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LENGTH-WEIGHT RELATIONSHIP AND GROWTH PATTERN INFERENCE OF A SMALL INDIGENOUS FRESHWATER PRAWN, *Macrobrachium lamarrei* (H. Milne-Edwards, 1837) IN BANGLADESH

Motia Gulshan Ara, Md. Noor Nabi, Zoarder Faruque Ahmed and Mst. Kaniz Fatema*

Department of Fisheries Management, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

*Corresponding author: Mst. Kaniz Fatema, E-mail: kanizhossain@gmail.com

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ABSTRACT

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The length-weight relationships (LWRs) of *Macrobrachium lamarrei* (H. Milne-Edwards, 1837) was studied to construct the generalized relationships of body weight to carapace length measurements for male, female and combined prawn population separately over a calendar year. A total of 1018 specimens were used for this study. The parameter values of the equation $W = a L^b$ describing the relationships between body weight and carapace length for male, female and combined prawns. The parameter of equations, a varied from 0.00096 to 0.00333, 0.00059 to 0.00728 and 0.00081 to 0.00440 for male, female and combined prawn population respectively. On the other hand, the slope of equations, b varied from 2.4363 to 2.8229, 2.0761 to 3.0314 and 2.2915 to 2.8998 for male, female and combined prawn population respectively indicating isometric growth in females but negative allometric for males suggesting that female prawns were comparatively in better condition than males of the same population. The generalized length-weight relationship was fitted with the pooled data of all monthly samples for male, female and combined prawn separately which were $BW = 0.0008 CL^{2.924}$, $BW = 0.0012 CL^{2.783}$ and $BW = 0.0010 CL^{2.845}$ respectively indicating negative allometric growth as b varied from 2.783 to 2.924. The results further revealed that all length-weight relationships (LWRs) were highly correlated ($r^2 > 0.904$).

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INTRODUCTION

The prawns of Palaemonidae family are very important economic resources in the world's crustacean fishery (Mantelatto and Barbosa, 2005; Hossain *et al.*, 2012). Palaemonid prawn has also immense importance in Bangladesh as it considered one of the most important sectors of the national economy. Among different prawn species available in Bangladesh, *M. lamarrei* is notable one, commonly known as "kuncho river prawn" that is a small indigenous freshwater prawn belonging to the family Palaemonidae. This kuncho river prawn has found in ponds and rivers in Bangladesh, India and some other countries (Holthius, 1980). Previously, a few studies were conducted on *M. lamarrei* based on their general biology. However, in Bangladesh there is hardly any work that has been conducted on the growth and length-weight relationships (LWR) in this very valuable Palaemonid prawn species.

Length-weight relationship is very important for establishing production and biomass estimation of a species. (Anderson and Gutreuter, 1983). Sarkar *et al.* (2008) and Mir *et al.* (2012) reported that the estimation of the average weight of the fish of a given length group by establishing a mathematical relation between length-weight. The relationships between length and weight are important in fisheries management for comparative growth studies (Hossain *et al.*, 2006). Besides this in setting yield equations for comparing the population in space and time and estimating the number of fish landed, length-weight relationship can also be used (Singh *et al.*, 2011). Length and weight data are a useful tool for standard result of fish sampling programs. Length-weight relationships are useful for estimating standing crop biomass and seasonal variations in fish growth can also be tracked by L-W relationship (Martin-Smith, 1996). Therefore, for assessing fish stock, length-weight relationship of fish species is important and for length-weight conversion, the parameters 'a' and 'b' can be used (Pauly and Gayanilo, 1996). Furthermore, the empirical relationship between the length and weight of the fish enhances the knowledge of natural history of commercially important fish species, thus making the conservation possible.

Subsequently, the aims of the present paper is to determine the length-weight relationships of monthly samples, to construct a generalized length-weight relationship of *M. lamarrei* for male, female and combined prawn separately over a calendar year and to evaluate the growth pattern of male, female and combined populations from L shaped pond at Bangladesh Agricultural University campus, Mymensingh, Bangladesh. Therefore, the present study provides baseline information for the growth of this species. The data and information will go a long way in supporting the management initiatives for the sustainability of this freshwater prawn as well as other species.

