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Length-weight relationships of 12 indigenous fishes and 3 shellfishes from mangrove and floodplain ecosystems in Southwestern Bangladesh

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ABSTRACT

The length-weight relationships (LWRs) were studied for 616 individuals covering 10 families of 12 fish species (i.e., *Planiliza subviridis, Opsarius barna, Nandus nandus, Clarias batrachus, Odontamblyopus rubicundus, Taenioides cirratus, Anabas testudineus, Mystus gulio, Mystus tengara, Oreochromis mossambicus, Puntius sophore and Hyporhamphus limbatus)* and 3 shellfish species (i.e., *Penaeus monodon, Fenneropenaeus indicus, Metapenaeus brevicornis*). Total length (cm) and body weight (g) were measured for each individual. The allometric co-efficient, *b* values of studied species ranged between 2.03 (*M. gulio*) to 3.27 (*O. mossambicus*) and were highly significant ($P < 0.001$) for all species. Our results contribute to updating the online database (FishBase or SeaLifeBase) of respective fish and shellfish species.

INTRODUCTION

Length-weight relationships (LWRs) have potential effects on fisheries resource management and population dynamics **(Erzini, 1994)**. They are essential for studying the life history pattern of fishes among different geographic territories, which can be very much useful in the preservation and maintenance of fisheries resources **(Ahmed *et al*., 2012; Hossain *et al*., 2013)**. Moreover, fisheries management and research frequently utilize LWRs for converting field data into understandable forms **(Ecoutin & Albaret, 2003).** LWRs are considered to be useful tools for the study of population biomass assessment while direct weight measurement is quite cumbersome in the natural population **(Santos *et al*., 2002; Baek *et al*., 2015)**. Besides, biomass indicates an indirect size of the production **(Geisler *et al*., 1979)**. While several regression data are available for freshwater fishes in Bangladesh, a few studies show regression data regarding fish and shell-fish species available in mangrove and coastal floodplain areas **(Hossain *et al*., 2012; Kaushik & Bordoloi, 2015; Hanif *et al*., 2018)**.

The Sundarban mangrove forest is situated in the Gangetic Delta (Ganges–Brahmaputra–Meghna) of Bangladesh and India **(Chaudhury & Naithani, 1985)**. The mangrove forest is one of the significant features of the coastline of Bangladesh, which is recognized as the world largest mangrove forest. Artisanal fisheries are mainly predominant in the mangrove and adjacent tributaries which comprises various kinds of traditional fishing gears and crafts. These fisheries activities are most often occurred in coastal areas to catch fish and shrimps. Many fish and shrimp are highly dependent on mangroves for completing their life cycle, and thus mangroves serve as a higher fisheries biodiversity **(Kabir *et al*., 2019)**. Mangrove also acts as a nursery ground for a variety of fishes and shell-fishes, including *P. monodon, M. brevicornis, O. barna, T. cirratus* **(Islam & Haque, 2005)**. Besides, a floodplain refers to an land area close to river gaining full of water during flooding time, also a significant source of freshwater fish **(Craig *et al*., 2004; Goudie, 2004)**. However, in the area mentioned above, the LWRs data for numerous species has not been recorded in FishBase or SeaLifeBase **(Froese & Pauly, 2020; Palomares & Pauly, 2020)** because of lack of understanding the commercial value and economic significance in extensive fisheries. Thus our goal was to provide information on LWRs for 12 fish (*P. subviridis, O. barna, N. nandus, C. batrachus, O. rubicundus, T. cirratus, A. testudineus, M. gulio, M. tengara, O. mossambicus, P. sophore,* and *H. limbatus*) and 3 shellfish species (*P. monodon, F. indicus,* and *M. brevicornis*) covering 10 families (Mugiliade, Cyprinidae, Nandidae, Clariidae, Gobiidae, Anabantidae, Bagridae, Cichlidae, Hemiramphidae, and Penaeidae), which would be helpful to update the online database (FishBase or SeaLifeBase).

MATERIALS AND METHODS

The present study area is located in greater Khulna ndistrict (included Khulna, Satkhira and Bagerhat District), a mangrove and coastal floodplain areas, southwestern (SW) Bangladesh. It appears to be significant feeding and breeding ground of many fish species including freshwater and brackish water. We collected fish and shell-fish samples fortnightly from Bhairab river ($22^0$71'43''N; $89^0$76'30''E) in Bagerhat, Shibsa river ($22^0$58'99''N; $89^0$32'57''E) in Paikgacha, Khulna and Kholpetua river ($22^0$25'75''N; $89^0$24'81''E) in Shyamnagar, Satkhira, with the help of local fishermen between July 2017 and June 2018. Several gears were used to catch fishes such as gill net (1.0-3.0 mesh size), cast net (1.0-2.0 mesh size), square lift net (~1.0 cm mesh size) and a range of traps (conical and box type).

