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OBSERVATION ON THE BODY MASS AND LENGTH RELATIONSHIP AND RELATIVE CONDITION FACTOR OF *Noemacheilus rupicola* (McClelland) FROM DOON VALLEY, INDIA

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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 findings of the present investigation revealed that the value of regression coefficient (b) for female *Noemacheilus rupicola* (McClelland) was slightly greater (2.657) than that of the males (2.261). From the trend so obtained it may be presumed that females gained more weight with an increase in length, indicating better health. The value of "b" varied from 2.5 to 4.0. Values were highest during the winter for both sexes. The relative condition factor (RCF) indicates that the winter season provided better feeding opportunities and environmental appropriateness.

Keywords: Body mass and length relationship; relative condition factor; *Noemacheilus rupicola*; Doon valley.

1. INTRODUCTION

Noemacheilus rupicola (McClelland) is an important loach inhabiting the snow-fed rivers as well as the spring-fed streams. It is widely consumed by rural folks as a protein-rich diet. Observations on the body mass and length relationship are extremely important in fisheries because they demonstrate the relevance of

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fish population dynamics and growth patterns in fish stocks. The study of body mass and length, as well as their relationship, is essential in the understanding of fish stock growth in a particular locality [1-4]. The numerical relationship between body mass and length enables the interconversion of these variables in the setup of yield equations for estimating population potency [5-7]. Several researchers [8-25] have thoroughly studied the relationship between body mass and length. Sexual dimorphism has been observed in several hill-stream fishes and prawns [26-28]. The physical characteristics of a fish change frequently with aging [28-32].

Le Cren [33] proposed a relative condition factor (Kn) instead of 'K' since the former takes into account all variables, such as those related to food and feeding, sexual maturity, and so on, whereas the latter only does so if the exponent value is equal to 3. The 'K' Factor, on the other hand, measures the variations from an ideal fish that follows the cube law whereas the 'Kn' measures the individual deviations from the expected weight derived from the length-weight relationship. Because there is currently no information on the body mass and length relationship, as well as the relative condition factor of *N. rupicola* (McClelland) from Doon valley, the present study was undertaken to determine the pattern of growth and general condition of this fish species in natural waters for use in fishery assessment.

2. MATERIALS AND METHODS

From January to December 2021, fish samples were taken from a commercial catch at a fish-landing center in the Dakpather region. Traditional fishing gear was used to catch the freshwater loach [34-39]. The fish's total length and weight were measured while it was still alive. Following Day [40], Talwar and Jhingran [41], and Jayaram [42], species identification was carried out simultaneously. Randomly selected specimens' total body length (TL) and body weight (BW) were measured to the nearest 0.1 cm and 0.1gm precision, respectively. The fish were then preserved in 12 percent formalin, labelled, and placed in plastic boxes before being transferred to the laboratory to be dissected and the sex verified.

Monthly data were grouped into 10mm class intervals. The formula $W = a L^b$, was used to determine length-weight regression for males and females separately, where "W" is weight in milligrams, "L' is length up to the caudal fork in mm, and "a" and "b" are constants.

The relative condition factor 'Kn' as an indicator or robustness of the fish was determined for male and female fish individually using the formula Kn= W/t, where 'W' is the observed weight and 't' is the expected weight derived from the length-weight relationship. After getting the mean lengths and weights for the corresponding length groups, 'Kn' values for the various length groups were determined.

3. RESULTS

The study was conducted on the relationship between body mass and length as well as the relative condition factor of 85 fish (35 males and 50 females) from the River Yamuna in Uttarakhand, India.

3.1 Body Mass Weight-length Relationship for *Noemacheilus rupicola* (McClelland)

Table 1 shows the results of a regression analysis of the body mass-length relationship in *Noemacheilus rupicola* (McClelland) considering male, female, and pool data. The fish samples were categorized as male, female, or pool data, revealing close relationships between length and body mass. The regression coefficient for gender and pooled data ranged from 2.261 for the male to 2.657 for the female. In the case of pooled data, the total length of *N. rupicola* was shown to be positively correlated to its weight (r= 0.8245). The correlation was also high for males (r = 0.7853) and females (r = 0.8771) separately.

