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Estimation of length-weight relationship and condition factor of the Mahseer fingerlings, *Neolissochilus hexagonolepis* (McClelland, 1839) of River Ghish in Darjeeling Himalaya of West Bengal, India

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Abstract

A Length-Weight Relationship (LWRs) and Condition Factor (K) of *Neolissochilus hexagonolepis* (McClelland, 1839) fingerlings collected from three adjoining sites of River Ghish, Darjeeling Himalaya, West Bengal, India was studied. A total of 90 specimens were collected during November 2019 and total length-weight data was measured. The total length of specimens studied ranged from 4.0 to 5.9 cm while, the total weight ranged from 0.54 to 1.92 g. Linear regression analysis was used to calculate the degree of relationship between total length and total weight. The Coefficient of Determination (r^2) value ranged from 0.976 to 0.974 exhibiting a highly significant correlation ($p \leq 0.001$) between length and weight. Estimates of parameter b ranged from 2.893 to 2.926 suggesting negative allometric growth, while estimates of parameter a ranged from 1.12×10^{-5} to 1.29×10^{-5} , for three river sites. The overall estimate of Condition Factor (K) indicated increasing growth pattern along with the length of fingerlings. Thus, the data obtained will complement the efforts to understand the biology of these stage specific fish species and will provide useful information for its culture in confined condition.

Keywords: *Neolissochilus hexagonolepis*, Mahseers, Jhora ponds, Darjeeling Himalaya, length-weight relationship (LWRs), condition factor (K)

1. Introduction

Mahseers are popular among the cold-water hill stream fish for angling, tourism and are considered a cultural icon from an economic, recreation, and conservation perspective in 11 Asian nations [1]. Out of 47 species of Mahseer found globally, there are about 15 Mahseer species with their natural habitats in India [2]. Among these, the natural population of copper Mahseer (*Neolissochilus hexagonolepis*, McClelland, 1839) in the water bodies of the major rivers and streams of upland of the Northeast Himalaya has markedly decreased due to over-exploitation and habitat loss in most of the regions, along with other species [3]. Hence, it is classified as a "Near Threatened" fish on the status of the International Union for Conservation of Nature, IUCN [4]. However, this constitutes one of the dominant fish species along the River Teesta and its tributaries in Darjeeling Himalaya, due to which the major stretch of the river is designated as 'Barilius-Mahseer-Snow Trout stream' [5]. Further, fishes are valued as a food source locally because of the very desirable flavour of the flesh, ample amount of n-3 (Omega-3) Polyunsaturated Fatty Acid (n3/n6 PUFA ratio, 2.21), and essential amino acids [6]. However, the rising concern regarding the decreasing population has led to the need for rehabilitation programmes through artificial propagation, ranching, and building sanctuaries [3, 7, 8, 9, 10]. Further, it is considered as a potential candidate species for culture in Jhora pond system of Darjeeling Himalaya [3, 11, 12, 13, 14]. Hence, investigations to enhance the knowledge on bioecological aspects with respect to its natural habitat and developing the protocols for propagation in confined areas have emphasized its studies in more detail. One such primary investigation is information on stage specific Length-weight relations (LWRs) of fishes in a given geographical region [15, 16, 17, 18]. It provides information on growth, life history, survival, as well as the overall condition of the fish [19, 20, 21].

It is widely used as a tool to calculate the biomass from the length data, converting individual lengths or mean lengths of a group of fishes to weights [22, 23]. LWRs are also used to compare the well-being of individuals within the specific stocks or separate stocks of the same species [24, 25]. The LWRs differ among fish species depending upon body shape and biological factors such as maturity and spawning [26]. Apart from LWRs, the Condition Factor (K) is equally important in fisheries, because it allows the estimation of average weight of the fish of a given length group by establishing a mathematical relation between them ($W=aL^b$) [27, 28]. The information regarding the LWR and K of most fishes from the Darjeeling Himalaya of India is lacking on Fish Base (www.fishbase.org) records leading to zero reference availability. So, the present study aimed to investigate the LWRs and K of the Mahseer fingerlings, *N. hexagonolepis* collected from River Ghish flowing through Darjeeling Himalaya. The findings, therefore, will provide critical prerequisite information for their rearing in captivity and more relevant stage specific data to Fish Base from the Indian region for records.

