Habitat Preferences and Abundance of Mole Crab at Spring and Neap Tide In Coastal Area Of Purworejo Central Java, Indonesia

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Habitat Preferences and Abundance of Mole Crab at Spring and Neap Tide In Coastal Area Of Purworejo Central Java, Indonesia

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Abstract

The South Coastal area of Central Java is a widely stretching sand area in Central Java including in Purworejo regency which possess potential to mole crab. Mole crab is a crustacean aquatic resource living on sandy intertidal areas. The more people know the economic value of mole crab, the more people will catch mole crab. Mole crab utilization which is not based on the proper information on mole crab habitat will affect on the population and habitat of mole crab. This study, conducted in December 2018 - January 2019 in Purworejo coastal area, aims to determine the abundance of mole crab at spring tide and neap tide, and to find out the distribution of mole crab and its habitat preferences. The method used is explanatory method while data collection and sampling method of mole crab abundance used transects 10 x 10 meter in three spring tide points and three neap tide points which include seawater submerged zones, swash zones, and temporal zones. The result showed the abundance of mole crab is 73- 135 individual/300m^2 at neap tide and 41-91 ind/300m^2 at spring tide. The distribution of mole crab for three species is *clumped*. The preferred habitat of mole crab is gentle beach slope, wide swash zone area, and medium sandy type with < 1 mm sediment diameter.

Keyword: Mole crab, abundance, distributions, habitat

INTRODUCTIONS

The south coastal area of Central Java which has direct border with Indian Ocean in the South is a widely stretching sandy area in Central Java, one of which is in Purworejo, possesses mole crab potential. Mole crab is an aquatic resource in the form of crustaceans living on sandy intertidal areas. Mole Crab is a species which likes to bury itself in the sand to avoid predators and to save energy (Boere, 2011). In addition, mole crab is one of marine potentials currently known and utilized by coastal communities. Coastal communities utilize mole crab as meals or snacks for beach tourists, and also as a livelihood for surrounding coastal communities.

The role of mole crab in the waters is as the first level consumers in food chain cycle. Moreover, mole crab is also as bio-indicator of environmental pollution (Dugan *et al.,* 2000). The more people recognize the economic value of mole crab, especially in Purworejo, the more people will catch mole crab. Thus, sporadic exploitation rates will be inefficient. Besides, it also will damage the ecosystem of the shore base againsts the waves. Accordingly, it is highly necessary to provide an accurate information about the habitat, population and distribution of mole crab in order to be wises to utilize mole crab and to make their populations preserved and sustainable. This study aims to determine the abundance of mole crab at spring tide and neap tide, as well as the distribution of mole crab and its habitat preferences.

MATERIALS AND METHODS

The material used in this study is mole crab found in Purworejo coastal area. The main variable is the abundance of mole crab at spring tide and neap tide, while the supporting variable is the habitat characteristics including temperature, pH, salinity, swash zone width, continental slope, organic materials/matters, humidity, texture and diameter of sediment. The method used is the explanatory method, which explains the relationship between two or more variables to test the hypothesis (Bungin, 2005).The sampling technique used in this research is simple random sampling technique. Simple random sampling is a sampling method which gives an equal chance taken to every element of the population (Sugiyono, 2017). Samples were taken at 6 stations (Figure 1 and Table 1) and every station has three points at spring tide and neap tide. Method of collection mole crab used transects 10 x 10 meters at three spring tide points and three neap tide points which include seawater submerged zones, swash zones, and temporal zones. Sampling was conducted in December 2018 - January 2019 in three replications in different weeks.

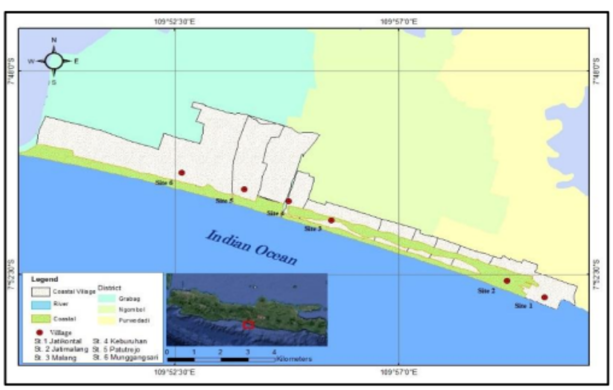

Figure 1. Sampling Locations

Table 1. Coordinates of Sampling Stations

Stations	Research site	Coordinate Position	
1	Jatikontal	7° 52' 28" LS	109 ° 59' 37" BT
2	Jatimalang	7° 52' 42" LS	109 ° 58' 43" BT
3	Malang	7 ° 51' 51" LS	109 ° 56' 25" BT
4	Keburuhan	7 ° 51' 18" LS	109 ° 54' 52" BT
5	Patutrejo	7 ° 50' 29" LS	109 ° 52' 1" BT
6	Munggangsari	7 ° 50' 54" LS	109 ° 53' 29" BT

