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A Comparative Study of Length-Weight Relationship and Condition Factor of Lesser Spiny Eel, *Macrognathus aculeatus* (Bloach) from the Different River Basins of India

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Abstract: The freshwater lesser spiny eel, *Macrognathus aculeatus* is commonly known as peacock eel. The selected sampling areas were spatially and geographically different and characterized by different environmental conditions in order to elucidation of ecotype. A total 186 samples were collected from the Ganges, Godawari and Mahanadi river basins of India to evaluate the stocks of *Macrognathus aculeatus* on the basis of length weight relationship. The values of exponent ' b 'of length weight relationships (LWR) of different regions ranged from 2.02±0.45 to 3.53±0.21 indicating varying isometric and allometric growth patterns. The linear regressions of different stocks were highly significant ($p<0.001$). The condition factor of all the regions showed a significant difference.

Key words: Length Weight Relationship · River Basin · *Macrognathus aculeatus*

INTRODUCTION

The freshwater spiny eel, *Macrognathus aculeatus* is an inland water teleostean fish commonly known as lesser or peacock eel. The fish is economically important and palatable as a table fish. This fish has been reported from India, Pakistan, Sri-Lanka, Bangladesh, Myanmar, Thailand, Malaysia and southern China. It occurs in a variety of freshwater habitats in the plains as well as in the hills of India. Rahman [1] reported the availability of spiny eels in rivers, canals, beels, ponds and inundated fields throughout Bangladesh. Despite of its palatability and consumer appeal a little information is available on the biology of this fish. The studies carried out on this fish are related to the seasonal variation in fat and water contents and functional anatomy of digestive organs [2]. Various workers used the study of length weight relationship for different purposes like the conversion of growth-in-length equations to growth-in-weight for stock assessment models, to evaluate stock assessment biomass from limited sample size, as indicators of fish condition, to compare the life histories of certain species among regions and other aspects of fish population dynamics [3-7]. In addition, the data on length and weight can also provide important clues about the climate and environmental changes and change in human subsistence practices. However, the size attains by the individual fish may also vary because of variation in food supply and these in turn may reflect vitiations in climatic parameters and supply of nutrients or in the degree of completion of food. Thus a change in size through a certain period of time may show a change in average age resulting from those factors [8]. The study on length- weight relationship is still scanty for most tropical and sub-tropical fish species [9-13]. The present study is focusing on the length-weight relationship of *M. aculeatus* from the different river basins of India characterized by different environmental conditions was undertaken, which would be useful for the artificial propagation of this fish in aquaculture.

MATERIALS AND METHODS

A total of 186 samples of *M. aculeatus* were collected from the Ganges (Saint Ravidas Nagar Bhodhohi of Uttar Pradesh and Kolkata), Godavari (Hyderabad) and Mahanadi (Bhuweneshwar) river basin of India using the cast and gill nets during January 2011 to Dec. 2013. These four sampling sites are geographically and spatially isolated from each other's and characterized by different

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environmental conditions. The total length (nearest 0.1 cm) and total body weight (nearest.01g) for each specimen were recorded using digital calipers and digital balance respectively. The statistical relationship between the total length and total body weight of the specimens were derived by using the formula: W= aLb, where W = weight of fish in grams, a = intercept (constant), L = length of fish in centimeter and b = regression coefficient (slope). For practical purpose this relationship is usually expressed in its logarithmic form [25].

LogW = Log a + b Log L

The Fulton condition factor was calculated using the formula:

K=W×100/L3

Where, K = Fulton condition factor, W = whole wet weight in (g) and L = total length (cm) and the factor 100 is used to bring K close to unity. The total length was log transformed before the subjection of length frequency distribution in order to compare their size structure. The coefficient of determination (r2>0.95) was estimated in order to indicate the quality of the linear regression. All the statistical analysis was done with the help of software (Graph pad prism 5).

RESULTS

The weight of *M. aculetus* in the population of Ganges River basin of Kolkata was equal to the cube of its length (3.07±0.12) as compared to the population of Godavari River basin of Hyderabad (b=3.53±0.22) and that of Mahanadi River basin at Bhuweshneshwar (b=3.52±0.22). The population of *M. aculetus* of Ganges River basin showed both isometric and negatively allometric growth patterns at Kolkata and Sant Ravidas Nagar Bhodhohi respectively. The specimens of Godavari and Mahanadi River basins were positively allometric. The logarithmic regression equation of length-weight relationships of 186 individuals of *M. aculeatus* are given in the Table 1. Logarithmic linear relationship fitted to estimated body weight and combined size frequency distribution of *M. aculeatus* in different river basins are given in Fig 1. and Table 2 respectively. The coefficient of correlation (r2) in all the cases was highly significant (*P<0.001*). The size frequency distribution of *M. aculeatus* in different sampling sites is given in Fig 2. The condition factor of all the sampling sites indicated a significant difference after subjected to one way analysis of ANOVA followed by post hoc test Newman Keuls multiple comparison test. The highly significant difference was noted between the Hyderabad and UP samples at P<0.0001 (Fig. 3).

