



Faculty of Resource Science and Technology

**Biodiversity and Population of Ghost Crabs at Sandy Beaches of Buntal, Santubong and Pasir Panjang, Sarawak**

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**Bachelor of Science with Honours  
(Aquatic Resource Science and Management)  
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Pasir Panjang, Sarawak**

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This report is submitted in partial fulfilment of the requirements for the degree  
Bachelor of Science with Honours  
(Aquatic Resource Science and Management)

**Faculty of Resource Science and Technology  
UNIVERSITI MALAYSIA SARAWAK  
2012**

## **DECLARATION**

I hereby proclaim that no portion of this dissertation has been submitted in support of an application for another degree of qualification of this study or any other university or institution of higher learning.

.....

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## List of Abbreviation

O. = *Ocypode*

CL = Carapace Length

CW = Carapace Width

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## **ABSTRACT**

Ghost crabs of the genus *Ocypode* are one of the sandy beach communities commonly found on subtropical and tropical shores. The genus consists of 28 species worldwide. They live in burrows along the sandy beaches and have been used as a bioindicator to measure the ecological responses to human disturbance. They are nocturnal animals and practise scavenging, predating and detritus feeding behaviour. Generally, they have unequal size of chelipeds between each individual either left or right handed. Three sites were chosen as study sites which are Buntal beach (7 – 8 March 2012), Santubong beach (9 – 10 March 2012) and Pasir Panjang beach (14 – 15 March 2012). In this study, two species of ghost crab: *O. ceratophthalmus* and *O. cordimanus* were found. The ghost crabs that inhabit all three beaches are *O. ceratophthalmus* and Pasir Panjang beach is the only area that inhabit by *O. cordimanus*. Their handedness ratio for both species is 2:1 for male and female. The male population is higher compared to female population about 19:1. Their populations are estimated to be huge in Buntal beach and Santubong beach based on the burrow counting method. Sediment analysis shows that Buntal beach and Santubong beach has high percentage mass of fine sand while Pasir Panjang beach has high percentage mass of medium sand. The temperature of sediment showed more fluctuations compared to burrow and air.

Key words: Ghost crab, biodiversity, population, distribution, sediment analysis.

## **ABSTRAK**

'Ketam angin' genus *Ocypode* adalah salah satu daripada komuniti pantai yang dijumpai di kawasan tropika dan sub-tropika. Genus ini mempunyai 28 spesies di seluruh dunia. Mereka hidup di dalam lubang yang digali sepanjang pantai dan digunakan sebagai bioindikator untuk menentukan tindakbalas ekologi terhadap gangguan manusia. Mereka adalah haiwan nokturnal dan mengamalkan pemakanan secara pembangkai, pemangsa dan pemakan detritus. Secara amnya, mereka mempunyai saiz penyepit yang tidak sama di antara setiap individu sama ada kiri atau kanan. Tiga kawasan kajian telah dipilih iaitu pantai Buntal (7 – 8 Mac 2012), pantai Santubong (9 – 10 Mac 2012) dan pantai Pasir Panjang (14 – 15 Mac 2012). Di dalam kajian ini, dua spesies 'ketam angin' dijumpai iaitu *O. ceratophthalmus* dan *O. cordimanus*. 'Ketam angin' yang mendiami semua ketiga-tiga kawasan adalah *O. ceratophthalmus* dan hanya pantai Pasir Panjang yang didiami oleh *O. cordimanus*. Nisbah perbezaan saiz penyepit untuk kedua-dua spesies adalah 2:1 untuk jantan dan betina. Populasi jantan lebih tinggi berbanding populasi betina iaitu 19:1. Populasi mereka dianggarkan besar di pantai Buntal dan pantai Santubong berdasarkan kaedah pengiraan lubang. Analisis sedimen menunjukkan pantai Buntal dan pantai Santubong mempunyai peratusan jisim pasir halus yang tinggi manakala pantai Pasir Panjang mempunyai peratusan jisim pasir sederhana kasar dan halus yang tinggi. Suhu tanah menunjukkan perubahan yang paling banyak berbanding dengan lubang dan udara.

