Faculty of Resource Science and Technology

STUDY ON THE DISTRIBUTION OF RAZOR CLAM (FAMILY SOLENIDAE) AT KUCHING BAY, SARAWAK

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TABLE OF CONTENTS

TABLES

FIGURES

Study on the Distribution of Razor Clam (Familiy Solenidae) at Kuching Bay, Sarawak

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Abstract

A study that has done was to compile a baseline data on density and distributions pattern of razor clam at Asajaya Laut and along the Kuching bay. This study was completed within four months (September, October, November and December) in Asajaya Laut and at other selected beaches of Buntal, Muara Tebas, Teluk Delima and Bako along Kuching Bay on December 2005. This study showed that the distribution patterns of razor clam at Asajaya Laut were distribute from the low tide level to the high tide level and the density of razor clam increased from the low tide area to the high tide area. Moreover, the razor clam size distribution study at Asajaya Laut showed that the size increased from the high tide area to low tide area. Beside that, sampling along Kuching bay showed razor clam was abundant at the Asajaya Laut and the most dominant species was Ambal Biasa, while Ambal Riong was dominant at Buntal and Ambal Jernang has low density at all sites. The experiments on razor clam burrowing behaviour done *in-situ* and in laboratory and the fastest record were 2 minute for both tests. The deepest depth recorded was 9.9 cm for *in-situ* test and 7.5 cm for the laboratory test.

Key words: Ambal Biasa, Ambal Jernang, Ambal Riong, distribution pattern and density

Abstrak

Kajian yang dijalankan adalah untuk mengumpul data asas tentang kepadatan dan corak taburan spesis ambal di Asajaya Laut dan di sepanjang Teluk Kuching. Kajian ini telah diselesaikan dalam empat bulan (September, Oktober, November dan Disember) di Asajaya Laut dan di pantai terpilih yang lain iaitu Buntal, Muara Tebas, Teluk Delima dan Bako sepanjang Teluk Kuching pada Disember 2005. Kajian ini, menunjukan corak taburan spesis ambal di Asajaya Laut bertaburan dari kawasan air surut hingga ke kawasan air pasang dan kepadatannya adalah meningkat dari kawasan air surut ke kawasan air pasang. Kajian tentang taburan saiz spesis ambal di Asajaya Laut pula menunjukan saiznya akan meningkat dari kawasan air pasang ke air surut. Selain itu, persampelan di sepanjang Teluk Kuching menunjukan spesis ambal mempunyai kelimpahan yang tinggi di Asajaya Laut dan spesis yang paling dominan adalah Ambal Biasa manakala Ambal Riong dominan di Buntal and Ambal Jernang mempunyai kepadatan yang rendah untuk semua kawasan. Ujian tingkah laku pengorekan spesis ambal dijalankan secara in-situ dan di makmal dan catatan paling pantas adalah 2 minit bagi kedua-dua ujian. Kedalaman yang dicatat adalah 9.9 cm untuk ujian in-situ dan 7.5 cm untuk ujian makmal.

Kata kunci: Ambal Biasa, Ambal Jernang, Ambal Riong, corak taburan dan kepadatan

1.0 INTRODUCTION

Ambal is a popular common name for razor clam in Sarawak. Definition of razor clam by Encyclopaedia Britannica is any species of marine bivalve molluscs of the family *Solenidae*. According to Fitch (cited in Lassuy and Simon (1989)) it is called razor clam because of it elongated shells, thin, flat and smooth, covered with a heavy, glossy and yellowish periostracum (Loh, 2005). There are many species of family *Solenidae* distributed around the world. In the west coast of America, species found are *Siliqua* spp., while in Scotland it is of *Ensis* sp. and in Hong Kong two common genera are found *Solen* and *Ensis*. *Solen* and *Ensis* are different in their shape and distributions. *Solen* has straight shells while *Ensis* has curve shells and more temperate in distribution (Hill and Phillips, 1981). In Sarawak, Pang (1992) reported that there are three different species of ambal being collected, 'ambal biasa', 'ambal riong 'and 'ambal jernang'. Then, in 1993 Pang again has identified which is according to Gray (1842) all these species of ambal are same as a *Solen brevis*.

One of the sedentary organisms at sandy beaches and the mud flat habitat is razor clam (Lassuy and Simons, 1989) that thrive in the intertidal zone and are found abundantly in the Kuching and Samarahan districts (Pang, 1993). Intertidal zone is an area of shoreline between low and high tide (Revan *et al.*, 1993) where it is submerged by high tide twice a day and exposed to air at low tide. Molles (2002) described the intertidal zone into three classifications, the sandy beach, rocky shore and mud flats. Sandy beaches provide an unstable, abrasive and nutrient poor substrate (Mackenzie *et al.*, 2001). The organisms in this area adapt by burrowing a few centimetres beneath the surface. By inhabiting the sand, they are able to find a stable environment to avoid the extreme condition.

Razor clams live as filter feeders that feed on the freshly deposited alluvial mud and sand for micronutrients (Loh, 2005). According to Boaden and Seed (1985), filter feeder is organisms that obtain their feed on sedentary forms and food feeding was controlled by siphons that filter out food particles from the water column (Odum, 1975). The morphology of the siphons varies depending on the depth in sediment of their habitat. For example, the siphons of *Mya* spp. are long, fused and extensible because they live at the certain depth in mud. However, for some clams like razor clam in Sarawak, that live near the surface have a short siphons and the shell is usually fairly thick (Pang, 1992).

The burrowing organisms are also known as bioturbating species because they inhabit burrowed sediment and produce openings on the sediment surface (Parry *et al.*, 2002). Razor clam is one of the bioturbating species that burrow itself into the sediment. Burrowing or vertical migrations behaviour was influenced by nutrient enrichment and predation. Predations are important in structuring marine soft sediment benthic communities, however the nutrient enrichment in marine benthic system is not well understood (Posey *et al.*, 1995). Some bivalves have a substantial capacity for anaerobic respiration in order to survive temporary burial and it also serve as sediment stabilizer under the surface.

