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Full Length Research Paper

Length-weight and length-length relationships of freshwater wild catfish *Mystus bleekeri* from Nala Daik, Sialkot, Pakistan

Muhammad Naeem[1]*, Amina Zuberi[2], Zaigham Hasan[3], Abdus Salam[1], Muhammad, Khalid[1], Muhammad Jamshed Khan[4], Muhammad Mazhar Ayaz[4], Muhammad Ashraf[1], Muhammad Farhan Nasir[1], Saeed Akhtar Rasool[1], Majid Aziz[1] and Abir Ishtiaq[1]

[1]Institute of Pure and Applied Biology, Zoology Division, Bahauddin Zakariya University, Multan 60800, Pakistan.
[2]Department of Animal Sciences, Faculty of Biological Sciences, Quaid-i-Azam University, Islamabad, Pakistan.
[3]Department of Zoology, University of Peshawar, Pakistan
[4]Faculty of Veterinary Sciences, Bahauddin Zakariya University, Multan 60800, Pakistan.

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Length-weight (LWR) and length-length relationships (LLR) were determined for a freshwater catfish *Mystus bleekeri* (Day, 1877) collected from Nala Daik, Sialkot, Pakistan. A total of 105 specimens (56 males; 49 females) were collected from February to March, 2010. Each specimen was weighed (g) and measured (cm). The total length of specimens studied ranged from 5.5 to 7.8 cm. Linear regression analysis was used, first to compute the degree of relationship between length and weight and then among total (TL), standard (SL) and fork lengths (FL). LWR exhibited a highly significant correlation ($P < 0.001$). The overall value of the exponent of LWR ($b = 2.62$) suggested negative allometric growth. Results for LLRs indicated that these are highly correlated ($P < 0.001$). Furthermore, the first reference for separate male, female and combined sex of length-weight and length-length relationships for *Mystus bleekeri* was provided.

Key words: *Mystus bleekeri*, length-weight relationship, length-length relationship, predictive equations.

INTRODUCTION

Mystus bleekeri (freshwater catfish Day, 1877), locally called Tingara (Mirza and Alam, 2002) is distributed from Khyber Pakhtunkhwa and Punjab to southern province Sindh in Pakistan (Mirza, 2002). It belongs to the order Siluriformes and family Bagridae. Maximum length for *Mystus bleekeri* is reported as 15.5 cm by fishbase (Froese and Pauly, 2012). It has high nutritional value and is used as food fish in different Asian countries (Musa and Bhuiyan, 2007; Shinde et al., 2009; Haniffa, 2009). Among the small size fishes, it is economically important and fetches high price when marketed. Length and weight are two basic components in the biology of species at the individual and population levels. Information on length-weight relationships (LWRs) has been used to predict weight from length during yield assessment, to convert growth in length equations for prediction of weight during different growth periods (Pauly, 1993).

This relationship also provides an index of well being of the fish population (Safran, 1992) and for comparison of fish life history between regions in species and populations (Bayhan et al., 2008). In addition, the data on length and weight can also provide important clues to climatic and environmental changes, and the change in human subsistence practices (Pauly, 1984). Relationships between different types of lengths (length-length relationships) are also important in fisheries management

*Corresponding author. E-mail: dr_naeembzu@yahoo.com.

Abbreviations: LWR, Length-weight; **LLR,** length-length; **TL,** total length; **SL,** standard; **FL,** fork lengths.

Table 1. Length (TL) (cm) - weight (W) (g) relationships in wild *Mystus bleekeri* collected from Nala Daik, Sialkot, Pakistan.

Sex	n	Length (cm)		Relationship parameter		95% CI of *b*	r^2
		Min	Max	*a*	*b*		
M	56	5.5	7.8	0.0134	2.64	2.56-2.72	0.987
F	49	5.5	7.5	0.0136	2.70	2.60-2.79	0.986
C	105	5.5	7.8	0.0147	2.62	2.44-2.80	0.892

n: Sample size; *a*: intercept; *b*: slope; CI: confidence intervals; r^2: coefficient of determination.

for comparative growth studies (Froese and Pauly, 1998; Moutopoulos and Stergiou, 2002).

The aim of the present study was to carry out the first complete and comprehensive description for separate estimates of LWRs and LLRs for males, females and combined sex for *Mystus bleekeri*.

MATERIALS AND METHODS

A total of 105 specimens were collected from Nala Daik, a stream near Sialkot (Pakistan), with various fishing gears (hand net, cast net, etc) during February to March, 2010. Collected fish were immediately transported to the laboratory in plastic containers. Fish were measured for total length (TL), fork length (FL) and standard length (SL) to the nearest 0.1 cm and weighed to the nearest 0.01 g (W, wet weight) by using a measuring board and electronic balance (MP-3000 Chyo, Japan). Specimens with abnormal or broken tails were rejected. Separate estimates for males, females and in combination were obtained. Sexes were separated on the basis of body shape, genital papilla and colouration. In the female, the base of the round genital structure had a round protrusion, the abdominal region was always broader and longer and the colour was also darker in comparison with that of the male. In the male, genital papilla was a soft, elongated structure, broad at the base and gradually tapering towards the end. The tip of the papilla was beyond the base of the first anal fin, the body was elongated, and the colour was light in comparison with that of the female (Musa and Bhuiyan, 2006). Length and weight data were also log-transformed and plotted for visual inspection of outliers. Extreme outliers were omitted from the analyses (Froese, 2006), and regressions was repeated for fish specimens.