Kata kunci: 'Ketam angin', biodiversiti, populasi, taburan, analisis sedimen.

## 1.0 Introduction

Ghost crabs also called sand crab, white crab, mole crab and local name is “ketam angin” that belong to the genus *Ocypode* which consist of 28 species (Grave *et al.*, 2009). This crab has a pale body colour that is similar to the colour of sand and it is invisible when it crawls on the sand. They live in burrows along the sandy beaches and they are omnivorous that eat other crabs, clams, insects, vegetation, detritus and also feed on turtle hatchling and egg (Jeffrey, 1998). They eat newly hatched turtle hatchlings that are going to the sea. However, there is also evidence that they may be effective scavengers of organic matter, on more protected beaches they eat the unhatched rotten turtle eggs and hatchlings of the loggerhead turtle, *Caretta caretta* (Dodd, 1988). The crabs drag the hatchling into their burrows and eat them up.

They also have club shaped eyestalks and can look for 360° vision and aid them to see and catch insects even in mid air (Milne and Milne, 1946). These crabs cannot swim but female crabs can keep themselves float by turning upside down in the water. This is done to let the egg mass under their abdomen respire freely (Strachan *et al.*, 1999). The zonation of the young and older crabs can be determined by looking the distance of the burrow from the shore. The burrow of the young crabs can be found near the shore while the older crabs burrow farther from water (Wolcott, 1978). The feeding activity takes place at night while burrowing occurs at daytime.

Ghost crabs have been used as a biomonitoring tool to measure the ecological responses to human disturbance. They play an important role in the ecology and food chain of the sandy beach habitat (Jackson *et al.*, 1997). The use of ghost crabs as a key species for evaluating the condition of sandy beach also had been reported by Steiner and Leatherman (1981); Wolcott and Wolcott (1984); Barros (2001); Neves and Bemvenuti (2006). The ghost crab predation on turtle eggs and hatchlings especially the green sea

turtle, *Chelonia mydas* was reported by Fowler (1979); Chan and Liew (1999) and Strachan *et al.*, (1999).

Most studies about the ghost crabs were conducted in other countries but in Malaysia a few of studies being done. Most of the studies are about the ecology of the ghost crab (Milne and Milne, 1946; Wolcott, 1978; Leber, 1982; Trott, 1988; Veloso *et al.*, 1997; Tureli *et al.*, 2009 and Branco *et al.*, 2010). There are two previous studies being done related to the diversity and population of ghost crabs by Norhakimi (2011) while ecology and burrow structure of ghost crabs by Asyraf (2011) at Satang Island, Sematan Beach and Teluk Pandan Beach.

Data collection in this study at selected beaches in Kuching, Sarawak could be undertaken to provide a baseline assessment of the ghost crabs population size and species composition. Moreover, this study is to continue the previous study done in Sematan, Lundu and Satang Island (Norhakimi, 2011). The population study will be carried out using burrows counting method (Antunes *et al.*, 2010) whereby the burrow openings was used as measurement of ghost crabs number. Live trapping is the standard field method for mobile species but the analysis of data gives unbiased estimates of density is problematic (Parmenter *et al.*, 2003).

The objectives of this study are: 1) to document the species composition of ghost crabs and their characteristics that occur at Buntal, Santubong and Pasir Panjang beaches; 2) to estimate the population size and distribution of ghost crabs along the beaches; 3) to compare the findings obtain from different locations and; 4) to relate the influence of environmental parameters (temperature and sediment types) on the ghost crabs population.

## 2.0 Literature Review

### 2.1 Biodiversity of Ghost Crabs

Biodiversity is defined as the variety of all forms of life from genes to species through the broad scale of ecosystem (Gaston, 1996) and it seen as a symbol for lack of knowledge about the components of life variation and their important to humankind (Takacs, 1996). Biodiversity or biological diversity means the existence of a wide variety of species called species diversity of plants, animals and microorganisms in a natural habitat within a particular environment (ecological diversity). The high level of biodiversity will contribute to the ecosystem stability. Biodiversity in natural habitats represents an important pool of species and genetic material of potential use to human societies (Martin, 2004).