The standard method for collecting information on burrowing macrofauna in the field is by the direct observations and counting by the divers (Parry *et al.*, 2002). However, these methods are limited for the certain level of water level, depth and timeframe. The technology development of underwater camera established the remotely operational vehicles (ROVs). In providing non-destructive sampling with greater controlled of observation. Instead, a traditional method was used by local people in Sarawak for collecting the razor clams. These people are known as a 'pengambal' and they use wood stick know as 'penugal' to find the razor clam burrow tube. After detecting a burrow, 'lidi' stick smeared with mixture paste of ash, salt and limestone powder made from burnt seashells (Pang, 1992) will be inserted inside each burrow to force out razor clam upward.

Shellfish cultures had started from 2000 B.C. in Eastern civilizations (Iverson, 1968) and around 400 and 100 B.C. in Greek and Roman civilizations (Milne, 1972). Bardach *et al.* (1972) mentioned that calm culture predates oyster culture in Japan and Japanese literatures during eighth century were referred as guidelines to calm culture nowadays (Bourne, 1981). In the United States calm populations support significant commercial fisheries where fourteen species of clams are harvested in 18 states (Dressel and FitzGibbon, 1978). Between 1966 and 1975, clam fisheries in United States were dominanted by four species (Ritchie, 1977): the hard clam (*Mercenaria mercenaria*), the surf clam (*Spasula solidissima*), the soft-shell clam (*Mya arenaria*), and the ocean quahog (*Arctica islandica*). However, along the Pacific Coast has a limited productions due to lack of suitable habitat (Glude, 1974) and other limiting factors such as pollutions, dredging and recreational demands.

Ambal or razor clam is consumed by local people in Sarawak and has a potential for aquaculture activity. Therefore it is important to study the characteristics, habitat and ecology of razor clam in order to establish clam culture. This study was designed to gather preliminary data about the distribution of razor clams in Kuching Bay. In addition, a preliminary study on burrowing behaviour of razor clam is also carried out to understand more about the razor clam behaviour. Objectives of this study are:

i. to determine the monthly distributions of razor clam in Asajaya Laut.

ii. to compare the distribution of razor clam along Kuching Bay in five different sites.

iii. to obtain initial information about burrowing behaviour of razor clam.

2.0 LITERATURE REVIEW

The habitat of bivalve

Coastal area is an important habitat to many organisms of fish and shellfish at the nearshore ecosystem. It also supported the natural resources for human, such as recreational, tourisms and the commercial fishing. This area can be divided into two zones; maritime zone and the intertidal zone. According to Raven *et al.* (1993), intertidal zone is an area of shoreline between the low and high tide area or from the seaward of coastal landform to mean low water level (Howes and Goehringer, 1996). It is also known as a tidal flat and can be classified to study it consist of three different classes; sandy beach, mud flat and rocky shore (Molles, 2002). A sandy beach, it has harsh conditions which is the substrate is unstable and abrasive and also have low nutrient (Mackenzie *et al.*, 2001) contents. The second classification is a muddy shore; it has support high organic material that can accumulate by bacteria to more fine particles and contain more water and the last classification is a rocky shore which the coastal area with the rocky substrate and hard conditions.

According to Encyclopedia Britannica tidal flat is define as "level muddy surface bordering an estuary, alternately submerged and exposed to the air by changing tidal levels". This definition shows that intertidal zone is a stressful zone and has exposed to the extremely conditions. The phenomenon of twice tidal a day was contribute to the extremely changes of conditions in the intertidal zone, from the extreme condition to other extreme condition. At the low tide water level it was exposed to the environment for instance high intensity of sun light and the air.

On the other hand, intertidal zone was covered by wave and also exposed to the higher currents when the high tides (Howes and Goehringer, 1996). However, the present of light and oxygen by exposed of environment and transported of nutrient by water current to the intertidal zone make it is a high production area and support a diversity of organisms. Intertidal area is the sloping area, according to Howes and Goehringer (1996), there was only colonized by infaunal and epibentic animals because of the overlying water column retreats at high tide. The animal inhibit that zone like bivalve was adapt by burrow beneath surface in role to avoid the extremely changes of conditions by tidal phenomenon, and also to avoid from the predation. Their burrowing behaviour is support by the well development of foot for example is razor clam species. When the high tide it will emerge to the seafloor surface to feed on plankton and detritus.

Moreover, the organisms also adapt well with the wide variations in light intensity, changes in temperature and intense wave action and the reducing of salinity and low availability oxygen in the interstitial water when water circulations is weak (Molles, 2002). In additional, sizes of particle of the shore also contribute in the zonation of intertidal organisms. The study of the distribution pattern within sandy beach and mud flat at intertidal area by John and Lawson (1991) in West Africa and by Santelices (1991) in Chile showed that bivalve was dominant low tide zone (Raffaelli *et al.*, 1996).

The bivalve

Bivalve is a member of phylum molluscs which is inhabit in the shallow water area at the intertidal zone. Ridzwan (1993) has stated in his book, that a part of Sunda shelf with 600 meter depth was suitable for molluscs because of the high production of phytoplankton and organic matters. Molluscs are shellfish and it was complex define by the biological definition but the important character of molluscs is, all molluscs have shell and because of this characteristic it do not have bone in the flesh (Dore, 1991). About 20,000 bivalve species are common benthic animal in the sea and fresh water area. The bivalve classes are constituted species of clams, oysters and mussels (Barnes *et al.*, 1993).

The general characteristics of class Bivalve are with a pair of shell valves and the shell was lateral and articulate along the dorsal mid line. It shell can open and close by the adductor muscles which possess of catch-fiber mechanism. Bivalve that lives at the tidal area will close it shell to prevent from dehydration with the low tide level. It body was flattened laterally located dorsally within the shell and the large mantle cavity is occupied at the lateral and ventral of the body (Ridzwan, 1993).

Other importance parts of bivalve are siphons; siphon was playing a role like a mouth to the bivalve which it used to feeding. Naturally bivalve is a filter feeders and feed on the plankton, so siphon are use to inhale and filter the food. Beside that, the siphon and the foot is also play apart on the burrowing behaviour of bivalve.

