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# Morphological Diversity of Banana Shrimp (*Penaeus merguiensis* de Man 1888) in Northern And Southern Java Water Areas

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**Abstract**

Banana Shrimp (*Penaeus merguiensis* de Man, 1888) is a type of penaeid shrimp with high economic value and offers many benefits to be cultivated. This study aimed to determine the genetic distance of banana shrimp from northern part of Java water areas, namely the water areas of Semarang and Lamongan, while the southern part selected were the waters of Sukabumi and Purworejo. Morphometric measurements were determined using 23 morphological characters. Discriminant analysis was used to define the morphological diversity among the four populations of banana shrimp. The results showed that the morphological characteristics of banana shrimp from Semarang and Lamongan (Northern Java water areas) with banana shrimp from Sukabumi and Purworejo (Southern Java water areas) were different. Cluster analysis was conducted to group the similarity level which was divided into two main clusters, where the first cluster was banana shrimp from the population of Semarang, Sukabumi, and Purworejo. Second cluster was banana shrimp belonged to Lamongan population. Genetic distance that has the closest kinship was banana shrimp from the population of Sukabumi and Purworejo (32.166) and the furthest kinship is banana shrimp of Semarang and Lamongan (67.552).

**Keywords**: Genetic distance, Morphometrics, Northern and Southern Java water areas, Banana shrimp

## INTRODUCTION

Banana Shrimp (*Penaeus merguiensis* de Man, 1888) or commonly known as bannana prawn or white shrimp is a shrimp native to the waters of Indonesia and Southeast Asia. Fishing areas of Banana shrimp in Indonesia spread almost in all

coastal waters, particularly in shallow waters around the estuary and mangrove areas (Naamin, 1992). Banana shrimp caught by fishermen in Javanese waters predominantly uses mini bottom trawl (Ernawati, 2010) and trammel net (Budianto, 2012).

The case of banana shrimp fishing in Indonesia is already at an alarming level as the amount of banana shrimp catch according to statitistical data in 2016 stated that the yield of banana shrimp fishing in Northern Java water area in 2012-2014 reached 9.109 tons, 6.654 tons and 6.068 tons. The yield of banana shrimp fishing in Southern Indian Ocean in 2012-2014 reached 957 tons, 1.091 tons and 398 tons. It can be concluded that the yield of banana shrimp fishing in Northern and Southern Java water area has decreased on each year due to the occurrence of over fishing. It was also reported that the estimation of penaeid shrimp resources in Northern and Southern Java water area was in the status of over exploitation (KEPMEN-KP/50/2017). The activity of preserving banana shrimp in nature must be carried out through cultivation activities. Banana shrimp offers many advantages if it is cultivated properly, among others; 1) The availability of banana shrimp broodstock spread through almost at the entire Indonesian water areas as geographical advantage that facilitates the development of this commodity. 2) The size of banana shrimp can be as big as tiger shrimp with faster growth. 3) The broodstock of banana shrimp has a relatively short reproductive cycle compared to tiger shrimp, and banana shrimp can reach matured gonads and spawn in big ponds. 4) The growth rate of banana shrimp is very fast with relatively easy larval rearing, 5) Banana shrimp is very tolerant to the wide range of salinity and temperature. 6) Low level of size variability, followed by stable market demands (Hoang, 2001). 7) Banana shrimp is resistant to disease (Haryati *et al.*, 2005), 8) In terms of feed, these shrimp require low levels of protein for normal growth, and feed on detritus (Hoang, 2002). It is expected that banana shrimp can become a superior shrimp commodity in Indonesia.

The series in banana shrimp cultivation activities, one of which is hatching activities of banana shrimp by examining the broodstock potential to support its domestication activity. Important aspect playing as essential role in domestication is the provision of qualified broodstock based on the genetical characterization of banana shrimp broodstocks. Collecting information or genetic basis data from a species is an initial requirement to determine its genetic differences or kinship. Data on kinship relations or genetic differences of each species will be very helpful in formulating cultivation management policies and genetic resources conservation in nature. Knowledge of the morphological and genetic variation of species in water areas around Semarang, Lamongan, Sukabumi and Purworejo is very important to obtain qualified banana shrimp broodstock in designing sustainable cultivation and shrimp conservation (Tsoi *et al.*, 2005, Mandal *et al.*, 2012).

