperature was recorded 25°C in winters. Water temperature was recorded minimum (250C) at site S4 in October and maximum (280C) at site S3 & S6 in October and S6 & S3 in September . Ogale (1997) reported in his study that different species of Mahseer occupy different ecosystems ranging from tropical waters where summer temperatures reach 350C, to sub-Himalayan regions, where the temperatures fall to 6°C. Desrita et al. (2019) reported that water temperature less than 300C is suitable for Tor species. Some authors consider water temperature as a factor inducing the spawning (Desai, 1973).

TOTAL DISSOLVED SOLIDS (TDS)

TDS is the sum of potassium, calcium, sodium, magnesium carbonates, bicarbonates, chlorides, organic matter, phosphate and other particles in water body (Bhat et al., 2013). During the present study, total dissolved solids in water varied between 360 ppm to 408ppm. The maximum TDS were recorded 408 ppm in (October) at site-S6 (Narmada Choural sangam) and the minimum TDS were recorded 360ppm at site-S1 (Chidiya Bhadak) in February month of winter season.According to Klein (1972) undesirably high TDS in water disturbs the physiological processes of aquatic life.

DISSOLVED OXYGEN (DO)

Dissolved oxygen regulates life processes of aquatic life and is indicator of ecosystem health (Gudoo et al. 2020). In the present study dissolved oxygen ranged from 5 mgL-1 to 6.4 mgL-1. The minimum dissolved oxygen were recorded 5mgL-1 in the month of October at site-S1 and maximum dissolved oxygen was recorded 6.4 mgL-1 at site S6 (Narmada-Choral sangam) in the month of October-February. Desrita et al. (2019) reported that Dissolved oxygen with ranges of >5 mgL-1 is suitable for survival of Tor species.

TOTAL ALKALINITY

Alkalinity refers to the tendency of water to neutralize the acids present in it and is basically because of concentration of carbonates, bicarbonates (Gudoo et al, 2020). During the present study, the value of Alkalinity fluctuated from 152 mgL-1 to 180 mgL-1 the maximum value of Alkalinity was recorded 180 mgL-1 in the September At site S4 and November month at site-S6, and minimum value was recorded 152 mgL-1 at the site S1 (Chidiyabhadak) in September month.Higher alkalinity indicates aquatic pollution due to increasing anthropogenic stress (Gudoo et al, 2020). Nautiyal et al. (2013) reported that Mahseer is sensitive to aquatic pollution and prefer clean waters.

TOTAL HARDNESS

The sum total of calcium and magnesium concentrations defines the total hardness of a water body (Gudoo et al, 2020). During the present study, the value of total hardness fluctuated from 212mgL-1 to 340 mgL-1. Maximum value of total hardness was recorded in the February month at site-S5 (Rupabedi) and minimum value was recorded 212 mgL-1 in September month at site-S3 (Jayanti mata) .

PH (HYDROGEN ION CONCENTRATION)

pH indicator the acidity and alkalinity of water and measures the concentration of hydrogen ions. Fluctuation in pH value depends upon the ingredients input in the water body (Gudoo et al, 2020). At higher temperatures fish are more sensitive to pH changes. During the present investigation, pH values ranged from 7.3 to 8.2 indicating alkaline nature of water. Highest PH (8.2) value was recorded at site S4 (karbala) in the month of Febuary & S5 (Rupabedi) and lowest PH value (7.3) was recorded at site S1 (Chidiyabhadak) in the month of September (Fig. 13) Sharma et al (2015) reported pH of 7.67 - 8.04 fairly good for mahseer. Desrita et al. (2019) reported that PH value between 6.5-8.5 is good for Tor fish life and Tor fish mortality is common at pH 4 (acid) and pH 11 (base).

Free CO2: In the present study Free CO2 was found absent at all the study sites during each months.