The study by Pechenik (2000) stated that the other major bivalve characteristics are;

1. a hinged shell, which two valves was joined together by a springy ligaments;
2. lateral compression of the body and foot;
3. lack of cephalization (virtual absent of the head and associated sensory structures);
4. a spacious mantle cavity;
5. a sedentary lifestyle; and
6. the absence of a radula complex.

Classifications

Kingdom: Animalia

Phylum: Molluscs

Class: Bivalvia

Subclass: Heterodonta Neumeyer, 1884

Order: Veneroida Solenoidea Lamarck, 1809

Superfamily: Solenaceae Lamarck, 1809

Family: Solenidae Lamarck, 1809

Genus: *Solen* Linnaeus, 1758

Family: Solecurtidae Blainville, 1824

Razor clam

As stated before, clams are bivalve filter feeding molluscs. Compare to others bivalve, clams was less active and adapt to burrow in the substrate with some have hard shell and others have a thin shell. The clam species is occupying of hardshell clam or quahog, surf clam, softshell clam, butter clam, razor clam and many other species with the potential value in the aquaculture and fisheries economic development. All clam species has a more or less oval shape of shell but an exception is the razor clam, which has an elongate shell (Encyclopedia Wikimedia).

According to Dore (1991), there are about 160 species of clam world wide and 28 of them have a commercial potential in fisheries. About 5.5 tonne of razor clams (*Solen* spp.) was landed in Sabah the fisheries market, as reported in the Sabah Fisheries Annual Report 1983 (Ridzwan,1993).

The species under the genus *Ensis* will found with a green-yellow to brown external colour. The distributions are from the South of Norway to the North Africa and Mediterranean and also occurred widely around the coasts of Scotland (Tuck *et al.*. 1999). Like, *Ensis diretus* which it can found from Canadian Maritimes to the Carolinas known as an Atlantic razor clam or Atlantic jackknife clam (American Fisheries Society). It has a sharp edge on the white shell and brownish covering and also. As Hill (1981) mentioned, genera of *Ensis* also can found in Hong Kong.

Solen genus is a yellowish in shell colour and with light brown periostracum. *Solen* spp. has wide distribution in the world and high diversity of species. *Solen vagina*, *Solen strictus* Gould and *Solen regularis* Dunker is the some species that listed in of genus *Solen*. The species of *Solen strictus* was found in Sabah (Ridzwan, 1993) and in the study of razor clam *Solen* sp. by Nantana (1992) found in Mae Klong estuary at Thailand bay is a *Solen regularis*.

Another common species of razor clam are called Pacific razor clam or known as *Siliqua patula*. The one of it characteristic are covered with a greenish or dark brown layer and with white under laying shell. On the other hand, this razor clam has slightly different in the shell shape, which the shell more like softshell clam in shape (Dore, 1991). According to Lassuy and Simons (1989) it was primarily found at the beach in the Pacific Northwest Region (Loh, 2005).

Burrowing behaviour

Burrowing or also known as a vertical migrations movement is an importance razor clam natural behaviour. As a bivalve, burrowing behaviour was influence by the adductor muscles which is when the adductor muscles was relax the shell valves gape slightly and the water drawn into and through the cavity mantel. Then, bivalve was laterally compressed its foot to burrow into the sediment. In the experiment by Dales *et al.* (1981) on the foot action of the bivalve burrowing behaviour, showed that the muscular strip will expand out and by it pulsation to be thrust into sand. This is also similarly occurred on the razor clam species like *Ensis*.

According to Barnes (1950), the adductor muscles help valve to open and close rapidly in every six hour (Dales *et al.*, 1981). This reaction was occurred because of the fibre productions action or the *phasi* contractions, which is during that process valve tightly closed and each adductor was producing prolonged contraction of tonus.

Burrow into the sediment is importance for a survival rate and protection from the predator of razor calm species. It is because, as have stated before the species of clams are passive swimmer than others bivalve and most of calms are sedentary organisms. According to Robinson and Richardson (1998), the study at the Bay of Ireland of survival rate and burrowing ability of *Ensis arcuatus* was most consumed by the predator crabs (*Carcinus maenas*, *Liocarcinus depurator* and *Pagarus bernhardus*).

The *in-situ* observation study of the *Solecurtus strigilatus* species by Bromley and Asgaard (1990), that bivalve need about 10 to 15 second to penetrate into sediment and to drawn into vertical position. Beside that, its take was about 30 to 60 second to disappear into sediment from view. This bivalve species can burrow deeply around 50 meter depth.

But, not all bivalve can burrow as fast as *Solecurtus strigilatus* species. For instance, in the *in-situ* observation of the *Ensis arcuatus* was displayed a slow initiation of escape-digging and some of specimen was failed to begin burrowing. In that experiment, its takes about 8 minute remained stationary on the sediment to reburrow after collected and about 14 minute to completely burrow (Robinson and Richardson, 1998).

Burrowing behaviour of bivalve can be divided into five phase to complete the digging cycle where large individual will perform the cycle in 10 second rhythm while the young one are more rapidly (Bromley and Asgaard, 1990):

1. siphon was opened and water drawn into posterior mantel cavity (posterior mantel and siphon were expanded and posterior mantel become elongated)
2. siphon was closed and the foot was extended as knife blade in role to dig the sediment.

3. muscular posterior mantel force a jet of water out (the hydrostatic pressure of posterior mantel will force the posterior part of the shell against the burrow walls to produce a powerful penetration anchor).
4. foot whips out along the water jet into sediment.
5. posterior adductor muscles will contract and release the penetration anchor and the pedal retractor muscles drawn the shell (the watery sand flow back fast the now narrow shell and shell muscles then relax again to re-establish).

3.0 MATERIALS AND METHODS

3.1 Study site and sources of razor clam

Razor clams were sampled during spring tides from five intertidal zone areas along Kuching Bay i.e.; Asajaya Laut, Muara Tebas, Buntal, Teluk Delima and Bako (Figure 1). These sites were chosen because they are known to be the production site of razor clam and according to Pang (1992), Asajaya Laut and Muara Tebas were the two major sites to collect razor clam during the collecting season.

Monthly distribution of razor clam was carried out only at Asajaya Laut from September 2005 to December 2005. The sampling dates were; 19 September 2005, 8 October 2005, 17 November 2005 and 5 December 2005.