MATERIALS AND METHODS

Sample collection

M. lamarrei prawn species was collected randomly using a fine-meshed push net from the L-shaped pond situated in Bangladesh Agricultural University campus, Mymensingh, Bangladesh once in a month over a calendar year. All specimens were preserved in 10% buffered formalin soon after collection.

Sex determination

Male was identified observing second chelate legs which were extraordinary large, spiny and strong with naked eyes. Individuals confirmed as female with the presence of one pair of genital pore in the cox of third pairs of walking legs under a stereo microscope (Figure 1 and 2).

Recording of carapace length and body weight

Carapace length (CL) was measured from the tip of the rostrum to the posterior edge of the carapace with a slide calipers to the nearest 0.01 mm, whilst body weight (BW) was taken with a digital balance to the nearest 0.01 g. Detailed description of prawn sampling is given in Table 1.

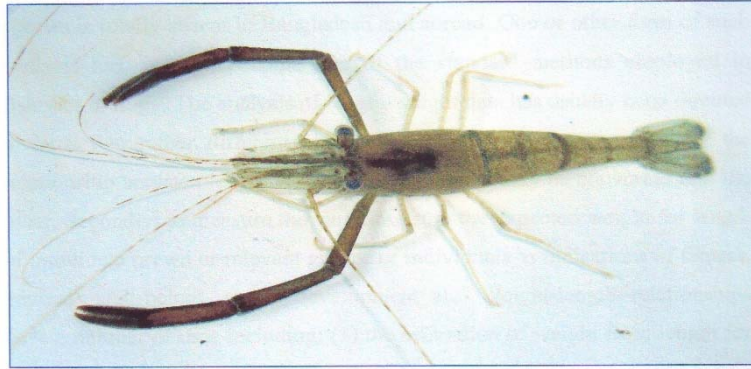


Figure 1. An image of a male freshwater prawn *M. lamarrei* (H. Milne-Edwards, 1837)

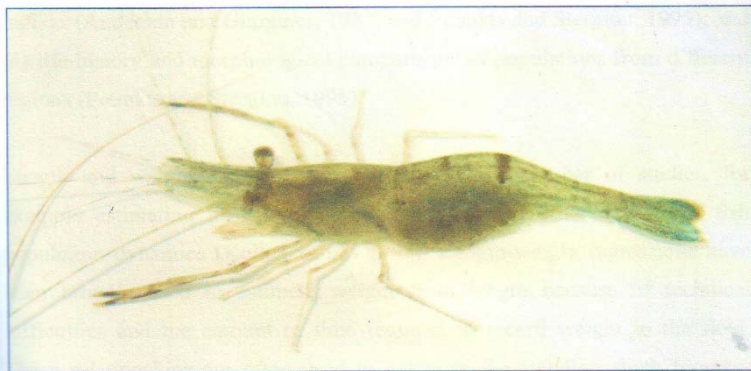


Figure 2. An image of a female freshwater prawn *M. lamarrei* (H. Milne-Edwards, 1837)

Length - weight relationship (LWR)

The relationship between carapace length and weight was calculated using the equation, $W = a CL^b$ where coefficient 'a' is the intercept in the y-axis, and the regression coefficient 'b' is an exponent indicating isometric growth when equal to 3. This equation was converted into its logarithmic expression: $\ln W = \ln a + b \ln CL$ where the parameters 'a' and 'b' were calculated by linear regression, as was the coefficient of determination (r^2). To test for possible significant differences in both slope and intercept, we followed the analysis of covariance (ANCOVA). All statistical analyses were considered significant at $P < 0.05$.

Growth pattern inference

Growth pattern of individuals in monthly sample were determined on the basis of b value in the equation $BW = a CL^b$. When 'b' is equal to 3, the growth was isometric resulting an ideal shape of prawn; when the value of b was less than 3.0, the growth was negative allometric and when the value of b was more than 3.0, the growth was positive allometric pattern. The growth pattern of the individuals in the population was evaluated judging the confidence interval of 'b' value at 95% confidence level.

