Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 25 (5): 787 – 798 (2021)
www.ejabf.journals.ekb.eg

Length-weight relationships and condition factors of five marine fish species collected from the Meghna River estuary of Bangladesh

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ARTICLE INFO

Article History:
Received: July 4, 2021
Accepted: Aug. 17, 2021
Online: Nov. 11, 2021

Keywords:
Morphometric study,
Condition factor,
Relative condition factor,
Growth pattern,
Marine fish species

ABSTRACT

Length-weight relationships (LWRs), condition factor (K), and relative condition factor (Kn) were estimated for 505 individuals. The species were: *Awaous guamensis*, *Taenioides cirratus*, *Mysus gulio*, *Polynemus paradiseus*, and *Lates calcarifer* from the Meghna River Estuary of southern Bangladesh collected between July 2018 and June 2019 by using traditional fishing gear (e.g. Dragnet, Purse net, Fixed Purse Net and Gill net). Total length (TL) was measured to 0.1 cm, and whole-body weight (BW) was taken to the nearest 0.1 g for each individual. The results of the length-weight relationship showed that the allometric coefficient, b values ranged from b= 1.48 (*Lates calcarifer*) to b= 3.28 (*Awaous guamensis*). The results revealed that *Awaous guamensis* showed positive allometry, whereas the other studied species showed negative allometric growth. In this study, the mean values of the relative condition factor (Kn) were recorded as close to 1.0, thus the condition of the Meghna River Estuary was good for the growth of those five marine species. Hence, the present study proved to assist the management of those five endangered species in the Meghna River Estuary ecosystem.

INTRODUCTION

Fish provides a major source of high-quality protein to more than one billion people in the world. The promotion of fisheries is to the monitoring of ecosystem and stock assessments. The ecological adaptation is different in various species **(Ahmad *et al.*, 2020; Khalid *et al.*, 2020; Hassan *et al.*, 2021a, b)**. Fish also play a vital role in aquatic ecosystem occupying the second trophic level in food chain **(Attaullah *et al.*, 2021)**. Estuaries that are connected to the freshwater originated from rivers and those connected to saltwater coming from the ocean are dynamic environments with massive fluctuations in environmental conditions (**James *et al.*, 2007; Hassan *et al.*, 2020a; Abro *et al.*, 2020**). The estuary is

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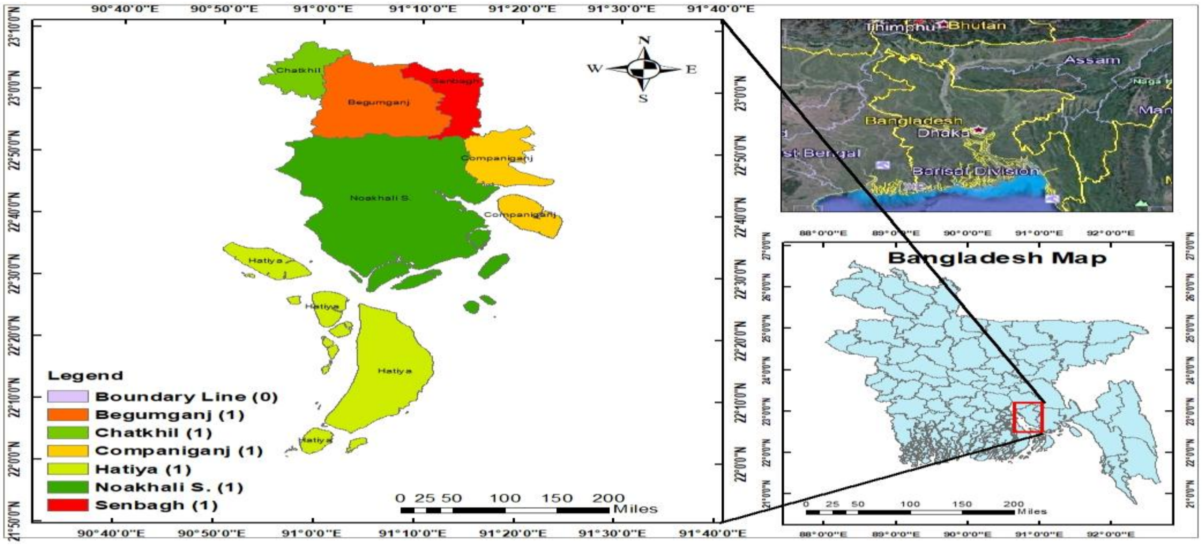
created within Bangladesh by the connection of the Surma and Kushiyara Rivers originating from the hilly area of eastern India. Down to Chandpur, this space is hydrographical because of the higher Meghna when the Padma joins, since the lower Meghna decreases to the Bay of the geographic region. Main tributaries within the Meghna River estuary region involved the Feni River Estuary, the Gumti River and the Dhaleshwari River. The Meghna discharges into the Bay of Bengal via four principal mouths; namely, Tetulia, Shahbazpur, Hatiya, and Bamni. In the estuary, freshwater originated from the rivers meets with saline ocean water from the Bay of Bengal. Due to strong currents and shallow depths, density stratification is not very characteristic. Alternately, there are fronts (or transition zones) between the water masses. The situation of these transition zones depends on the river discharge and also the tide. The fisheries' population within the estuary witnesses a lot of dynamic in each temporal and 3-D spectrum.