For other study sites (Muara Tebas, Buntal, Teluk Delima and Bako) the razor clam distributions was determined only once within four days in December 2005. The sampling dates were:

- 3 December 2005 – Buntal
- 4 December 2005 – Muara Tebas
- 6 December 2005 – Teluk Delima
- 18 December 2005 – Bako.

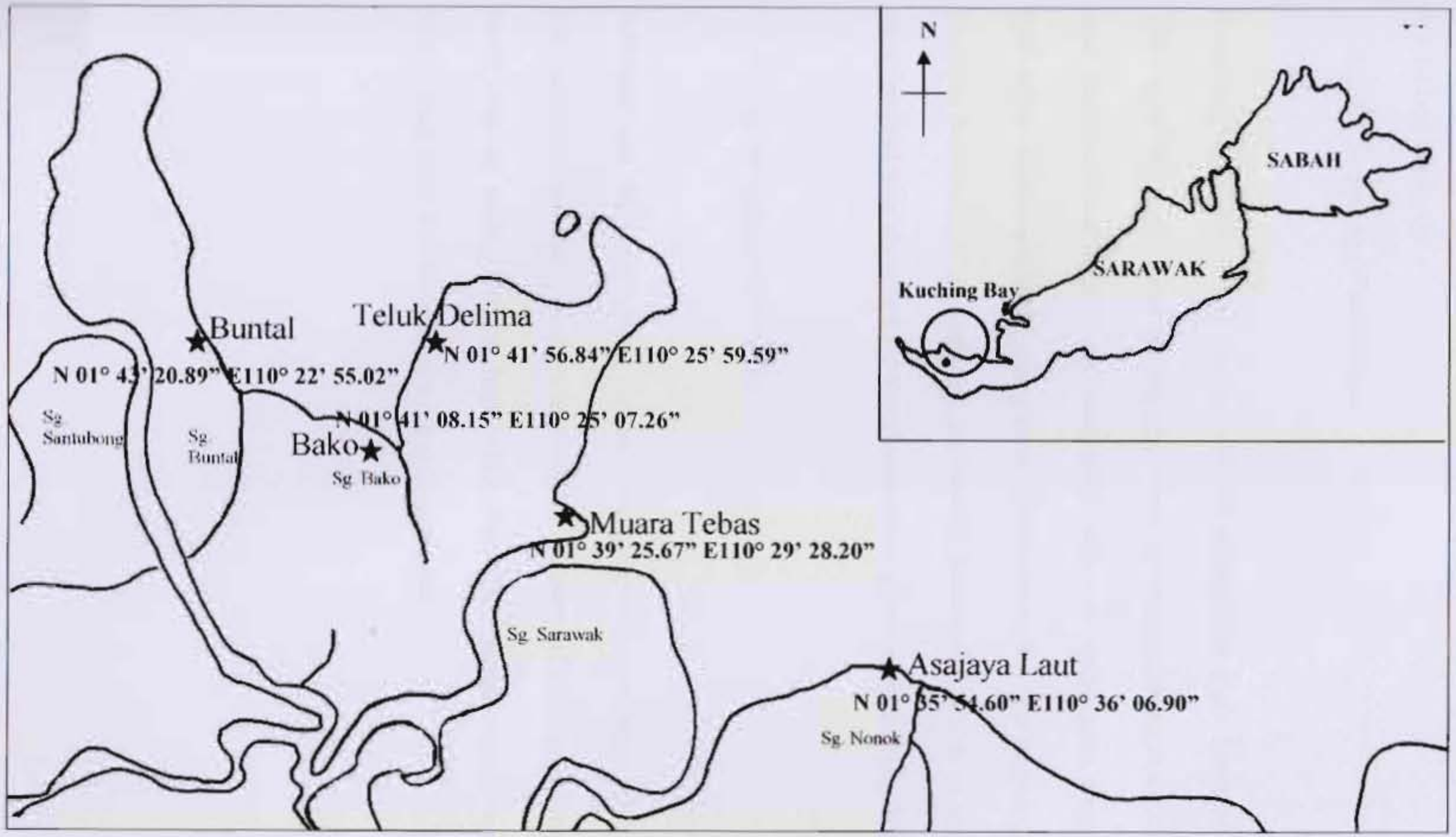


Figure 1. Locations of sampling sites along Kuching bay

3.2 Razor Clam Sampling Methods

3.2.1 Field Methods

3.2.1.1 Sampling of razor clam

Sampling was done during the low tide of spring tides from September until December 2005 by hiring a few local people who were expert in catching razor clam. The collectors used the traditional method as mentioned before to catch razor clam within the 0.25 x 0.25 meter square quadrates along each line transect. The line transect for all sampling of monthly distributions in Asajaya Laut started from the high tide to low tide area and the same method was also used for the distributions of razor clam along Kuching Bay.

3.2.1.2 Sampling of sediment

Sediment use for observations the burrowing behaviour of razor clams was taken from the intertidal mud flat of razor clam habitat at three different areas; the mean low water neap, mid tide level and mean high water neap. The sample of sediment was taken about 50 cm deep from the surface for each different area.

3.2.1.3 The distribution and density of razor clam

The distribution pattern of razor clam within intertidal region along Kuching were measured using the line transect method. The number of razor clams caught in each quadrate of transect was recorded and the density of razor clam in the quadrate was determined. Total individual caught at each site was measured and the comparison was done on the different sites along Kuching Bay in order to find the distributions of razor clam. During the sampling process, three line transects were done. The distance between line transects was more then 30 m and then it went down to low tide area from high tide area (Figure 2). for each line transect the distance between two quadrate was 50 m and the first quadrate were marked as Q1 at the high tide area and continued until last the edge (low tide area) of the beach.