Phylum: Crustacea
Class: Malacostraca
Subclass: Eumalacostraca
Order: Decapoda
Family: Ocypodidae (Rafinesque, 1815)
Genus: <i>Ocypode</i> (Weber, 1795)

**Figure 1:** Scientific classification of ghost crabs

Figure 1 shows the taxonomic classification of ghost crabs is based on Powers (1977), Manning and Holthuis (1981) and Martin and Hine (2004). There are 28 species of ghost crabs under the genus *Ocypode* had been described (Grave *et al.*, 2009) in Table 1.

**Table 1:** List of ghost crabs species under the genus *Ocypode*. (Source: Grave *et al.*, 2009)

<b>Species name</b>	
<i>Ocypode africana</i>	De Man, 1881
<i>Ocypode brevicornis</i>	H. Milne Edwards, 1837
<i>Ocypode ceratophthalmus</i>	Pallas, 1772
<i>Ocypode convexa</i>	Quoy & Gaimard, 1824
<i>Ocypode cordimanus</i>	Desmarest, 1825
<i>Ocypode cursor</i>	Linnaeus, 1758
<i>Ocypode fabricii</i>	H. Milne Edwards, 1837
<i>Ocypode gaudichaudii</i>	H. Milne Edwards & Lucas, 1843
<i>Ocypode jousseaumei</i>	Nobili, 1905
<i>Ocypode kuhlii</i>	De Haan, 1835
<i>Ocypode laevis</i>	Fabricius, 1798
<i>Ocypode longicornuta</i>	Dana, 1852
<i>Ocypode macrocera</i>	H. Milne Edwards, 1852
<i>Ocypode madagascariensis</i>	Crosnier, 1965
<i>Ocypode minuta</i>	Fabricius, 1798
<i>Ocypode mortoni</i>	George, 1982
<i>Ocypode nobili</i>	De Man, 1902
<i>Ocypode occidentalis</i>	Stimpson, 1860
<i>Ocypode pallidula</i>	Jacquinet, 1846
<i>Ocypode pauliani</i>	Crosnier, 1965
<i>Ocypode platytarsis</i>	H. Milne Edwards, 1852
<i>Ocypode pygoides</i>	Ortmann, 1894
<i>Ocypode quadrata</i>	Fabricius, 1787
<i>Ocypode rotundata</i>	Miers, 1882
<i>Ocypode ryderi</i>	Kingsley, 1880
<i>Ocypode saratan</i>	Forsk. 1775
<i>Ocypode sinensis</i>	Dai, Song & Yang, 1985
<i>Ocypode simpsoni</i>	Ortmann, 1897

## 2.2 Population of Ghost Crabs

Population is a group of individuals of the same species within a community. The nature of a population is determined by factors such as density, sex ratio, mortality, natality, emigration and immigration (Martin, 2004). In the previous study, two species of ghost crabs were found *Ocypode ceratophthalmus* (Pallas, 1772) and *Ocypode cordimanus* (Desmarest, 1825) in Satang Island, Sematan beach and Teluk Pandan beach by Norhakimi (2011).

### **2.3 Ecology of Ghost Crabs**

*Ocypode* means “swift – of – foot” (Milne, 1946) and these crabs inhabit sandy beaches above the waterline, most active at night and spend the day in burrows where the insulating sand keeps them moist and cool (Williams, 1984). Adult crabs become active at dusk to dig and repair their burrow while young crabs are seen on the sand surface both night and day (Weinstern, 1995).

Ghost crabs live solitary in their burrow and the size of the burrow opening indicates the size of the crab that lives in it. The burrow dug by ghost crabs up to 1.3 m deep (William, 1984). Normally, they close the burrow opening with sand during hot season and remaining within the burrow during cold season to provide sufficient protection from the extreme climate. Burrows have different shapes beneath the sand are found from high tide line to a distance as 400 m from the ocean (William, 1984).

