Aceh Journal of Animal Science (2020) 5(1): 18-25
DOI: 10.13170/ajas.5.1.14858
Printed ISSN 2502-9568 Electronic ISSN 2622-8734

RESEARCH PAPER

Length-weight relationships and environmental parameters of *Macrobrachium malayanum* (J. Roux, 1935) in Senggarang Water Flow, Tanjungpinang City, Riau Islands, Indonesia

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Received: 18 October 2019
Accepted: 29 January 2020

ABSTRACT

Macrobrachium malayanum (J. Roux, 1935) is a freshwater prawn found in Senggarang Water Flow, Tanjungpinang City, Riau Islands, Indonesia. Basic research on this species is considered important due to the limited research available for this species in Senggarang Water Flow, and its Least Concern (LC) status on the IUCN red list of threatened species. The objective of this study is to examine the length-weight relationship of *M. malayanum* in Senggarang Water Flow. A total of 84 samples were used in this study, consisting of 32 samples taken in February and 52 samples taken in April. Length-weight relationship of *M. malayanum* in February was $W=0.093TL^{1.425}$ ($R^2 = 0.59$) and $W=0.052TL^{2.195}$ ($R^2 = 0.75$). Samples in February and April showed negative allometric growth pattern. A temporal analysis of the negative allometric in b value found in April (2.195) is higher than the b value found in February (1.425). Environmental parameters such as temperature, current, dissolved oxygen, pH, salinity, nitrate, and phospate are within acceptable limits. *M. malayanum* are found in both slightly gravelly sand and gravelly sand substrate types.

Keywords: Length-weight relationship; Environmental parameters; *Macrobrachium malayanum*; Senggarang Water Flow

INTRODUCTION

Freshwater prawn (*Macrobrachium malayanum*) is categorized as under a Least Concern (LC) status within the IUCN red list of threatened species. This species can be found in areas ranging from southern Thailand, Peninsular Malaysia, Singapore, Sarawak, to Sumatera (Cai *et al.*, 2004; Liu *et al.*, 2007; Ng and Choy, 1990; Purnamasari *et al.*, 2016). The distribution is likely to be affected by the environmental parameters that is tolerated by *M. Malayanum*, such as canopy cover and water pH levels (Cai *et al.*, 2016; Ho *et al.*, 2016). Limiting factors that influence the presence of freshwater prawns include environmental quality, habitat characteristic, and riparian conditions. Freshwater ecosystems are experiencing changes due to forest conversion, water pollution, river conversion, and water flow modifications (Dugdeon, 2006; Foley *et al.*, 2005; Iwata *et al.*, 2003). The introduction of non-native freshwater species may also affect the freshwater community (Revenga *et al.* 2005; Muchlisin, 2012).

Freshwater decapod crustaceans such as *M. malayanum* serve several important ecological functions, such as providing food source for predators, mediating nutrient cycles (facilitating macro-decomposition of wood litter, leaf litter, etc), influencing primary production, and influencing

benthic stream communities (Cai *et al*., 2007; Cai *et al*., 2016; Esser *et al*., 2008). In general, the Senggarang Water Flow is short and shallow with clear, moderately flowing waters and considerable canopy coverage. The human community around Senggarang Water Flow did not exploit *M. malayanum*. They only used the water flow for washing and as water source for household needs.

There are no previous records of research done on *M. malayanum* in Senggarang Water Flow, and as far as we known, there is no available information on the biology of this species particularly in Senggarang Water Flow. Basic biology research, such as studies on length-weight relationship, would allow the conversion of growth in length equations to growth in weight which could be used in a stock assessment model (Afzaal *et al*., 2016; Muchlisin *et al*., 2017). Therefore, this study is initiated to obtain essential information on length-weight relationship and environment parameters to update the record of *M. malayanum* biological conditions in Senggarang Water Flow.