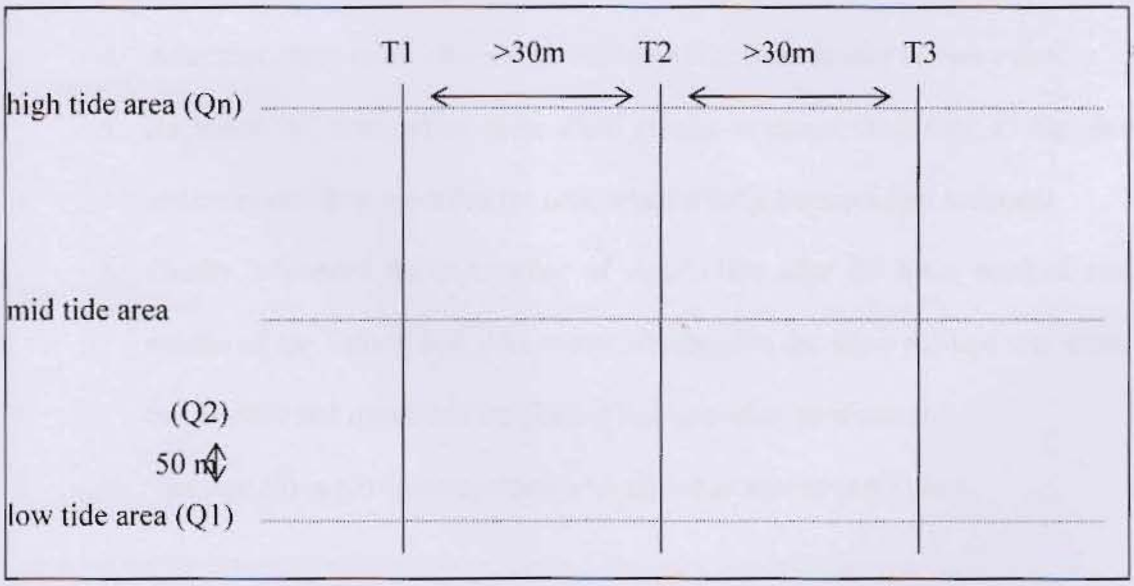


Figure 2. The layout of line transects at sampling sites

3.2.2 Laboratory Methods

3.2.2.1 Measurement of the razor clam

The measurement of razor clam sizes of shell length, shell width and total wet weight were done in the laboratory after the field trip. The shell length and shell width was measured using digital calliper (model Mitutoyo CD-6"B), while the measurement of total wet weight was taken using the digital balance (model Ohaus CT 200-S).

3.2.2.2 Observation of burrowing behaviour of razor clam

1. The three tanks were used and labelled as A, B and C.
2. Each tank was mixed and stir with seawater and left to settle.
3. Razor clams were tagged with the fishing line. This was to estimate the depth of razor clam burrowing ability.
4. After that, three razor clams with the same size were placed in every tank.
5. Recorded the time when razor clam started to move their foot to dig into sediment and then recorded the time when it fully burrows into sediment.
6. Finally, observed the burrowing of razor clam after 20 hour, marked and measured the fishing line. (At *in-situ* observation the same method was used, but marked and measured the fishing line was after 10 minute).
7. The step (3) to (5) were repeated with the other size of razor clam.

3.3 Water Quality Assessment

3.3.1 *In-situ* Physico-chemical parameters

The physico-chemical parameters such as salinity, temperature, pH and dissolved oxygen were measured *in-situ*. Salinity was taken by using the refractometer (model Atago S-28) and Hanna instrument (model Hanna HI 9835). Dissolved oxygen (DO) and temperature were taken using Cyberscan meter (model DO 300/310) and pH meter was used for pH reading.

3.3.2 Laboratory Analysis

3.3.2.1 Biochemical Oxygen Demand (BOD_5)

Three replicates of 300 ml water sample were taken for each month at the sampling site. The samples were wrapped with aluminium foil and stored in a cooler box at 25°C of temperature. The initial DO value was measured *in-situ*. After five days, the final DO reading of each replicate was measured using the same model of Cyberscan:

The formula used to calculate the BOD_5:

$$BOD_5 = \frac{DO_1 - DO_5}{P}$$

Where:

DO_1 = initial DO (mg/l)

DO_5 = DO value after five days or final DO (mg/l)

P = Volume of water sample

3.3.2.2 Total Suspended Solid (TSS)

The glass fibre filter paper (GF/C) was soak in distilled water and dry in oven at 103-105 °C overnight. Each filter paper was raped in aluminium foil individually and labelled. Then, the weights of each raped filter paper were recorded. After that, the overnight dry filter paper was used to filter of a well-mixed water sample. Dry the filter paper overnight and recorded the final reading weight.

The formula that using to calculate TSS:

$$TSS = \frac{(A - B) \times 1000}{C}$$

Where:

A = final weight of filter

B = initial weight of filter

C = volume of water filtered

3.3.2.3 Chlorophyll a

Two hundred fifty milliliters of well-mixed water sample was filter using the glass fibre filter paper (GF/C) and it was dry in the silica gel desiccators prior to the grinding process. The filter paper was grinded with pestle and mortar with 5 ml of 90% aqueous acetone. The grinded filter paper was transferred into a centrifuge tube and make up the volume to 10 ml by adding of 90% aqueous acetone; wrapped with aluminium foil and placed in a refrigerator (model Nuve NF 615) for about 18 hours. Then, the samples were centrifuged for 10 minutes under 3,000 rpm. The supernatant was used for determination of optical density in a spectrophotometer (model Secoman BP 106) at the different wavelength: 664, 647 and 630 nm. Blank used was 90% aqueous acetone. The formula used to get individual chlorophyll contents are:

Chlorophyll a (C) = E_{664} - E_{647} - E_{630}

The calculations of chlorophyll a:

$$\text{Chlorophyll a} = \frac{C \times v}{V \times l}$$

Where:

C = Chlorophyll a

v = volume of 90% aqueous acetone (ml) used

V = volume of water (l) filtered for the extraction of the chlorophyll

l = path length (cm) of the cuvette used in the spectrophotometer

4.0 RESULTS

4.1 Physico-chemical Parameter

4.1.1 In Asajaya Laut

In this study, the highest temperature was recorded in September (37.50 ± 2.50 °C). The lowest temperature value was recorded in November (29.43 ± 0.31 °C). The highest salinity reading in Asajaya Laut was in November with 28.67 ± 0.58 PSU and the lowest was in September with 26.67 ± 0.58 PSU. The highest and the lowest dissolved oxygen content were 4.37 ± 0.09 mg/l in November and 6.58 ± 0.29 mg/l in September. The highest pH reading was 7.87 ± 0.04 in September. Meanwhile, the lowest reading was 7.43 ± 0.06 in December.