Data analysis

a. Abundance

Formula of mole crab abundance (Odum, 1971):

$$K = N / A$$

Where :

K: Abundance (individual / 300m^2), N: Total number of individual (individual), A: area (m^2)

b. Distribution

Formula distribution of mole crab is seen from the standard error value (Fowler and Cohen, 1990):

$$S^2 = \frac{n\sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_1\right)^2}{n(n-1)}$$

Where:

S^2 : variance x : average

Xi : x to i n : Total number of samples

The result will have a meaning, if:

S^2 / x = 1 means random distribution (random)

S^2 / x> 1means the clumped distribution (clumped)

S^2 / x <1 means the uniform distribution (uniform)

c. Sediment texture

Calculation of percentage sediment weight can be measured using the formula:

$$\text{Wt} = \frac{weight\ fraction\ i}{\text{total sample weight}}\ \text{x}\ 100\%$$

The formula to determine the sediment grain size:

$$\text{sediment grain diameter (d)} = \Sigma\ \frac{weight\ percentage\ fraction\ \ x\ grain\ size\ fraction}{100}$$

d. Organic matter

Total organic matter content is calculated using the formula:

$$\text{Organic Materials} = \frac{(\text{Wt}-\text{C})-(\text{Wa}-\text{C})}{\text{Wt}-\text{C}}\ \text{x}\ 100\%$$

Where :

Wt : Total weight of *crucible* and sample before drying

Wa : Total weight of *crucible* and samples after drying

C : Weight of blank/empty *crucible*

e. Continental slope

Calculation of the continental slope appropriate in Figure 2 can be calculated using the formula:

$$\text{Tan}\ \beta = \frac{\text{h}}{\text{x}}\ \text{x}\ 100\%$$

Where :

β: Angle of the beach ; h : Height (m); x: Length of rope (m); f. Width of Swash Zone

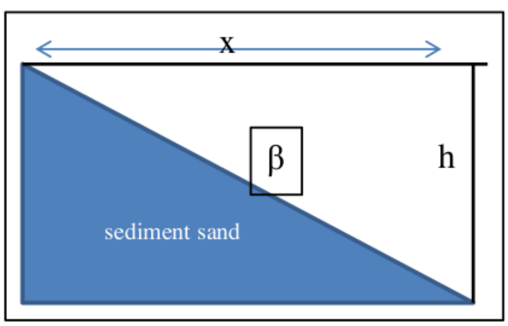

Figure 2. Continental Slope Sketch

Width of swash zone is measured from the point where the position of the farthest seawater up to the beach to the water table position by using meter gauge as seen in figure 3.

Figure 3. Line arrows indicate the width of swash zone

Statistic analysis

The data were processed by SPSS using T-Test Independent Test between the abundance of mole crab at spring tide and neap tide to determine whether there is a difference of mole crab capture result at spring tide and neap tide. *Principal Component Analysis* Test is used to find out the contiguous factors group which is then analyzed by multiple linear regression to determine the variables which significantly affect the abundance of mole crab. In addition, the distribution of mole crab is described using ArcGIS satellite imagery.

RESULTS AND DISCUSSION

Total mole crab obtained is 1.945 individuals at neap tide and 1.271 individuals at spring tide. Moreover, mole crab abundance (Table 2) and graphic of abundance per sampling area (Figure 4) are as follow:

Table 2. Mole Crab Abundance At Spring Tide and Neap Tide

No	Locations	Type	Abundance average / 300m^2	
			Neap tide	Spring tide
1	Jatikontal	Emerita emeritus	104	83
		Hippaadactyla	6	6
		Albuneasymmista	1	2
			111	**91**