Total length (TL) in cm and total body weight (BW) in g for each individual were measured using digital slide calipers and an electronic balance, respectively. For shell-fishes, total length estimation was observed between the tip of the rostrum and the end of the telson. We calculated LWR using the equation: $\mathbf{BW} = \boldsymbol{a} \times \mathbf{TL}^{\boldsymbol{b}}$, where BW is the total body weight (g), and TL is the length (cm). The estimation of parameters *a* and *b* was done by linear regression analyses, which follows equation such as $\mathbf{ln}\ (\boldsymbol{W}) = \mathbf{ln}(\boldsymbol{a}) + \boldsymbol{b}\ \mathbf{ln}(\boldsymbol{L})$. Additionally, 95% confidence interval was calculated for parameters *a* and *b*. We also calculated the coefficient of determination (r^2). Regression analyses were performed to eliminate outliers **(Froese, 2006)**.

GraphPad Prism 6.5 software was used to perform statistical analyses (GraphPad Software, Inc., San Diego, CA). The statistical difference from the isometric value ($b = 3$) for LWRs were determined by t-test. All statistical analyses were considered at 5% significance level ($P < 0.05$).

RESULTS

Results of the LWRs analyses for 616 individuals of 12 fish (*P. subviridis, O. barna, N. nandus, C. batrachus, O. rubicundus, T. cirratus, A. testudineus, M. gulio, M. tengara, O. mossambicus, P. sophore,* and *H. limbatus*) and 3 shellfish species (*P. monodon, F. indicus,* and *M. brevicornis*) from 10 families (Mugiliade, Cyprinidae, Nandidae, Clariidae, Gobiidae, Anabantidae, Bagridae, Cichlidae, Hemiramphidae, and Penaeidae) were shown in **Table 1**. Lowest and highest TL for fish were observed as 5.8 cm for *P. sophore* (~4 g BW) and 30.5 cm for *O. barna* (~86 g BW), respectively. Besides, lowest and highest TL for shellfish were found as 4.6 cm for *M. brevicornis* (~1.8 g BW) and 18 cm for *P. monodon* (~45 g BW), respectively. The obtained *b* values for fishes were estimated as 2.09 for *P. subviridis*, 2.41 for *O. barna*, 2.66 for *N. nandus*, 2.39 for *C. batrachus*, 2.67 for *O. rubicundus*, 2.45 for *T. cirratus*, 2.55 for *A. testudineus*, 2.03 for *M. gulio*, 2.27 for *M. tengara*, 3.27 for *O. mossambicus*, 2.83 for *P. sophore*, and 2.84 for *H. limbatus*. Besides, the *b* values for shell-fish species were estimated as 2.33 for *P. monodon*, 2.15 for *F. indicus*, and 2.77 for *M. brevicornis*. All LWRs were highly significant ($P < 0.001$), with all r^2 values was ≥ 0.950 **(Table 1)**.

Table 1. Descriptive statistics and estimated length-weight relationships (BW = a*TL^b, BW in g and TL in cm) parameters for 12 fish and 3 shell-fish species captured from mangrove and floodplain ecosystems of Southwestern Bangladesh