The value of chlorophyll-a, biochemical oxygen demand (BOD_5) and total suspended solid (TSS) is show in Table 2. The result showed that, the chlorophyll-a content in September was higher than other months with 0.024 mg/l and lower in November with 0.00028 mg/l. The highest BOD_5 value was 2.01 ± 0.266 mg/l in September while the lowest was 1.18 ± 0.20 mg/l in December. The highest TSS level in Asajaya Laut was in December 363 ± 30 mg/l and lowest value was 193 ± 44 mg/l in November.

4.1.2 In Kuching Bay

The physico-chemical of water parameters of Kuching bay in December 2005 for five study sites are shown in Table 3. Among all sites, the highest temperature was recoded in Muara Tebas with 35.10 ± 0.15 °C and the lowest value was at Teluk Delima with 30.20 ± 0.20 °C. The salinity of four sites along Kuching bay has a same value of 30 PSU except Asajaya Laut (28 ± 1 PSU). The highest dissolved oxygen content was 8.15 ± 0.02 mg/l at Buntal and the lowest was 5.36 ± 0.24 mg/l at Teluk Delima. The highest pH level among the sampling sites was at 7.70 ± 0.20 in Teluk Delima and the lowest level at 6.40 ± 0.11 in Muara Tebas.

The values of the chlorophyll-a, BOD_5 and TSS of Kuching Bay in Dec 2005 are shown in Table 4. The chlorophyll-a content at Muara Tebas was highest with 0.042 μg/l and the lowest was at Teluk Delima with 0.00028 μg/l. The highest BOD_5 value was 1.69 ± 0.31 mg/l at Buntal while the lowest was 0.79 ± 0.21 mg/l at Bako. The highest TSS level along the Kuching Bay was at Bako 514 ± 26 mg/l and lowest level was 77 ± 12 mg/l at Muara Tebas.

Table 1. The *in-situ* physico-chemical parameters of Asajaya Laut in Sep, Oct, Nov and Dec 2005

Date	Temperature (°C)	Salinity (PSU)	Dissolved Oxygen (mg/l)	pH
19/09/2005	37.50 ± 2.50	26.67 ± 0.58	6.58 ± 0.29	7.87 ± 0.04
08/10/2005	30.80 ± 0.53	29.67 ± 0.58	5.21 ± 0.05	7.64 ± 0.12
17/11/2005	29.43 ± 0.31	28.67 ± 0.58	4.37 ± 0.09	7.45 ± 0.05
05/12/2005	30.60 ± 1.31	28.00 ± 1.00	5.46 ± 0.27	7.43 ± 0.06

Table 2. The laboratory analysis of Asajaya Laut water sample

Date	Chlorophyll-a (mg/l)	BOD_5 (mg/l)	TSS (mg/l)
19/09/2005	0.024	2.01 ± 0.27	236 ± 32
08/10/2005	0.022	1.22 ± 0.09	214 ± 35
17/11/2005	0.00028	1.78 ± 0.42	193 ± 44
05/12/2005	0.0006	1.18 ± 0.20	363 ± 30

Table 3. The *in-situ* physico-chemical along Kuching Bay (Buntal, Muara Tebas, Asajaya Laut, Teluk Delima and Bako)

Site	Date	Temperature (°C)	Salinity (PSU)	Dissolved Oxygen (mg/l)	pH
Buntal	03/12/2005	34.63 ± 0.12	30 ± 0.0	8.15 ± 0.02	6.97 ± 0.02
Muara Tebas	04/12/2005	35.10 ± 0.15	30 ± 0.0	5.50 ± 0.42	6.40 ± 0.11
Asajaya Laut	05/12/2005	30.60 ± 1.31	28 ± 1.0	5.46 ± 0.27	7.43 ± 0.06
Teluk Delima	06/12/2005	30.20 ± 0.20	30 ± 0.0	5.36 ± 0.24	7.70 ± 0.20
Bako	18/12/2005	30.50 ± 1.61	30 ± 0.0	6.46 ± 0.21	7.26 ± 0.02

Table 4. The laboratory analysis of Kuching Bay water sample

Site	Date	Chlorophyll-a (mg/l)	BOD_5 (mg/l)	TSS (mg/l)
Buntal	03/12/2005	0.00036	1.69 ± 0.31	262 ± 32
Muara Tebas	04/12/2005	0.042	1.09 ± 0.15	77 ± 12
Asajaya Laut	05/12/2005	0.0006	1.81 ± 0.20	363 ± 30
Teluk Delima	06/12/2005	0.00028	0.99 ± 0.15	304 ± 69
Bako	18/12/2005	0.00052	0.79 ± 0.21	514 ± 26

4.2 Razor clam species

There were three species of razor clam found in this study and locally known as Ambal Biasa, Ambal Jernang and Ambal Riong. These three species were classified under *Solen* genus and their scientific names are:

i. Ambal Biasa – *Solen corneus* (temporary)

ii. Ambal Jernang – *Solen vagina* (temporary)

iii. Ambal Riong – *Solen sarawakensis* Cosel, 2002 (comfirm)

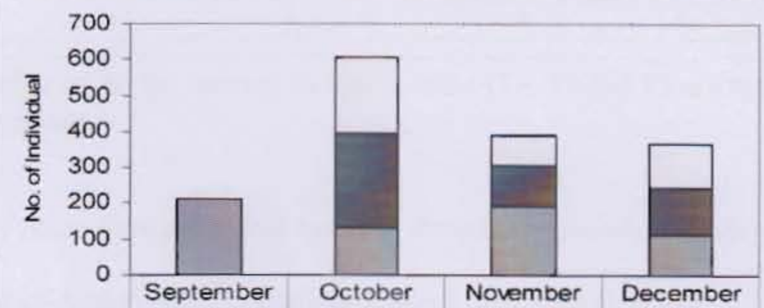
The distribution of razor clams in sampling site (along Kuching Bay) was different between these species.