The length-weight relationship (LWR) has vital implications for fisheries and marine science and their stock assessments **(Erzini, 1994; Sabbir *et al.*, 2020; Islam *et al.*, 2020)**. The LWR approach has been used as one of the stock assessment models **(Morato *et al*., 2001; Borges *et al.*, 2003; Mendes *et al.*, 2004)** and is usually used in the ecosystem modelling approach **(Siddique *et al.*, 2016; Pauly *et al*., 2000; Christensen & Walters, 2004)**. Moreover, the LWR approach is selected to estimate the production over biomass quantitative relation (P/B) of various functional groups. taking into account that for a lot of precise weight calculations, it is well to use native values **(Safran, 1992; Moutopoulos & Stergiou, 2002; Morey *et al*., 2003)**. Besides, LWR allows life history and morphological assessments between totally different fish species and between fish populations from totally different habitats and areas **(Gonc alves *et al*., 1997; Petrakis & Stergiou, 1995; Hasan *et al*., 2020; Khatun *et al.*, 2021)**. In addition, it provides baseline information for conservation and management strategies **(Habib *et al.*, 2021)**. Furthermore, it is commonly used to track differences in fish growth with respect to seasons **(Safran, 1992; Richter *et al*., 2000)**. Remarkably, the LWR may also be used for the estimation of discarded quantities of every species due to the length–frequency distribution of the species **(Lamprakis *et al*., 2003)**. Length–weight relationships (LWRs) are needed to assess weight from length as a result of direct weight measurements that often take long time within the field **(Martin-Smith, 1996; Koutrakis & Tsikliras, 2003; Sinovcic *et al*., 2004)**. These parameters are vital in fish biology and might give proof with regard to the stock condition **(Bagenal & Tesch, 1978; Gonzalez Acosta *et al*., 2004)**. Length–length relationships (LLRs) are vital for comparative growth studies **(Moutopoulos & Stergiou, 2002)**. LWR and LLR are still scarcely used for many tropical and sub-tropical fish species **(Martin-Smith, 1996**; **Harrison, 2001; Ecoutin *et al*., 2005)**. The authors of the current research found no previous information on LWRs for these species. Subsequently, the main aim of this study was to estimate the length-weight relationships (LWRs) for those five species in the Meghna River Estuary southwestern Bangladesh.

MATERIALS AND METHODS

Study area and sample collection

A total of 505 fish samples were collected from three fish landing sites in the Meghna River Estuary during the study period (from 2018- 2019) (Fig. 1). The main goal of these surveys was to assess the distribution and relative abundance of the main demersal species in the Meghna River Estuary. The fishes were captured using different types of traditional fishing gears, such as Drag net (min mesh size 2 cm; max mesh size 5 cm), Push net (min mesh size 0.2 cm; max mesh size 1 cm), and Gill net (min mesh size 2.5 cm; max mesh size 5 cm). For each individual, total length (TL) and total body weight (BW) were measured using digital slide calipers and an electronic balance with 0.1 cm and 0.1 g accuracy, accordingly.



Map. 1. A map of Meghna River Estuary showing study areas

Length–weight relationships equation

The total weight (TW) for all specimens was recorded in grams. Length–weight relationships were calculated using the following equation:

W = a × Lb **(Hassan *et al*., 2020b)**

The LWR was calculated using W = a × Lb, where W is the total body weight (g), and L is the total length (cm). The parameters a and b were estimated by linear regression analyses based on natural logarithms: ln (W) = ln(a) + b ln (L).

