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Reoccurrence of *Salmo trutta macrostigma* (Duméril, 1858) in Lake Sapanca Basin (Sakarya, Turkey): Implications for Conservation

¹Ali Serhan Tarkan, ¹Özcan Gaygusuz, ²Müfit Özuluğ and ³Çiğdem Gürsoy Gaygusuz
¹Faculty of Fisheries, Istanbul University, Ordu Cad. No. 200,
34470 Laleli, Istanbul, Turkey
²Department of Biology, Faculty of Science,
Istanbul University, Vezneciler-34118 Istanbul, Turkey
³Natural and Applied Sciences Institute, 17020,
Çanakkale Onsekiz Mart University, Çanakkale, Turkey

Abstract: *Salmo trutta macrostigma* is a freshwater fish species, which is very important in terms of biodiversity and economic utilization. The present study aims to study the reoccurrence and conservation of *S. t. macrostigma* in Lake Sapanca Basin (Sakarya, Turkey) during 2006. It has only once been reported from Lake Sapanca Basin in 1943. This fish species was not found until 2006, when a single specimen was found during routine and follow-up surveys. The mesural and meristic characters of the specimens were similar to those reported elsewhere for the species. Conservation needs and threats for the species are discussed.

Key words: Lake Sapanca, re-appearance, fish fauna, streams, brown trout, conservation

INTRODUCTION

Salmo trutta macrostigma (Duméril, 1858) is distributed North Africa, South Europe, West Asia and Anatolia. This subspecies occurs in the upper parts of streams and rivers and was reported from many running waters in Turkey (Alp *et al.*, 2005). It is economically and ecologically very important fish species (Geldiay and Balık, 1996).

Many fish species are in decline and some have become endangered due to a combination of over exploitation, pesticides and aquatic pollution, spread of disease, uncontrolled introduction of exotic fishes and habitat modification due to industrialization, river-valley projects, excessive water abstraction and siltation due to clearing (Mijkherjee *et al.*, 2002).

In Turkey, native *S. t. macrostigma* population decline or extinction due to a number of reasons such as illegal and heavy fishing pressure, reduced spawning success caused by pollution of streams, degradation of spawning habitats, river damming and interspecific competition with introduced rainbow trout *Oncorhynchus mykiss* (Walbaum, 1792) (Alp *et al.*, 2005). For this subspecies, there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. Therefore, the subspecies is listed as DD = Data Deficient in IUCN Red List of Threatened Species (Smith and Darwall, 2006).

In Lake Sapanca, *S. t. macrostigma* was first reported in 1943 by Kosswig and Battalgil (1943). In this study, the authors gave a fish list collected by Istanbul Zoology Institute. Afterwards, no report has been given on *S. t. macrostigma* and considered to be disappeared or replaced by introduced rainbow trout from the Lake Basin. The aim of present study was to report on the reoccurrence of *S. t. macrostigma*, after 63 years of no reports in Lake Sapanca Basin. The present study also aims to

discuss conservation measures and threats for *S. t. macrostigma* in Lake Sapanca as well as other freshwater ecosystems within its distribution range.

MATERIALS AND METHODS

Lake Sapanca is located in the Marmara region of northwest Turkey ($40^{\circ}41'$ to $40^{\circ}30'$ N, $30^{\circ}09'$ to $30^{\circ}20'$ E) and is one of the most important lakes in the region in terms of fisheries, recreation and drinking water resource (Fig. 1). Its surface area is 46.8 km^2 with a maximum depth of 55 m. It is 30 m above sea level. 13 streams mainly flow into the lake namely, Karaçay, Yanık, Kurtköy, Mahmudiye, İstanbul, Maşukiye, Keçi, Sarp, Balıkhane, Eşme, Limon, Maden and Arifiye. The lake has one outlet (Çark). Its water is used as a source of drinking water by the city and district of Adapazarı and as a recreational area. Although Lake Sapanca water is enriched by water from trout farms, which are common in this region, with more than thirty in the vicinity of the lake, it has an oligotrophic character (Albay *et al.*, 2003).

