SUMMARY AND CONCLUSION

Indian Mahseers, the big scaled carps, have been an attraction to the anglers as well as naturalists from all over the world since the nineteenth century. Langer et al. (2001) while compiling the bibliography of mahseers in the Indian sub-continent described this group as the ‘King of Indian aquatic systems’. The mahseers are not only well known sport and food fish; they are our national heritage as well (Oliver et al., 2007). Several authors have observed that mahseer is declining in different parts of India due to indiscriminate fishing of brood stock and juveniles, fast degradation of aquatic ecosystems and construction of dams, barrages, weirs etc. under river valley projects (Nautiyal, 1989; Sehgal, 1992; Tandon et al., 1992; Bhatt et al., 1998; Nautiyal et al., 1998; 2007; Kumar, 2000; Menon et al., 2000; Ogale, 2002a; 2002b; Chalkoo et al., 2007; Dinesh and Nandeesh, 2007; Kalita et al., 2007; Oliver et al., 2007; Vinod et al., 2007).

Though the biology and taxonomic status of mahseers from the Himalayan region is relatively well studied, the same from the peninsular India, especially the Western Ghats is still poorly understood. The Deccan mahseer, Tor khudree is endemic to the river systems of Peninsular India and Sri Lanka. The species inhabits rapid rivers and streams with rocky substrates and attains a maximum size of one meter in length and 23 kg in weight (Chandrasekharah et al., 2000). It is one of the common species of the Chalakudy River and forms the major fishery for the tribes residing on the banks of the upper reaches of the river in colonies. They belong to the Kadar community which is one of the most primitive communities of Asian region. The species has recorded a decline in the population and a need has arisen to conserve this important resource.
Chalakudy River, the fifth longest river in Kerala with a total length of 144 km. supports rich fish diversity (Ajithkumar et al., 1999). The watershed of the river lies between 10° 05’ to 10° 35’ N and 76 ° 15’ to 76 ° 55’ E and it spreads over Palakkad, Thrissur and Ernakulam Districts of Kerala State. The river originates from Anamalai and Nelliampathy hill ranges of the Western Ghats, joins River Periyar in the lower stretch at Elanthikkara and empties into the Arabian Sea. The major tributaries are Parambikkulam, Sholayar, Kuriarkutty and Karappara. Chalakudy River has a catchment area of 1704 sq. km. and the total run off is 3,121 x 10^6 m³. The reservoirs in the river system are Parambikkulam, Thunakadavu, Peruvaripallam, Malakkappara, Lower Sholayar and Peringalkuthu. The fishing right of the up-stream waters have been limited to the native tribal populations of Kadar and Malayar communities.

The study was undertaken to investigate the biological and fisheries aspects of mahseer in the Chalakudy River. It had another objective of defining the role of mahseer in the tribal livelihood of the region. Finding out the problems faced by the mahseer population in the river and suggesting measures for better conservation also formed another important objective. 11 sampling stations in the river starting from Orukomban (up-stream area) to Adichily with a length of 40km were selected for fish sampling. Along with the common mahseer, Tor khudree, another variety of mahseer with significant red colour were also caught in small numbers from Muthirachal region. It was reported by the tribes that this particular type of mahseer (they call it ‘Choppan choora’, means: red mahseer) is not edible because of the presence of a toxin in the meat.

Detailed taxonomical examination was carried out to morphologically differentiate the so far un-described red mahseer. The morphometry and meristics proved that it is a distinct sub species and was given the name, Tor khudree erythrosa sub sp nov. The fish specimens are preserved in the museum of the Department of Aquaculture, College of Fisheries. To resolve the ambiguity on its genetic identity, molecular studies were also taken up using mitochondrial DNA techniques (16S rRNA, Cyt b and COI). The results of the molecular studies also confirmed the variation of the new sub species with the Tor khudree. Interestingly,
the mtDNA sequence data showed similarity with *Tor malabaricus* collected from an entirely different location—near Kanyakumari.

Food and feeding and reproductive biology of *Tor khudree* was studied in detail to know the major food items, breeding season and other biological details of the fish. The river was surveyed to identify the major threats to the fish fauna and to suggest conservation strategies to be followed to protect this group from endangerment.