MATERIALS AND METHODS

Site and Time

The study was conducted in Senggarang Water Flow, Tanjungpinang City, Riau Islands Province on February 2019 (rainy season) and April 2019 (dry season) (Figure 1.) The samples were collected from four stations with different attributes: Station 1 (0.560091° N and 104.263821° E) is upriver; Station 2 (0.559095° N and 104.263453° E) is upriver with anthropogenic influence; Station 3 (0.556080° N and 104.264453° E) is midriver without anthropogenic influence, and station 4 (0.552016° N and 104.261940° E) is downriver. Sample analysis was done in the Marine Biology Laboratory of the Marine Science and Fisheries Faculty, Raja Ali Haji Maritime University, Tanjungpinang. Nutrient analysis (nitrate and phospate) was done in the Class 1 Laboratory of Environmental Health Engineering Center and Disease Control, Batam.

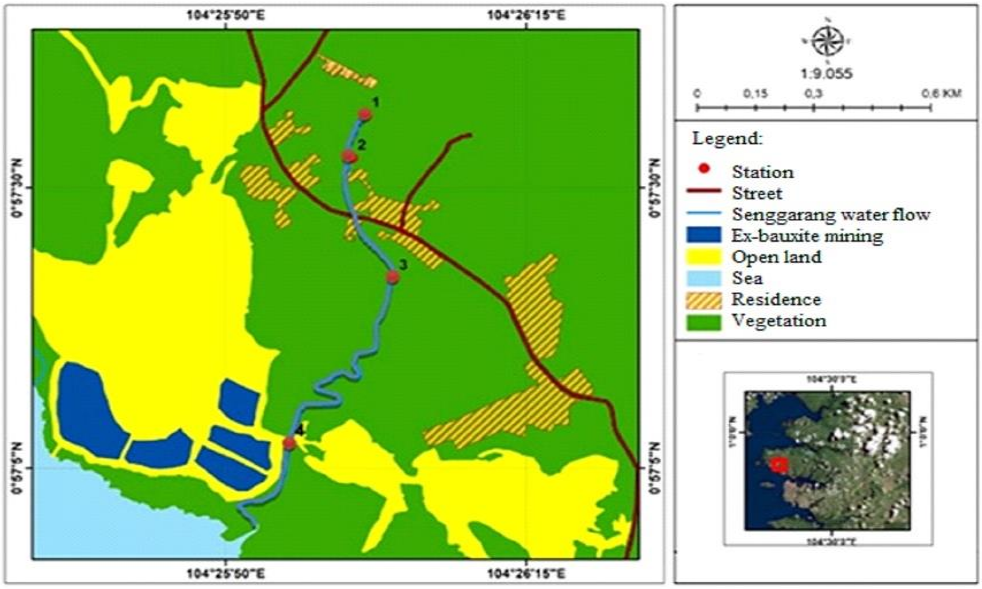

Figure 1. The map of the Tanjung Pinang City showing the research location

Environmental Parameters

Data on environmental parameters were collected as an indicator of *M. malayanum* living conditions, such as the physical-chemical factors that affects the conditions for the survival of *M. malayanum*. Eight environmental parameters that were measured are presented in Table 1.

Table 1. Environmental parameters that measured in Senggarang water flow.

No.	Parameter	Instruments	Description
1.	Temperature (°C)	Multitester	In situ
2.	Tranparancy (%)	Secchi disc	In situ
3.	Current (m/s)	Current droudge	In situ
4.	Salinity (ppt)	Hand-refraktometer	In situ
5.	Dissolved oxygen (ppm)	Multitester	In situ
6.	pH	Multitester	In situ
7.	NO_3^- (ppm)	Spectrophotometer	Laboratory (APHA, 2012)
8.	PO_4^{3-} (ppm)	Spectrophotometer	Laboratory (APHA, 2012)

Data Collection

The prawns were collected using hand scoop net (30 cm long, 25 cm wide, with 3 mm mesh size), the net was pushed opposite of the water current, and moved as far as one meter with three repetition in each station. Data were recorded from each prawns from the respective season groups (rainy and dry season), including data on wet body weight (g) and total body length (cm). Once captured, the prawns were fixed in 70% alcohol and stored in properly labeled plastic bottles. Wet body weight was measured using a precision digital scale (range: 0.01 g) and total body length was measured using a digital caliper (standard errors: 0.1 mm).