Parameters of the length-weight relationships were estimated by the least-squares method applied to the log-transformed data for males, females, and combined as: $\log W = \log a + b \log L$, where W is the total weight (g), L is the total length (cm), a is the intercept, and b is the slope of the linear regression. For length-length relationships (LLRs), the following relationships were established using linear regression analysis: (a) SL versus TL; (b) FL versus TL; (c) SL versus FL.

RESULTS AND DISCUSSION

Estimated and descriptive statistics parameters of the length-weight relationships are summarized in Table 1. The results indicate that wild estimated relationship had *b* values within the usual range (2.5 to 3.5) as defined by Carlander (1969) (Froese, 2006). An over-proportional increase in length relative to growth in weight is reflected in an exponent of $b < 2.5$ or to the contrary, an exponent of $b > 3.5$ indicates an over-proportional increase in weight relative to length increments (Froese, 2006). The results of length-weight relationship displayed negative allometric growth ($b < 3$) for males, females and when both sexes were combined. Regression slope *b* was significantly similar between males and females. For *Mystus bleekeri,* only one estimate of length-weight and length-length relationships was previously available in the global electronic data bank on fishes, “FishBase” with undetermined sex (Froese and Pauly, 2012) by Hossain and Afroze (1991) ho reported value of the scaling exponent *b* 2.666 from Bangladesh. Our results are quite similar to those reported by Hossain and Afroze (1991). To compare our estimates for length-weight relationship of *Mystus bleekeri* with other fishes of the same family, and other miscellaneous species, a plot of log *a* versus *b* (Froese, 2006) in FishBase was also used and results found that the present estimation (Black dot) was close to the existing data figures of LWR of *Mystus bleekeri* on FishBase (Red dot) and of the same family (Green dots) (Figure 1).

The value of slope (*b*) of *M. bleekeri* is also compared to those reported by other investigators for other fish species (Table 2). The variation is due to the reason that length-weight relationship in fish is affected by a number of factors including gonad maturity, sex, diet, stomach fullness, health, and preservation techniques, as well as season and habitat, none of which were taken into consideration in the present study. Even though the change of *b* values depends primarily on the shape and fatness of the species, various factors may be responsible for the differences in parameters of the length-weight relationships among seasons and years, such as temperature, salinity, sex, and time of year and stage of maturity (Pauly, 1984). Population *b* values are also dependent on physiological growth condition such as gonad development or food availability (Jennings et al., 2001), biological and environmental conditions, geographical, temporal and sampling factor (Bagenal and Tesch, 1978; Froese, 2006). Muchlisin et al. (2010) assumed that the *b* values are mostly affected by the availability of food and environmental conditions such as