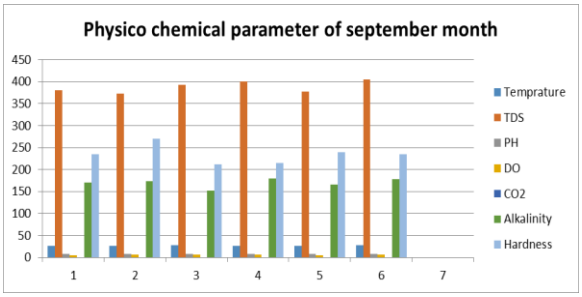

Fig no.02 Physico chemical parameter at various sites of Choral river tributary of Narmada in the month of September

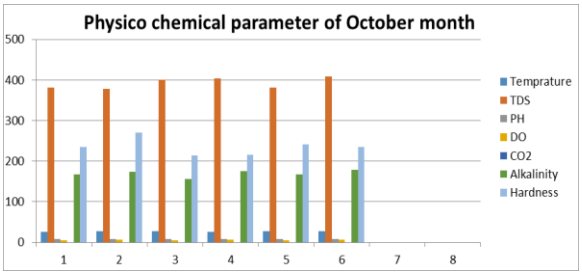

Fig no .03 Physico chemical parameter at various sites of Choral river tributary of Narmada in the month of October

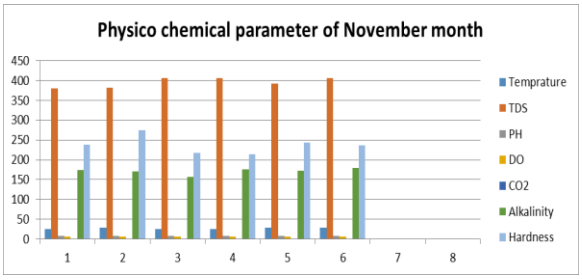

Fig no .04 Physico chemical parameter at various sites of Choral river tributary of Narmada in the month of November

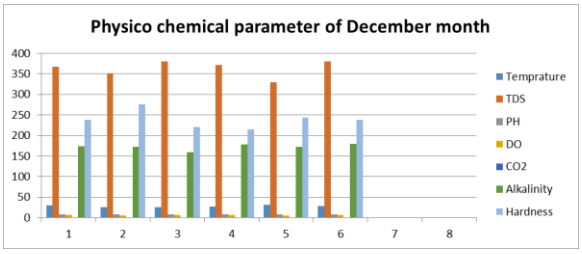

Fig no .05 Physico chemical parameter at various sites of Choral river tributary of Narmada in the month of December

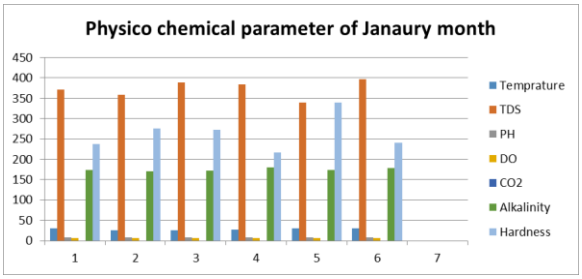

Fig no .06 Physico chemical parameter at various sites of Choral river tributary of Narmada in the month of January

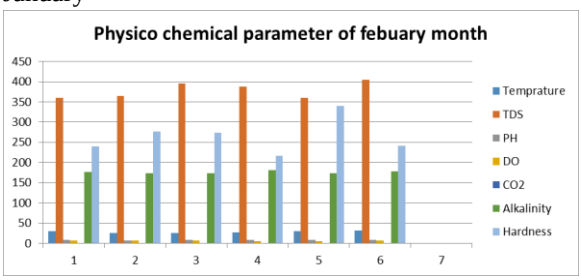

Fig no .07 Physico chemical parameter at various sites of Choral river tributary of Narmada in the month of February

Systematic position of Tor tor (9iko0+-)
Misra (1959) classified this genus as:
Phylum - Vertebrata
Subphylum - Craniata
Super class - Gnathostomata
Series - Pisces
Class - Teleostomi
Subclass - Actinopterygii
Order - Cypriniformes
Division - Cyprini
Suborder - Cyprinoidei
Family - Cyprinidae
Genus - Tor
Species - tor (Hamilton 1822)

Fig. 08. Tor tor (Hamilton, 1822)

LIFE HISTORY OF MAHSEER (TOR TOR)