Data Analysis

The Length-weight relationship that indicates the growth pattern of *M. malayanum* follows a cubic law pattern of the two parameters analyzed. Ideally every length accretion will result in a weight gain. The length of *M. malayanum* often can be more rapidly and accurately measured than their weight. Moreover, back-calculations of past growth from the measurement of scales, etc., usually only yields data on length. Thus it would be very convenient to be able to determine the weight where only the length value is known, and occasionally this ability would be useful to reverse this process if needed. The length-weight relationship may be expressed graphically by plotting a chart of the observed length and weight values as a black dot diagram. The points for *M. malayanum* having the same length-weight relationship will lie on a straight line with some scattered points due to individual variations. We analyzed length-weight relationship *M. malayanum* using an estimation that follows the work of Le Cren (1951) and Effendie (2002): $W = aL^b$ (where "W" is wet body weight, "L" is total body length, "a" is intercept, and "b" is the estimator of growth pattern (regression coefficient) for *M. malayanum*.

RESULTS

A total of 84 *M. malayanum* were collected, consisting of 32 samples taken in the rainy season (February) and 52 samples taken in the dry season (April). The number of samples collected in

Station 1 is highest compared to all the other stations in each collection period, while no sample was found in Station 4 (Table 2). All samples were measured for their length (cm) and weight (g). Table 3 lists the variables obtained from a length-weight biometric analyses as sorted by month. All calculation results using length-weight relationship equation shows R^2 to be higher than 0.5 for each month (Figure 2). Minimum length was recorded on April (1.20 cm) and maximum length was recorded on February (3.91 cm). Minimum weight was recorded on April (0.05 g) and maximum weight was recorded on February (1.07 g). Out of all the samples that we found, the minimum-maximum length lies in a range between 1.20 – 3.91 cm with a mean of 2.61 cm ± 0.56, and the minimum-maximum weight lies in a range between 0.05 – 1.07 g with a mean of 0.43 g ± 0.20.

Table 2. Samples collected in Senggarang water flow

Month	Samples collect				Total
	Station 1	Station 2	Station 3	Station 4	
Feb	18	1	13	0	32
Apr	24	21	7	0	52
Total	42	22	20	0	84

Table 3. Summary dimension of length-weight *M. malayanum*

Month	Dimension	Min	Max	Average ± SD
Feb	Length (cm)	1.56	3.91	2.58 ± 0.60
	Weight (g)	0.10	1.07	0.38 ± 0.21
Apr	Length (cm)	1.20	3.50	2.63 ± 0.54
	Weight (g)	0.05	0.97	0.47 ± 0.20
Feb & Apr	Length (cm)	1.20	3.91	2.61 ± 0.56
	Weight (g)	0.05	1.07	0.43 ± 0.20

