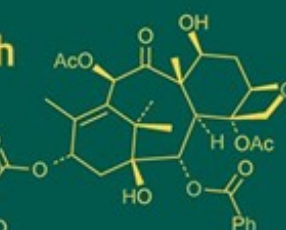
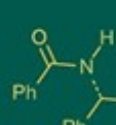


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Comparative growth study for three species of snow trout, *Schizothorax Richardsonii*, *S Plagiostomus* and *S progastus*

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ABSTRACT

A field study was conducted to evaluate the growth potential of three important indigenous species of snow trout viz. *Schizothorax richardsonii*, *S. plagiostomus* and *S. progastus* in captive condition under the coldwater environment. Seed of the all three species was produced by using wild brooders collected from the streams of Uttarakhand and Himachal Pradesh. Six months old fingerlings having average weight of 20g was stocked in the FRP tanks with the Stocking density of 40 fingerlings/m³. In early 120 days, *S. plagiostomus* and *S. progastus* showed better growth over the *S. richardsonii* with highest net weight gain by *S. plagiostomus* as 56.08g. Further, field trial for 360 days also showed 12% better growth of the *S. plagiostomus* and 7.9% better growth of the *S. progastus* over the *S. richardsonii*. The observed survival was in the range of 92.6-97.8%. The total harvested biomass was 4.380-4.470 kg/m³ in 12 months with 6-10 litres per minute water flow. The recorded FCR was in the range of 3.82-3.46, which showed slow growth of the tested species. *S. progastus* and *S. plagiostomus* are well adopted species for coldwater environment. Though, the growth of all the species are not encouraging for aquaculture practice, but fish showed hardy nature having good survival and possibility of high stocking density.

Keywords: Snow trout, FRP tank, Stocking density, Survival, FCR

Introduction

Among other important food and game fishes one of the specialized and specific group of economic significance are the snow-trout (locally known as Asela, Sela or Rasella in Uttarakhand, Gulgali in Himanchal, Koushar gad in Kashmir and Buche & chuche asla in Nepal) belonging to the family Cyprinidae and sub-family Schizothoracinae. They form an important natural fishery inhabiting torrential streams, but later on adapted to lentic system as well in the upper regions of most of the SAARC countries. Their distribution is mainly restricted to mountain regions of Asia-mainly the highlands of Himalaya and central Asian. The Indian snow trout fall under seven genera, majority of which constitute an important part of cold-water fishery in the Himalayan region (Mirza, 1991; Tilak, 1987; Vass *et al.*, 1978) [1, 2, 3]. Snow trout are known as short distance migratory species and such migration is mainly performed for food and spawning (Sharma, 1998; Mohan, 2011) [4]. The species is widely distributed in the *Himalayan streams* at altitudes ranging from 1400 to 3000 m above mean sea level (Sivakumar, 2008). Though, this species contributes a major share in the wild composition, but does not consider as candidate species for cold-water aquaculture due to its slow growth in captive condition (Pandey *et al.*, 2010) [5]. Due to overexploitation, many of the species were listed as 'endangered' by the National Environmental Protection Agency and Endangered Species Scientific Commission (Yue *et al.*, 1998) [6]. The IUCN has listed these species as vulnerable due to declining population trends in its natural habitat. Catches of snow trout have been reported to the tune of 67-74% from north-western Himalayas; 59-67% from Uttarakhand Himalayan streams/rivers, however, by and large their overall size frequency have gone down by 10-20% over the years (Sunder, 2005) [7]. Besides indiscriminate killing, destructive fishing methods and ecological degradation, the inherent biological factors of low fecundity and long hatching period have also added its decline in the natural streams (Qadri *et al.*, 1983) [8]. Among 17 recognized members of snow-trout, *Schizothorax richardsonii* is widely distributed and typical variable example of the group. The growth of this species is not very encouraging, so that its culture in captivity has not attracted the attention of the aquaculturists. As this is an important group of fish for hill biodiversity and is a preferable fish of the people, it is desirable to explore fast growing species of snow trout to be a candidate species for culture in coldwater condition. There are limited candidate species for coldwater aquaculture and species diversity is priority for sustainability of the sector. Hence, the field study was conducted to evaluate growth potential of *S. richardsonii*, *S. progastus* and *S. plagiostomus* for coldwater aquaculture practice. *S.*

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progastus occurs more widely in Eastern Himalayas and *S. plagiostomus* is distributed almost all along the Himalayas.

