Growth Pattern and Length-Weight Relationships Model of Estuarine Fish in the Matang Mangrove Estuaries, Malaysia

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ABSTRACT Matang Mangrove Estuaries is dominantly surrounded with mangrove vegetations, making it rich with numerous types of commercially important fish species and thus has a critical role for providing food resources and generating income for local residents. Several studies about the species availability and distribution of fish have been conducted at there but none have been conducted on assessing the Length-weight relationships (LWR) of commercially important fishes. Thus, the main objective of this study was to establish the first record of LWR of estuarine fish from Marudu Mangrove Estuaries. A total of 16 species of fish from Matang Mangrove Estuaries located in Perak, Peninsular Malaysia were selected for the study. The total length and wet weight of the specimens, totaling of about 4372 individuals and comprising of 13 families were measured and estimated. The dominant families were Clupeidae, Engraulidae and Leiognathidae with two species for each of them, and only one species each for other remaining families. Overall, negative allometric growth was observed in 15 species whereas only one species showed isometric growth. This research serves as the first record of LWR data for 16 fish species in the Malaysian waters of Matang Mangrove Estuaries. It is hoped that these findings can help researchers in extending future studies, particularly about fish population in this study area.

KEYWORDS: Fish species, length-weight relationship, Matang mangrove, Malaysia
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Short Report

INTRODUCTION

Hundreds of population studies had been conducted worldwide since 1950s until now in order to assess and understand the distribution and diversity of fish in the mangrove estuary (Faunce & Serafy, 2006). From those studies, many researchers suggested that it is essentially important to maintain sustainably the mangrove ecosystems and their surrounding areas as they contribute a lot in conserving many types of valuable and endangered spesies (Janekarn & Boonruang, 1986; Kennish, 1990; Kathiresan & Bingham, 2001; Huxham *et al.*, 2007; Sarpédonti & Chong, 2008). Furthermore, various types of ecosystem models, either quantitative or qualitative, had been established in previous research as benchmarks for other types of population study (Blaber, 2000). The output and results from the findings can be used by the policy makers (government and local authorities) in planning numerous conservation measures and enforcing numerous acts over there (Nagelkerken *et al.*, 2008).

In order for the models to function properly, the raw data that usually involves data on annual catch and annual index abundances have to be obtained first (Cushing, 1975). Of all sorts of raw input that available for mangrove study, the length-weight relationships (LWR) data had been known by many researchers as fundamental in describing the preliminary status of fish stocks as it can determine temporal and seasonal variations of fish growth as well as comparing the morphological, habitat and life history of different fish species (Huxham *et al.*, 2007). Furthermore, due to its simplicity in obtaining the data, the study of LWR had been frequently selected as pioneer benchmark whenever the scientists start their population research of fish species in their respective mangrove habitats (Sarpédonti & Chong, 2008). Despite the usefulness of LWR data in the construction of ecosystem modeling for mangrove fishes, the scientific publication about LWR for

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the mangrove fishes in Malaysia, one of the country in South East Asia that have considerably large areas of mangrove waters, is still scarce and limited, with the exemptions from the study in Johor (Arshad *et al.*, 2008), Kedah (Mansor *et al.*, 2012), Selangor (Ya *et al.*, 2015), and Sabah (Amin *et al.*, 2014). All of those studies were commenced both in Peninsular Malaysia and East Malaysia.

Matang Mangrove Estuaries which is situated in the northern part of Peninsular Malaysia is dominantly surrounded with mangrove vegetations, making it rich with numerous types of commercially important fish species and thus has a critical role for providing food resources and generating income for local residents (Affendy & Chong, 2006). Shrimps, mainly from penaeid family, are the prized catches for local communities over there as they constitute higher marketing prices and demands, although there are numerous species of valuable fish and crab that are also available abundantly in the mangrove waters (Kiso & Mahyam, 2003). Meanwhile, aquaculture activities, especially the culture of oyster by attaching the spat at submersible poles and the culture of finfish (grouper and catfish) in the cage are becoming trendy and popular day by day for nearby residents of these mangrove areas as they realized that they cannot sustain their living by only continuously and solely relied on fishing activities (Alongi *et al.*, 2003).

Several studies about the species availability and distribution of fish have been conducted in Matang Mangrove Estuaries as the area is started to face deforestation problems (Khoo, 1990; Sasekumar *et al.*, 1994; Hayase & Muhammad Fadzil, 1999; Chong, 2005). Other than those studies, none have been conducted on assessing the LWR of commercially important fishes in this estuarine area with the exception from the LWR study of Carangid fish by Mohd Azim *et al.* (2018). Realizing the importance of fish species in Matang Mangrove Estuaries in term of ecologically and economically, the main objective of this study was to establish the first record of LWR of 16 fish species from Matang Mangrove Estuaries, Peninsular Malaysia as well as continuation for the previous study by Mohd Azim *et al.* (2018). Furthermore, the information that was obtained from this study can be shared with respected authorities and researchers for management purposes and extending population studies.