3.2 Relative Condition Factor (Kn) for *Noemacheilus rupicola* (McClelland)

The relative condition factor (Kn) value for each fish was determined, and the average K_n value for males and females during each season was calculated and shown in Table 2. It was observed that during the monsoon season, the relative condition factor was as low as 0.054±0.027 in males and 0.094±0.068 in females. The greatest value for female data was 0.456±0.186 during the winter season. The second maximum value was observed during the summer season (0.417±0.079) for males and females (0.501±0.096) data. It might be attributed to a high level of sexual maturity. The values were also relatively high over the winter, indicating that the environment is suitable for food availability in the Yamuna.

Table 1. Regression analysis and coefficient of correlation on the body mass and length relationship of *Noemacheilus rupicola (McClelland)* from January 2021 to December 2021

S. No.	Condition	Parabolic Equation	Correlation Coefficient "r"
1.	**Sex wise and pooled data**		
a	Male	$W = -4.654\ L^{2.261}$	0.7853
b	Female	$W = -3.928\ L^{2.657}$	0.8771
c	Pool data	$W = -4.252\ L^{2.486}$	0.8245

Table 2. Season-wise variation in relative condition factor (K_n) for Male and female fish, *Noemacheilus rupicola* (McClelland) from January 2021 to December 2021

S. No.	Male				Female			
	Min	Max	Average	S.D.	Min	Max	Average	S.D.
Winter (Dec., Jan., Feb	0.204	0.787	0.456	0.106	0.322	0.898	0.587	0.186
Spring (March, April)	0.110	0.565	0.387	0.042	0.189	0.634	0.437	0.086
Summer (May, June)	0.157	0.682	0.417	0.079	0.242	0.778	0.501	0.096
Monsoon (July, August)	0.032	0.083	0.054	0.027	0.021	0.094	0.068	0.024
Autumn (Sept., Oct., Nov.)	0.098	0.489	0.259	0.175	0.054	0.562	0.435	0.087

4. DISCUSSION

The assessment of the body mass-length relationship is very important when measuring the growth pattern of aquatic invertebrates and vertebrates. Growth is a crucial biological aspect that has a direct impact on total productivity.

The parameters of the body mass-length relationship of *Noemacheilus rupicola* (McClelland) in this study exhibited lower position allometric growth with a 'b' value of 2.261 for males and 2.657 for females in relation to fish length from Yamuna River. In the present study, it was noticed that the regression coefficient (b) of females (2.657) is observed to be slightly higher when compared to that of males (2.261). This pattern suggests that females gained more weight as their length increased, indicating better well-being.

According to Bahuguna et al. [20], the observed overall values of the regression coefficient (b) for the males, females and combined sexes (Male= 1.412, Female = 1.298 and combined sexes =1.334) are less than 03 is an indication of negative allometric growth. It is also noticed that the correlation coefficient ® of females (0.959) is found to be slightly higher when compared to that of males (0.941). From this trend, it is presumed that females gained more weight with increases in length, indicating a better being. The length-weight relationship of *Noemacheilus denisonii* from the Mandal River shows low growth rates due to the ecological condition of the mountain river or feeding grounds. Bahuguna et al. [1] also give a type of information on the length-weight relationship for *Garra lamta* fish species from the Kumaun hill stream. Kumar et al. [10] found no significant differences in the length-weight relationship of the hillstream loach *Botia dai* Hora in different sexes and seasons, although they did find strong growth throughout the spring-summer month, pushing the value of "n" to a high number. While working on the fish *Barilius bendelisis*, Bahuguna et al. [13] found that the length and weight relationship between males (r = 0.921), females (r = 0.909), and pooled data (r = 0.932) was quite close. The length-weight relationship of *B. bendelisis* was found to be significantly closed, while the value of "b" fluctuated from a low of 1.72 to a high of 3.74 in females over the summer and then peaked in the autumn.

