Pertanika J. Trop. Agric. Sc. 41 (4): 1659-1668 (2018)

PERTANIKA JOURNALS

TROPICAL AGRICULTURAL SCIENCE

Journal homepage: http://www.pertanika.upm.edu.my/

Length-weight and Length-length Relationship Models of Four Carangid Fishes from The Matang Mangrove Estuaries, Perak, Malaysia

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ABSTRACT

Four species of Carangid fishes from Matang Mangrove Estuaries, Perak, Peninsular Malaysia were selected for the study of length-weight relationships (LWR) and length-length relationships (LLR). A total of 308 individuals were collected from September 2015 to August 2016 by push net (mesh sizes ranges from 2.5 to 5.0 cm). Overall, the growth coefficient (b) values were 2.005, 3.014, 3.452 and 3.194 for *Carangoides malabricus*, *Atule mate*, *Decapterus macrosoma* and *Selaroides leptolepis*, respectively. Growth coefficient of three species (*A. mate*, *D. macrosoma* and *S. leptolepis*) in the present study were within expected range of 2.5 – 3.5 and this indicated that those species have normal growth pattern. This research serves as the first record of LWR and LLR data for four species of Carangid fishes in the Matang Mangrove Estuaries and surrounding ecosystem, Malaysia.

Keywords: Carangid, length-weight relationship, Matang mangrove, Malaysia

ARTICLE INFO

Article history:
Received: 27 February 2018
Accepted: 30 August 2018
Published: 14 November 2018

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INTRODUCTION

The Carangid fishes are important component of fisheries throughout tropical regions. They also form important portion of income for the majority of commercial and subsistence fishermen (Alongi, Chong, Dixon, Sasekumar, & Tirendi, 2003; Chong,2006). These fishes had been

ISSN: 1511-3701
e-ISSN 2231-8542

exploited as food production where they considered as high-quality food fish in some regions and are cooked or conserved by a variety of methods (Kiso & Mahyam, 2003; Affendy & Chong, 2006). They comprise about 30 genera worldwide that can be subdivided into approximately 140 species (Qamar, Panhwar, & Brouwer, 2016). The fishes can be found abundantly in the Indo-Pacific region from east Africa in the west to Hawaii in the east, extending north to Japan and south to Australia (Ambak, Isa, Zakaria, & Ghaffar, 2012). Copepods, small fish and invertebrate are some of common example of their staple diet (Thabet, Mansour, Al Omar, & Tlig-Zouari, 2016). The range of their maximum length size are within 25 – 100 cm, depend mainly on the species (Bray & Justine, 2013).

The length-weight relationship (LWR) and length-length relationship (LLR) are among the fundamental analysis in observing fisheries status as well as estimating and comparing life histories of fishes among different study sites (Chew, Chong, & Hanamura, 2007; Chong, 2005; Faunce & Serafy, 2006; Laegdsgaard & Johnson, 2001). For LWR, the researchers utilize the graph of total length (TL) versus body weight (BW) in order to obtain the value of a (intercept), b (growth slope or coefficient) and r^2 (regression coefficient). The b value is the most important for LWR analysis as it is an indicator for the type of growth of fishes; $b < 3.0$ (negative allometric growth), $b = 3.0$ (isometric growth) and $b > 3.0$ (positive allometric growth) (Froese, 2006). Meanwhile, the analysis of LLR is essential where one length type is preferable in comparative growth studies (Quinn & Deriso, 1999).

Matang Mangrove Estuaries which are situated in Malaysia is one good example of a specific single location where several studies have been carried out to elucidate its importance in various field of fisheries (Chew & Chong, 2011; Chong, 2006; Ooi & Chong, 2011), yet those previous studies showed little about the importance of LWR of dominant fish except the study by Chong (2005). This is unfortunate because a complete understanding of the stock status of fish and their dependence on the study area is not possible without a complete finding of their distribution and morphometric statistics. Thus, the analysis of LWR and LLR in several parts of study area would reveal partially the population model and stock status for the targeted fishes that are resided over there. The main objective of this study was to establish the LWRs and LLRs of four Carangid fishes from Matang Mangrove Estuaries, Peninsular Malaysia as well as to share the information with respected authorities and researchers for management purposes and extending population studies.

