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Morphology Variation of *Macrobrachium lar* (Fabricius, 1798) occuring in Rivers of Manokwari, West Papua, Indonesia

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ABSTRACT

Morphology character is the result of interaction between genetic and environmental factor, and the last factor is the dominant factor of variation. Morphometric character of shrimp is required to determine the value of portion of body part that can be consumed, so that it can be used as baseline in designing breeding program. This research aimed to study the variation of morphometric and meristic of *Macrobrachium lar* population from several rivers i.e. Andai, Wariori, Muara Prafi and Pami, in Manokwari West Papua Province. We found eight morphometric characters which were significanly different ($p<0.01$) among lar shrimp populations. Among the eight characters, there were three best morphometric characters, body weight (BT), total length (PT), and rostrum length (PR) that could be used for determining the differences between populations. Total number of upper teeth rostrum ranged between 7-9, while lower teeth ranged between 0-5. The meristic characters between populations were not significanlly different ($p>0.05$). Morphometric characters of Andai and Pami population tended to similar each other as well as those of Wariori and Muara Prafi population. It showed that the similarity of the characters might related to close distance of the rivers. Although the four those rivers came from different upstream source, the closer distance of the *M. lar* population, the closer genetic relationship of *M. lar* population.

1. Introduction

Indonesia has various species of freshwater shrimp which are potential to be develop. *Macrobrachium lar* (Palaemonidae family), or commonly known as monkey river prawn, is freshwater shrimp which spread naturally in Indonesia including Papua region. This shrimp have lage size (adult shrimp > 140 mm), fast growth relativelly, and good taste (Lal *et al.* 2014).

Macrobrachium lar is commonly sold by local people in Manokwari at traditional market. The price is quite high, which is around IRD. 40,000-80,000/ kg. The continuous chatching will result the decline of this shrimp population in nature (Nandlal 2005; Fauzi 2013). Therefore, conservation efforts need to be undertaken by first examining the aspects relating to these shrimp.

The information of *M. lar* is still less well known. However some the studies have undertaken, although only on limited fields such as on biology and taxonomy (Riek 1951; Short 2004; Nandlal 2005; Sethi *et al.* 2013b), reproduction (Lal *et al.* 2014), and food (Sethi *et al.* 2013a). The study of morphometric character of a population is very important, because such study intend to determine the value of the portion of the body part that can be consumed so that it can be used as baseline in designing breeding program (Wahidah *et al.* 2017).

Morphometric character of a population is the result of interaction between the genetic and environment factors. The geographical condition of Manokwari varies widely, ranging from coastal, lowlands, highlands to mountains. Thus geographical variations resulted formation of several watersheds (DAS) in this region. The geographical location, springs, flow direction and vegetation conditions along the rivers could caused the morphology variation of *M. lar* This research aimed to figure out the morphometic characters of *M. lar* from four rivers in Manokwari.

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2. Materials and Methods

This research was conducted from December 2014 to January 2015. The research sites were located on Andai River, Wariori River, Muara Prafi River and Pami River, in Manokwari, West Papua Province. At each site, 20 samples of adult size of *M. lar* were collected. Measurement of morphometric and meristic characters were performed at Zoology Laboratory of Biology Department FMIPA University of Papua.

The morphological character observation was conducted based on observation method of Munasinghe and Thusari (2010). 11 morphometric characters and two meristic characters were measured i.e weight (gr), total length (mm), abdominal length (mm), telson length (mm), carapace length (mm), carapace widht, carapace diagonal length (mm), rostrum length (mm), first abdominal length (mm), first abdominal widht (mm), second abdominal length (mm), upper and lower teeth rostrum. Measurements of length, width and body weight of morphometric shrimp were performed using digital veener calliper with 0.01 mm accuracy level, while the observation of meristic character was done by counting the number of rostrum teeth. Symbol and definiton of morphological characteristics were presented in Table 1.

2.1. Data Analysis

Analysis of morphology variation were done based on morphometric dan meristic character. Mean and standard deviation were analyzed descriptively. Difference of morphometric character of *M. lar* were analyzed using One Way Analysis of Variance (ANOVA) and Duncan (DMRT) test. In order to finding the best character in characterizing differences among populations Analysis Principal Component Analysis (PCA) were used. All analysis were performed using R program version 3.1.2 (R Development Core Team 2014) and SPSS 19.0 version. Before all characters analyzed statistically, data measurement of morphometric character was standardized through regression analysis, that is length of carapace as standard length (independent) and ten other morphometric parameter as character influenced by carapace length (dependent) (Munasinghe and Thusari 2010).

