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Snowtrout fishery in Garhwal Himalaya: Causes of depletion and strategy for propagation

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Abstract

Snowtrout (*Schizothorax* sp.) is an important group of fishes in Indian uplands and is prone to decline due to several anthropogenic activities and natural disasters. However, the natural behaviour of the group is also one of the important constraints for its self-propagation in the nature. It requires attention for the conservation and propagation through *in-situ* as well as ex-*situ* measures. The *in-situ* refers to - aquaculture under controlled conditions for propagation of the group by developing artificial breeding programmes for high seed requirement, better management of incubation patterns and rational management of water bodies including development of sanctuaries, where the fishing would be banned. The artificial breeding and snowtrout seed production technique in flow through hatchery can be adopted at commercial level for mass scale snowtrout seed production. Sometimes unavailability of either sex of the mature brooder at the time of artificial fertilization in hatchery is a major constraint in the artificial breeding programmes. Cryopreservation of gametes has emerged as a promising and a very useful technique to facilitate artificial breeding in several fishes. The cryopreservation of milt of snowtrout finds its role right here. Initial attempts for developing cryopreservation protocol for snowtrout milt are very much promising. More concerted efforts for commercializing the reproductive techniques including cryopreservation of gametes will certainly be helpful for the strategic propagation of snowtrout in cold-water bodies.

Keywords:- *Snowtrout, Habitat destruction, Breeding, In-situ conservation, Ex-situ conservation, Cryopreservation*

Introduction

India is blessed with the vast and varied fish germplasm resource distributed widely in various aquatic bodies. With an estimate, the coldwater fish germplasm resource contributes around 3.32% to the total fish germplasm resource of the country (Das and Pandey, 1999). More than 725 freshwater fish species have been reported to occur in India and 68 species dwell in the Garhwal Himalayas. Among these fishes, some species are on decline. Likewise, the schizothoracids, the dominant group of fishes in Garhwal Himalayas, are rapidly decreasing since past 3-4 decades due to various factors including over exploitation, habitat destruction besides having its own specific genetic reasons. It requires urgent consideration for its conservation and propagation by making scientific strategies and sustainable exploitation.

In view of the global slogan of "seed, feed and breed" for intensification of fish farming and organized pisciculture, fish sperm bank has gained current importance (Gjedrem, 1981). Therefore, the preservation of gametes has emerged as a promising and a very useful technique to facilitate artificial breeding. In order to meet high fish seed requirements, pressure on harvesting of brooders from wild stocks, in the absence of availability of the farm-raised bloodstock, is on the increase. At the same time, fish farming is in a state of expansion. This situation further emphasizes the need for the

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cryopreservation of gametes for propagation of fishery in captivity as well as in the wild.

Materials and Method

The snowtrout were surveyed for their occurrence in river Ganga from Chilla-barrage to Rishikesh, in river Bhagirathi from Tehri to Harsil, in river Bhilangana from Tehri to Ghansali, in river Alaknanda from Devprayag to Chamoli, in river Mandakini from Rudraparyag to Agustmuni. The fishermen and the local inhabitants were interviewed for their past knowledge regarding the fish catch experiences. The breeding and feeding ground of the fishes were identified on the basis of presence of eggs, fry and brooders.

Results and Discussion

The fishery in Garhwal Himalaya is observed mainly in the nature of capture fishery. The survey conducted during the present study has noticed that snowtrout fishery contributes a large (nearly eighty percent of total fish catch), for subsisting fish food resources to the local denizens of the villages settled nearby to rivers and streams. The old aged experienced fisherman largely reported that now they have to make more efforts to catch fish as their nets often found without fish when they do fishing. It is not like as such those of 30-40 years back when they fished out their nets from rivers contained number of fish. They remember it as a past story. The fish catch per unit effort is declining year after year resulting in to overall decline in capture fishery of the region. This has also well documented in several previous reports by number of workers (Singh *et al.*, 1987; Agarwal *et al.*, 2005)

Factors affecting snowtrout population

With the rapid ever-increasing demand of fish as food, the aquatic ecosystems are under constant pressure of man-induced stresses to the determent of the aquatic flora and fauna (Jhingran, 1991). Though the decline of snowtrout species in the Garhwal Himalayan region is very often related to more than one proximate factor, the various causes of decline in the population of snowtrout has been observed and grouped as –Anthropogenic or man induced factors and Natural or Genetic factors of the population.