In 2006, routine electrofishing surveys of the streams, using standard catch-per-unit effort sampling, were initiated on an irregular basis. For the present study, the selected streams are Maşukiye Stream, Yanık Stream, Kurtköy Stream, Mahmudiye Stream and İstanbul Stream (Fig. 1). It was chosen two or three different sampling stations on each stream based on their physical properties (i.e., stone or sandy, high or low velocity, slope situation). A single *S. t. macrostigma* sample was fixed and preserved in a 5% formaldehyde solution. Meristic counts and mensural measurements were made on the left side of the specimen.

Measurements were made with digital slide calliper and recorded to 0.1 mm. Meristic counts were made under a binocular dissection microscope. Standard length (SL) was measured from the tip of upper lip to the end of hypural complex. The length of the caudal peduncle was measured from behind the base of the last anal-fin ray to the end of hypural complex, at mid-height of caudal-fin base. Gill rakers were counted on the anterior gill arch. The last two branched rays articulating on a single pterygiophore in the dorsal and anal fins are noted as "1½". The specimen has been deposited in the collection Istanbul University, Faculty of Fisheries and Department of Freshwater Biology. We obtained background information on fish fauna of Lake Sapanca from amateur fishermen, anglers and local people.

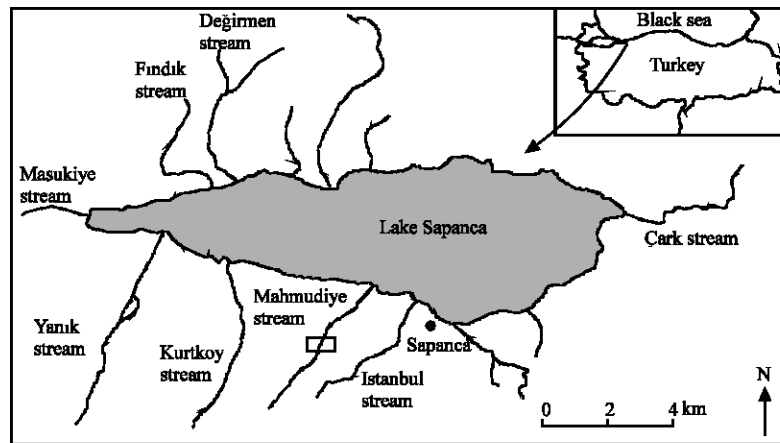


Fig. 1: Map of Lake Sapanca, sampling point for *S. t. macrostigma* in Mahmudiye stream was indicated by rectangular

RESULTS

We found a single *S. t. macrostigma* specimen from Mahmudiye stream that flows into the Lake Sapanca in 14 July 2006 during our routine and follow-up surveys. It was found upper stream which called as "trout zone". The individual had all the distinguishing features of the species, including metric and meristic characters that agree with those reported for the species. Figure 2 for general appearances of the species. Some of its diagnostic features are as following;

Salmo trutta macrostigma (Duméril, 1858)

Material Examined

14 July 2006, 1 specimen, Length: 164.9 mm SL.

Description

Dorsal fin rays IV 9%; anal fin rays III 9%; pelvic fin rays I 12; ventral fin rays II 7. 18 gill rakers on the first branchial arch. Head length 25.1%; body depth 24.5%; predorsal length 48.2%; preanal length 75.1%; depth of caudal peduncle 9.9%; length of caudal peduncle 18.5%; head depth at eye 12.7% of SL; snout length 29.5%; Eye diameter 19.7%; interorbital width 28.0% of HL.

DISCUSSION

The reoccurrence of *S. t. macrostigma* after more than 60 years is perplexing and may due to an absence of detailed studies in the streams flowing into the Lake Sapanca. Report on reoccurrence of a fish species in the same area after for a long time would be very considerable for the information on their population survivorship and continuum. For instance, reappearance of a non-native fish species, white sucker *Catostomus commersonii* (Lacepède, 1803) was reported from River Gade, UK (Copp *et al.*, 2006). Even though this phenomenon is crucial for threatened native fish species at least as non-natives, we could not find any report on reoccurrence of *S. t. macrostigma* from other areas.