Ghost crabs are marine organisms, when they search food at night, they can be found along the waterline. They are able to spend most of their time above the reach of the sea because they have a water tight external skeleton that prevents water loss from their tissues and keeps them from dry (Rupert and Fox, 1998). Ghost crabs are scavengers and run up and down the beach to find the food. They will eat plant or animal material washed ashore by the waves and tides (Berry, 1976).

Ghost crabs are not listed as threatened or endangered species and there is no human exploitation of this species. Berry (1976) reported that because of their burrowing and scavenging habits, ghost crabs can be affected by increase in oil tanker traffic and the amount of stranded oil on beaches causes reduction in the breeding rate and increase mortality at moulting stage. It proves to be a useful indicator of the health of that environment. For example, burrow distribution were observed near the low water level on shores with more human activity, small number of juvenile burrows were observed

indicating a low recruitment rate of juvenile ghost crabs. These results provide quantitative evidence that human activities affect the abundance of ghost crabs. More number of burrows indicates that low disturbance.

## 2.4 Previous Study

There were several studies being done related to the diversity and population of ghost crabs. The studies of the ghost crabs ecology such as behaviour of ghost crab, ghost crabs as scavenger and effects of seasonal changes to ghost crabs have been done in Atlantic Coastline (Milne and Milne, 1946), North Carolina barrier beach (Wolcott, 1978), North Carolina sandy beach (Leber, 1982), South Nannygoat beach, Sapelo Island, Georgia (Trott, 1988), Prainha beach, Rio de Janeiro State (Veloso *et al.*, 1997), Yumurtalik Bay, North Eastern Mediterranean, Turkey (Tureli *et al.*, 2009) and in Southwestern Atlantic (Branco *et al.*, 2010)

The use of ghost crabs as a key species for evaluating the condition (disturb or undisturbed) of sandy beach had been reported in Assateague Island, Maryland, Virginia (Steiner and Leatherman, 1981), Mid Atlantic beach (Wolcott and Wolcott, 1984), New South Wales beach (Barros, 2001) and in Rio do Sul coast (Neves and Bemvenuti, 2006). The ghost crab predation on turtle eggs and hatchlings especially the green turtle, *Chelonia mydas* was reported in Tortuguero, Costa Rica (Fowler, 1979), Northern Cyprus beaches (Strachan *et al.*, 1999) and in Redang Island, Terengganu (Chan and Liew, 1999).

In the previous study in Sarawak, two species of ghost crabs were found *Ocypode ceratophthalmus* (Pallas, 1772) and *Ocypode cordimanus* (Latreille, 1818) in Satang Island, Sematan beach and Teluk Pandan beach by Norhakimi (2011) and burrow structure of ghost crabs have been done in Sarawak division by Asyraf (2011).