No	Locations	Type	Abundance average / 300m^2	
			Neap tide	Spring tide
2	Jatimalang	Emerita emeritus	92	70
		Hippaadactyla	10	2
		Albuneasymmista	1	0
			103	**72**
3	Malang	Emerita emeritus	126	55
		Hippaadactyla	9	1
			135	**56**
4	Keburuhan	Emerita emeritus	70	41
		Hippaadactyla	3	0
			73	**41**
5	Patutrejo	Emerita emeritus	94	68
		Hippaadactyla	5	8
			99	**76**
6	Munggangsari	Emerita emeritus	124	85
		Hippaadactyla	4	2
			128	**87**

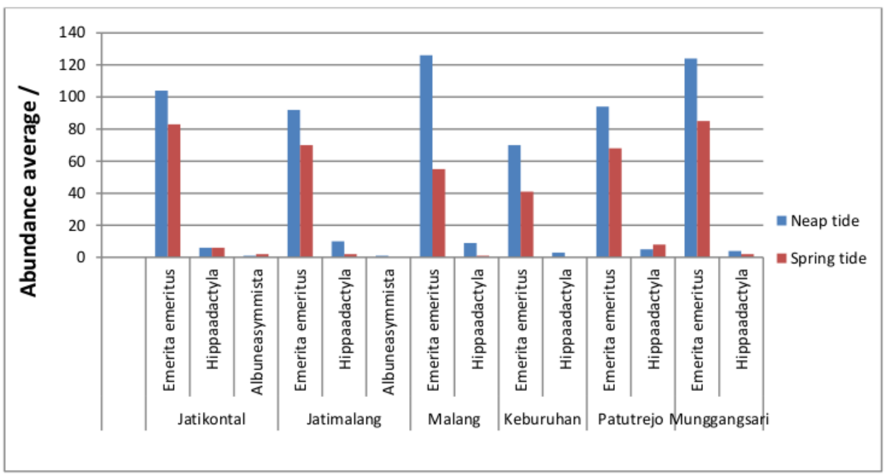

Figure 4. Abundance graphic per sampling area

7 Based on Table 2 and Figure 4, the abundance 5 of mole crab in Purworejo coastal area at neap tide is higher than it is at spring tide. The result of Independent T-Test shows that there is an abundance difference between neap tide and spring tide. This is probably because mole crab tends to feed at neap tide. In addition, mole crab's food is plankton and detritus carried by water (Subranomiam, 1979). Forward *et al*., (2005) says that mole crab is active at 1-2 hours after spring tide, actively moving by following the rise and fall of the neap tide and spring tide. At the spring tide, mole crab becomes inactive as shown by not swimming to swash zone at the spring tide. This pattern is an adaption of mole crab to avoid a potential of being stranded at maximum spring tide. Therefore, mole crab is mostly found during neap tide conditions which make it easier to catch.

The average abundance of mole crab in Purworejo coastal area at neap tide is 73 – 135 individual/300m^2 and at spring tide is 41-91 individual/300m^2. Based on abundance value, *Emerita emeritus* has a greater abundance than *Hippa adactyla* and *Albunea symmysta*. This shows that *Emerita emeritus* type dominates more than the other two types. The difference in abundance is due to the differences between its habitat and behavior. According to Bonriang and Phasuk (1975), *Emerita emeritus* tends to be in the top layer of sand around 0 – 30 cm depth and it is more shallow than the other two types making it easier to find, and *Albuneasymmsyta* type can be found in 50-150 cm depth (Boyko and Harvey, 1999; Corsini-Foka and Kalogirou,2013).

Table 3. Results of Distribution Pattern Calculation of Mole Crab at Spring Tide and Neap Tide

No	Species	Variance (S^2) / x	
		Neap Tide	Spring Tide
1	*Emerita emeritus*	11,89	7,43
2	*Hippaadactyla*	5,28	10,1
3	*Albuneasymnista*	2,18	6,21

Based on table 3, distribution pattern calculation shows the value of variance $S^2/x > 1$. This shows that mole crab makes clumped distribution pattern. The clustered distribution pattern is assumed as an adaptation of crustaceans to overcome ecological stress from the environment. Thus, organisms tend to clump in areas where the factors needed for life are available, as a strategy in responding to weather and seasons, habitat changes and reproductive processes (Odum, 1998). According to Nugroho *et al*., (2018), the distribution pattern of mole crab which clump causes an uneven biota distribution making it difficult to catch as not all of the mole crab can be found in all places. However, the difficulty of capturing mole crab becomes easy if the potential area of mole crab abundance has been known. The following is a map description of mole crab abundance in Purworejo coastal area.