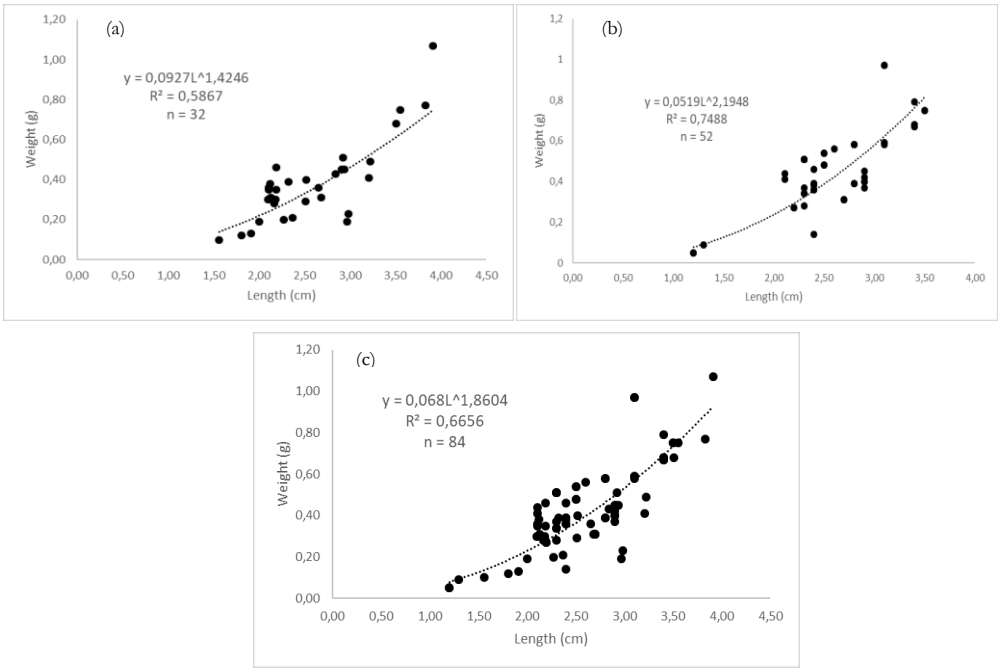

Figure 2. Length-weight relationship of *M. malayanum* on February (a), April (b), and both (c)

All environmental (physical-chemical) parameters are shown in Table 4. Temperature in February ranged between 26.7°C – 27.4°C and in April between 26.5°C – 30.1°C. Water current speed in February ranged between 0.03 – 0.47 m/s and in April between 0.06 – 0.51 m/s. Brightness value in both February and April was 100%, except in station 4 on April when the value was only 54.2%. Dissolved oxygen value in February ranged between 6.70 – 7.37 mg/L and in April between 6.53 – 7.87 mg/L. The range of pH value in February were between 6.67 – 7.35 and in April were between 5.03 – 6.40. Salinity value both in February and April were 0 $^0/_{00}$, except in station 4 in February (16 $^0/_{00}$) and in April (6.67 $^0/_{00}$). Nitrate levels in February was <0.007 mg/L and 0.153, and in April the range was between 0.57 - 1.47 mg/L. Phosphate levels in February was <0.02 mg/L in every station, and in April ranged between 0.016 – 0.025 mg/L. Substrate types in February were all slightly gravelly sand except in station 4 where the substrate type was sand, and in April substrate type were slightly gravelly sand in station 1 & 2, gravelly sand in station 3, and sandy gravel in station 4.

Table 4. Summary of physic-chemical parameters value in Senggarang Water Flow

No	Parameter	Unit	Month	Station			
				1	2	3	4
1.	Temperature	°C	Feb	27.3±0.12	27.4±0.15	26.7±0.06	27.3±0.15
			Apr	26.7±0.23	26.5±0.06	26.5±0.23	30.1±0.45
2.	Current	m/s	Feb	0.16±0.12	0.07±0.01	0.03±0.02	0.47±0.03
			Apr	0.51±0.59	0.28±0.07	0.08±0.02	0.06±0.02
3.	Transparency	%	Feb	100	100	100	100
			Apr	100	100	100	54.2
4.	DO	mg/L	Feb	7.37±0.15	7.13±0.12	7.20±0.10	6.70±0.10
			Apr	6.77±0.25	6.90±0.26	6.53±0.58	7.87±0.15
5.	pH		Feb	6.70±0.15	6.95±0.15	6.67±0.15	7.35±0.16
			Apr	5.03±0.01	5.25±0.09	5.17±0.08	6.40±0.08
6.	Salinity	$^0/_{00}$	Feb	0±0.00	0±0.00	0±0.00	16±0.00
			Apr	0±0.00	0±0.00	0±0.00	6.67±0.58
7.	Nitrate	mg/L	Feb	<0.007	<0.007	<0.007	0.153
			Apr	0.57±0.12	0.8 ± 0.17	0.7±0.30	1.47±0.15
8.	Phosphate	mg/L	Feb	<0.02	<0.02	<0.02	<0.02
			Apr	0.016±0.003	0.018 ± 0.002	0.016±0.002	0.025±0.015
9.	Substrate type		Feb	Slightly Gravelly Sand	Gravelly Sand	Gravelly Sand	Sand
			Apr	Slightly Gravelly Sand	Slightly Gravelly Sand	Gravelly Sand	Sandy Gravel