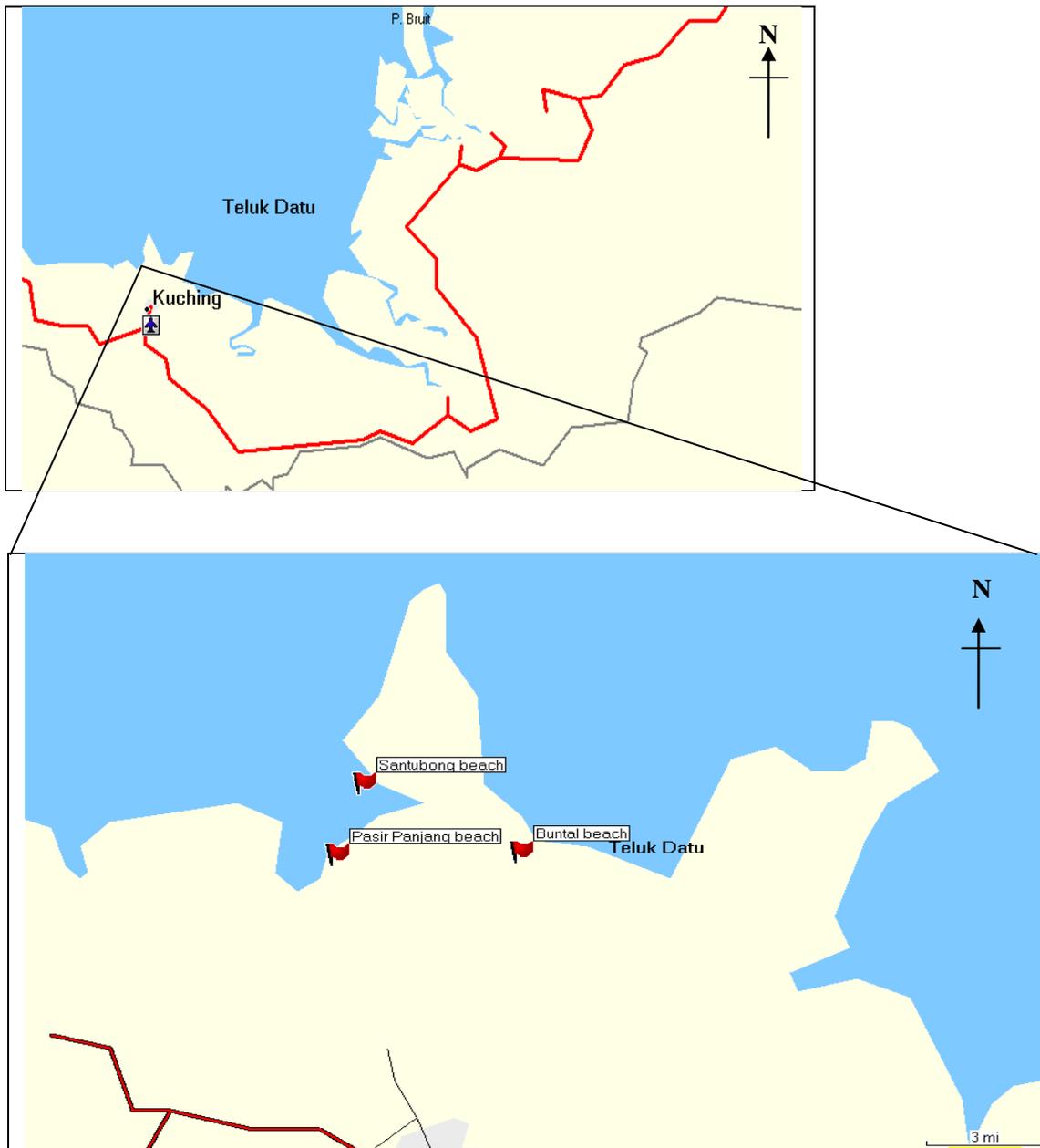
### 3.0 Materials and Methods

#### 3.1 Study Area

This study was carried out at sandy beaches of Buntal, Santubong and Pasir Panjang. Coordinates of study area (Table 2) were obtained using Global Positioning System (GARMIN GPS map 60 CSx). The distance of sampling site at Buntal and Pasir Panjang were 150 m while Santubong was 180 m and the size of each plot was 900 m<sup>2</sup> and was measured using range finder (Bushnell). Figure 2 shows the location of study sites at three beaches.

**Table 2:** The locations of sampling sites, coordinates and the sampling dates

<b>Sampling Sites</b>	<b>Coordinates</b>	<b>Sampling Dates</b>
Buntal Beach	N 01° 41' 41.8" E 110° 22' 09.5" to N 01° 41' 37.2" E 110° 22' 09.6"	07 & 08 March 2012
Santubong Beach	N 01° 43' 29.0" E 110° 18' 41.2" to N 01° 43' 34.7" E 110° 18' 43.9"	09 & 10 March 2012
Pasir Panjang Beach	N 01° 41' 36.2" E 110° 18' 05.8" to N 01° 41' 37.7" E 110° 18' 10.8"	14 & 15 March 2012