Materials and Methods

The experimentation and field study was conducted at Central Institute for Coldwater Fisheries Research, Bhimtal (29° 21'N and 79° 34'E, Altitude 1370 msl) Uttarakhand, India. Mature brooders of the age of 2-3 years were collected from the streams of Uttarakhand and Himachal Pradesh and reared in the FRP tanks to obtain the maturity. Mature and healthy brooder of 3 years age group were selected for breeding operation and seed of the all three species was produced at 18.0 to 21.0 °C water temperature during the month of September and October 2020. After the six months, fingerlings of the each species were stocked @ 40 fingerlings/m³ in three replications. Growing fish were fed by utilizing formulated extruded pelleted feeds with roughly 35% crude protein. Physico-chemical parameters of rearing tanks were estimated by standard methods for the examination of water and wastewater (APHA, 1998) [9]. FRP tanks of the capacity-1200 litre having sand and pebbles in bottom were used for the rearing with 6-10 litres per minute water flow. The standard formula for Fulton's condition factor (*K*) was used to estimate the isometric growth assessment. The Food Conversion Ratio (also known as Feed Conversion Ratio or FCR) was calculated by dividing the total weight of food or feed consumed by the total weight gained by the fish. The survival rate was estimated by the number of fish harvested divided by the number of fish stocked, multiplied by 100. Statistical analysis of the data was done by one way Analysis of Variance (ANOVA) to determine differences between the means taking at 1% ($P < 0.01$) or 5% ($P < 0.05$) significance levels.

Results

The observed water quality parameters showed the cold-water condition having the lower thermal regime (8.2-20.6 °C) and moderate dissolved oxygen (6.8-7.6 mg/L). Significant seasonal variation was observed during the field experimentation for all the water quality parameters (Table 1). The initial average weight at the time of stocking was recorded as 20g. During the culture period of 120 days, the growth of *S. plagiostomus* was recorded highest as 76.34g followed by *S. progastus* (72.80g). The recorded growth of *S. richardsonii* was 54.38g. The observed survival was in the range of 92.6-97.8% for all the species. The recorded FCR was in the range of 3.82-3.46, which showed slow growth of the tested species. The total harvested biomass of the fish was 4.380-4.470 kg/m³ in 12 months with 6-10 litres per minute water flow. After the rearing of 12 months, *S. plagiostomus* showed 12% better growth from the *S. richardsonii* with average weight of 180g. *S. progastus* also showed 7.9% better growth over the *S. richardsonii* (Table 2, Fig 1 and 2).

Table 1. Physico-chemical parameters of rearing tanks

Parameters	FRP tanks
Air temperature (°C)	10-21.4
Water temperature (°C)	8.2-20.6
Water pH	7.9-8.2
Dissolved oxygen (mg/L)	6.8-7.6
Free CO ₂ (mg/L)	1.0-1.6
Total alkalinity(mg/L)	78.6-84.4
Total hardness (mg/L)	88.4-90.8

Table 2. Growth performance in 120 days field rearing

Rearing days	<i>S. richardsonii</i> weight (g)	<i>S. progastus</i> weight (g)	<i>S. plagiostomus</i> weight (g)
0 day	20.16 ± 1.58 ^a	20.42 ± 1.53 ^a	20.26 ± 1.48 ^a
30 days	31.22 ± 2.34 ^a	36.85 ± 2.88 ^b	39.16 ± 2.39 ^b
60 days	46.42 ± 3.42 ^a	56.16 ± 2.71 ^b	60.20 ± 4.80 ^c
90days	54.36 ± 2.56 ^a	69.16 ± 3.30 ^b	72.40 ± 4.46 ^b
120 days	54.38 ± 3.48 ^a	72.80 ± 2.44 ^b	76.34 ± 2.56 ^b
Net wt. gain (g)	34.22 ^a	52.38 ^b	56.08 ^c
<i>K</i> -value	0.95 ^a	0.98 ^b	1.02 ^b
FCR	3.82 ^a	3.42 ^b	3.46 ^b
Survival	93.4	92.6	97.8