4.3 Monthly Distribution of Razor Clam in Asajaya Laut

4.3.1 Density and distribution pattern within the intertidal area at Asajaya Laut

During the four months of study period (Sep to Dec 2005) in Asajaya Laut, there was two razor clam species found; Ambal Biasa and Ambal Jernang. The number of individual of Ambal Biasa was more abundantly than Ambal Jernang; 1,575 individual for Ambal Biasa and only 15 individual of Ambal Jernang.

For Ambal Biasa the highest number of individual found was in October with the total number for three transects at 606 individual. The lowest number was 212 individual on September but on September there was only one transect done. The total for other two months were almost same with 392 individual in November and 365 individual in December was found (Figure 3).



	September	October	November	December
T3	0	213	86	123
T2	0	262	112	127
T1	212	131	194	115

Figure 3. Number of Ambal Biasa in four months (T1, T2 and T3 are referring to the line transect numbers)

The number of individual of Ambal Jernang in Asajaya Laut was shown in the Figure 4. The highest number of individual was in September with 7 individuals found. In September and October, none of Ambal Jernang was found in Asajaya Laut and for the other two month the number of individual found was 5 individuals in November and 3 individuals in December.

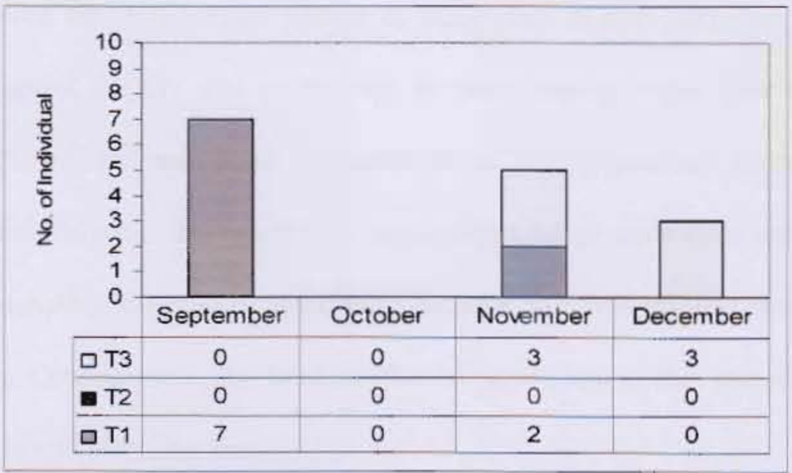


Figure 4. Number of Ambal Jernang in four months (T1, T2 and T3 are referring to the line transect numbers)

Comparison of razor clam individual between these both species in Asajaya Laut showed that the density of Ambal Jernang was much lower than Ambal Biasa.

4.3.2 First sampling (19 September 2005)

On 19 September 2005, the first sampling to monitor the monthly distribution of razor clam was done at the Asajaya Laut. One line transect approximately 1000 m along the intertidal area from low tide area to high tide area was performed. There were 19 quadrates within the transect line and the distance between quadrates was 50 m. Each quadrate was mark with quadrate 1 (Q1) for the first quadrate, quadrate 2 (Q2) for the second quadrate and continued until the last quadrate with Q19. However, the distance between Q2 and Q3 was 150 m because of the water level rose very quickly and flooded the area.

Figure 5 showed the distributions pattern of razor clam in first sampling in September 2005. The highest density was at the 500 m from starting point (low tide) with 28 individual/6.25 m^2. No individual was collected at 200 m quadrate because the water already flooded the area. This sampling was lowest total of razor clam individual found between all sampling times (219 individual) because only one transect was done during this sampling. Consequently, the total number of razor clam in this sampling cannot be compared to others sampling time.

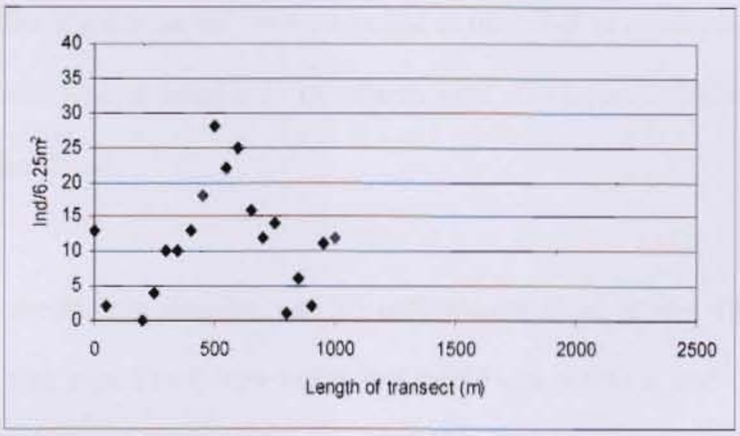


Figure 5. Density of razor clam (individual/6.25 m^2) along 1000 m from low tide to high tide area

During the first sampling, the distributions pattern of razor clam within intertidal zone cannot be determined because only one line transect was done and only at the low tide area (0 to 1000 m). There was no data on distribution of razor clam at high tide area.

4.3.3 Second sampling (8 October 2005)

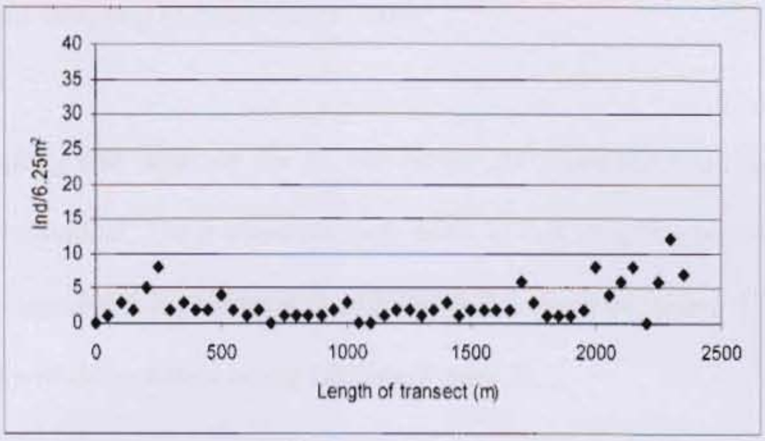
On 8 October 2005, the second sampling of razor clam was done at Asajaya Laut. In this sampling, three line transects was successfully done with 48 quadrates for Transect 1, 40 quadrates for Transect 2 and 41quadrate for Transect 3. The starting point for each transect was at the low tide area and up to high tide area (Figure 6). The total number of individual caught in October is the highest between all sampling times (606 individual).