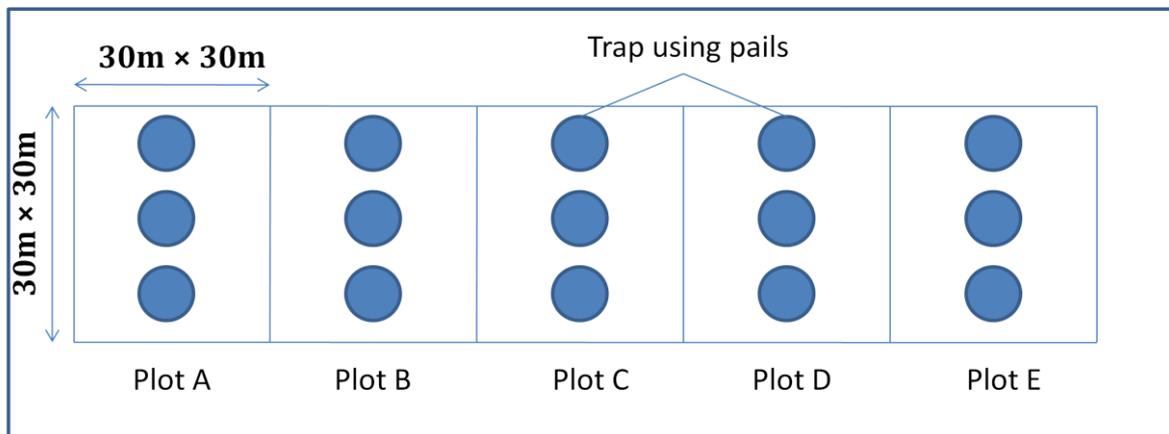
**Figure 2:** Locations of study sites are mark with the flags.

### 3.2 Estimation of Ghost Crabs Population Size

Sampling of ghost crabs population was carried out on the sandy beach using burrow counting, it was assumed that the number of burrows present on the beach was as same as the number of ghost crabs.

### 3.2.1 Crab Trapping

This method was carried out during night because the ghost crabs are more active at this time to find the source of food. The pails and baits were used for trap ghost crabs to come out to the shore for feeding. The pails are chosen must be big and deep to prevent the ghost crabs from escape. The bait that was used internal organ as stomach and gills of fish. For Buntal and Pasir Panjang beaches, five plots were set up while Santubong beach six plots was set up. The size of each plots were 30 m × 30 m and for every plot have three pails (Figure 3).



**Figure 3:** Shows the illustration of plot at Buntal and Pasir Panjang beach

### 3.2.2 Burrow Counting

Burrow counting method (Wolcott, 1978) provide a baseline assessment of the ghost crab population size and it was carried out during daytime. Firstly, the area that has burrows of ghost crabs was identified. Five plots (Buntal and Pasir Panjang beaches) and six plots (Santubong beach) were set up using range finder (Bushnell). Each plot was 30 m × 30 m and each plot corner was marked with wooden stick. All burrow of ghost crabs (fresh and abandoned) found in each plot were counted.

For each plot, ten different burrows were selected to measure the diameter of a burrow opening using dial caliper (Mitutoyo, 505-671) to the nearest 0.02 mm.

### **3.3 Laboratory Work**

Carapace width (CW) and carapace length (CL) was measured and the sex was determined by looking at abdominal segment. CL and CW of the ghost crabs was measured using dial caliper (Mitutoyo, 505-671) to the nearest 0.02 mm. The CL of the ghost crabs was measured at the middle part of the body that divided them into two parts while CW of the ghost crabs was measured at the greatest distance between the lateral margins of the carapace (Vaccaro *et al.*, 2005). The maximum carapace width is used as principal measurement indicating the size of the crab (Ng, 1998). The cheliped size was observed to record the handedness, either right or left cheliped is bigger.