Additionally, 95% confidence intervals of a and b and the coefficient of determination (R2) were estimated. Extremes outliers were deleted from the regression analyses in line with **Froese (2006)**. A t-test was accustomed to confirm whether b values obtained within the linear regressions were significantly different from the isometric value (b =3) **(Shuaib & Ayub, 2011)**. While, the values of Condition Factor (K) and Relative Condition Factor (Kn) were also calculated using the equations followed by **Khawar *et al* (2015)** as follows: K=W*100/L3, where “W” is the total body weight (g), and “L” is the total length (cm), whereas the relative condition factor was determined as follows:

Kn=Wt/We, where “Wt” is the observed body weight (g) and “We” is the estimated length (g).

Statistical analysis: The R used was of (Version 3.5.0) Programming language and excel 2013 for data analysis. A t-test was applied to determine significant differences from the isometric value of b = 3 for LWR. All statistical analyses were considered significant at 5% ($P < 0.05$).

RESULTS

During this study, 505 specimens belonging to five fish species were collected from the Meghna River. The length-weight relationship was calculated by the following equation of W= 0.003x $L^{3.278}$ for *Awaous guamensis*, W= 1.061x $L^{1.473}$ for *Lates calcarifer*, W= 0.083x $L^{2.070}$ for *Mystus gulio*, W= 0.990x $L^{1.496}$ for *Polynemus paradiseus* and W= 0.005x $L^{2.815}$ *Taenioides cirratus*. Results of the descriptive statistics are shown in Table (1). Minimum and maximum TL were observed at 7.4 cm for Mystus (20 g BW) and 21.4 cm for Tulardandi (120g BW), respectively. The growth pattern analysis revealed that *Awaous guamensis* showed positive allometric growth, where b= 3.28 b>3.0, while the other studied species showed negative allometric growth pattern with b<3.0 as shown in Table (1). The values of R^2 indicated that length and weight have a strong linear relationship.

Table 1. Minimum and maximum length (cm) of five marine fish species collected from the Meghna River Estuary of South-Eastern Bangladesh

Table 2. Regression coefficients for length-weight relationship of 5 marine fish species collected from Meghna River Estuary of South-Eastern Bangladesh. 95% C.I. (Confidence Interval) for a (intercept), b (slope), r and r^2 values are given, N= number of fishes

Species	No	Length Characteristics (L in cm)			Weight Characteristics (W in g)			Regression coefficients						Correlation Type
	N	Min.	Max.	Mean± S.D	Min.	Max.	Mean ± S.D	a	b	R^2	$S.E_b$	95% CI of a	95% CI of b	(CT)
Awaous guamensis	101	12.8	29.0	19.5±3.59	12.0	170	59.4±32.9	-112.8	8.85	0.93	8.69	0.0018-0.0052	3.106-3.4509	S
Taenioides cirratus	101	8.4	21.0	16.3±2.54	2.0	34	15.3±6.13	-19.0	2.11	0.77	2.94	0.0026-0.0115	2.549-3.0809	S
Mystus gulio	101	7.4	13.0	10.1±1.29	5.0	20	10.3±3.11	-11.1	2.12	0.77	1.48	0.0479-0.1448	1.8304-2.3104	S
Polynemus paradiseus	101	15.0	30.0	20.3±3.45	50.0	143	90.4±23.0	-38.7	6.38	0.92	6.54	0.7634-1.2859	1.4095-1.5834	S
Lates calcarifer	101	15.0	30.0	20.3±3.50	50.0	143	90.7±22.9	-36.6	6.27	0.92	6.69	0.8163-1.37996	1.3858-1.5607	S

*Note: S.D=Standard Deviation; S.E=Standard Error; 'S' shows strong correlation when R^2 >0.70; 'W' shows weak correlation when R^2 <0.50

Furthermore, the values of condition factor (K) and relative condition factor (Kn) revealed that *Awaous guamensis* and *Mystus gulio* with average Kn values were greater than

Species	N	Log a	95% C.I. of log a	Log b	95% C.I. of log b	r	r^2
Awaous guamensis	101	-2.504	-0.221	3.278	0.172	0.967	0.935
Lates calcarifer	101	0.026	-0. 114	1.473	0.087	0.958	0.918
Mystus gulio	101	-1.079	-0.24	2.070	0.239	0.864	0.747
Polynemus paradiseus	101	-0.004	-0.113	1.496	0.087	0.960	0.921
Taenioides cirratus	101	-2.257	-0. 321	2.815	0.265	0.904	0.817

1.0 as shown in Table (3). Thus, the environmental conditions of the Meghna River Estuary were suitable for the growth of these two species.