Three tribal colonies Pokalappara, Peringalkuthu and Mukkampuzha were identified to study the quantity of fish landings, efficiency of various fishing methods, percapita fish availability, average income from fisheries etc.

The studies on the species assemblage also led to a number of findings. The major indigenous food fishes of the area include *Puntius dobsonii*, *Barbodes carnaticus*, *Osterochilichthys longidorsalis*, *Anguilla* sp., *Puntius filamentosus*, *Gonoproktoperus* spp. etc. The number of *Tilapia* has been alarmingly increased in the up-stream areas which may bring about negative impacts on the local fish fauna on a long term basis.

In total 33 species could be collected during the period of study from 2005 to 2008 in significant quantities.

Morphological observations of the specimens collected were recorded following Talwar and Jhingran (2001). Molecular studies were carried out as per the procedures given by Lakra *et al.* (2009). The species assemblage and other riverine observations were taken adopting Manojkumar and Kurup (2002). Food and feeding of the species was studied as proposed by Natarajan and Jhingran (1962). Maturity stages were recorded following, Wood (1930). Ova diameter was measured following Clark (1934). Statistical analysis was done adopting SPSS software.

Since *Tor khudree* is basically an inhabitant of the up-stream riverine habitats, there was uncertainty that whether it could be cultured in the pond system of the plains along with other carps. To investigate the aspect, 20 fingerlings were collected from the river and stocked along with the Indian Major Carps in a pond (200m²) of the Instructional Farm, College of Fisheries, Kochi. The percentage survival and growth of the fish were recorded for a period of two years. The
percentage survival showed similarity in all the four species stocked. *Tor khudree* gave less specific growth rate and normalized biomass index compared to the other carps in the culture period.

Water and soil quality parameters of the sampling locations and the culture pond were analyzed using standard methods. For assessing the status of mahseer fishery, the fishermen of the area were individually interviewed. The fish sales-register of the retail outlet managed by the Pokalappara Vana Samrakshana Samithy at Puliyilappara was also utilized. The average income of the tribal fisher folk from fishing was calculated by collecting separate data from the members of the folk.

A detailed investigation was carried out to assess whether there is any threat to the mahseer population of the river. The various fishing methods used by the tribes were critically examined for this. Finally, the possible conservation strategies for the mahseers in the river were formulated and presented. A fish sanctuary and a mahseer hatchery have been proposed to save this fish from endangerment.

It may also be noted that there is ample potential for developing a few mahseer angling stations in the Chalakudy River to encourage the sport fisheries and tourism. It has to be ensured that all the ethical aspects of angling are strictly followed by the sport fishers.

A comprehensive study at molecular level incorporating all the mahseer varieties of the Western Ghats has to be undertaken urgently to resolve the ambiguities in the mahseer identification. This is a group exhibiting large amount of phenotypic ‘plasticity’ which also has to be looked into.

The results of the study are summarized below:

1. The mahseer is a world renowned sport fish having excellent food value and considered as a cultural icon of many countries including India.
2. It has fair distribution in the rivers of Kerala including Chalakudy river and the important species present in the river is *Tor khudree*.
3. A morphologically and molecularly different sub species has also been identified during the study and described as *Tor khudree erythrosa sub sp nov*.
4. Classical taxonomical tools including morphometry and meristics were used for differentiating the two mahseers.
5. Mitochondrial DNA analysis (16S rRNA, COI and Cyt b genes) was carried out to molecularly identify the new sub species.

6. *Tor khudree* was found to be an important edible fish caught from Chalakudy river while the new sub species seems unedible because of the presence of toxic ingredients.

7. Fishing from Chalakudy river is one of the major avocations of the local tribes belonging to *Kadar* community residing in Pokalappara, Peringalkuthu and Mukkampuzha colonies.

8. Average annual catch of approximately 7tonnes has been recorded from the study area out of which about 23% is contributed by mahseer.

9. Several anthropogenic reasons have been attributed for the decline in fish catches of the river.

10. Game fisheries which is a growing sector world over can be promoted in Chalakudy river linking the same with tourism and tribal empowerment.

11. Establishment of a mahseer hatchery and fish sanctuary have been proposed to conserve the mahseers in Chalakudy river.

12. It was also observed that *Tor khudree* can survive and grow satisfactorily in the ponds of the lower areas of Kerala.