3. Results

The sample of *M. lar* were collected from four locations: Sungai Andai, Sungai Wariori, Sungai Muara Prafi and Sungai Pami. Each location was collected 20 samples. Total number of *M. lar* were 80 samples. The total length of *M. lar* ranged 92.67-142.27 mm and the body weight ranged 12.50-47.70 g.

Table 2 showed statistic analysis of 11 morphome tric analysis of *M. lar* using ANOVA test. The result showed that eight character morphometric of *M. lar* (body weight/BT, total length/PT, abdomen length/ PAb, telson length/PTel, rostrum length/PR, first abdomen length /1PAp, first abdomen widht/LAP and second abdomen length/2PAk) interpopulation were significantly different ($p<0.05$), while carapace length (PK), carapace widht (LK) and carapace diagonal length (PDK) were not showed the different. Based on DMRT test result at $p<0.05$ showed that *M. lar* population from Andai river differ to Wariori river. The three character of carapace (PK, LK, and PDK) were not showed the differences interpopulation.

Eight morphometric characters which found significantly different according to ANOVA test then continues to analyze using PCA analysis for finding the best character morphometric in characterizing differences inter population of *M. lar.* Table 3 showed that three components (PC) be able to inform 99.22% of morphometric characters of *M. lar* which were significantly different (BT, PT, Pab, PTel, PR, 1PAp, LAP, and 2PAk). The first component (PC1) was able to explain 91.66% of these characters.

Table 1. Symbol, characteristic, and definition of morphology character of *M. lar*

Morphometric character	Symbol	Definition of characteristic
Body weight	BT	Body weight in fresh
Total length	PT	The distance between the tip of the rostrum and the tip of the telson
Abdomen length	Pab	The distance between the first segment and the tip of the telson
Telson length	Ptel	The maximum length of the telson
Carapace length	PK	The distance between the eye and the base of the carapace
Carapace widht	LK	The maximum widht of the carapace
Carapace diagonal length	PDL	The distance between the base of the eye and the base of lower carapace
Rostrum length	PR	The distance between the tip of the rostrum and the base of the rostrum
First abdominal length	1Pap	The maximum length of the first abdominal
First abdominal widht	LAP	The maximum widht of the first abdominal
Second abdominal length	2Pak	The maximum length of the second abdominal

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Table 2. Statistic analysis result of morphometric characters of *M. lar* (ANOVA & DMRT)

Morphometric Character	Location	Mean	Standart Deviation (SD)	Significancy (*p value*)
Body weight (gr)	Andai	18.67[a]	4.47	0.002*
	Wariori	27.07[b]	12.69	
	Muara Prafi	20.07[a]	5.37	
	Pami	27.36[b]	9.62	
Total Length (mm)	Andai	105.59[a]	6.21	0.000*
	Wariori	120.26[c]	15.19	
	Muara Prafi	115.39[bc]	7.85	
	Pami	110.74[ab]	10.77	
Abdomen Length (mm)	Andai	57.92[a]	3.14	0.000*
	Wariori	65.43[b]	7.63	
	Muara Prafi	62.29[b]	3.84	
	Pami	62.50[b]	4.97	
Telson Length (mm)	Andai	13.61[a]	1.09	0.016*
	Wariori	15.14[b]	2.19	
	Muara Prafi	14.56[ab]	0.97	
	Pami	14.79[b]	1.56	
Carapace Length (mm)	Andai	36.30[a]	2.66	0.162
	Wariori	38.79[a]	6.59	
	Muara Prafi	35.80[a]	3.04	
	Pami	37.78[a]	5.04	
Carapace Widht (mm)	Andai	17.64[a]	1.72	0.151
	Wariori	18,54[a]	3.14	
	Muara Prafi	17.97[a]	1.57	
	Pami	19.16[a]	2.11	
Carapace Diagonal Length (mm)	Andai	35.13[a]	2.82	0.185
	Wariori	37.40[a]	6.49	
	Muara Prafi	34.60[a]	3.10	
	Pami	36.85[a]	5.24	
Rostrum Length (mm)	Andai	27.06[a]	2.03	0.000*
	Wariori	32.48[b]	4.72	
	Muara Prafi	32.35[b]	2.96	
	Pami	27.11[a]	3.56	
First Abdominal Length (mm)	Andai	5.35[a]	0.41	0.002*
	Wariori	6.09[b]	0.87	
	Muara Prafi	5.70[ab]	0.43	
	Pami	5.85[b]	0.53	
First Abdominal Widht (mm)	Andai	16.23[a]	1.26	0.006*
	Wariori	17.87[b]	2.00	
	Muara Prafi	17.01[ab]	1.21	
	Pami	17.01[ab]	0.98	
Second Abdominal Length (mm)	Andai	8.55[a]	0.49	0.000*
	Wariori	9.80[bc]	1.04	
	Muara Prafi	9.45[b]	0.67	
	Pami	10.14[c]	0.77	