Anthropogenic or man induced factors:

The anthropogenic or man induced factors responsible for the decline of the snowtrout population are-

Habitat Destruction

The feeding and breeding grounds of snowtrout including many others were found adversely affected by heavy silt load in the river Bhagirathi and Bhilangana due to developmental activities such as road construction etc. from the catchment areas. Collection of stones and boulders from riverbanks as building material resulted into the destruction of breeding grounds of snowtrout and mahseer. Recent emergence of reservoirs due to hydroelectric projects (Maneri Bhali and Tehri Project) has dramatically changed the breeding and feeding habitats of the fish. Singh *et al.* (1992), Kirchhoffer and Hefti (1996) and Shrestha (1997) have also reported that siltation in the feeding and breeding grounds and damming of rivers for power generation are the reasons of habitat degeneration for local fish communities. The migration routes of the important native fishes such as mahseer (*Tor putitora* and *T. tor*) and snowtrouts (*Schizothoraichthys progastus*) have also been blocked by the construction of dam infrastructures at Tehri and Maneri in Bhagirathi River and Veer Bhadra Barrage at Rishikesh in River Ganga.

The recent emergence of Tehri dam reservoir has resulted into the large destruction of natural habitat of snowtrout species (*viz. Schizothorax richardsonii, Schizothorax plagiostomus, Schizothorax curvifrons*) that are basically bottom feeder and lithophil spawner, thrive in the snowfed river habitat of clear, shallow water of stony substratum with a average depth from 1 to 3 meters, and river flow not less than 0.5 meter per sec (Singh

et al., 1985; Singh and Agarwal, 1986; Agarwal, 1996, Agarwal, 2001). The impoundments of the river Bhagirathi and Bhilangana for Tehri dam reservoir has caused a loss of riverine habitat of 44 km stretch between Tehri and Chinyalisaur and 25 km stretch between Tehri and Ghansali The impoundments of these two river for Tehri Hydro-Electric project has affected the snowtrout population in this area up to the extent that snowtrout population has totally disappeared from the reservoir and shifted upstream to chinyalisour and Ghansali in the river Bhagirathi and Bhilangana respectively due to its highly sensitive nature to river bed, being bottom feeder and lithophil spawner. (High water column and steep banks of the reservoir do not support feeding and breeding behaviour of the snowtrout)

Over-exploitation

Increasing dependence of human population for nutrition on fishes has caused diminishing of the resources in Uttaranchal. The fish resource has also been found over-exploited for extraordinary economic benefits and has caused increasing vulnerability of the snowtrout population as evidenced by decline in catch of snowtrout in per unit effort in the Bhagirathi, Bhilangana and Alaknanda Valleys.

Mass-destruction

Use of dynamites and electric shocks by the persons involved in road construction & hydroelectric projects are very often for catching fishes. Some people also used ichthyotoxic plants (viz. *Xenthoxylum armatum*, common name Timuru) and chemical poisons (viz. bleeching powder) to catch fish with fewer efforts in the shallow portion of the river. These methods not only kill adults but Juveniles also and cause severe damage to the micro habitat by affecting the survival of micro-organism including periphyton and benthic invertebrates that serve as food of the fish. Thus cumulative effect of it leads to decline in the fish population. Dehadrai *et al.* (1994), Shrestha (1997) and Ponniah *et al.* (1998) also opined that the unscientific fishing techniques causes mass-destruction of brooders, small sized fishes, fingerlings and fry, which have distinct impact on capture fisheries in subsequent years.

Uncontrolled Introduction of Exotics

Many exotic fish species have been introduced and well established in Indian waters due to their fast growing capability. However, these species have initiated competition with indigenous fish species at different levels and are becoming dominant in Indian waters (Pullin, 1994; Singh and Pandey, 1995). Common carp introduced in the Kashmir has almost exterminated the indigenous schizothoracids of the Valley. Though in the Garhwal Himalayan rivers, common carps was not introduced till the year 2006. But recent survey to Tehri dam reservoir has shown the presence of substantial number of common carp in the catch along with mahseer population. Although snowtrout from the reservoir has shifted itself to upstream due to its highly sensitive nature with the river bed but there is a further threat to riverine population of snowtrout from the exotic common carp. If common carp established to themselves in the reservoir and somehow migrate to the downstream (passive migration with downstream water into the river after dam) or upstream (where river entering into the reservoir at Chinyalisour and Ghansali), may give tough competition to the indigenous local population of snowtrout and may dominate over them in coming years.

Another exotic fish species brown trout and rainbow trout have been introduced in the coldwater of Garhwal Himalaya. The seeds of trout are being raised in Varagana, Talwari and Gangori hatcheries and stocked in the adjacent high altitude streams by state fishery department. These exotic trout being carnivore in nature may cause danger to the survival of native herbivore snowtrout by feeding upon their hatchlings and small fry. Therefore one must be aware of the potential hazards of the introduction of the exotics and this should be done under careful monitoring.