Bahuguna and Dobriyal [24] reported the length-weight relationship of *Puntius conchonius* and observed that the values of 'b' were 1.9104 to 1.9939 from Mandal River, Uttarakhand, India. Bahuguna et al. [7] noticed that the length-weight relationships of a species could vary according to season and locality. The growth rate of *N. rupicola* varied based on numerous aspects in the present investigation, including food availability, month and season of the year, and reproductive cycle, and many others. Throughout the research period, *Noemacheilus* had low allometric growth, indicating that they are influenced by one or more environmental

variables. Negative growth rates may be the outcome of poor individual health and reproductive success [2]. Le Cren [33], who converted the cubic parabola into a general parabola, studied the length-weight relationship in *Preca fluviatilis*. Rashid et al. [23] found that the regression coefficient for gender in *M. armatus* fishes ranged from 3.997 for males to 3.977 for females. Bahuguna et al. [43] reported the negative allometric growth in males (b = 1.7128), females (b = 1.8623) and pool data sexes (b = 1.7128) of *P. ticto.*

The relative condition factor (RCF) was calculated as a general indication of the general well-being of fish. Le Cren [37] stated that by employing a relative condition factor (Kn) based on the observed and calculated length-weight relationship, the influence of fish length and its correlated factors might be eliminated. Kn>1 implies that the fish is in good health, whereas Kn<1 suggests the contrary. In the present study on *N. rupicola*, the relative condition factor for males was maximum in the winter season (0.456±0.106) and minimum in the monsoon season (0.054±0.027). For the female fish, the value of R.C.F. was also recorded high in winter (0.587±0.186) and minimum in monsoon (0.094±0.068). The lowest K_n value during monsoon might be because during this period, mostly the fish with spent or immature gonads were available and the food was scarce. The second peak value was observed during summer in males (0.417±0.079) and female data probably due to a better feeding period.

According to Hart [44], the inflection point on the Kn value curve is an excellent predictor of size at initial sexual maturity. According to Bahuguna et al. [1], the length-weight relationship of *G. lamta* from the Kalapani stream indicated reduced growth rates attributed to the stream's ecological condition. Length-weight correlation of *G. lamta* was shown to be substantially narrow with the varied value of 'b' between 1.035 and 3.164. In February, the relative condition factor for male *M. armatus* was 1.265±0.199, while for females it was 1.339 ±0.074. In July, the lowest value was 0.779±0.167 for males and 0.888±0.058 for females [21]. For male, female, and pooled data of *P. conchonius*, Bahuguna [22] found that the relative condition factor was lowest in August while it was highest in the month of May [23].

In July, the relative condition factor values for males, females, and pool data of *P. ticto* were the lowest, at 0.701 for males, 0.735 for females, and 0.719 for pool data. The highest peak value was recorded in December (0.945 for males, 0.954 for pool data), indicating the optimal feeding time for fish, while the second-highest peak value was observed in June (0.904 for males, 0.925 for females, 0.913 for pool data), indicating the reproductive phase of *Puntius ticto* [43]. The relative condition factor correlates with the changes and reproductive phase, suggesting that the highest relative condition factor value may show the starting of the reproductive period of *M. tengara* in the Dhemaji district of Assam [45].

Finally, habitat and area, as well as a variety of other factors such as riparian and seasonal effects [46-47], periphyton food [48-54], availability of microzoobenthos [55-63], macrozoobenthos density [64-69], time of gonad maturity [70-79], and fish aging [29-32], can affect the length-weight or body mass-length relationship in fishes.

5. CONCLUSION

The species *Noemacheilus rupicola* (McClelland) is predominantly found in the river Yamuna. Correlation coefficient "r" indicated a strong positive correlation between body mass and length; suggesting that the fish become get plumper as they grow longer.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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