* The difference of characters interpopulation were performed using ANOVA at p< 0.05. The value of mean followed by the same subset alphabet (a,b,or c), indicates not significantly different according to DMRT at p < 0.05

Table 3. PC1, PC2, and PC3 of eight characters morphemetr*ic M. lar*

Morphemetric character	PC1	PC2	PC3
Body weight (BT)	-0.54441604 *	0.773251974 *	0.30534756 *
Total Length (PT)	-0.71646701 *	-0.441143742 *	-0.04010509
Abdominal Length (PAb)	-0.34805244 *	-0.013290474	-0.67104710 *
Telson Length (PTel)	-0.09456418	0.009294044	-0.01009236
Rostrum Length (PR)	-0.22900599 *	-0.452061793 *	0.56056243 *
First Abdominal Length (1PAp)	-0.03667661	0.010653727	-0.04182585
First Abdominal Widht (LAP)	-0.06786950	-0.003598693	-0.32031969 *
Second Abdominal Length (2PAk)	-0.04252209	0.052194351	-0.19016848 *
Standart Deviation	16.1362	4.30903	1.7025
Varians Proportion	91.66%	6.54%	1.02%
Accumulation Proportion	91.66%	98.20%	99.22%

* the value of charater ≥ 0.1

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PC1 showed the value with the same direction of all morphometric characters, while in PC2 the value of BT, PTel, 1PAp, and 2PAk contrast with the value of PT, PAb, PR and LAP. It means, according to PC2 if the values of BT, PTel, 1PAp, and 2Pak increased, so the values of PT, PAb, PR, and LAP decreased. In PC3, the values of BT and PR were contrast with the other character values. Therefore, three character morphometrics (body weight/BT, total length/PT and rostrum length/PR) were the best morphometric characters for characterizing the differences among *M. lar* populations, because the variation proportion of PC1 (91.66%) and PC2 (6.54%) is greater than PC3 (1.02%). Thus, the characters with the greatest value ≥ 0.1 in PC1 and PC2 were strongly influence the differences among *M. lar* populations.

Figure 1 showed the cluster of four groups of *M. lar* based on the first component (PC1) and the second component (PC2). However, some individuals appeared to interconnected between populations. Wariori population had a wide distribution, but more interconnected to the Muara Prafi population compared with Andai population. Meanwhile, the Pami population only interconnected with Andai population. Thus the morphometric characters of the *M. lar* from Wariori River were more similar to the Muara Prafi River, whereas *M. lar* population of the Pami River were more similar to Andai River.

The *M. lar* meristic had upper teeth rostrum (NaR) ranging between 7-9 and lower teeth rostrum (NbR) ranging between 0-5 (Table 4). Table 4 showed the range of upper teeth rostrum of the shrimps from Andai River population were different from the other three populations. While based on the range of lower teeth rostrum of the population of Muara Prafi and Pami were different from those of Andai and Wariori. The result of Kruskal-Wallis test in Table 5 showed that there were not significantly different (p>0.05) on the meristic character among *M. lar* population.

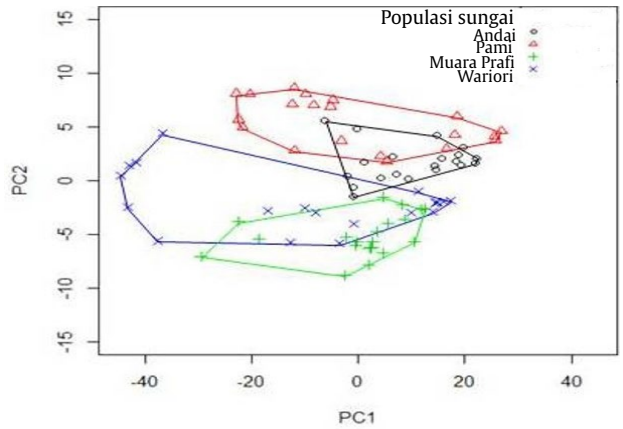

Figure 1. Scatterplot PC1 and PC2 of eight morphometric characters (BT, PT, PAb, PTel, PR, 1PAp, LAP, and 2Pak) of *M. lar*

