

Morphometric characteristics of Crayfish *Cherax quadricarinatus* from Atokan River, West Sumatera, Indonesia

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ABSTRACT

The objectives of this study were to determine the length–weight relationships (LWRs), sexual dimorphism and condition factors (K) of *Cherax quadricarinatus* from Atokan River, West Sumatera Indonesia. The sex ratio of *C. quadricarinatus* was: 1.3:1 (Males:females). Males and females' crayfish exhibited negative allometric growth ($b < 3$). The length–weight regression was not significantly different between males and females. The condition factor (K) for males and females were 2.85 and 2.32 respectively. There was no significant difference between weight of males and females, however the total length of females was longer than male. There was no significant difference between length and weight of males and females. Carapace width of males and females were not significantly different, meanwhile carapace length of female was longer than the male. The chelae length and chelae width of males and females were not significantly different. This study provides baseline information on morphometric characteristic of *C. quadricarinatus* in Atokan River, which will be useful for further reference such as management and conservation of the crayfish.

Key words : Redclaw, Growth, Sexual dimorphism, Atokan river, West Sumatera.

Introduction

The redclaw crayfish, *Cherax quadricarinatus* (Decapoda: Parastacidae) belongs to the group of *Cherax* crayfish, a native crustacean distributed at Northern Territory and far north Queensland in Australia, and the southern part of New Guinea (Bláha *et al.*, 2016). This species has been successfully introduced to, and has established feral populations within, several tropical, subtropical countries, and temperate zone, including Jamaica, Mexico, Puerto Rico, Singapore, Indonesia, South Africa, and Slovenia (see review Patoka *et al.*, 2016).

The introduction history of *C. quadricarinatus* in

Indonesia is not well known (Patoka *et al.*, 2018). Edgerton (2005) noted that *C. quadricarinatus* was imported into Indonesia for the establishment of aquaculture industries in 2003. Nevertheless, information about the methods of farming and harvesting in this region remains anecdotal and detailed monitoring is lacking (Patoka *et al.*, 2018). Because there are no effective legislative measures against non-native crayfish introductions in Indonesia, *C. quadricarinatus* is already found in different areas of the country including Sumatera (Patoka *et al.*, 2018). Purnamasari *et al.* (2018) have conducted the study of morphometric characteristics of *C. quadricarinatus* collected from Maninjau Lake (West Sumatra). To

complete the data on the biology of *C. quadricarinatus*, we conducted a study on the morphometric characteristics of this crayfish that lives in the Atokan River, located 15 km to the west of Maninjau Lake.

A basic morphometric procedure in the scientific study of species is measuring individual body length and weight. The length–weight relationship (LWR) is a very important parameter for the characteristics of a crayfish population such as: to estimate growth rate, to evaluate size at sex maturity, calculating of weight at a certain length (and vice versa) as well as for calculation of a condition factor in order to allow comparisons between populations from different regions (Lindqvist and Lahti, 1983; Silaen *et al.*, 2018; Nurfadillah *et al.*, 2019; Ndobe *et al.*, 2019). Moreover, Pauly (1993) stated that LWR provides valuable information on the habitat where the species lives. Therefore, understanding the relationship between length and weight might have important implications for the management of crayfish in their natural habitat.

The condition factor can be used to assess the degree of well-being of the organisms in their habitat (Khallaf *et al.*, 2003; Suryanti *et al.*, 2018; Zainuddin *et al.*, 2019). When condition factor value is higher it means that the animal has attained a better condition. In crustaceans, chelae length and width are important factors in aggressive behavior and play a significant role in determining competitive outcomes. Crayfish species compete for limited resources such as food, shelter, and space (Mazlum and Eversole, 2005); thus, morphometric relationships between chelae length and width may be very important to be studied.

The objective of the present study was to provide the baseline information on the length–weight relationships, sexual dimorphism and condition factors of redclaw crayfish from Atokan River, West Sumatera, Indonesia which will be beneficial for further reference especially for the management of the crayfish as non-native animal.