Samples collected were preserved with 10 % buffered formalin. The identification of the ghost crabs were determined by observing their physical characters such as types of eyes, shape of carapace, colour of carapace and cheliped and ridge at distal end of cheliped. Species identification was based on a book (Barnes, 1993) and published journal. The sample for identification was photographed using camera (Canon Cybershot, DSC-WX30).

### **3.4 Measurements of Environmental Parameters**

#### **3.4.1 Temperature**

Temperature of sediment, burrow and air were taken every one hour for three replicates using water proof thermometer (Traceable). The temperatures were randomly taken at each plot.

### **3.4.2 Sediment Analysis (Buchanan, 1984)**

Sediment particle size was analyzed to relate with the numbers of ghost crabs burrow. The purpose of sediment particle size analysis is to determine the size fraction of sand. Samples for sediment particles size was taken using a corer tube which was driven into the sediment to a depth of 15 cm. The samples were taken at high tide level, middle tide level and low tide level of each plot.

Subsequently, analysis of the sand fraction was done by dry sieving. In the laboratory, samples were dry using oven (Esco model, Isotherm IFA-54-1) at temperature from 60°C to 70°C on a petri dish. Then, 30 g of dried sample was weighed using an electronic balance (Shimadzu type, BL 220H). Six sieve layers were used: > 1000 µm > 500 µm > 250 µm > 125 µm > 62 µm and < 62 µm. Sediment retained on each layer was weighted using an electronic balance. The Udden-Wentworth grade scale was used to analyze the sediment from the beach.

Each of sand fraction collected was weighed using electronic balance and converted to the percentage. Calculation of sand fraction was done using this formula:

$$\text{Grain size (\%)} = \frac{\text{mass retained in each sieve layer (g)}}{\text{total mass of sediment (g)}} \times 100$$

### **3.5 Data and Statistical Analysis**

Data collected were analyzed using Microsoft Excel 2007. For the analysis, the number of the individual, species composition and number of burrows, size of burrows and frequency of handedness based on sex and size class was taken for each sampling period. In order to see the sediment type preferred by the crabs to make their burrow, the relationship between burrow abundance and the highest (for Buntal and Santubong) or second highest (Pasir Panjang) sediment fraction was analysed. Then, the regression lines were plotted.

Mean values were calculated from three replicates of sediment grain particle size. Mean values of sediment particle size from three beaches were compared for significant difference by using two way ANOVA ( $p < 0.05$ ) and multiple comparison test, Tukey test ( $p < 0.05$ ).