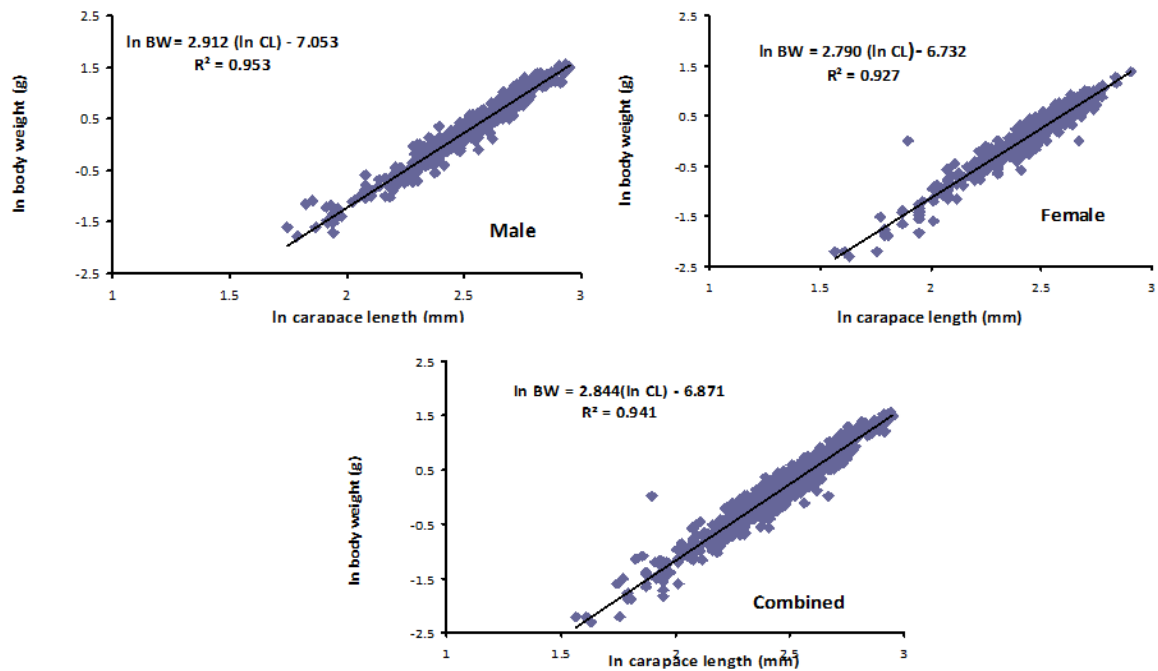


Figure 3. The generalized relationships between the natural logarithm of body weight (g) and the natural logarithm of carapace length (mm) in male, female and combined prawn of *Macrobrachium lamarrei*.