Table 3. Condition factor (K) and Relative Condition factors (Kn) values for five marine species collected from the Meghna River Estuary of South-Eastern Bangladesh

		Range (K-values)			Range (Kn-values)	
Species	**Mean±S.D**	**Min.**	**Max.**	**Mean±S.D**	**Min.**	**Max.**
Awaous guamensis	0.72±0.12	0.43	1.10	*1.10±0.83	0.61	9.03
Taenioides cirratus	0.34±0.08	0.19	0.85	0.94±0.51	1.3	2.48
Mystus gulio	1.001±0.23	0.65	2.31	*1.01±0.18	0.68	2.03
Polynemus paradiseus	1.13±0.27	0.51	1.71	0.99±0.06	0.84	1.16
Lates calcarifer	1.13±0.28	0.52	1.71	0.99±0.069	0.83	1.16

Note: * shows the mean Kn values > 1.0. S.D= Standard deviation.

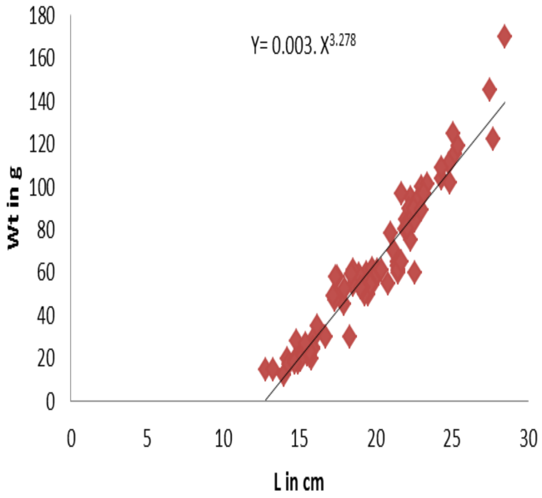


Fig 1. Length-Weight data of *Awaous guamensis* (N=101)

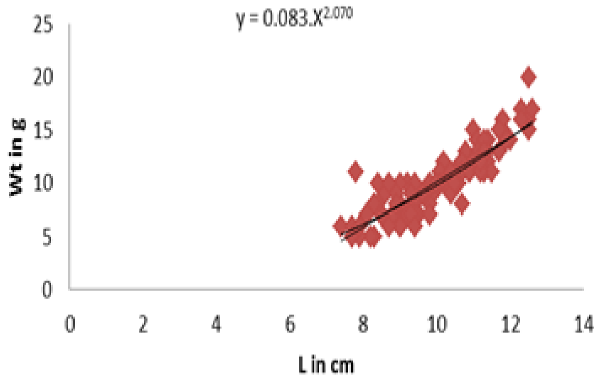


Figure .3. Length-Weight data of *Mystus gulio* (N=101)

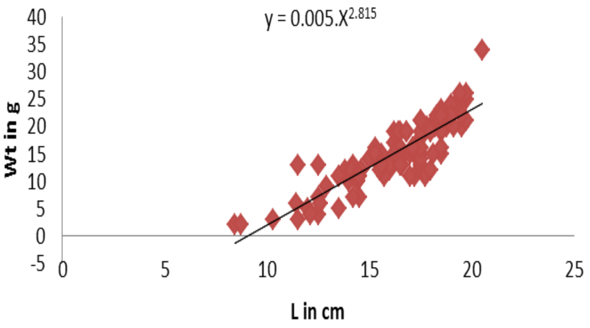


Fig. 2. Length-Weight data of *Taenioides cirratus* (N=101)