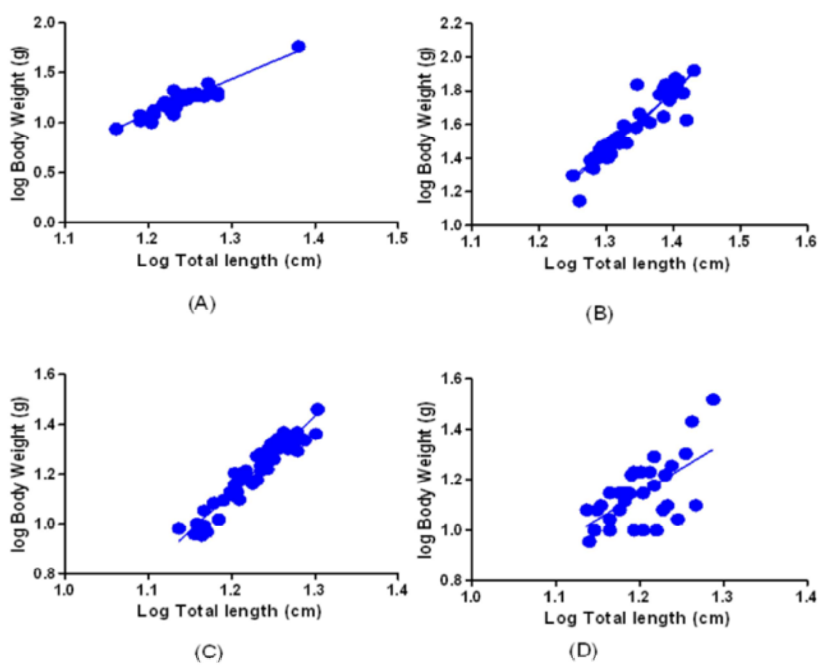


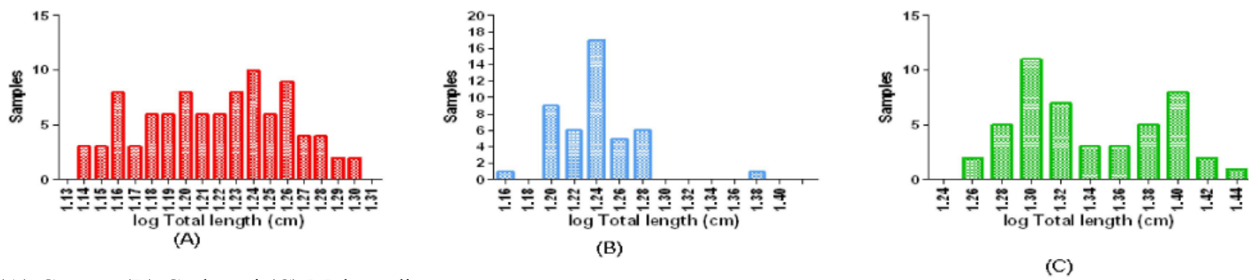
Fig. 1: Logarithmic linear relationship fitted to estimated body weight of M. aculeatus in different river basins. (A) Godavari (B) Mahanadi (C) Ganges (Kolkata) (D) Ganges (SRN UP)

Table 1: The logarithmic regression equation of length-weight relationship of 186 individuals of *M. aculeatus*

River Basin		Intercept (a)	Slope (b)	95% CI of b	r2
Ganges	SRN UP	-1.28±0.55	2.02±0.46	1.09-2.95	0.38
	Kolkata	-2.55±0.15	3.07±0.12	2.82-3.32	0.91
Godavari		-3.16±0.27	3.53±0.22	3.09-3.97	0.88
Mahanadi		-3.14±0.27	3.52±0.20	3.12-3.93	0.88

Table 2: The size frequency distribution of *M. aculeatus* in different river basins

	Ganges		Godavari		Mahanadi	
Source	Mean±SE	Sampling Size (N)	Mean±SE	Sampling size (N)	Mean±SE	Sampling size (N)
Size (cm)	16.04±0.49	94	17. 34±1.02	45	21.98±0.37	47



(A) Ganges (B) Godavari (C) Mahanadi

Fig. 2: The size frequency distribution of *Macrognathus aculeatus* in different river basin.