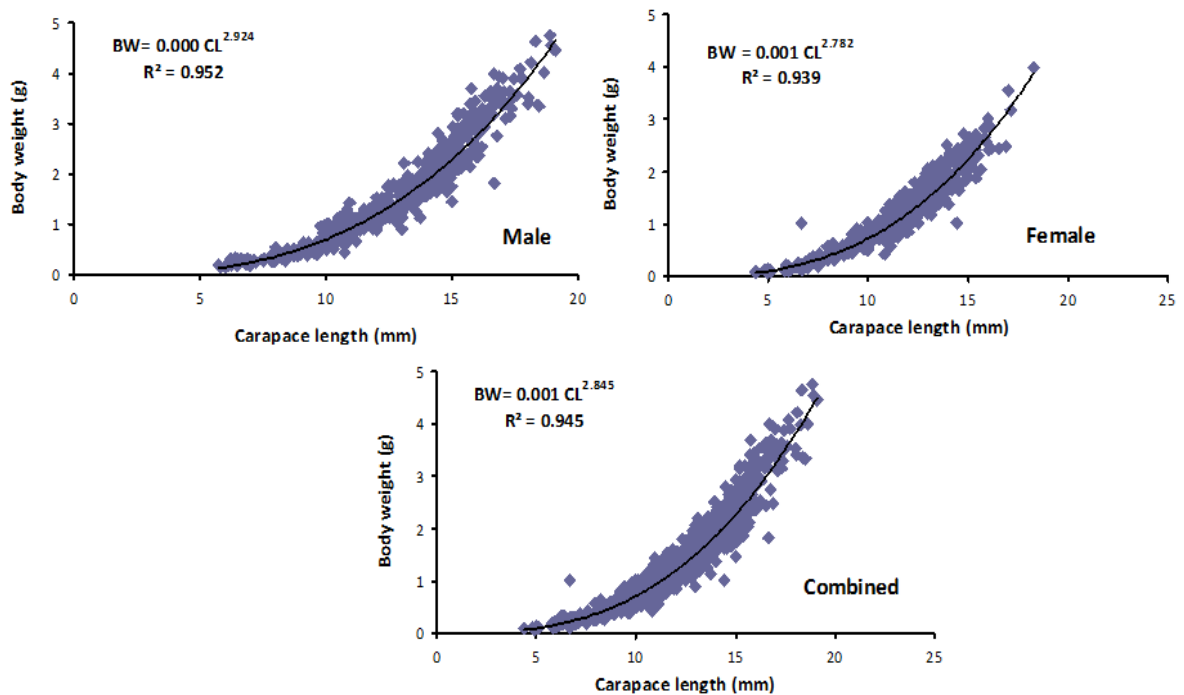


Figure 4. The generalized relationships between the body weight (g) and the carapace length (mm) in male, female and combined prawn of *Macrobrachium lamarrei*.

RESULTS AND DISCUSSIONS

The carapace length and body weight of all monthly samples collected all over the year varied and ranged from 4.80 mm to 19.10 mm and from 0.10 g to 4.76 g respectively. A total of 1018 specimens of *M. lamarrei* were used to determine the length- weight relationship where 485 were male and 533 were female prawns showing a sex ratio 1: 1.09 (male: female). The carapace length and body weight of male ranged from 5.75 mm to 19.10 mm and from 0.17 g to 4.76 g respectively. And the carapace length and body weight of female ranged from 4.80 mm to 18.29 mm and the body weight ranged from 0.10 g to 3.98 g (Table 1).

Table 1. Collection record of freshwater prawn *M. lamarrei* from the L shaped pond at Bangladesh Agricultural University (BAU), Mymensingh

Sampling Date	Number of Male	Size Range		Number of Female	Size Range	
		CL(mm)	BW(g)		CL(mm)	BW(g)
January	39	5.75-16.00	0.18-2.36	48	4.80-15.60	0.11-2.36
February	26	10.00-18.00	0.76-3.60	41	6.68-15.14	0.45-2.50
March	37	6.22-18.48	0.32-4.08	24	11.05-18.29	1.10-3.98
April	42	9.80-19.10	0.81-4.76	32	9.70-15.15	0.86-2.51
May	43	10.93-17.31	1.07-3.65	34	5.89-16.05	0.22-2.52
June	26	6.78-18.92	0.30-4.64	39	7.63-15.45	0.41-2.73
July	35	8.24-15.66	0.41-2.82	53	9.22-15.35	0.46-2.65
August	43	7.12-15.35	0.25-2.11	71	7.00-15.50	0.21-2.44
September	44	6.00-15.30	0.17-2.11	53	8.30-15.80	0.31-2.83
October	55	6.00-13.10	0.17-1.38	51	5.00-13.80	0.10-1.93
November	41	6.40-18.00	0.34-3.53	34	7.60-17.10	0.42-3.17
December	54	7.00-15.00	0.26-2.20	53	8.00-17.00	0.46-3.56

By establishing the relationship of body weight to carapace length different 'a' and 'b' values were found in this study for male, female and combined prawn separately. In case of male, monthly variation was found in coefficients of equations 'a' and it was from 0.00096 to 0.00333. The maximum and minimum values of 'a' were on March and September. The slope of equations 'b' of male also varied monthly and it was from 2.4363 to 2.8229. The maximum and minimum values of 'b' were on September and March. In case of female, monthly variation was found in coefficients of equations 'a' and it was from 0.00059 to 0.00728. The maximum and minimum values of 'a' were on January and June. The slope of equations 'b' of female also varied monthly and it was from 2.0761 to 3.0314. The maximum and minimum values of 'b' were on June and January. This result revealed that the growth in females were isometric but negative allometric in males suggesting that female prawns were comparatively in better condition than males of the same population.