## MATERIAL AND METHOD

### Sampling Location

Shrimp sampling was conducted in four different locations, namely the water areas of Northern Java water areas consisting of Semarang and Lamongan water areas, Southern Java water areas selected was Sukabumi and Purworejo water areas (Figure 1). Total sample of each location was 50 samples. The sampling procedure was done with the assistance of local fishermen using trammel net. Shrimps were put into the net and on the coolbox, then given shaved ice cubes and brought to the laboratory.

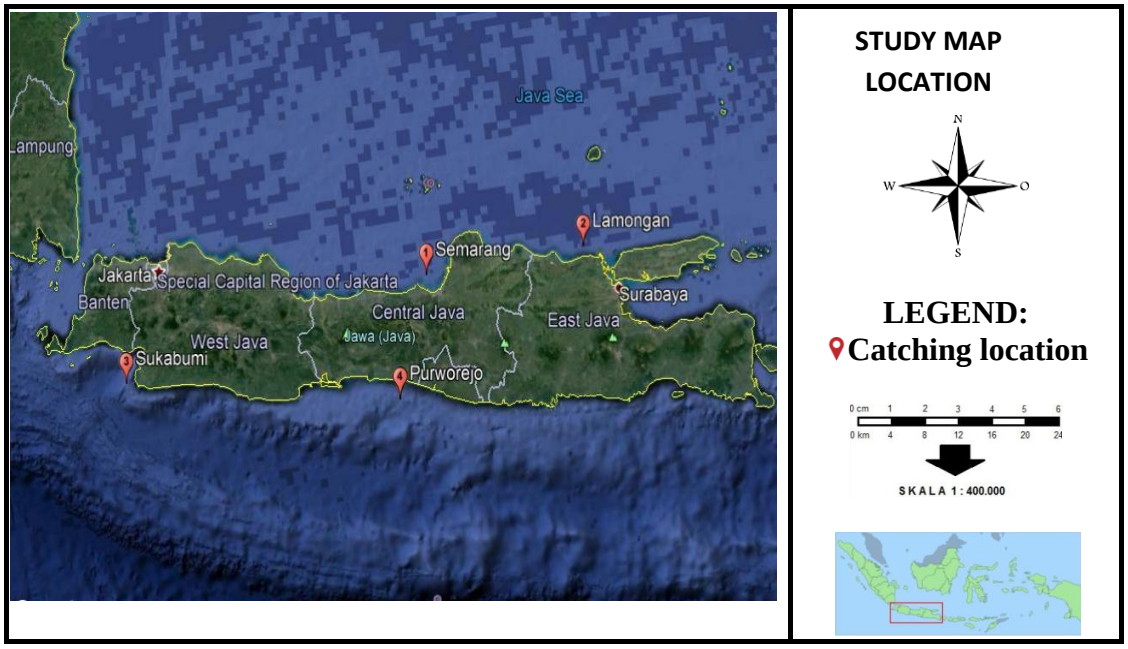


**Figure 1.** Sampling Location of banana shrimp, *P. Merguiensis* in Semarang, Lamongan, Sukabumi and Purworejo.

### Morphometric Measurement

Shrimp samples collected from each study site was morphologically measured using capilar pipe with 0.01 mm accuracy; while the weight of shrimp was measured using *O-Hause* scales with 0.01 g accuracy. Morphometric measurement is a modification of the measurement technique carried out by Dall (1957) and Lester (1983). Morphometric measurements uses 23 morphological characters, namely prosertema length (PPt), rostrum length (PR), partial carapace length (PKP), Carapace depth (DK), carapace length (PK), standard length (PS), first segment length (PR1), second segment length (PR2), third segment length (PR3), fourth segment length (PR4), fifth segment length (PR5), sixth segment length (PR6), first segment depth (DR1), second segment depth (DR2), third segment depth (DR3), fourth segment depth (DR4), fifth segment depth (DR5), sixth segment depth (DR6), anterior abdominal circumference (LAA), posterior abdominal circumference (LAP), Telson (TS), Exopod (Ex), Endopod (En), Total Weight (BT), Total Length (PT).