Table 4. Total number of meristic character of *M. lar* in four location

Location	Meristic character range	
	Total number upper teeth rostrum (NaR)	Total number lower eeth Rostrum (NbR)
Andai	8-9	1-5
Wariori	7-9	0-3
Muara Prafi	7-9	2-3
Pami	7-9	2-3

Table 5. Kruskal-Wallis test of meristic characters of *M. lar*

Location	Meristic character range	
	Total number upper teeth rostrum (NaR)	Total number lower eeth Rostrum (NbR)
Andai	45.28	46.80
Wariori	41.00	37.10
Muara Prafi	42.03	38.10
Pami	33.70	40.00
p-value	0.305	0.440

4. Discussion

M. lar in Manokwari rivers varied in morphometric characters. We found three morphometric characters (body weight/BT, total length/PT and rostrum length/PR) which were the best and could be used for characterizing the differences among *M. lar* populations. It was caused by the variation proportion of PC1 (91.66%) and PC2 (6.54%) which were greater than PC3 (1.02%), so that the character with the greatest value (≥ 0.1) in PC1 and PC2 were strongly influence the differences between *M. lar* population. Therefore, the three characters have been able to represent other characters in showing the differences in morphometric characters among *M. lar* population. Sethi *et al.* (2013) also explained that morphometric characters of *M. lar* in Andaman island varied between sex. Correlation analysis between the morphometric characters showed that the total length (PT) was significantly correlated with telson length (PTel), whereas body weight (BT) was correlated with carapace length (PK), carapace width (LK), abdomen length (PAb), and while rostrum length (PR) was not correlated with the other characters. Other shrimp in South Sulawesi, M. *rosenbergii*, which is closed relationship with *M. lar,* also showed having the variation of morphometric characters in three locations (Wahidah *et al.* 2017).

Upper teeth rostrum (NaR) of *M. lar* ranged between 7-9 and lower teeth rostrum (NbR) ranged between 0-5. Total number of rostrum teeth in this study were still relatively within the range of study of Short (2004) which stated that *M. lars* have 7-9 teeth on the top (dorsal) and 2-4 teeth on the bottom (ventral). Munasinghe and Thusari (2010) reported that meristic characters can not be used to indicatethe differences between populations of *Macrobrachium rosenbergii* prawns. So it can be said that the meristic character

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is a trait which was not influenced by geographical differences and environmental conditions. Thus meristic characters of rostrum characteristics can be used as a tool for identifying and for differentiating *M. lar* with other freshwater prawns (Palaemonidae Family) as well as giant prawns (New 2002).

Morphometric differences among populations with different geographies can be caused by differences of genetic structure and environmental conditions. Between the two, the enviromental conditions were the dominant factor affected morphology variations. The presence of morphometric characters that have the same value indicated the occurrence of mixing between populations or the traits were maintained when a gene flow occurs. Thus it can be said that the Carapace Length (PK), Carapace Widht (LK), and Carapace Diagonal Length (PDK) were the traits maintained by *M. lar,* while other morphometric characters (BT, PT, Pab, PTel, PR, 1PAp, LAP, and 2PAk) were affected by geographical differences and environmental conditions of *M. lar* habitats (Kusrini *et al.* 2009; Munasinghe and Thusari 2010). Trijoko *et al.* (2013) reported water quality, substrate structure, and food composition were the environment condition which could affected adaptation morphology of shrimp.

Based on cluster analysis, *M. lar* population from Wariori dan Muara Pami tended to similar each other, while *M. lar* population from Andai and Pami also tended to similar. The similarity of morphometric characters between those rivers might be related to the closer distance between Wariori and Muara Pami, as well as between Andai and Pami. Wariori is the longest river among other rivers and the river upstream comes from Arfak mountain, while the upstream of the three other rivers come from different source. Although the four those rivers come from different upstream source, the *M. lar* population which had closer distance to each other, might have a closer relationship genetically compared to the *M. lar* population coming from the remote river.

We conclude that *M. lar* in the rivers area of Manokwari have difference of morphometric characters based on the differences of geography. The three morphometric characters (body weight/BT, total length/PT, and rostrum length/PR) were determine the differences between populations. The cluster of *M. lar* population shows that morphometric of *M. lar* from Andai and Pami relatively different with Wariori and Prafi.

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