Table 2. Monthly descriptive statistics and estimated parameters of length–weight relationships of *M. lamarrei* prawn species from a large perennial pond at Bangladesh Agricultural University, Mymensingh

Month	Sex	n	a	b	S _e (b)	95% CI of a	95% CI of b	r ²	Growth Inference
January	Male	39	0.00151	2.67713	0.09078	0.0011-0.0023	2.4932-2.8611	0.95919	Allometric
	Female	48	0.00104	2.80382	0.07238	0.0008-0.0015	2.6581-2.9495	0.97026	Allometric
	Combined	87	0.00110	2.78924	0.05485	0.0009-0.0014	2.6802-2.8983	0.96818	Allometric
February	Male	26	0.00156	2.69836	0.13116	0.0008-0.0031	2.4277-2.9690	0.94634	Allometric
	Female	41	0.00728	2.07607	0.15752	0.0034-0.0156	1.7575-2.3947	0.81664	Allometric
	Combined	67	0.00440	2.29152	0.10361	0.0026-0.0073	2.0846-2.4984	0.88271	Allometric
March	Male	37	0.00327	2.43627	0.10228	0.0019-0.0057	2.2286-2.6439	0.94189	Allometric
	Female	24	0.00267	2.53837	0.18698	0.0011-0.0072	2.1506-2.9261	0.89336	Allometric
	Combined	61	0.00363	2.40504	0.08430	0.0023-0.0056	2.2364-2.5737	0.93242	Allometric
April	Male	42	0.00185	2.66422	0.10148	0.0011-0.0032	2.4591-2.8693	0.94515	Allometric
	Female	32	0.00342	2.43162	0.18002	0.0013-0.0088	2.0641-2.7993	0.85879	Allometric
	Combined	64	0.00216	2.60819	0.07813	0.0014-0.0033	2.4524-2.7639	0.93931	Allometric
May	Male	43	0.00129	2.79799	0.10942	0.0007-0.0023	2.5770-3.0191	0.94100	Allometric
	Female	34	0.00149	2.72730	0.09532	0.0009-0.0024	2.5331-2.9215	0.96238	Allometric
	Combined	77	0.00129	2.79262	0.05634	0.0011-0.0017	2.6804-2.9048	0.97038	Allometric
June	Male	26	0.00184	2.67344	0.14587	0.0008-0.0041	2.3724-2.9745	0.93331	Allometric
	Female	39	0.00134	2.78644	0.15746	0.0006-0.0029	2.4674-3.1055	0.89434	Allometric
	Combined	65	0.00142	2.76582	0.09022	0.0009-0.0023	2.5855-2.9461	0.93717	Allometric
July	Male	35	0.00105	2.80381	0.11113	0.0006-0.0018	2.5777-3.0299	0.95071	Allometric
	Female	53	0.00059	3.03145	0.15581	0.0003-0.0013	2.7187-3.3442	0.88127	Isometric
	Combined	88	0.00088	2.87554	0.08944	0.0006-0.0014	2.6977-3.0533	0.92319	Allometric

Table 2. Contd.