Although its high species richness and importance of fisheries, fish fauna of Lake Sapanca has poorly been studied. Indeed, no study has been yet conducted on the fishes inhabiting in streams, which feed the lake. After first report of *S. t. macrostigma* by Kosswig and Battalgil (1943), Numann (1958) reported *Salmo trutta labrax* Pallas, 1814 from Lake Sapanca. He emphasized that this fish



Fig. 2: *Salmo trutta macrostigma*, 164.9 mm standard length, not preserved; Turkey: Lake Sapanca

species was caught in streams connected with the lake. However, they did not give any detailed information on definition of these species and they were not deposited anywhere. So, we were not being able to compare diagnostic characters with these species and our findings found for *S. t. macrostigma*.

According to our observations, local people and anglers, we may suggest that population of *S. t. macrostigma* was more abundant in the past and is now in risk of extinction in Lake Sapanca. There would be several explanations for the decline of this species. Human disturbance as habitat destruction, overfishing and pollution could be the main reasons. Another important reason would be occurrence of rainbow trout *Oncorhynchus mykiss* and recently reported fish from the streams of Lake Sapanca, Eurasian minnow, *Phoxinus phoxinus* (Linnaeus, 1758; Özulug *et al.*, 2007). Both species are known as predator of trout's egg (Geldiay and Balık, 1996; Tarkan *et al.*, 2007). They may easily ascend the trout zones in running waters and become a significant threat for trout populations. We found both species, especially numerous *P. phoxinus* individuals, in all zones of Mahmudiye stream. This finding would suggest that there is a habitat overlap between *S. t. macrostigma* and these species in the stream. Furthermore, *O. mykiss* may be hybridized with *S. t. macrostigma* and this phenomenon may cause decline of pure race of *S. t. macrostigma*. This was the case for endemic trout, *Salmo trutta abanticus* Tortonese, 1954 in Lake Abant (Anatolian part of Turkey). After introduction of *O. mykiss* into Lake Abant, there have been dramatic changes in morphology and species specific characters of *S. t. abanticus* population possibly due to genetic interactions (personal communication, O.Külköylüoğlu). In Lake Sapanca, there are several rainbow trout farms in Mahmudiye stream. We found many *O. mykiss* individuals during our surveys along Mahmudiye stream. However, we do not know that occurrence of introduced *O. mykiss* populations had such an adverse effect on naturally isolated *S. t. macrostigma* population in Mahmudiye stream. Further studies are urgently needed to better understand interactions between these co-occurring fish species in the stream.

Implications for Conservation

Although *S. t. macrostigma* is wide spread in Turkish waters, studies related to this subspecies are generally taxonomic determinations and research on its growth and life history traits are limited. However, previous studies showed that *S. t. macrostigma* prefers cold, well-oxygenated upland waters and favors large streams in the mountainous areas with adequate cover in the form of submerged rocks, undercut banks and overhanging vegetation. With these features, this fish shows quite fragile life history characteristics and consequently its several populations diminishing or have become extinct in Turkish inland waters (Alp *et al.*, 2003). In Lake Sapanca and other inland waters including all streams and rivers in Turkey, this fish was officially protected and its catching was banned by the Turkish government. However, there is still an illegal and heavy fishing pressure on *S. t. macrostigma* probably because of its highly economic importance e.g. local people believed this fish is good for some human diseases such as stomach problems when it is consumed as raw. Collections should be limited for only scientific purposes and for good reasons. Habitat restoration and removal of non-native rainbow trout would be effective to protect and recover of *S. t. macrostigma* populations. A recovery plan should be implemented, after successful restoration of destroyed habitats, these should be restocked with *S. t. macrostigma*. Furthermore, preventing pollution is essential for conserving self-sustaining populations in the future.

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