**Data Analysis**

The measurement results of 23 morphometric characters were correlated with the total length to avoid different sizes and possibility of different ages. Data was converted into percentage and transformed into arcsin. Data was analyzed using Multivariate analysis containing Discriminant Analysis used to observe differences between groups of characteristics observed in four populations of banana shrimp and determine the distribution pattern of morphological characteristics of banana shrimp from four sampling locations. Hierarchical Cluster analysis was conducted to determine the genetic distance matrix and dendograms of four populations by using between group linkage method and Squared Euclidean Distance measurements.

## RESULT AND DISCUSSION

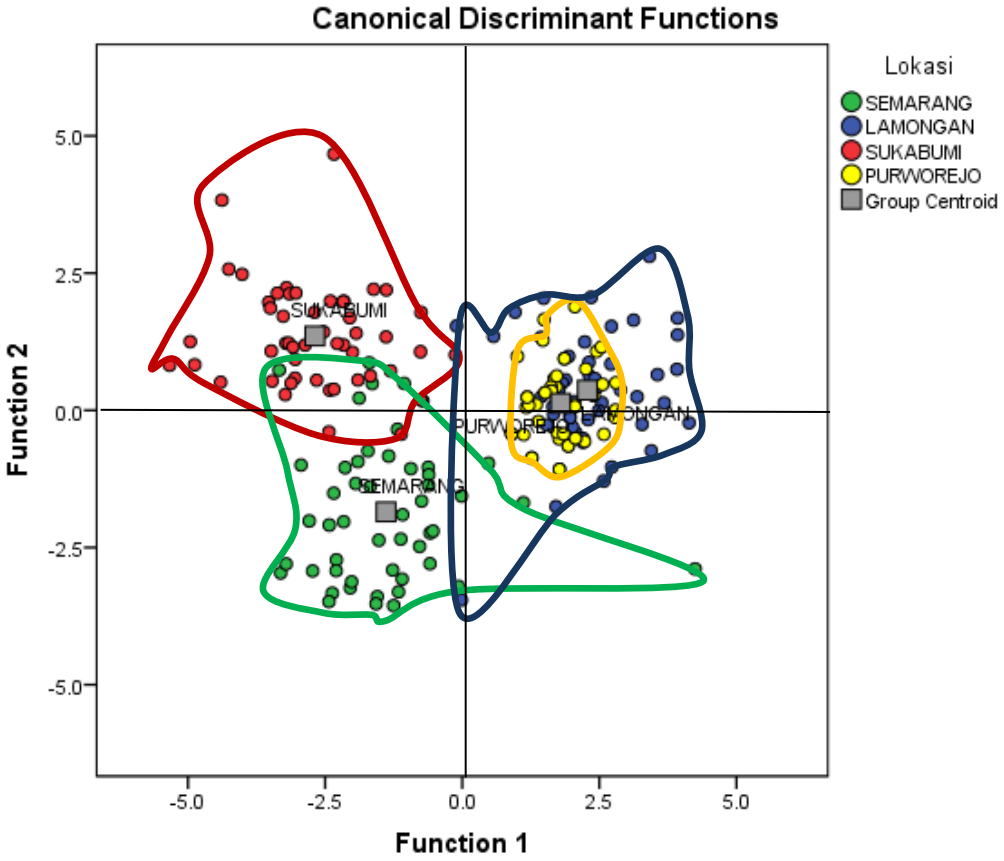


**Figure 2.** Distribution Pattern of Banana Shrimp Population Groups in northern and southern of Java water areas based on morphological characteristics

The results of Kanonical Discriminant function analysis showed that the morphological characteristics of banana shrimp from Purworejo and Lamongan at

centroid points appear to be centered and closed to the positive right x axis and vice versa, centroid point of Sukabumi shrimp population was located on the negative left x axis, and Semarang banana shrimp population centroid points were at downward negative y axis. The distribution pattern of banana shrimp population groups based on morphological characters (Fig. 2) shows that four populations clustered into three groups, namely Lamongan and Purworejo groups, Semarang group, Sukabumi group, whereas three groups intersect each other. According to Suparyanto et al., 1999 intersecting groups indicates the closeness of phenotypic characters between samples. According to the figure of population distribution it can be seen that Lamongan population intersects with Sukabumi and Semarang population.