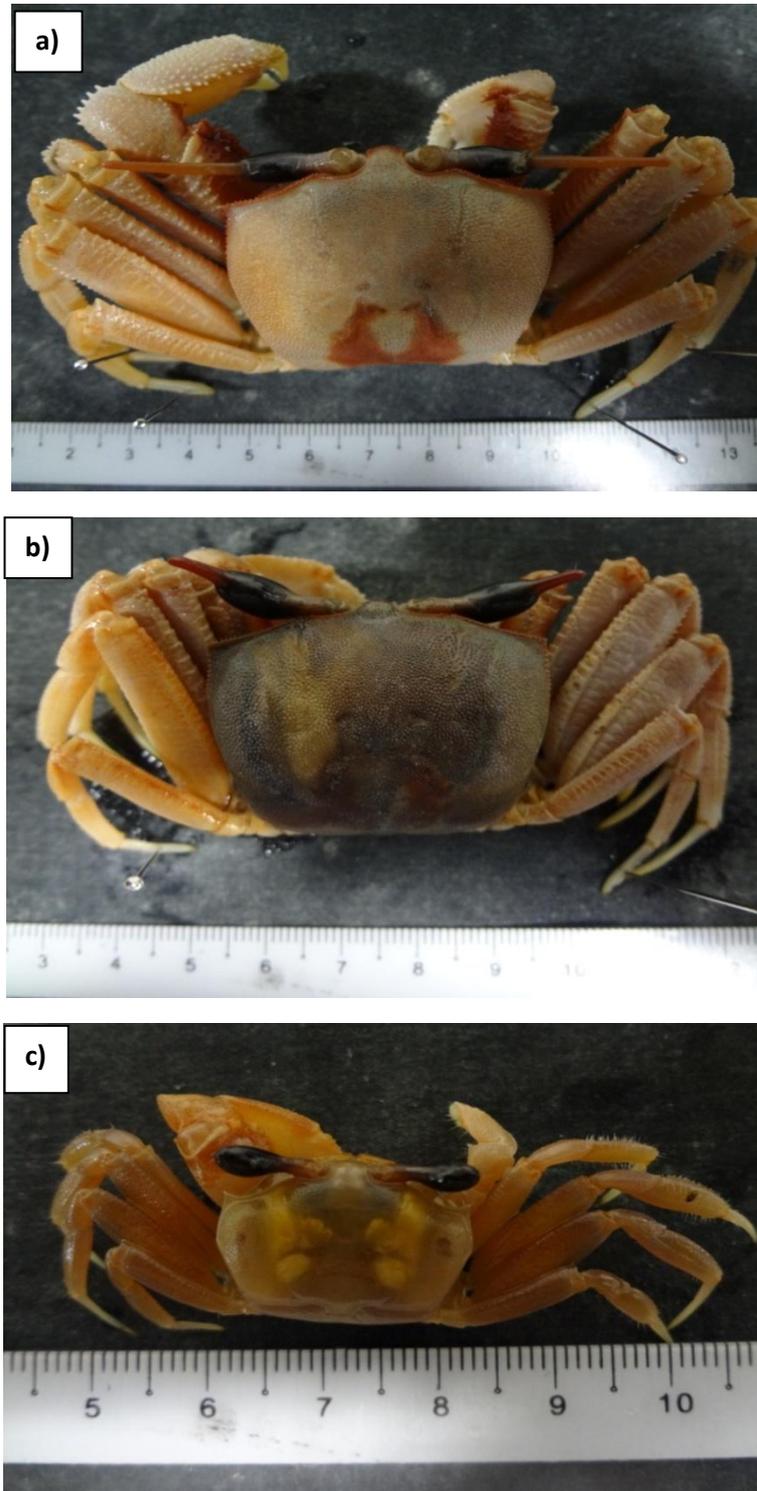
## **4.0 Results**

### **4.1 Species Diversity**

Throughout this study at Buntal, Santubong and Pasir Panjang beaches, two species of ghost crab were found: *Ocypode ceratophthalmus* (Pallas, 1872) and *O. cordimanus* (Desmarest, 1825). The *O. ceratophthalmus* is commonly known as Horned-eye ghost crab and was found at all study areas. The obvious physical characters of *O. ceratophthalmus* were their horned eyes and slightly brown colour pattern on their carapace. The adult males have long tapering horny tubercle at its eyestalks (Figure 4a) while the adult females have short pointed horned eyes (Figure 4b). Besides that, the adult male and female can be distinguished by the shape of their abdomen. In male, the abdomen was triangular to broadly T- shaped while female was broad usually semicircular and often covering most part of the ventral surface. The young *O. ceratophthalmus* has undeveloped horned eyes and brown colour pattern on their carapace. However, the similarity between adult and young were slightly brown to yellow colour at the chela tip or claw (Figure 4c). *O. ceratophthalmus* also has different colour pattern on its ventral side either at the abdomen or chelipeds. At Buntal and Santubong beach, it was observed that the immature or young ghost crabs from species *O. ceratophthalmus* to inhabit these two sites.

For the second species, *O. cordimanus* is commonly known as Common ghost crab and was found only at Pasir Panjang beach. This species is lacking of the horned eyes

shape, stridulatory ridge on the palm and paler colouration which is slightly yellow to light brown colour of their body. *O. cordimanus* has transversely rectangular shape of carapace (Figure 5). Besides that, *O. cordimanus* has large cheliped compare to *O. ceratophthalmus* (Ng, 1998).



**Figure 4:** The dorsal view of the *O. ceratophthalmus*: a) male; b) female and c) juvenile.