2. Materials and Methods

2.1 Study area and sampling

Fingerlings of Copper Mahseer, *Neolissochilus hexagonolepis* were collected during November 2013 from three adjoining sites (Site1, Site2 and Site 3) of their natural habitat, River Ghish, over the stretch of 300 meters having similar substrate condition of sand, gravel, cobble, and boulder forming pockets with lower water temperature of around 14 to 20°C [11]. It rises from the south-western face of the Labha saddle in Kalimpong subdivision (Lat. 26°51' to 27°12'N and Long. 88°53' E), receiving number of anonymous tributaries and flows south meandering along incised valleys within jungles of the Teesta-Chel Reserved Forest. The total length of River Ghish within Darjeeling Himalaya is 30.20 km (18.75 miles) and joins the mighty Teesta in Jalpaiguri district. The fish samples were identified according to Jayaram [29] and transported to the Aquaculture and Limnology Research Unit, Department of Zoology, University of North Bengal where counting and measurement for total length (TL) and body weight (BW) was done. Lengths were measured with a digital caliper to the nearest 0.1 mm and body weight was determined with a digital balance to the nearest 0.01 g.

2.2 Data analysis

The Length–weight relationships of fingerlings were

established using Linear Regression Analysis (Least Square Method). Parameters of the Length–weight relationship were estimated using the equation proposed by [30]:

$$W = aL^b$$

After logarithmic transformation of Length–weight data, this equation may be expressed as:

$$\log_{10}W = \log_{10}a + b\log_{10}L$$

Where, W is the weight of the fish in grams and L is the total length of the fish in mm, a is the intercept of the Regression curve (coefficient related to body form) and b is the Regression Coefficient (exponent indicating isometric growth) [31].

The relationship between length and weight for mean samples were used to calculate Fulton's Condition Factor Index [32] which is estimated using the following equation:

$$K = W/L^3 \times 100$$

Where, L is the length in centimeters (cm) and W is the weight in grams (g) 100 is a factor to bring the value of K near to unity [31].

Statistics were performed using the SPSS package version 20.0. Prior to Regression Analysis length and weight data of individual specimen were log transformed using MS Excel 2010. Outliers were removed [31]. To compare the variations the 95% Confidence Limits were determined.

3. Results

Altogether a total of 90 *N. hexagonolepis* fingerlings were collected from three different sites of the River Ghish, West Bengal. Estimated parameters of length–weight relation including sample sizes (N), regression parameters a and b and their 95% Confidence Limits (CL) for “ a ” and “ b ”, the Coefficient of Determination (r^2) and Condition Factor (K) values for the *N. hexagonolepis* fingerlings are given in Table 1. For all analyzed individuals from three different sites LWRs were highly significant ($P < 0.001$), with similar r^2 values of 0.976, 0.972 and 0.974, respectively (Figure 1). The values of coefficient arranged from 1.12×10^{-5} to 1.29×10^{-5} and the values of exponent “ b ” ranged from 2.893 to 2.926. The K -value of these fingerlings ranged from 0.841 to 0.850.

Table 1: Descriptive statistics, estimated Length–weight relation parameters and Condition Factor (K) of *Neolissochilus hexagonolepis* fingerlings from three different sites of River Ghish, Darjeeling Himalaya, West Bengal.

Sites	N	Total Length (mm)	Total Weight (g)	a [95% CI of a]	b [95% CI of b]	r^2	K
1	30	40-59	0.57-1.91	1.29×10^{-5} [5.56×10^{-6} , 2.52×10^{-5}]	2.893 [2.720, 3.065]	0.976	0.850 [0.775-0.930]
2	30	40-59	0.54-1.92	1.23×10^{-5} [5.91×10^{-6} , 2.55×10^{-5}]	2.904 [2.716, 3.092]	0.972	0.845 [0.769-0.935]
3	30	40-59	0.54-1.92	1.12×10^{-5} [5.51×10^{-6} , 2.27×10^{-5}]	2.926 [2.744, 3.108]	0.974	0.841 [0.769-0.935]

N = Number of individuals; a = Intercept; b = Slope; CI = Confidence Limits; r^2 = Coefficient of Determination; K = Condition Factor; K - value in bold, is less than value recorded in FishBase.