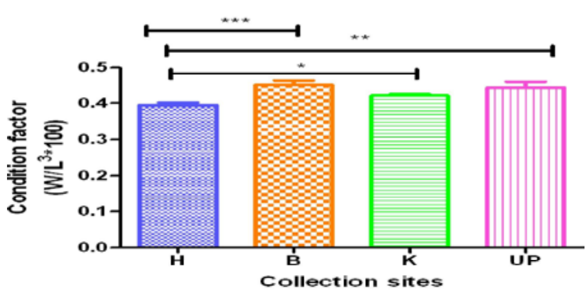


Fig. 3: Condition factor of *M. aculeatus* in different sites of river basins, H=Hyderabad, B=Bhuwaneshwar, K=Kolkata, UP=Uttar Pradesh

DISCUSSION

The regression equations and the values of coefficient of correlation (r2) of the samples collected from different river basins are suggestive of a close relationship between length and weight in *M. aculeatus*, but the fish did not follow the cube law strictly and the weight increase was not a rate of the cube of its length in all the samples collected from spatially and geographically different places characterized by different environmental conditions except in the population of Kolkata. The exponent 'b' often has a value close to three but varies between 2 and 4 [14]. The departure from the cube law in the present study (2.02-3.53) was found to be within the expected range as reported by various workers such as Bagenal and Tesch; Koutrakis and Tsikliras and Froese [15-17] for most fishes. The differences in value of 'b' in the different populations of *M. aculeatus* in the present study are because of difference in environmental conditions of different regions. However, Hossain *et al*. [18] reported the isometric growth (b=3.026) in a closely related species *M. pancalus* collected from river Mathabhanga a tributary of river Padma in Bangladesh. The other workers such as Narejo *et al*. [19] and Serajuddin, [20] reported low value of 'b' in the closely related species, *Mastacembelus armatus*. The rate of increase in weight in relation to length was slightly higher in the fish collected from river Godavari basin was (b= 3.53) as compared to those collected from the other river basins. It may be due to ecological factors particularly high dissolved oxygen concentration, circulation of water and forage organisms to the fish. The present findings is similar to those of Mustafa [21] who reported variation in length-weight relationship associated with habitat differences in *Esomus danricus* and emphasized that fishes living in running water show rapid growth compared to those which inhabit stagnant water. Tesch [22] also reported that the length-weight relationship in fishes can be affected by habitat and area besides other factors such as seasonal effect, degree of stomach fullness, gonad maturity, sex, health, preservation techniques and differences in the observed length ranges of the specimens. Nowak *et al*. [23] also observed the negative value of intercept in *Leuciscus leuciscus*, *Phoxinus phoxinus*, *Salmo trutta* of Dniester River drainage of Poland. Froese [17] also pointed out the concept of isometric and allometric growth of fishes whenever the value of slope (b) deviates its standard value of 3 in his review. Pathak *et al*. [24] also studied the length-weight relationship of *M. pancalus* from the Ganges and Brahmaputra river basin.

The mathematical relationship between length and weight is a practical index suitable for understanding their survival, growth, maturity, gonadal development and general well being of the fish [25]. The general equation forms the basis for the calculation of unknown weights from known lengths or unknown lengths from known weights. The general expectation is that the weight increases as the cube of length [26, 27]. Various workers have studied the length weight relationship of many fish species from different water bodies. Hossain *et al*. [12] studied length -weight relationship of 10 small fish species from the Ganges, Bangladesh and Sarkar *et al*. [28] studied the length weight relationship of an commercially important species *Chitala chitala* (state fish of Uttar Pradesh) from river Ganga basin. Weight- length relationships are used for estimating the weight corresponding to a given length and condition factors are used for comparing the ‘condition’, ‘fatness’, or ‘well-being’ of fish [29]. Carlander [30] reviewed the relative condition factor (Kn) of LeCren [25] and concluded that “while the relative condition factor is useful in certain studies, it is not suitable for comparisons among populations”. So the Fulton’s condition factor (K) was used in the present study. The highest condition factor in the individuals of *M. aculetus* of river Mahanadi at Bhuweshneshwar suggested their better condition in these environments because of the availability of their forage items. The decline of condition factor (Kn) in very large fish may be because of inadequate feeding or empty stomach. These comparative attributes of length-weight and length frequency distribution provides new insights in the size structure of *M. aculeatus* in relation to environmental plasticity or genetic differentiation. However further investigations by common garden experiments on variations of life history traits including length-weight and size structure in relation to environmental conditions or genetic differentiations of populations are needed to establish beyond doubt whether these parameters are plastic or genetically governed.

CONCLUSION

The length-weight relationship of *Macrognathus aculeatus* provides basic information for the stock discrimination in order to determining their intraspecific diversity on the basis of length-weight relationship.

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