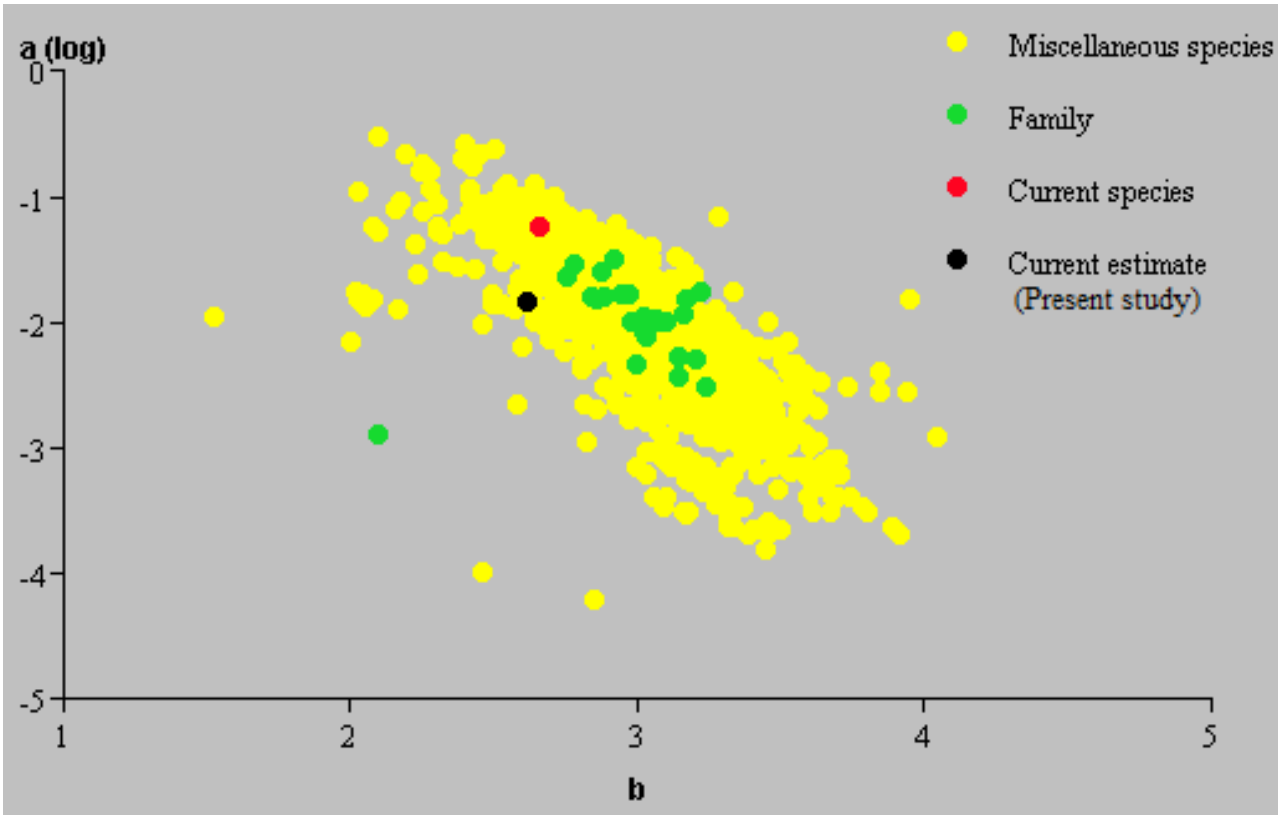

Figure 1. Comparative length-weight relationship plot of log a versus b [as Suggested by Froese (2006)] of *Mystus bleekeri*, with other fishes of the same family, and other miscellaneous species. [Source: FishBase (Froese and Pauly, 2011)]

Table 2. Length-weight relationship for fish species from different localities.

Fish species	Sex	*b*	References
Aristichthys nobilis	-	2.80	Salam et al. (1993)
Gerres oblongus	M	2.95	
Gerres oblongus	F	3.13	Sivashanthini and Abeyrami (2003)
Gerres oblongus	C	3.10	
Salmo trutta	M	2.96	
Salmo trutta	F	2.96	Arslan et al. (2004)
Salmo trutta	C	2.96	
Mystus vittatus	M	2.96	
Mystus vittatus	F	3.13	Hossain et al. (2006)
Mystus vittatus	C	3.05	
Wallago attu	M	3.20	
Wallago attu	F	3.34	Yousaf et al. (2009)
Wallago attu	C	3.27	
Mystus pelusium	C	2.99	Heydarnejad (2009)

Table 2. Continued.

Rita rita	M	3.87	
Rita rita	F	2.34	Laghari et al. (2009)
Rita rita	C	3.56	
Orechromis niloticus	M	2.66	
Orechromis niloticus	F	2.75	Naeem et al. (2010)
Orechromis niloticus	C	2.72	
Poropuntius tawarensis	M	2.68	Muchlisin et al. (2010)
Poropuntius tawarensis	F	2.57	
Tor putitora	M	2.76	
Tor putitora	F	2.86	Naeem et al. (2011)
Tor putitora	C	2.85	

b = Slope; M = Male; F = Female; C = Combined Sex.

Table 3. Morphometric relationships between total length (TL), fork length (FL) and standard length (SL) in cm for *Mystus bleekeri* collected from Nala Daik, Sialkot, Pakistan.

Sex	n	Equation	Relationship parameter		95% CI of *a*	95% CI of *b*	r^2
			a	*b*			
		SL = *a* + *b* TL	-0.015	0.888	-0.088 to 0.058	0.798 to 0.979	0.878
Male	56	FL = *a* + *b* TL	0.044	0.867	-0.032 to 0.120	0.774 to 0.960	0.865
		SL = *a* + *b* FL	-0.034	0.990	-0.082 to 0.013	0.927 to 1.054	0.948
		SL = *a* + *b* TL	0.083	0.772	-0.038 to 0.205	0.621 to 0.922	0.693
Female	49	FL = *a* + *b* TL	0.030	0.890	-0.054 to 0.114	0.786 to 0.994	0.863
		SL = *a* + *b* FL	0.070	0.851	-0.032 to 0.171	0.716 to 0.986	0.773
		SL = *a* + *b* TL	0.032	0.833	-0.036 to 0.100	0.748 to 0.917	0.789
Combined	105	FL = *a* + *b* TL	0.041	0.873	-0.015 to 0.097	0.804 to 0.943	0.857
		SL = *a* + *b* FL	0.014	0.926	-0.039 to 0.067	0.855 to 0.997	0.867

n: Sample size; *a*: intercept; *b*: slope; CI: confidence intervals; r^2: coefficient of determination.

temperature, pH and dissolved oxygen. Conversion among length measurements that is, relationships between TL, FL and SL, along with the estimated parameters of the length-length relationship and the coefficient of determination r^2 are presented in Table 3. All LLRs were highly significant ($P < 0.001$). The present study provides baseline information on LWRs and LLRs for *Mystus bleekeri* that will support researchers in future and fishery managers for reliable growth estimation and health status of small catfishes.

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