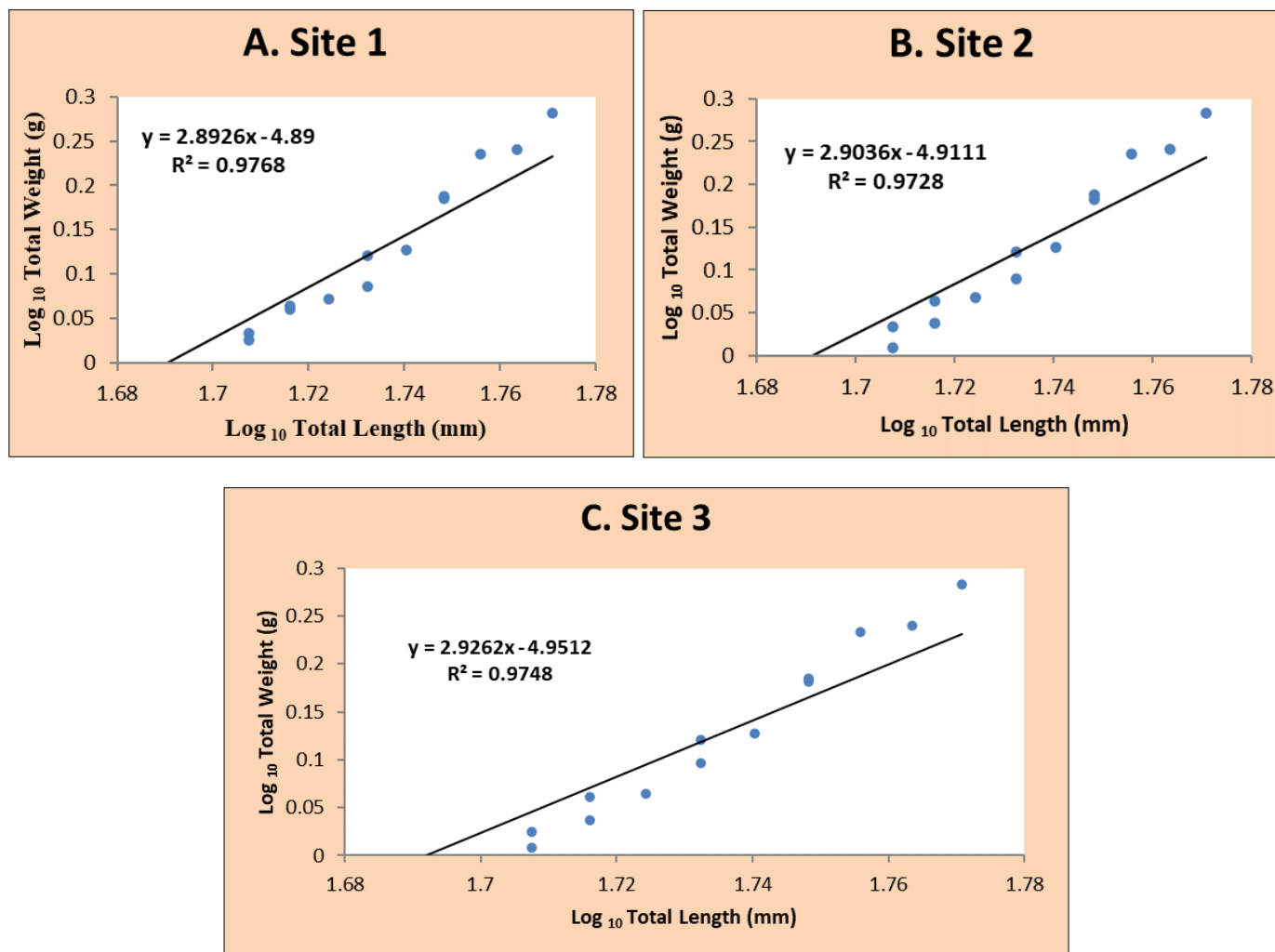


Fig 1: Shows the Regression graph of Length Weight Relationship of *N. hexagonolepis* fingerlings collected from three different sites (Site1, Site2 and Site 3).

4. Discussion

It is widely established that a number of different factors influence the growth and LWRs of fishes. Such factors include sex, health, the effect of gonad maturity on somatic growth, seasonality of resources, stomach fullness, sample size, and preservation techniques^[30] and these were not accounted for in this study. For all individuals, the higher value of r^2 as shown in Figure 1 (Site1, Site2 and Site 3) suggests a strong relation between total length and body weight. The estimated b values were within the normal range of 2.5 to 3.5, as suggested^[31]. Variations in the b values are usually attributed to several factors such as sample size, life-stages habitat, season, sex, diet, and gonadal maturity^[33, 34]. Considering the somatic type of growth, the fingerling stage showed negative allometric growth ($b < 3$). The size range covered in this study was narrow. Hence, the LWR for these species should be considered preliminary and need to be verified in future studies using larger sample sizes as well as with other life-stages. The value of “K” > 1 indicates good general condition of fish^[30], however in this study it has been found that the K value is lesser than 1 (one), not previously reported in FishBase, may be attributed mainly to its juvenile stage and cold water temperature, besides other factors such as water depth and or the food availability^[34].

5. Conclusion

In conclusion, these results provide preliminary information for the conservation and sustainable management of these

fishes of River Ghish of Darjeeling Himalaya, West Bengal, India. Based on the results of Length- weight relationship from this study, the species showed huge potential as candidate species for rearing in confined water bodies, if environmental parameters are well managed. In order to enhance aquaculture of Copper Mahseer in Darjeeling Himalaya more researches are still required especially on nutrition, economic feasibility and genetic identification. The information on nutrition and economic feasibility will be useful to local community along with policy makers who are involved in strategic small scale aquaculture.

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