MATERIALS AND METHODS

This study was conducted in the estuarine waters of Matang Mangrove Forest Reserve (MMFR), Perak, Peninsular Malaysia and sampling activities were carried out monthly between September 2015 and August 2016. Fish samples were collected from landing sites of three main rivers ('Sungai' in

Malay Language) in MMFR areas, namely 'Sungai Tiram', 'Sungai Tinggi' and 'Sungai Sepetang'. The coordinates of sampling stations were ranged from N 04º 55' to N 04º 40' for latitude and E 100º 25' to E 100º 40' for longitude. These geographic locations were considered sufficient enough in covering the fish species that available in the study area.

Fish samples were obtained from local fishermen who operated push net boat in MMFR areas for their main source of income. This medium size of motorized boat is operated and trawl net is attached at the front side of the boat, with the net specification is 14.0 – 15.0 m in length, 2.0 – 5.0 m in width, and 2.5 – 5.0 cm mesh sizes. At each station, around 4 kg of unsorted fish samples were obtained and they were immediately preserved in ice chest. The species identification was done by using the identification key of Ambak et al. (2012). The total length (TL) and standard length (SL) 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. Both types of measurements of the specimens were directly conducted in the field.

The commonly used relationship $W = aL^b$ was applied 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). The parameters of 'a' and 'b' were estimated by least squares linear regression from log–log transformed data: $\log_{10} W = \log_{10} a + b \log_{10} L$. The coefficient of determination (r^2) was used as an indicator of the quality of the linear regression (Pauly, 1980). Additionally, the statistical significance level of r^2 and 95% confident limits of the parameters 'a' and 'b' were estimated. Total length and standard length relationships were estimated by using linear regression analysis of TL = a + b SL.

RESULTS AND DISCUSSION

A total of 308 individuals representing four different fish species of Carangid were analyzed in this study. The LWR parameters of four Carangid fishes are presented in Table 1 while the LLR regressions are given in Table 2. From Table 1, two species (*D. macrosoma* and *S. leptolepis*) showed positive allometric growth ($b > 3$) with only *C. malabricus* showed negative allometric growth ($b < 3$). In contrast, *A. mate* was the only species in this study that showed isometric growth ($b = 3$). All LLRs were highly correlated ($P < 0.05$) with $r^2 \geq 0.984$ (Table 2). Additionally, supplemental data that contained spatial and monthly data of water parameters in the study area were also shown in Table A and Table B. Both tables showed the specific water parameters that had significant variation ($P < 0.05$) amongst different sampling stations and months in this study.

The results of LWRs and LLRs in this study were varied to each species might be due to several factors that were not considered earlier such as feeding

Table 1

Statisctical description and LWR parameters obtained for four Carangid fishes in the Matang Mangrove Estuaries, Malaysia from September 2015 to August 2016

		TL (cm)		BW (g)		Regression parameters				
Species	**n**	**Min**	**Max**	**Min**	**Max**	***a***	**95% CI of *a***	***b***	**95% CI of *b***	**r^2**
Atule mate	57	5.5	27.0	2.0	228.0	0.0115	0.0101 – 0.0132	3.014	2.92 – 3.14	0.99
Carangoides malabricus	117	3.0	10.0	0.5	20.0	0.0699	0.0665- 0.0742	2.005	1.91 – 2.12	0.76
Decapterus macrosoma	70	6.5	19.0	0.5	20.0	0.0026	0.0016 – 0.0042	3.452	3.23 – 3.65	0.94
Selaroides leptolepis	64	9.0	17.5	6.0	60.0	0.0070	0.0049 – 0.0113	3.194	3.09 – 3.32	0.95

n, number of specimens sampled; TL, total length; BW, body weight; a, intercept; b, slope/growth coefficient ; CI, confidence interval; r^2, coefficient of determination.

Table 2

Length-length relationship parameters comparison of total length (TL) and standard length (SL) of four Carangid fishes from Matang Mangrove Estuaries, Malaysia between September 2015 and August 2016