Species	Family	n	TL (cm)		BW (g)		Regression parameter		95% CL of *a*	95% CL of *b*	r^2
			Min	Max	Min	Max	*a*	*b*			
Planiliza subviridis (Valenciennes, 1836)	Mugilidae	52	9.9	20.3	33	99	0.21	2.09	0.1471-0.3046	1.96-2.22	0.952
Osparius barna (Hamilton, 1822)	Cyprinidae	50	11.7	30.5	12	86	0.03	2.41	0.0168-0.0440	2.25-2.56	0.950
Nandus nandus (Hamilton, 1822)	Nandidae	30	10.9	17.0	29	88	0.05	2.66	0.0299-0.1007	2.43-2.90	0.950
Clarias batrachus (Linnaeus, 1758)	Clariidae	40	14.7	28.5	44	208	0.08	2.39	0.0483-0.1405	2.21-2.57	0.950
Odontamblyopus rubicundus (Hamilton, 1822)	Gobiidae	40	9.9	19.1	13	66	0.02	2.67	0.0168-0.0332	2.54-2.79	0.981
Taenioides cirratus (Blyth, 1860)	Gobiidae	30	12.5	25.4	14	66	0.02	2.45	0.0154-0.0380	2.30-2.61	0.974
Anabas testudineus (Bloch, 1792)	Anabantidae	40	9.1	15.2	16	63	0.06	2.55	0.0443-0.0852	2.42-2.68	0.977
Mystus gulio (Hamilton, 1822)	Bagridae	50	9.7	20.3	23	98	0.24	2.03	0.1976-0.2973	1.96-2.11	0.984
Mystus tengara (Hamilton, 1822)	Bagridae	50	9.1	15.5	17	56	0.11	2.27	0.0734-0.1527	2.12-2.42	0.952
Oreochromis mossambicus (Peters, 1852)	Cichlidae	34	9.7	16.0	14	73	0.01	3.27	0.0052-0.0195	3.01-3.54	0.952
Puntius sophore (Hamilton, 1822)	Cyprinidae	40	5.8	9.2	4	15	0.03	2.83	0.0205-0.0365	2.69-2.97	0.977
Hyporhamphus limbatus (Valenciennes, 1847)	Hemiramphidae	50	7.4	16.0	3	37	0.02	2.84	0.0100-0.0249	2.65-3.03	0.950
Penaeus monodon (Fabricius, 1798)	Penaeidae	30	9.9	18.0	9	45	0.05	2.33	0.0277-0.0779	2.14-2.53	0.954
Fenneropenaeus indicus (Milne-Edwards, 1837)	Penaeidae	35	5.3	8.9	2.8	7.6	0.08	2.15	0.0546-0.1066	1.98-2.32	0.951
Metapenaeus brevicornis (Milne-Edwards, 1837)	Penaeidae	45	4.6	7.9	1.8	7	0.02	2.77	0.0153-0.0310	2.58-2.97	0.952

n, sample size; TL, total length; BW, body weight; Min, minimum; Max, maximum; *a* and *b* are regression parameter; CL95%, 95% confidence limits; r^2, coefficient of determination

DISCUSSION

The present results add to the evidence for LWRs of fish and shellfish species, which may act as complementary to the few LWRs datasets available in the online database of FishBase or SeaLifeBase **(Froese & Pauly, 2020; Palomares & Pauly, 2020)**. Allometric co-efficient (*b*) value had been from 2.03 to 3.27 for our studied species, which was also found within the acceptable limit described by **(Froese, 2006)**. Previous studies showed that *b* values of LWRs were 3.156 for *P. subviridis* **(Hussain *et al*., 2010)**, 2.89 for *B. barna* **(Freitas *et al*., 2017)**, 3.27 for *N. nandus* **(Hossain *et al*., 2017)**, 2.70 for *C. batrachus* **(Garcia, 2010)**, 2.90 for *O. rubicundus* **(Xu *et al*., 2016)**, 2.59 for *T. cirratus* **(Chu *et al*., 2011)**, 2.90 for *A. testudineus* **(Hossain *et al*., 2015)**, 3.18 for *M. gulio* **(Panda *et al*., 2016)**, 3.05 for *M. tengara* **(Hossain *et al*., 2016)**, 3.302 *P. sophore* **(Kaushik & Bordoloi, 2015)**, 2.945 for *H. limbatus* **(Karna *et al*., 2017)**, and that those values were higher compared to our present results (**Table 1**). However, previously found *b* value of LWR for *O. mossambicus* was 3.172 **(Blühdorn & Arthington, 1990)**, which was lower compared to our present finding (Table 1). Besides previous studies found that *b* values of LWRs were 3.250 for *P. monodon* **(Devi, 1987)**, 3.693 for *F. indicus* **(Ivanov & Krylov, 1980)**, 2.845 for *M. brevicornis* **(Mane *et al*., 2019)** and that those values were higher than our present results **(Table 1)**.

The allometric co-efficient (*b*) value of the LWRs can be useful for a range of studies including fish physiology, gonadal improvement, nourishing rate, ecological niche, seasonal impact, sex, diet, wellbeing and protection strategies **(Ricker, 1975; Froese, 2006; Hossain *et al*., 2006)**. As such, the accurate determination of *b* value is crucial for fisheries management. It is known that the precise calculation of *b* might vary because of sampling bias, for example, small sample sizes or unrepresentative samples concerning a size class. In our study, while we likely maintained a standard sample size, sometimes little sized individuals were not always caught due to fishing gear selectivity (personal observation). Thus, the information of LWRs exhibited here could be restricted to the length ranges given in **Table 1**.

In conclusion, our present data regarding LWRs for 12 fish and 3 shellfish species from the mangrove and floodplain ecosystems, SW Bangladesh could serve as a baseline for future studies. The present data would also contribute to the conservation and management of these species in the mangrove and floodplain areas, SW Bangladesh and surrounding regions.

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