Materials and Methods

Males and females *C. quadricarinatus* were collected during January to February 2019 at a segment (between 0°19'33.00"S, 99°59'20.38"E and 0°19'20.67"S, 99°59'59.96"E) of Atokan River, District Lubuk Basung, Agam Regency, West Sumatera Indonesia (Fig. 1). The sampling location of crayfish was lo-

cated about 15 km west of Maninjau Lake. The riverbed of the river consists of rocks, pebbles, and sand with depths ranged from 0.5 to 1 m. Riparian vegetations were found in certain sites in riverbank offering plenty of shelters for crayfish.

Sampling of crayfish was conducted using five baited traps, the method usually used by local fishermen. The traps were baited with meat of fish, coconut and pellet-shape fish food and installed during one night (13-14 hours) (Purnamasari *et al.*, 2018). All collected crayfish were placed in clean plastic buckets and transported to the laboratory for analysis. The morphological identification followed Holthuis (1949) and Souty-Grosset *et al.* (2006). The measurement of morphometric parameters followed Purnamasari *et al.* (2018). The crayfish were placed on filter paper for several minutes to remove excess water, then weighed to the nearest 0.1 g. Total length (L, from the tip of the rostrum to the tip of telson), carapace length (CL, from the tip of the rostrum to the posterior median edge of the cephalothorax), carapace width (CW), chelae length (ChL, tip of propodus to carpal joint), and chelae width (ChW, greatest palm width) were measured to the nearest 0.1 cm. Only individuals with the complete chelipeds, full complement of walking legs and no visible body deformations were used to determine the length–weight relationships. Individuals were separated by sex, and ovigerous female crayfish were noted, but were not included in morphometric analysis.

To evaluate the sex ration, a chi-squared (χ^2) test

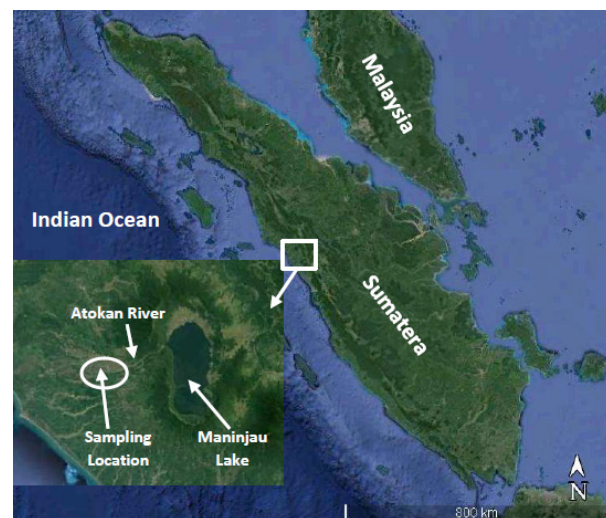


Fig. 1. Sampling location of *Cherax quadricarinatus* in Atokan River, West Sumatera, Indonesia

was used for the entire sample. The length-weight relationships (LWRs) were calculated using the equation $W=aL^b$, where W is the total weight of the crayfish (g), L is the total length (cm), a is the intercept, and b is the slope (Ricker, 1975). The parameters a and b were estimated by linear regression of the transformed equation: $\log W = \log a + b \log L$. The determination coefficient (r^2) was used as an indicator of the quality of the linear regression. The slope (b) is used to describe the growth type of crayfish: for $b = 3$ growth is isometric, for $b < 3$ is negatively allometric and for $b > 3$ is positively allometric (Zar, 1999). Difference between L , W , ChL , ChW , CL and CW values of females and males was tested using the student's t-test (Zar, 1999).

The Fulton's condition factor (K) was calculated using the equation $K=100(W/L^3)$ (Ricker, 1975), where W is the total weight of the crayfish (g) and L is the total length (cm). K values of crayfish were determined separately according to the total length of female and male individuals excluded ovigerous female and crayfish with incomplete claws and legs. Difference between K values of females and males was tested using the student's t-test (Zar, 1999).