METHODOLOGY

Matang Mangrove Estuaries, which is situated in Matang Mangrove Forest Reserve (MMFR), Perak, Peninsular Malaysia was selected for LWR study. The duration of sampling was one year (September 2015 and August 2016) with the frequency of sampling was once a month. The samples were collected from three landing sites of fish, with each site correspond to three main rivers ('sungai' in Malay Language) in MMFR areas, namely 'Sungai Tiram', 'Sungai Tinggi' and 'Sungai Sepetang'. The latitude and longitude of the study areas were ranged from N 04º 55′ to N 04º 40′ and E 100º 25′ to E 100º 40′, respectively. These coordinates were adequately enough in covering the species availability in the study area.

Push net was the main gear in capturing samples for this study. Usually, the local fishermen operate the net by using trawling method, but unlike common practise, the net was attached at the front side of their boat. The standard dimension of the net are as follow; 14.0 – 15.0 m in length, 2.0 – 5.0 m in width, and, 1 – 2 inches in mesh sizes. At each station, one bucket of unsorted samples was obtained from local fishermen and they were immediately preserved in ice chest for further field work such as species identification and length-weight measurement. The manuals from Rumpet *et al.* (1997) and Ambak *et al.* (2012) were used as references in species identification of the samples. The total length (TL) of specimens were measured using a digital caliper to the nearest 0.1 mm while the electronic balance of up to 0.01 g accuracy were utilized in measuring the wet weight of specimens.

The relationship between the total length and whole body weight was estimated by using the equation $W = aL^b$ in order to establish the length-weight relationship (Ricker, 1975; Quinn & Deriso, 1999) where W is the weight (g), L is the total length (cm), a is the intercept and b is the growth slope (growth coefficient). Then, the parabolic equation ($W = aL^b$) was then transformed into a linear equation by using a logarithmic method: $\log_{10} W = \log_{10} a + b \log_{10} L$. The value of *b* determines the type of growth of the fish species; positive allometric growth ($b > 3$), negative allometric growth ($b < 3$), and, isometric growth ($b = 3$). The coefficient of determination (r^2) was used as an indicator of the quality of the linear regression (Scherrer, 1984). Additionally, the t-test analysis was carried out for the length and weight data of each species to confirm the significance of relationship at $P < 0.05$.

RESULTS AND DISCUSSION

Approximately 4372 individuals comprised of 16 species from 13 families were obtained in this study. The most dominant species were *Nematolosa come*, *Ambassis nalua*, *Stolephorus tri*, *Escualosa thoracata* and *Johnius belangerii* with the number of individuals were 790, 652, 556, 523 and 447, respectively. Actually, there were more than 40 species were found and identified in the study area but only 16 species were selected as those species had more than 10 individuals each which were suitable for the calculation of LWR due their wide range of sizes. In term of family composition, Clupeidae, Engraulidae and Leiognathidae came with 2 species for each of them and other remaining families were composed with only one species each. The results of statistical analysis of LWR for 16 species from Matang Mangrove Estuaries were shown in the Table 1 and it contained all the necessary output for LWR analysis such as the total number of samples (N), the estimated values of exponent *a* and *b*, the coefficient of regression (r^2), *P-value*, and, last but not least, the type of growth.

Table 1. LWR parameters obtained for 16 fish species sampled in the Matang Mangrove Estuaries, Perak, Malaysia:

Family	Species	Parameters of the LWR					Growth type
		N	*a*	*b*	r^2	*P-value*	
Ambassidae	*Ambassis nalua*	652	0.0160	2.149	0.51	0.007	Allometric -
Ariidae	*Arius maculates*	229	0.0160	2.682	0.91	0.023	Allometric -
Belonidae	*Strongylura strongylura*	57	0.0180	2.202	0.84	0.010	Allometric -
Clupeidae	*Escualosa thoracata*	523	0.0490	2.169	0.63	0.008	Allometric –
	Nematolosa come	790	0.1080	1.690	0.52	0.002	Allometric -
Engraulidae	*Coilia macrognathus*	96	0.1240	1.542	0.58	0.002	Allometric -
	Stolephorus tri	556	0.0780	1.877	0.56	0.003	Allometric -
Leiognathidae	*Gazza minuta*	289	0.0620	2.015	0.65	0.005	Allometric –
	Leiognathus brevistoris	103	0.0300	2.440	0.75	0.013	Allometric -
Lutjanidae	*Lutjanus lutjanus*	56	0.0850	2.030	0.77	0.005	Allometric -
Mugilidae	*Liza macrolepis*	73	0.1170	2.075	0.94	0.005	Allometric -
Scatophagidae	*Scatophagus argus*	199	0.0730	2.494	0.86	0.015	Allometric -
Sciaenidae	*Johnius belangerii*	447	0.0150	2.783	0.86	0.036	Allometric -
Siganidae	*Siganus javus*	143	0.0240	2.685	0.94	0.024	Allometric -
Terapontidae	*Terapon theraps*	69	0.1280	1.804	0.70	0.003	Allometric -
Tetraodontidae	*Lagocephalus gloveri*	90	0.0200	3.004	0.96	0.045	Isometric

N: number of specimens sampled. *a:* intercept. *b:* slope. *P-value* and r^2: coefficient of determination and type of growth [isometric or allometric (positive or negative)].

Estimation of the intercept values *a* were ranged from 0.0020 (*Decapterus macrosoma*) to 0.1280 (*Terapon theraps*), while the values of exponent *b* in this study were varied from the highest for *Decapterus macrosoma* (3.452) to the lowest went to *Coilia macrognathus* (1.542). The estimation of r^2 values showed that only one species (*Lagocephalus gloveri*) was greater than 0.95 with all the species in this study area obtained significant linear regressions ($P < 0.05$). Hence, the coefficient of regression (r^2) ranged from 0.51 for *Ambassis nalua* to 0.96 for *Lagocephalus gloverii*. For type of growth, negative allometric growth ($b < 3$) was found to be majority with 15 species, whereas only one species revealed isometric growth ($b = 3$).

The comparison of LWR parameters had been made between the present study which is located in the Peninsular Malaysia with the recent similar studies in Selangor by Ya *et al.* (2015), Kedah by Mansor *et al.* (2012) and in Johor by Arshad et al. (2008), which are also located in Malaysia. Overall, it was revealed that most of LWR values especially *b* values between present study and the study in Selangor and Kedah differed significantly as majority of the species in Selangor and Kedah study showed positive allometric growth while most of the species in the present study had negative allometric growth. Meanwhile, the results from present study and studies from Johor obtained almost the same results in term of type of growth which were negative.

Additionally, the present study was also compared to other LWR studies in Malaysia which correspond with only single species or family in order to emphasize the validity of the results from the present study. Both studies of single species in Selangor (Simon *et al.*, 2014) and in Negeri Sembilan (Usman *et al.*, 2016), together with a study of single family in Selangor (Khaironizam & Norma-Rashid, 2002), yield similar results with the present study, which were the target species or family showed negative allometric growth. However, the LWR study of single species in Kedah by Nor Aziella & Mansor (2012) and in Sabah by Amin *et al.* (2014) obtained different results with the present study as the target species showed positive allometric growth.

From these comparisons, it can be said that the main reason for either similarities or differences of allometric growth to happen probably lied on the fact that there were geographical similarities and differences of estuarine waters between present study and other studies. Furthermore, the numerous variations of physico-chemical characteristics of water together with other environmental and biological parameters between these coastal waters can greatly influence the LWR parameters of selected species. For instance, the present study, together with other studies (Usman *et al.*, 2014; Arshad *et al.*, 2008; Khaironizam & Norma-Rashid, 2002) that showed negative allometric growth of fish, were probably due to the disturbed or polluted environment of those sites, which were generally caused by heavily development area and over-fishing activities. Hence, the competition for getting food sources between fish at those study areas were probably higher and tougher as the occurrence of unfavorable environment over there made it harder for the low level organisms, mainly phytoplankton and zooplankton, to grow abundantly. On the other hand, the pristine and undisturbed environment for aquatic organisms to reside may be the main factor of positive allometric growth for the fish at these study areas (Ya *et al.*, 2015; Amin *et al.*, 2014; Nor Aziella & Mansor, 2012; Mansor *et al.*, 2012).

CONCLUSION

This study is served as the first record of LWR for selected 16 fish species in Matang Mangrove Estuaries, Malaysia. It is hoped that these findings can help researchers in extending future studies, particularly about fish population in the study area. More studies about fish condition as well as population dynamics in the study area and other mangrove waters in Malaysia will give better view for fisheries scholars and policy makers (the government) in managing diligently the conservation programmes and management of fish stocks.

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