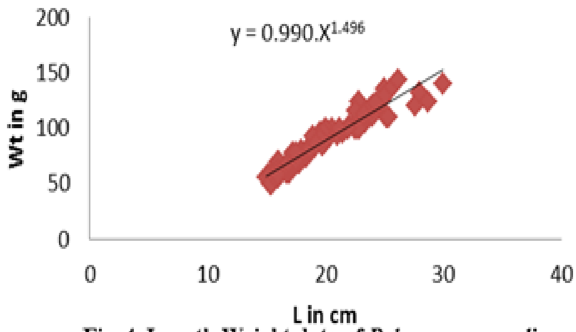


Fig .4. Length-Weight data of *Polynemus paradiseus* (N=101)

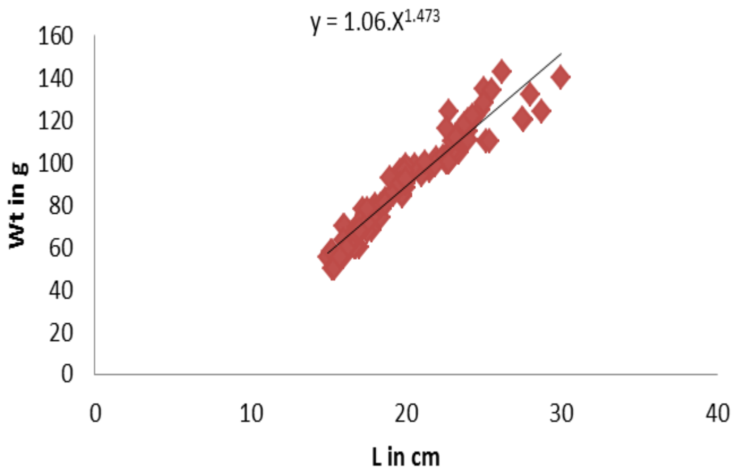


Fig 5 . Length-Weight data of *Lates calcarifer* (N=101)

DISCUSSION

Information is deficient on LWRs related to the coastal areas of Bangladesh; nevertheless, several studies have been conducted on freshwater species **(Hossain *et al*., 2006a, b, 2009, 2012b, 2014)**. In the present study, collecting a large number of specimens from this coastal river was available using traditional fishing gear. However, it was not possible to catch fishes smaller than 7.0 cm TL during the sampling period, which may be indicative of the selectivity of the fishing gear **(Hossain *et al*., 2012d)** rather than their absence in the fishing grounds. **Hossain (2010a, b)** assumed a similar hypothesis while studying the LWRs of some small indigenous species from the Ganges River (northwestern Bangladesh). However, this lack of smaller fishes might be overcome if specimens smaller than the smallest specimens (<7.0 cm) could be collected by larval survey net and by later adjusting the length-frequency data for gear selectivity **(Ahmed *et al*., 2012; Ayub *et al*., 2021)**. It was noted that, the individual condition factor may cause the weight variance in the sampled batches related to the well-being and degree of fatness **(Pauly, 1983)**. **Duaz *et al*. (2000)** found similar results in demersal fishes from the upper continental slope of Columbia. In the present study, b values were almost the same (1.47–3.35) as those reported in the study of **Froese (2006)** regarding most fishes. In terms of growth rate, earlier studies from Bangladesh, Thailand, and the Philippines revealed negative allometric growths in *A. testudineus* (b values ranged from 2.51 to 2.84). This result concures with those of the previous studies, although some of these investigations detected much lower b values **(Froese & Pauly 2015)**. However, the differences in b values can be attributed to the combination of one or more factors, including habitat, area, seasonal effect, degree of stomach fullness, gonad maturity, sex, health, preservation techniques, and differences in the observed length ranges of the captured specimens **(Gonzalez-Acosta *et al*., 2004; Hossain *et al*., 2006 a, b, 2013b, 2014; Ruiz-Camposet *et al*., 2006)**. On the other hand, no references have been found on LWRs of the other species under study. Although LWRs are easily obtained, they remain unused on many Bangladesh species, including those mentioned earlier. Consequently, this study provides a significant baseline data on the LWRs of nine fish species from Bangladesh and can be useful for further studies or other key parameters needed for fisheries management in the Meghna River, southern Bangladesh.

CONCLUSION

To the best of our knowledge, no previous references have been found dealing with LWR for the studied species. This study provides basic information on length-weight relationships that fishery biologists and conservation agencies can use to impose adequate regulations for sustainable fishery management and conservation in the Meghna River Estuary basin Bangladesh and the surrounding areas.

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