During the collection of crayfish, water quality parameters of habitat such as temperature, pH, and dissolved oxygen were 26 - 27°C, 7.9 - 8.0, and 5.12 - 8.41 mg/L.

Results

Sex ratio, length-weight relationship and condition factor

The characteristic of crayfish samples is presented in Table 1. The sex ratio (male : female) was found to be 1.3:1 ($p>0.05$). The LWRs for male and female's crayfish were described as follows: $W=0.184L^{2.108}$ and $W=0.108L^{2.301}$ (Table 2). Male and female's crayfish exhibited negative allometric growth ($b<3$). The length-weight relationship was not significantly

Table 1. Crayfish sample characteristic

Category	N	Number of crayfish with incomplete cheliped	Ovigerous female
Male	37	11	-
Female	20	8	9
Total	57	19	9

Note: N = number of crayfish

Table 2. Weight-length regression analysis and condition factor (K) of crayfish from Maybrat Papua Indonesia

Category	N	Total length (cm)		Weight (g)		Parameter of relationship		Growth type	K		
		Mean ± SD	Min Max	Mean ± SD	Min Max	a	b		Range	Mean ± SD	
Male	37	8.48 ± 1.36 ^a	5.66 11.10	17.56 ± 7.41 ^a	9.00 36.20	0.184	2.108	0.777	-A	1.72 - 4.96	2.85 ± 0.75 ^b
Female	20	9.28 ± 1.23 ^b	6.41 11.61	18.89 ± 6.51 ^a	7.80 33.80	0.108	2.301	0.849	-A	1.50 - 3.07	2.32 ± 0.37 ^a
Total	57	8.76 ± 1.36	5.66 11.61	18.02 ± 7.07	7.80 36.20	0.193	2.070	0.782	-A	1.52 - 6.60	2.67 ± 0.69

Note: N = number of crayfish, SD = standard of deviation, K = condition factor, a = intercept, b = slope, r^2 = determination coefficient, -A= negative allometric growth, lowercase (a) indicates no significant difference ($p>0.05$).

Table 3. Chelae length, chelae width, carapace length, carapace width and chelae weight-length regression of crayfish from Maybrat Papua Indonesia

Category	N	Chelae length (cm)		Chelae width (cm)		Carapace length (cm)		Carapace width (cm)	
		Mean ± SD	Min Max	Mean ± SD	Min Max	Mean ± SD	Min Max	Mean ± SD	Min Max
Male	37	2.79 ± 0.57 ^a	1.90 4.10	0.89 ± 0.28 ^a	0.50 1.31	3.98 ± 0.72 ^a	1.6 6.0	1.70 ± 0.45 ^a	0.6 4.1
Female	20	2.80 ± 0.67 ^a	1.34 4.70	0.99 ± 0.53 ^a	0.51 2.10	4.37 ± 0.54 ^b	3.12 5.54	1.84 ± 0.39 ^a	1.10 2.91
Total	57	2.80 ± 0.60	1.34 4.70	0.93 ± 0.39	0.4 2.5	4.12 ± 0.69	1.6 6.0	1.75 ± 0.43	0.6 4.1

Note: N = number of crayfish, SD = standard of deviation, a = intercept, b = slope, r^2 = determination coefficient, different letters indicate significant difference ($p<0.05$, $a<b$)

different between males and females (ANCOVA; $p > 0.05$). The condition factor (K) for males and females were 2.85 and 2.32 respectively (Table 2). The K value of male was higher than that of female ($p < 0.05$).

Sexual dimorphism

There was no significant difference between weight of males and females, however the total length of females was longer than male. (Table 2). Carapace width of males and females were not significantly different, meanwhile carapace length of female was longer than male (Table 3). The chelae length and chelae width of males and females were not significantly different.

