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SNOW TROUT, *Schizothorax richardsonii* (GRAY), FROM THE RIVER YAMUNA, UTTARAKHAND, INDIA: A STUDY ON THE LENGTH-WEIGHT RELATIONSHIP AND RELATIVE CONDITION FACTOR

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The length-weight relationship and relative condition factor of snow trout, *Schizothorax richardsonii* (Gray), from the Yamuna River in Uttarakhand are investigated in this study. The results of this study revealed that there is a close relationship between length and weight. For sex-specific data, the regression coefficient ranged from 2.621 for males (r = 0.7683) to 2.795 for females (r = 0.8027) The relative condition factor was maximum 0.645 ± 0.061 for males and 0.756 ± 0.086 for females during the winter season. The minimum value was calculated as 0.019±0.002 for males and 0.048±0.007 for females in the monsoon season. The relative condition factor indicated that the winter season represented better feeding opportunities and suitability of the river habitat.

Keywords: Length-weight relationship; relative condition factor; *Schizothorax richardsonii;* snow trout; Yamuna River.

1. INTRODUCTION

Schizothorax richardsonii (Gray) is an important snow trout, which is commonly found in the snow-fed hill stream rivers, occasionally in spring-fed streams and is extensively used by the village folk as a protein-rich diet. It is herbivorous in feeding habits and spawns twice a year [1]. The fish

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attains a maximum size of about 34.7cm [2]. Several fish species inhabiting the Garhwal Himalayan region are small to moderate in size. Their distribution depends on ecological conditions like the velocity of water current, nature of substratum and availability of foodstuff. The length-weight relationship is valuable for studying the growth pattern and health status of the fish [3]. The body parameters of a fish frequently change with aging [4-9]. The length of fish has a special relationship with its weight. The environmental conditions or habitat of the fish greatly influence body growth and well-being, and it is immediately reflected in the length-weight relationship [10-11].

The relative condition factor (Kn) is an important part of the fish culture [12-18]. The higher values of condition factor show well being of the fish and lower values indicate that the fish are in poor condition. The condition of a fish is affected by the seasonal changes of food and feeding habits, gonadal cycle, health, etc. [19]. Several ichthyologists studied the length-weight relationship, condition factor and relative condition factor in freshwater fishes [20-45]. The aim behind selecting the fish from the study area for the present work may help in highlighting the need for the study of the relationship between length and weight, as well as the relative condition factor of Garhwal Himalayan snow trout, *Schizothorax richardsonii* from Yamuna River.

2. MATERIALS AND METHODS

2.1 Study Site

River Yamuna is the longest tributary of river Ganga and originates from Yamnotri glacier at a height of 6387 meters from Bandar pooch peaks of the lower Himalayas in Uttarakhand. It flows through Uttarakhand, passes Paonta sahib at Himachal Pradesh then travels through Haryana, UP and Delhi. It finally merges with Ganga at Triveni sangam in Prayagraj. Its habitat has inundated from riverine to lacustrine due to its impoundment for various reservoirs viz. Asan Barrage, Dakpathar Barrage and Hathnikund Barrage etc. Asan Barrage in 2020 was declared as Uttarakhand's first Ramsar site. Some other hydropower plants namely Dhalipur Dhakrani powerhouse, Kulhaal hydro powerhouse, etc. have been constructed on the river Yamuna. This obstructs the natural flow pattern as well as affects the fish density and diversity of river Yamuna and its tributaries [46]. For the sampling, the Barkot site was selected which is located at 30°48'39.2"N, 78°11'59.3"E.

2.2 Sampling Methods

121 specimens of *Schizothorax richardsonii* (Gray) were collected from the river Yamuna of Doon Valley from March 2020 to February 2021. Local fishermen used conventional fishing techniques; using cast net and gill net [47-51]. The length and weight of fish were measured in fresh condition for each specimen and fixed in 10% formalin. Based on 121 specimens of *Schizothorax richardsonii* (Gray), length-weight relationship was determined by applying the parabolic equation [52], $W = a L^{n}$. Where W = Fish weight, L = Total fish length, a = Constant, b = Regression of coefficient.

The Relative condition factor was determined using the formula $Kn = W / W^{-}$, where Kn represents the relative condition factor, W represents the observed weight of the fish in gm, and W^{-} represents the calculated weight of the fish in gm.

3. RESULTS AND DISCUSSION

The length and weight of *Schizothorax richardsonii* (Gray) fishes ranged from 10.8 to 35.2 cm and 29.5 to 225.6 gm respectively in males, while it was 11.0 to 34.9 cm and 30.0 to 240.92 gm respectively in female fishes. Table 1 shows the length-weight relationships for male and female fishes after regression analysis. The regression coefficient for sex-wise data ranged from 2.621 for males (r = 0.7683) to 2.795 for females (r = 0.8027), as shown in Table 1.

The Cube law applies for fishes, which maintains the same shape and specific gravity throughout their life. However, the length-weight relationship of most of the fishes deviates from the Cube law [53] because they change their form as they grow. Thus, it is better to express the length-weight relationship of fishes in the general parabolic equation $W = a L^{n}$ given by Martin [54] rather than the Cube law.