Species	n	Equation	a	b	**95% CI of *b***	r^2
Atule mate	57	TL = *a* + *b* SL	0.751	1.047	0.995-1.010	0.997
		SL = *a* + *b* TL	1.322	0.952	0.904-1.000	
Carangoides malabricus	117	TL = *a* + *b* SL	0.835	1.043	0.991-1.010	0.993
		SL = *a* + *b* TL	1.200	0.951	0.903-0.999	
Decapterus macrosoma	70	TL = *a* + *b* SL	0.736	1.057	1.004-1.110	0.984
		SL = *a* + *b* TL	1.379	0.930	0.884-0.977	
Selaroides leptolepis	64	TL = *a* + *b* SL	0.683	1.074	1.020-1.128	0.988
		SL = *a* + *b* TL	1.464	0.920	0.874-0.966	

n, sample size; *a*, intercept; *b*, slope; r^2, coefficient of determination; CI, confidence interval

habit, seasonal affect, sexual maturity and environmental condition (water parameters) (Zain et al., 2018). For instance, it is likely that Carangid fish that had positive growth rate in this study (*D. macrosoma* and *S. leptolepis*) were more tolerable toward variation and fluctuation of water parameters especially in the estuarine area, thus, enabled them to survive and grow better. Furthermore, the b values of *D. macrosoma* and *S. leptolepis* in the present study were 3.452 and 3.194, respectively, and these were in agreement with other studies of other Carangid fishes (*Rastrelliger kanagurta* and *Atule mate*) in Malaysia by Amin, Mohd Azim, Fatinah, Arshad and Rahman (2014) and Mohd Azim, Amin, Romano, Arshad and Yusoff (2017) that yielded the b value = 3.215 and 3.148, respectively. It can be assumed that the body of these Carangid fishes grows faster in relation to their body size and this indicates good environmental condition and food availability in the habitats. The slope (b) values of LWR of three Carangid fishes (*A. mate*, *D. macrosoma* and *S. leptolepis*) in the present study were within expected range of 2.5 – 3.5 as suggested by Froese (2006). The intercept (a) values showed a fusiform body shape in these three species and comparable with other Carangid fishes, based on the Bayesian length-weight predictions available in FishBase website (Froese & Pauly, 2016). Only one species, *Carangoides malabricus*, was below the expected range of b value (2.005) and this was maybe due to very low yield of sufficient variable in sample size.

CONCLUSION

Overall, *C. malabricus* showed negative allometric growth (b = 2.005) and *A. mate* indicated isometric growth (b = 3.014) whereas *D. macrosoma* (b = 3.452) and *S. leptolepis* (b = 3.194) shown positive allometric growth. This baseline study on LWR and LLR of Carangid fishes could be part of fishery management in Matang Mangrove Estuaries.

ACKNOWLEDGEMENTS

This study was supported by Ministry of Science and Technology Malaysia Ministry and Universiti Putra Malaysia through JSPS ACORE Programme & Research University Grant Scheme No. 05-01-09-0727RU. Extended thanks to Siti Balqis binti Abdul Razak and Fareha binti Haji Hilaluddin from Laboratory of Marine Biotechnology, Institute of Bioscience, UPM and also to Mr. Abdul Rahman, a staff from Department of Fisheries Malaysia for their assistance in the field work.

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APPENDIX

Table A

Spatial variation among three different stations of different water parameters in the estuarine waters of Matang Mangrove Estuaries, Malaysia from September 2015 to August 2016

Parameters	Sg. Tiram	Sg. Tinggi	Sg. Sepetang
*Temp. (°C)	30.59	30.85	29.76
DO (mgL^{-1})	3.86	4.74	3.99
*Salinity (psu)	27.49	27.02	14.78
pH	7.41	7.48	7.13
*Con. ($mS\ cm^{-1}$)	44.06	43.50	24.78

Table B

Monthly variation of different water parameters in the estuarine waters of Matang Mangrove Estuaries, Malaysia from September 2015 to August 2016

Month / Year	***Temp. (^0C)**	***DO (mgL^{-1})**	***Salinity (psu)**	***pH**	***Cond. ($mS\ cm^{-1}$)**
September2015	21.29	2.75	16.24	6.85	28.53
October 2015	29.14	3.15	18.52	7.02	29.68
November2015	29.26	3.36	20.29	7.08	32.46
December2015	29.32	3.49	21.13	7.22	33.78
January 2016	29.61	3.76	22.59	7.29	37.44
February 2016	30.13	3.93	23.69	7.31	38.89
March 2016	30.15	3.97	24.64	7.44	39.34
April 2016	30.46	3.99	25.04	7.45	40.16
May 2016	30.97	4.13	25.55	7.52	40.31
June 2016	31.26	4.60	25.73	7.53	40.41
July 2016	31.75	5.34	25.84	7.60	43.54
August 2016	32.51	7.88	27.89	7.76	44.80

Legend: Temp. = Temperature; DO = Dissolved Oxygen; Cond. = Conductivity

Note: *The mean difference is significant at 5% level ($P < 0.05$).