Mahaseer prefer to inhabit streams and rivers with clean and fast flowing water, stony, pebbly or rocky bottoms. Desai (1982) reported that clean water is a significant factor as it results in a deeper penetration of sunlight, thus allowing aquatic plants, molluscs and algae to inhabit deeper waters which enhances the food supply for mahseer. According to Karamchandani (1972), the river with rapids, pools and rocks provide suitable and protective environment to mahseer. Mahseers are local migrants which perform seasonal migrations within a short distance mainly for feeding and breeding. The limit of such migrations are determined by water temperature and floods (Karamchandani et al., 1967). During monsoon season (August-September) the fish migrate from low streams to up streams for breeding and feeding purposes as also observed by McDonald (1948) and Lal et al (2012) where the fish lay eggs in sheltered rock pools. The prime prerequisite for a fish to lay eggs is gravel substratum where fish eggs safely covered by the gravel and thus saved from being washed away by strong current. Females discharge enormous numbers of eggs and males milt in shoals during spawning and the discharged eggs are fertilized externally Desai (1973). According to Desai (1982), the fish leaves the mainstream when it becomes turbid during monsoon and ascends the hill stream in search of clear water for breeding and feeding. Jhingran (1975) mentioned such migration of Tor species to clear upper waters in the post-monsoon period. Desai (1973) collected the larval stage of Tor tor together with hatchlings, larvae and fry of other carps from the rocky bed of the Narmada River from July to March. The advanced stages of fry and juveniles of Tor tor from the Narmada River were also collected by Desai and Karamchandani (1967). Karamchandani et al.

(1967) also recorded adult fishes from the Narmada River at Hoshangabad during the peak breeding season (July-September) which suggests that the fish migrates upstream to find suitable spawning grounds. After spawning mahseer returns to the mainstream when the water begins to subside as also opined by Desai (1973). In Narmada River, 5% of Tor tor mature at 280 mm, 50% at 360 mm, 90% at 440 mm and all the fish are mature after attaining the size of about 500 mm. The males matured at 250 mm (175 g) in the second year and females at 360 mm (500 g) in the third year (Desai, 1973).

CONCLUSION

The present investigation depicted the systematic analysis of habitat conditions of mahseer species in Narmada River from September to February month of 2020. The physico-chemical parameters of water including temperature, TDS, DO, pH, total alkalinity, total hardness and free CO2 along with physical characteristics/substrate type of habitat were studied extensively at each study site. The study concluded that mahseer (Tor tor) prefer the type of habitat with following characteristic features:

1. Clean water
2. Water with high current velocity/swiftly flowing water
3. Water with good amount of dissolved content >5 mgL-1
4. Optimum water temperature (20°C to 28°C).
5. Optimum pH (6.5-8.5.)
6. Presence of rocks, pebbles and gravels

Further the study concludes that increasing anthropogenic pressure on habitat of mahseer is responsible factor towards the sharp decline of mahseer population in natural water bodies. Construction of dams, canals and thermal plants on Narmada River are some detrimental threats to mahseer home ground, breeding ground and shelter. Habitat fragmentation, over exploitation beyond normal regeneration rates, extensive deforestation, and massive collection of fry and fingerlings of mahseer by local fisherman during downward migration are some notable reasons behind sharp decline of mahseer population

RECOMMENDATION

Though there is continuous decrease in population density of mahseer in Narmada River and its tributaries, but there is some scope for restoration and protection of this iconic fish. The study recommends the implementation of following strategic measures to protect the fish from population extinction:

1. Installation of highly efficient sewage treatment plants and various inlets of Narmada River and its tributaries to prevent or minimize aquatic pollution.
2. Organizing mass awareness programs to highlight the economic, cultural, and ecological significance of mahseer
3. Raising mahseer fingerlings to maturity in captivity (small ponds) by following efficient aqua cultural practices followed by extensive artificial propagation
4. Efficient utilization of techniques of cryopreservation of mahseer milt and gene banking of endangered mahseer
5. Prevention of habitat fragmentation, over exploitation, extensive deforestation and Fingerling and fry fishing of mahseer

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