Discussion

The sex ratio (females:males) of *C. quadricarinatus* from Atokan River was close to 1:1. This similar sex ratio was found for *C. quadricarinatus* from Maninjau Lake at February 2017. Other researches confirmed that the most sex ratio of crayfish populations both natural and aquaculture which is close to 1:1 (Abrahamsson 1971; Kirjavainen and Westman, 1999; Mukti *et al.*, 2007). However, Purnamasari *et al.* (2018) found the number of females exceeded the males of *C. quadricarinatus* in Maninjau Lake on Oct 2017. Similarly, Westman and Pursiainen (1982) observed the number of females *Astacus astacus* exceeded the males in Slickolampi Lake Finland. This uneven sex ratio may result from the increased activity of the females that had molted after the hatching of the juveniles (Westman and Pursiainen, 1982; Purnamasari *et al.*, 2018). Other researchers found the higher catches of males than females for other crayfish species, such as *Astacus leptodactylus* (Deniz Bok *et al.*, 2010), *Austropotamobius pallipes* (Grandjean *et al.*, 2000), *Orconectes limosus* (Duris *et al.*, 2006), and *Pacifastacus leniusculus* (Capurro *et al.*, 2007). The higher catch of males than females could be caused by the fact that the males of crayfish were more active than the females, therefore the males are more frequently trapped than the females. The occurrence of ovigerous females (8.41 – 13.51 cm length size) during this study indicating that breeding populations are established in this river. The success in reproduction could be supported by the optimum water temperature (26-27 °C), sufficient dissolved oxygen (5.12 – 8.41 mg/L), food supply (riparian vegetation), and shelters (rocky substrates) in

Atokan River. Jaklic and Vrezec (2011) reported that adult and sexually maturity of *C. quadricarinatus* were found in habitat with the dissolved oxygen level between 2.8 and 7.2 mg/L and the temperature range from 21 to 31 °C.

The LWRs of males and females *C. quadricarinatus* from Atokan River were similar with those from Maninjau Lake (Purnamasari *et al.*, 2018), they had the negative allometric growth ($b < 3.0$). However, Austin (1995) and Rodriguez-Canto *et al.* (2002) observed positive allometric and isometric growths of *C. quadricarinatus*, respectively. The difference of growth types of crayfish among species and locations may be a reflection of a number of factors, including population density, food abundance, photoperiod, water level fluctuations, water quality, and sampling method (Acosta and Perry, 2000).

The values of condition factor (K) of males were higher than those of females. Similarly, K values of males *C. quadricarinatus* in Maninjau Lake were higher than female. Crayfish lived in Atokan River had K values ranged from 1.72 to 4.96 for males and 1.50 to 3.07 for females respectively. According to Weya *et al.* (2017) the crayfish in Atoka River has attained a better condition ($K > 1$). Crayfish inhabiting habitat without any anthropogenic influence upon their habitat and with a variety of suitable shelters has higher values of K (Anderson and Simon, 2015). Atokan River which is characterized by rocky and sandy substrate, high dissolved oxygen, suitable temperature, and plenty of riparian vegetation provides a suitable environment and food supply for crayfish. Similarly, Weya *et al.* (2017) and Purnamasari *et al.* (2018) Sedik *et al.* 2019, reported that crayfish living in a habitat which provides the more suitable environment and higher supply of food have higher values of K.

Sexual dimorphism is common in freshwater crayfish species (Wang *et al.*, 2011). During study we observed that total length and carapace length of female *C. quadricarinatus* in Atoka River were higher than those of male. Meanwhile, weight, carapace width, chelae length and chelae width of males were not significantly different than those of females. Our previous study showed that male *C. quadricarinatus* from Maninjau Lake had chelae length and chelae width higher than those of female (Purnamasari *et al.*, 2018). In crustaceans, chelae's sizes are important factors in aggressive behavior, and play a significant role in activities related to sexual reproduction and to competition for food, shelter, and space

(Mazlum and Eversole 2005).

Conclusion

The present study is the first report on the growth and morphometry of *C. quadricarinatus* in Atokan River, West Sumatera, Indonesia. This study provides baseline information on length-weight relationships, sex ratio, sexual dimorphism, and condition factors of red claw crayfish that will be useful for further reference.

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