In the present study of length and weight, a close relationship was observed in *Schizothorax richardsonii* (Gray) male and female fishes. The value of regression coefficient "b" was obtain 2.621 for males (r = 0.7683) and 2.795 (r = 0.8027) for females. In the case of *S. richardsonii* from Sindh Nallah, Qadri et al. [55] found the value of 'b' to be 2.448. Thakre and Bapat [44] calculated length-weight relationship of the fish *Rasbora daniconius* and noticed that the values of b were 3.1529 for females and 3.219 for males. Bali and Sharma [42] worked on the length-weight relationships in *Tor putitora* from Beas River and noticed a low regression coefficient (2.5) for the male fishes. Kumar et.al. [13] found no significant differences in the length-weight

relationship of *Botia dayi* Hora in different sexes and seasons but observed a good growth during the spring-summer month which pushed the value of "n" to go high.

In *Schizothorax curviforns* from the River Jhelum, Mir et al. [56] observed varied values of 'b' (<3) in different months. For *Schizothorax curvifrons*, Khan and Sabah [57] calculated an exponential value of 'b' equal to 2.69. Rani et.al.[58] reported that the "b" value for *S. niger* 2.5720 and *S. richardsonii* 3.0273 indicated the better condition of *S. richardsonii* and physiological stress for *S. niger* in natural habitat. Based on age, sex, and maturity Le Cren [52] classified *P. fluviatilis* into six groups and found there was no significant difference in the length-weight relationship, while significant difference was reported between other groups. A higher relationship between log weight and log length of Chocolate mahseer *Acrossocheilus hexagonolipis* from Assam has been noticed by Dey [35].

The value of Kn (relative condition factor) for individual fish and the average Kn values for both the Male and female *S. richardsonii* during the study period (March 2020 to February 2021) are presented in Table 2. The relative condition factor was maximum 0.654 ± 0.061 for males and 0.756 ± 0.086 for females during the winter season. The minimum value was calculated as 0.019±0.002 for males and 0.048±0.007 for females in the monsoon season. In this way, the relative condition factor values were highest for both the sexes during winter. During the winter, both sexes had higher values of relative condition factor than during the monsoon.

It may be due to the availability of quality food in the aquatic environment. The peak values observed during winter for both sexes represent the good condition of fish based on active feeding and suitability of the environment.

The Relative Condition Factor (RCF) is noticed as a marker of the general well-being of fish [13,14,15,16,19,]. Le Cren [52] reported that the condition factor is affected by the length and other factors i.e. parasitism, food supply, habitat, etc. He also suggested the effect of length and its correlated factors may be eliminated by using a relative condition factor (Kn) which is based on the empirical (observed) and calculated length-weight relationship. In his work on perch *P. fluviatilis*, Le Cren indicated that (Kn) was the function of fatness and condition of gonads. Pillay [59] noticed in *Hilsa ilisha*, that the curve of K_n for females showed a steady increase from July onwards reaching the upper limit in November with a sudden fall thereafter. According to Bahuguna and Dobriyal [3], the relative condition factor for male fish in *Puntius conchonius* was highest in May (1.006±0.058) and lowest in August (0.970±0.001). For female fish, the value of the relative condition factor was observed maximum in May (1.0020±0.081) and minimum in August (0.911±0.228).

Table 1. Regression analysis and coefficient of correlation on the length-weight relationship of snow-trout, *S. richardsonii* (Gray) during March 2020 to February 2021

S.No.	Condition	Parabolic Equation	Correlation Coefficient "r"
1.	**Sex wise and pooled data**		
a	Male	$W = -3.524\ L^{2.621}$	0.7683
b	Female	$W = -3.782\ L^{2.795}$	0.8027

Table 2. Season-wise variation in relative condition factor (Kn) for Male and female fish, *S. richardsonii* (Gray) during March 2020 to February 2021

S. No.	Male				Female			
	Min	Max	Average	S.D.	Min	Max	Average	S.D.
Spring (March, April)	0.170	0.782	0.567	0.089	0.129	0.878	0.605	0.073
Summer (May, June)	0.101	0.635	0.457	0.052	0.124	0.734	0.537	0.043
Monsoon (July, August)	0.021	0.069	0.019	0.002	0.034	0.076	0.048	0.007
Autumn (Sept., Oct., Nov.)	0.073	0.598	0.435	0.053	0.089	0.629	0.469	0.078
Winter (Dec., Jan., Feb.)	0.224	0.873	0.654	0.061	0.242	0.968	0.756	0.086

Finally, it may be concluded that habitat and area, as well as other factors such as riparian and seasonal effects [60-61], periphyton food [62-67], availability of microzoobenthos [68-76], macrozoobenthos density and diversity [77-82], time of gonadal maturity [83-92], and fish aging [4,5,6,7,93], can affect the length-weight relationship in fishes.

4. CONCLUSION

The present work provides important baseline information on the Length-weight relationship for the *S.richardsonii* species from Yamuna River. It would be beneficial for fishery science and conservationists to impose adequate regulations for sustaining fish management and conservation of biodiversity for this species in Uttarakhand state.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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