**Table 1.** Phenotype mixing in and between population (%) of banana shrimp

| **Location** | **Semarang** | **Lamongan** | **Sukabumi** | **Purworejo** | **Total (%)** |
|---|---|---|---|---|---|
| Semarang | 84 | 0 | 10 | 6 | 100 |
| Lamongan | 2 | 62 | 2 | 34 | 100 |
| Sukabumi | 4 | 0 | 94 | 2 | 100 |
| Purworejo | 0 | 0 | 0 | 100 | 100 |

Morphometric character similarity between populations studied can be seen using the sharing component estimation or similarity value (Index of similarity) from the results of discriminant analysis. The highest internal morphometric characteristic similarity was shown by banana shrimp population from Purworejo of 100% (50). The diversity in internal population of Sukabumi was 94% (47), sharing with 4% (4) of Semarang population and 2% (1) of Purworejo population. The internal diversity of Semarang population was 84% (42), sharing with 10% (5) of Sukabumi population and 6% (3) of Purworejo population. The lowest internal diversity was found in Lamongan population with 62% (31), sharing with 34% (17) of Purworejo population, 2% (2) of Semarang population, and 2% (2) of Sukabumi population. Parenrengi et.al, 2007 stated that morphological similarities indicate the occurence of measurable mixing between a population with another population.

The morphological similarities in Table 1 shows the existence of measurable mixing (Sharing component) between a population with another population. Variable size equation is a symptom of mixing between each region through gene mixture in the past. The largest similarity of body size was found in Purworejo population (100%), which means that the population has very high internal diversity. Lamongan population had the smallest internal sharing component value compared to other populations. In other words, internal population of banana shrimp in Lamongan is more diverse. Thus, Lamongan population can be used as broodstock sources for selection program. The results of this study on banana shrimp (*Fenneropenaeus merguiensis* De Man 1888) from 5 populations, namely Sunda, Pontianak, Strait,

Lombok, and Cilacap straits obtained phenotype mixing values in population ranging from 57,14% - 86,36% and between populations with 3,45%-21,43% (Kusrini, et.al 2009), while giant freshwater prawn (*Macrobrachium rosenbergii*) from three natural populations showed phenotype mixing value in population ranged from 68,33% - 90,00% and between populations ranged from 5,00%-26,67% (Hadie *et al*., 2002). The mixing value of the pama shrimp phenotype (*Penaeus semisulcatus*) in three populations of South and Southeast Sulawesi ranged from 67,8%-93,1% and between populations were 0.0% - 30.5% (Parenrengi *et al.*, 2007). Sharing components in four populations of finger shrimp (*Metapenaeus Elegans* De Man 1907) in Cilacap ranged from 65%-52,2% and between populations were 5%-32.5% (Soewardi *et al*., 2006).

The cluster characteristic analysis results of banana shrimp with mahalonobis approach obtained genetic distance matrix values of phenotypic characters as shown in Table 2. The closest kinship was found between population of Sukabumi and Purworejo with 32.166; followed by Sukabumi and Semarang of 35.360; Purworejo and Lamongan 43.472; Purworejo and Semarang of 44.341; Sukabumi and Lamongan of 53.109, while the farthest kinship was found between Lamongan and Semarang.