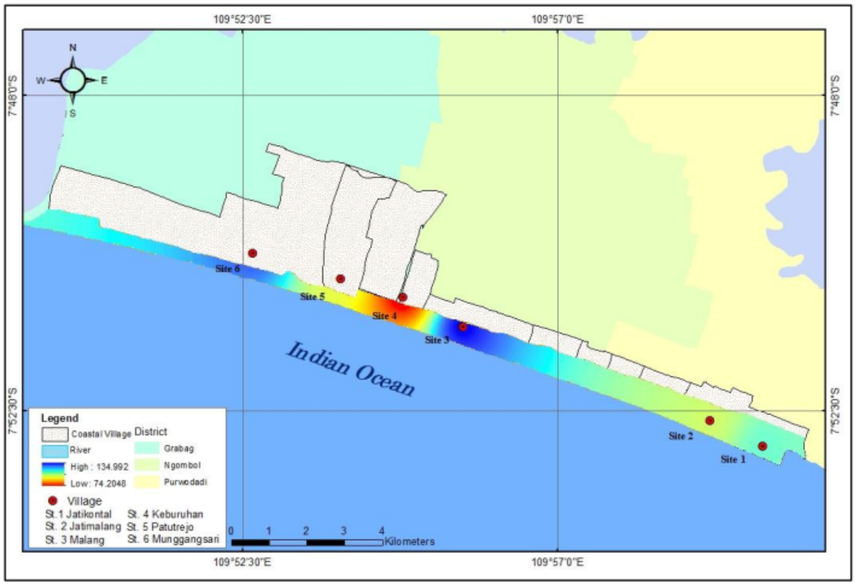

Figure 5. Distribution Map of Mole Crab Abundance in Purworejo Coastal Area

Based on figure 5, Malang coastal area (station 3) has the highest abundance of mole crab which is shown in blue color, while Keburuhan coastal area (station 4) has the lowest abundance as shown in red color. After finding out the potential area of mole crab abundance, it is necessary to wisely and sustainably utilize mole crab, such as not destroying its habitat. Therefore, it needs suggested capture areas which can later be optimally utilized and preserved to make its utilization sustainable. The measurement result of mole crab habitat characteristics is presented in table 4 and table 5.

The characteristics of mole crab habitat (Table 4 and Table 5) explain that the width of swash zone at neap tide ranges from 4,5 m – 6,1 m, and 6,3 m – 10,96 m during spring tide. The wider the swash zone is, the wider the movement or the habitat of mole crab will be which gives opportunities for the highly abundance of mole crab in the area (Wardiatno *et al.,* 2018). Purworejo coastal area is categorized as sloping beach. Mole crab's habitat is sandy beach with 4^o– 9^o continental slope (Bowman and Dolan, 1985). The organic matter in Purworejo coastal area is classified as low because of oxidation as an effect of the presence of larger water pores. Thus, organic material will run out quickly, and in contrast, the clay sediment which has smoother texture contains higher organic matter (Hartoko, 2010).

Table 4. Habitat Characteristics of Mole Crab

Stations	Wideswash zone (m)		Slope (°)		Organic matter (%)		Mean grain size(mm)		Sediment texture	
	Neap tide	Spring tide	Neap tide	Spring tide	Neap tide	Spring tide	Neap tide	Spring tide	Neap tide	Spring tide
Jatikontal	4,9	8,1	4,76	7,86	1,96	2,19	0,64	0,47	Rough sand	Medium sand
Jatimalang	5,8	9,2	5,76	9,13	2,09	2,24	0,48	0,42	Medium sand	Medium sand
Malang	6,1	10,96	4,56	8,93	2,04	2,14	0,51	0,41	Medium sand	Medium sand
Keburuhan	5,5	6,3	4,9	7,43	2,09	2,21	0,43	0,42	Medium sand	Medium sand
Patutrejo	4,75	8,3	4,96	7,9	2,05	2,09	0,55	0,44	Medium sand	Medium sand
Munggangsari	4,5	8,1	4,83	7,83	2,12	2,2	0,54	0,42	Rough sand	Medium sand