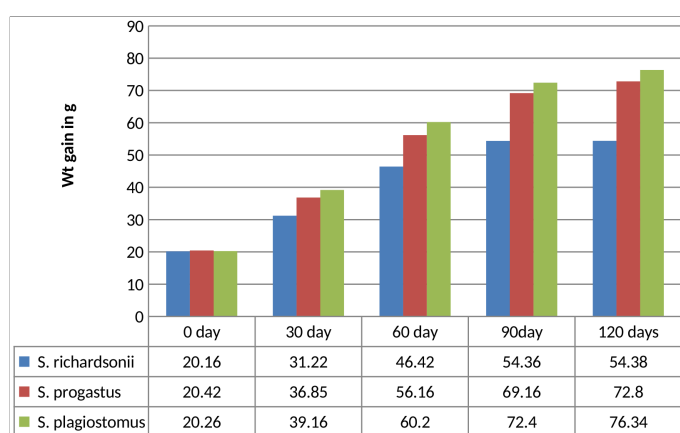


Figure 1. Comparative growth of three species of snow trout in 120 days rearing

Discussion

The water quality of the culture system showed the moderately cold-water condition with seasonal fluctuation. However, the flow through system has maintained the sufficient level of dissolved oxygen during

the culture operation. Previous studies reflected that experimental floating cage culture in sub-Himalayan lakes has shown high survival rates (up to 70% for fingerlings) when utilizing formulated extruded pelleted feeds with roughly 40% crude protein (Basade *et al.*, 2012) [10]. Flow-through cement raceways were also used for culture, though growth in captivity can be relatively slow compared to natural feeding behaviors, requiring optimized artificial diets to match their nutritional needs (Basade *et al.*, 2012) [10]. The present study in FRP tanks also showed the high survival and better growth. Joshi *et al.* (2005) [11] and Joshi (2004) [12] reported that *S. richardsonii* merely attained an average length of 8.4 cm, 12.1 cm, 15.6 cm, 18.2 cm, 20.4 cm, with corresponding weight of 5.2 g, 10.6 g, 25.8 g, 44.6 g and 72.0 g. during 1st to 5th year life span, respectively. However, present study showed the better growth with all the species. Previous studies also showed the better growth of *S. plagiostomus*, which grew up to 226 g, while *S. progastus* grew up to 363 g in the fourth year (Masuda, 1979) [13]. Dhar (1967) [14] reported the snow trout to reach 175 g in the second year and 330 g in the fifth year. The present study also reflects the similar trend of growth, however, the low water temperature in the winter months adversely affects the growth.

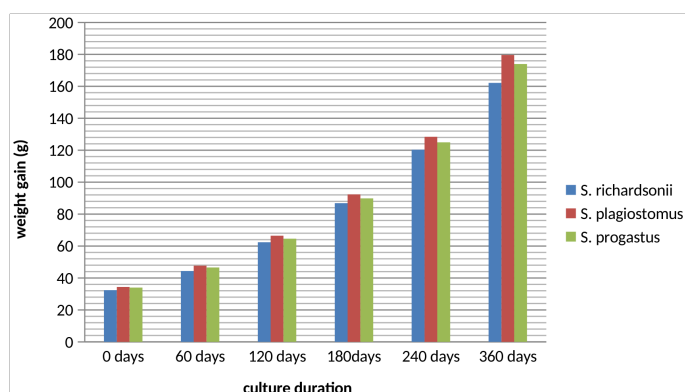


Figure 1. Comparative growth of three species of snow trout in 360 days rearing

Conclusion

Snow trout is a group of indigenous fish species of Himalayan and sub-Himalayan region having the sports and food value. As per IUCN, the species has been categorized under vulnerable and the wild population is fragmented and declining having stressful condition. This group of fish has high consumers' preference and fetches good sale price in local markets. The present study revealed that *S. progastus* and *S. plagiostomus* are well adopted species for coldwater environment. Though, the growth of these species are not encouraging for aquaculture practice, but fish showed hardy nature against the cold-water conditions having good survival and possibility of high stocking density. Further, field trials in raceways are required to develop the monoculture protocol of these species with high stocking density and polyculture with carp using yearlings for stocking.

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