DISCUSSION

Information about individual length-weight relationships in populations is important for estimating the population size of a stock, specifically for the purpose of its exploitation. The length-weight relationships is regarded as suitable for evaluating crustacean populations and assessing their stock (Abohweyere and Williams, 2008; Hamid and Wardiatno, 2015; Kunsook *et al.*, 2014). A

length-weight relationship characteristic found in *M. malayanum* was that the exponent value (b value) for isometric growth pattern was found to be 3. For allometric growth pattern, b value would not be 3, as it could be negative allometric growth pattern (b value < 3) or positive allometric growth pattern (b value > 3). Coefficient correlation value for length-weight relationship in *M. malayanum* is shown to be greater than 0.5, which is strong enough to describe real conditions in their natural habitat. Results from this present study of length-weight relationship shows negative allometric growth pattern for both February and April, with b value 1.4246 (Feb) and 2.1948 (Apr), several factors that may cause negative allometric phenomenon include puberty molt and sexual activity, as shown by several research on crustaceans (Collins and Petriella, 2013; Muzammil, 2015).

Fresh water prawns from the genus *Macrobrachium* are free living decapod crustaceans that are commonly encountered in tropical streams and lakes (Wowor *et al*., 2009). Environmental parameters such as physical-chemical parameters are essential in determining suitable habitat conditions for *M. malayanum*. Results of the present study of environmental parameters in Senggarang Water Flow shows that its waters can be categorized based on PP No. 82 2001 as water quality standard class 2 suitable for aquaculture activities. Environmental parameters such as temperature, salinity and dissolved oxygen are major factors affects crustacean biology such as their age, growth, survival, and reproduction, including molt stage, social condition, and nutrition (Bindhu *et al*., 2007; Kemp and Britz, 2008; Vidya and Shoji, 2012). The suitable habitat did not necessarily caused the growth pattern of *M. malayanum* to become isometric or positive allometric, we assume that in their natural habitat, resources based mechanisms such as competition between predator-prey and feed availability could also influence growth patterns. Thus, the overall interaction between predator and prey is a potential mixture of competition and predation, and feed availability have negative and positive effect on their growth pattern (Olson *et al*., 1995; Polis *et al*., 1989).

This research showed that *M. malayanum* prefer slightly gravelly sand and gravelly sand substrate types, which is similar to the habitat preference behavior observed for members of *Macrobrachium, Litopenaeus,* and *Crangon* genera that prefer fine substrate (Nogueira *et al*., 2018; Oullette *et al*., 2003). We presume this substrate preference to be related to their survival in terms of protection and energy minimum required, in other words, *M. malayanum* are better able to protect itself from potential predators in finer substrate (slightly gravelly sand and gravelly sand) because it is easier to excavate, and requires less energy expenditure (Dall *et al*., 1990).

CONCLUSIONS

The results from the present study indicated negative allometric pattern for the length-weight relationship of *M. malayanum* in their natural habitat (Senggarang Water Flow), we assume that competition between predator-prey and feed availability could influence growth pattern, this is a challenges that needs to be investigated in future studies. Environmental parameters such as temperature, water current, brightness, dissolved oxygen, pH, salinity, nitrate, and phosphate show that parameters suitable for *M. malayanum* is categorized under class 2 water quality standards, which is suitable for aquaculture activities. *M. malayanum* prefers fine substrate such as slightly gravelly sand and gravelly sand.

ACKNOWLEDGEMENTS

This project was funded by the LP3M of Raja Ali Haji Maritime University (internal grant research), and we would thank Adi Setiabudi, Tewi Resiana, Evan Roy Herdiwan, Aknes Safitri, Listia Nengsih, and Yohanes Sina for their support in the field.

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