**Table 2.** Genetic distance matrix values between populations of banana shrimp *P. Merguiensis* from Semarang, Lamongan, Sukabumi and Purworejo

| Population | Semarang | Lamongan | Sukabumi | Purworejo |
|---|---|---|---|---|
| Semarang | 0 | | | |
| Lamongan | 67.552 | 0 | | |
| Sukabumi | 35.360 | 53.109 | 0 | |
| Purworejo | 44.341 | 43.472 | 32.166 | 0 |

The value of genetic distance matrix between populations of banana shrimp *P. Merguiensis* from Semarang, Lamongan, Sukabumi and Purworejo presented in Table 2 is the grouping basis for dendogram graphic. Genetic distance between populations is used to determine the distance and proximity of genetic distance matrix from each population observed (Soewardi *et al*., 2006). The closest genetic distance was found between Purworejo-Sukabumi population, while the farthest was found between Lamongan-Semarang population. The genetic distance value of phenotypic character can be used as a reference recommendation for population cross. Cross-breeding population between Lamongan and Semarang or Lamongan and Sukabumi is expected to significantly increase diversity compared to breeding between the population of Purworejo and Sukabumi or Sukabumi and Semarang. This is due to far kinship is assumed as heterosis can be obtained by the diversity carried by both sides. While breeding conducted between populations with closed kinship only produces heterosis from the group itself.

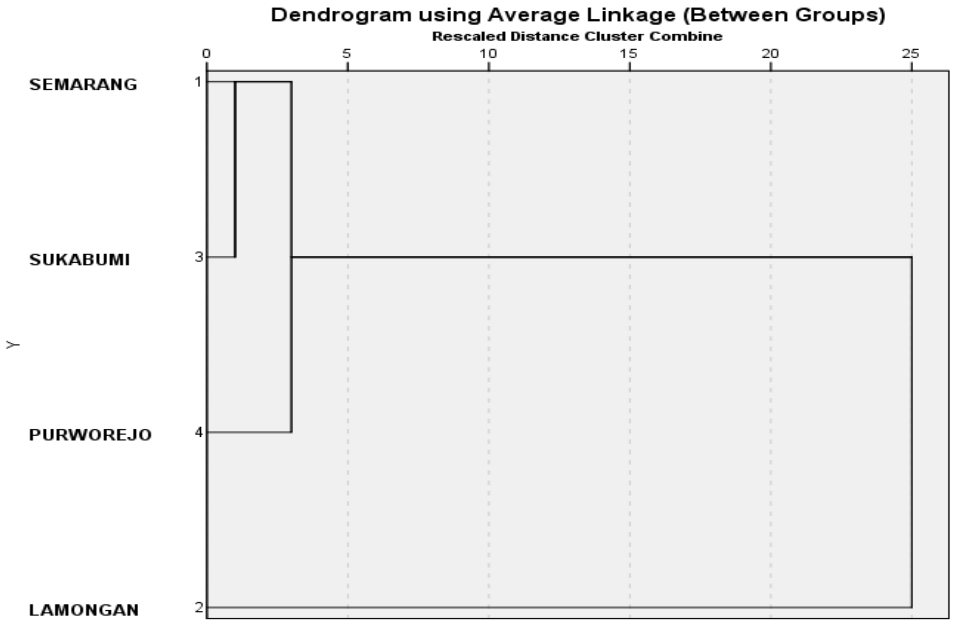


**Figure 3.** Dendogram of genetic distance of Banana shrimp (*F. Merguiensis*) from Semarang, Lamongan, Sukabumi and Purworejo

The dendogram of banana shrimp phenotypic observation from four populations (Figure 3) formed two main groups, namely Semarang-Sukabumi-Purworejo group and Lamongan group. Lamongan group was formed likely due to the different environmental conditions of shrimp population in Lamongan compared to shrimp populations in Sukabumi, Semarang and Purworejo, causing different morphometric differentiation between samples. This result is supported by Kursini *et al*., 2009 who stated that the individual phenotype is an expression of genotype and environment. According to Santhanam *et al*., 2011 differences in environmental conditions of tiger prawns resulted in morphometric differentiation.

## CONCLUSION

Through the diversity of morphometric characters of banana shrimp, it can be concluded that there are differences in morphometric characteristics of banana shrimp in four populations of northern and southern Java water areas grouped into two main groups, namely Semarang-Sukabumi-Purworejo group and Lamongan group. The value of mixing phenotypes in each population of banana shrimp ranged from 62% - 100% and between populations was 0% -34%. The closest kinship was found from southern Java water area, namely Sukabumi-Purworejo (32.166) and the farthest kinship was found from northern Java water area, namely Semarang-Lamongan (67.552).

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