Table 5. Habitat Characteristics of Mole Crab

Stations	Temperature (°C)				pH				salinity (‰)		Sand moisture (%)	
	Neap tide		Spring tide		Neap tide		Spring tide		Neap tide	Spring tide	Neap tide	Spring tide
	water	sand	water	Sand	water	sand	water	sand				
Jatikontal	30	29	31	31	7,6	6,11	7,3	6,13	33	34	18,48	19,61
Jatimalang	31	29	32	29	7,3	6,15	7,6	6,12	32	33	18,67	17,84
Malang	28	27	29	28	7,6	6,15	7,3	6,12	34	34	16,14	18,5
Keburuhan	30	29	32	31	7,6	6,22	7,6	6,14	31	31	20,59	21,45
Patutrejo	31	30	31	30	8	6,17	8	6,17	34	34	15,18	17,64
Munggangsari	28	27	30	30	8	6,15	8	6,18	33	33	15,47	16,3

Purworejo coastal area at the neap tide and spring tide is dominated by medium sand and it has sediment diameter size ranging from 0,43 mm – 0,64 mm and 0,41 mm – 0,47 mm at the neap tide and spring tide. Mole crab prefers sediments with medium sand texture. Mahapatro *et al* ., (2018) who has conducted a study on Golpapur Beach, India stated beach which has medium sand is preferred by mole crab for better growth. Mole crab usually inhabits sandy beach with a sediment grain diameter size of 0,5 mm – 1 mm (Bonruang and Phasuk, 1975). In addition, the temperature of water and substrate; pH of water and substrate, salinity at the neap tide and spring tide is not significantly different in each location. The result of sand moisture in Purworejo coastal area is high since the sampling locations are swash zone area. Thus, the seawater content is high. The conditions of coastal topography close to the land have less water content than the sand area which tends toward the sea because it has a higher water content (Miller, 1997).

Based on the result of PCA Test, the factors which can explain interconnected variables are swash zone width, organic matter, and sediment (grain) diameter size. The result of the calculation of multiple linear regressions analysis at the neap tide and spring tide shows that the variable of organic matter does not possess close relationship to the abundance of mole crab, while the width of swash zone and grain sediment diameter size have a close relationship to the abundance of mole crab. The result of multiple regression analysis at spring tide shows that it does not have a relationship between mole crab's abundance and habitat characteristics. Based on the calculations, the highest swash zone width in Malang coast results in the highest abundance average as well, while at spring tide with high swash zone width in Malang coast shows low abundance of mole crab. This result is similar to that of Nugroho *et al*., (2018) stating that the wider swash zone results in the higher the movement or habitat off mole crab. Accordingly, it gives the opportunities for the highly abundance of mole crab in the area. However, wide swash zone at spring tide makes the abundance of mole crab low because mole crab becomes inactive during at spring tide as indicated by not swimming towards the swash zone area at spring tide. This pattern is an adaptation of mole crab to avoid potential of eing stranded at maximum high at spring tide. Therefore, mole crab is often found at neap tide that makes it easier to catch.

Purworejo coastal area at the neap tide and spring tide is dominated by medium sand with sediment grain diameter size between 0,25 mm – 0,55 mm. Based on the analysis result, sediment grain diameter is one of factors possessing a close relationship with the abundance of mole crab as mole crab lives in sandy substrate so that changes and differences in sandy beach substrate will affect the composition as well as the abundance of mole crab. Environmental factors greatly determine the spread and population density of organism; if the density of one genus in an area is very abundant, it shows the abiotic factors at the station strongly support the life of the genus. Mole crab lives by burying itself in the sand. If the size of sediment grain diameter is large, it will make mole crab difficult to enter the sand. Accordingly, mole crab will look for a relatively medium substrate. The population of mole crab on beaches with dissipative characteristics, wider beach with finer sand grains and gentler beach slopes has higher production than those with reflective characteristics, narrower beaches with medium sand grains sediment and steeper slopes. (Petracco *et al.,* 2016). Based on this statement, coastal area of Purworejo is an appropriate area for habitat mole crab

CONCLUSIONS

1. The average abundance of mole crab in Purworejo coast at neap tide is 73-135 individual/300m^2 and 41-91 individual /300m^2 at spring tide. There are significant differences and effects based on the conditions at the neap tide and spring tide on the abundance of mole crab. The distribution pattern of the three types of mole crab at the neap tide and spring tide is a clumped distribution pattern.
2. The habitat preferred by mole crab is gentler slope beach, wide swash zone area, and medium sandy beach with < 1mm sediment grain diameter.

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