Month	Sex	n	a	b	S _e (b)	95% CI of a	95% CI of b	r ²	Growth Inference
August	Male	43	0.00114	2.73272	0.09232	0.0007-0.0018	2.5463-2.9192	0.95531	Allometric
	Female	71	0.00077	2.93153	0.09812	0.0005-0.0012	2.7358-3.1273	0.92825	Allometric
	Combined	114	0.00081	2.89983	0.07301	0.0006-0.0011	2.7552-3.0445	0.93372	Allometric
September	Male	44	0.00096	2.82288	0.09215	0.0006-0.0015	2.6369-3.0088	0.95716	Allometric
	Female	53	0.00067	2.98841	0.09676	0.0004-0.0011	2.7942-3.1827	0.94925	Isometric
	Combined	97	0.00082	2.89806	0.06739	0.0006-0.0011	2.7643-3.0318	0.95115	Allometric
October	Male	55	0.00159	2.62406	0.06238	0.0012-0.0021	2.4989-2.7492	0.97092	Allometric
	Female	51	0.00128	2.73920	0.07639	0.0009-0.0018	2.5857-2.8927	0.96329	Allometric
	Combined	106	0.00145	2.67235	0.04945	0.0012-0.0018	2.5743-2.7704	0.96562	Allometric
November	Male	41	0.00221	2.53743	0.06925	0.0016-0.0031	2.3974-2.6775	0.97177	Allometric
	Female	34	0.00227	2.53001	0.11811	0.0013-0.0040	2.2894-2.7706	0.93481	Allometric
	Combined	75	0.00225	2.53063	0.06102	0.0017-0.0030	2.4090-2.6522	0.95929	Allometric
December	Male	54	0.00122	2.79011	0.10109	0.0007-0.0020	2.5872-2.9931	0.93611	Allometric
	Female	53	0.00174	2.65731	0.04818	0.0014-0.0022	2.5606-2.7540	0.98351	Allometric
	Combined	107	0.00152	2.70523	0.05102	0.0012-0.0021	2.6041-2.8064	0.96399	Allometric

n: number of specimens, a: coefficient parameter of length-weight relationship, b: slope of length-weight relationship, S_e(b): standard error of b, CI: confidence interval, r²: coefficient of determination

In case of combined prawn, monthly variation was found in coefficients of equations 'a' and it was from 0.00081 to 0.00440. The maximum and minimum values of 'a' were on February and August. The slope of equations 'b' of combined prawn also varied monthly and it was from 2.2915 to 2.8998. The maximum and minimum values of 'b' were on August and February. This result agrees with the finding of Soomro et al. (2012) for *Macrobrachium malcolmsonii*. They found the values of b were 2.97 for males and 3.04 for females indicating the growth was isometric for female and allometric for male.

Table 2 illustrated that the length-weight relationships of male *M. lamarrei* prawn species indicated negative allometric growth in all months over a calendar year. Similarly in female prawns, the length-weight relationships indicated negative allometric growth in all months except July and September where the growth was isometric. But in combined population the length-weight relationships indicated negative allometric growth for all the months over a calendar year. Finally, this study constructed the generalized length-weight relationship of all monthly samples for male, female and combined prawn that were $BW = 0.0008 CL^{2.924}$, $BW = 0.0012 CL^{2.783}$ and $BW = 0.0010CL^{2.845}$ respectively. Lalrinsanga et al. (2012) reported similar results for *M. Rosenbergii* prawn and the length weight relationship were $W = 0.073299 L^{3.5502}$, $W = 0.102962 L^{3.2443}$ and $W = 0.087694 L^{3.3893}$ for male, female and total prawn respectively. In the present study, analysis of covariance revealed significant differences between sexes for the slopes 'b' of the regression lines ($P < 0.05$), with all coefficient of determination values being >0.904 .

CONCLUSION

Length-weight relationship (LWR) is an important fishery management tool (Bagenal and Tesch, 1978; Gonzalez Acosta et al., 2004). They are used for various aspects including estimation of weight from length observations, calculation of production and biomass in the assessment of fish populations, in addition providing information about body condition of specimens in stocks or populations (Lai and Helser, 2004; Gerritsen and McGrath, 2007). Information regarding any biological aspects of *M. lamarrei* prawn species from Bangladesh waters is quite insufficient. To the best of our knowledge, no references dealing with length-weight relationship (LWR) for *M. lamarrei* is available from Bangladesh waters. Therefore, this study presents the first attempt to describe this length-weight relationship for the *M. lamarrei* species from Bangladesh. In conclusion, this study has provided the first basic and baseline information on the LWR that would be beneficial for fishery biologists and conservationists to impose adequate regulations for sustainable fishery management and conservation of biodiversity for this species in Bangladesh. Further, the information provides a platform for future research into other growth and reproductive attributes of this fish species.

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