Genetic Factors

In addition to above-mentioned factors, snowtrouts have some own genetic constrains for its vast and speedy propagation in the nature. Important ones are-

Asynchronization of Gonadal Maturation

It is one of the major constraints that impede breeding in schizothoracids. Males often show testicular recrudescence earlier during the season, therefore causing earlier ripeness of the males than females when they are not yet mature and ready for spawning (Agarwal, 1996, 2001). Similarly, during the later periods of the breeding season, the males become spent while the females are still capable of producing eggs. This asynchronization in the maturation of the sexes causes lesser chances of fertilization thereby less production.

Low Egg Production Potential

The egg production potential (fecundity) of snowtrouts is comparatively very less than other plain counterparts as well as other coldwater fishes (Agarwal *et al.*,1988, Agarwal, 1996; Thapliyal, 2002). However this may be due to the struggle for existence in adverse coldwater environment, but it has also caused low production of the group.

Strategies for Snowtrout Protection and Propagation

The further decline of the fish germplasm resource may be prevented by devising all the possible measures of conservation and rehabilitation (Pavolov, 1993; Penczak, 1996; Das and Pandey, 1999). The irreparable harm caused to the snowtrouts and its habitat need to be compensated through strict implementation of Indian Fisheries Act, 1897 (modified, 1956) along with adoption of the following strategies. Legal measures for protecting and propagating fish germplasm resources cannot be implemented without taking the ground socio-economic realities in the consideration.

In situ Protection & Propagation

In situ protection of fish is useful where genetic diversity exists and where wild forms are present. This can be done through their maintenance within natural or man-made ecosystems in which they occur. Rishikesh, Har-ki-Pauri (Haridwar) and Baijnath (Almorah) are some examples of religiously protected areas in Uttaranchal where fishing is totally banned and protected by the community. Such type of protected areas can be developed with the support of community participation. The successful artificial breeding and larval rearing of the snowtrout, *Schizothorax richardsonii* (Agarwal *et al.*, 2002, 2007; Thapliyal, 2002) has opened up the new avenue of river ranching in depleted areas for stock replenishment and conservation. The stocking-restocking pattern by establishing flow through hatcheries may be one of the strategies for the development of snowtrout fishery in rivers and reservoirs. But the natural breeding grounds of the snowtrout should also be protected and developed all along the riverside and near the headwater of reservoir.

Ex situ Conservation

In this measure, the targeted species are conserved outside their natural habitats. The two main pillars of *ex-situ* conservation programmes are live gene bank and Gamete/Embryo banks. In a live gene Bank, the endangered species are reared in captivity, bred therein and genetically managed avoiding inbreeding depression, domestication and unintended selection (Minckley and Deacon, 1991). In Gamete/Embryo Banks, adequate samples representative of the natural genetic variations of the threatened species are kept in liquid nitrogen (LN_2) at extreme low temperatures (-196° C). Establishment of Sperm Bank by cryopreserved milt assures further availability of genetic materials of desired species for intensive breeding programmes. Cryopreservation of snowtrout milt (Semen) may

play an important role in the protection and propagation of species through intensive seed production in the hatcheries.

Cryopreservation of Snowtrout milt

Cryopreservation of fish milt (sperm) without loss of viability is of considerable value in propagation of snowtrout fishery. It helps in the availability of male gametes round the year for seasonal breeders, and in organizing easy transport of germplasm, genetic selection and hybridization programmes. The cryopreservation of snowtrout milt overcome the problem of asynchronization of maturation of males and females by making available cryopreserved milt round the year for fertilizing eggs in hatcheries. This will not only improve the snowtrout seed production efficiency of the hatchery but also greatly minimize the cost of maintenance of male brooders. By raising snowtrout seed in the hatchery, river ranching programme can be initiated for stocking the rivers and streams to replenish the snowtrout in the wild. The research group has developed short term and long term preservation techniques for snowtrout milt. The milt of *Schizothorax richardsonii* and *Schizothoraichthys progastus* can be stored in refrigerator (0-4 ^{0}C) upto 5 days with 50% motile sperm in Mounib's and KCl extender respectively (Agarwal 2005). The protocol for the cryopreservation of snowtrout (*S. richardsonii* and *S. progastus*) milt in Liquid nitrogen (-196 ^{0}C) has been developed (Agarwal *et al.*, 2009). The initial success has been achieved in fertilizing the eggs with 375 days old cryopreserved milt and developing the snowtrout seed. Commercialization of the crypreservation technique for snowtrout milt at the level of field trial is now awaited. This will certainly open up an avenue for the development of cold-water fishery through protection and propagation of snowtrout in cold-water bodies of Indian uplands.

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