At Transect 1, the highest density was recorded at the 2300 m quadrate which is at the high tide area with 12 individual/6.25 m^2. There were also have several quadrates where no individual was found.

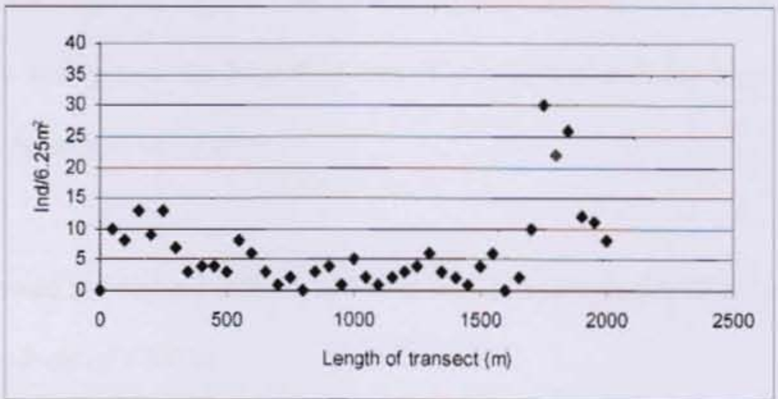
In Transect 2, the highest density was 30 individual/6.25m2 at the 1750 m quadrate within the high tide area. The lowest individual found was at 800 m and 600 m quadrates (no individual).

The highest density in Transect 3 was also recoded at high tide are at 1900 m of 2000 m along with 34 individual/6.25 m^2. No razor clam was found in three quadrates (700 m, 850 m, and 1000 m)

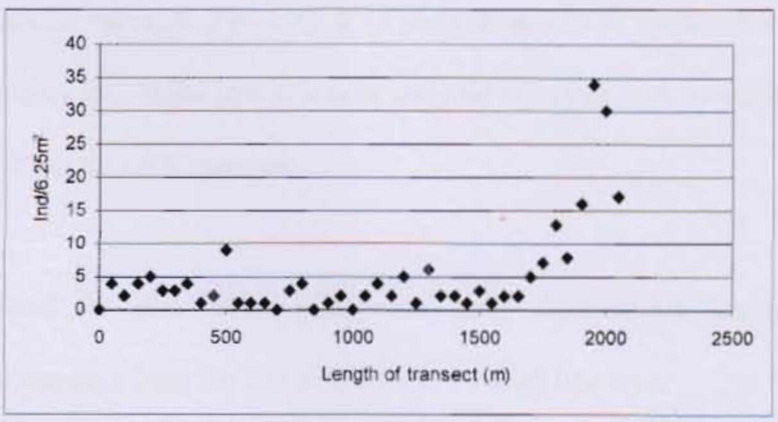
The highest density of razor calm was at the high tide area and the distribution pattern showed that the number of individual increased from low tide area to high tide area. Data was shown in the Appendix 4 and distributions pattern shown in Figure 6.



Transect 1 (T1)



Transect 2 (T2)



Transect 3 (T3)

Figure 6. Density of razor clam (individual/6.25 m^2) along three transects from low tide to high tide area (8 Oct 2005)

4.3.4 Third sampling (17 November 2005)

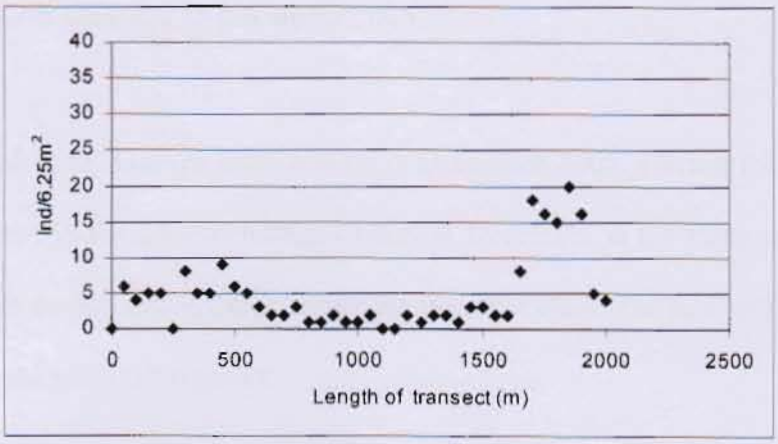
The third sampling was done on the 17 November 2005 and the total number of razor clam was 397 individual. Three transects were done, in this sampling transect 1 (T1) with 40 quadrate along 2000 m, transect 2 (T2) with 35 quadrate along 1750 meter and transect 3 (T3) with 36 quadrate along 1800 m (Figure 7).

Transect 1 showed that the highest density was 20 individual/6.25 m^2 recorded at 1850 m within 2000 m transect on the high tide area. The others plot at the high tide area also recorded high density of razor clam.

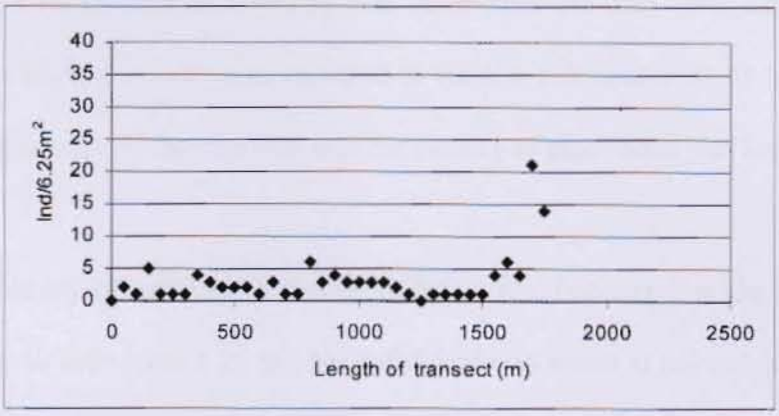
Transect 2 showed the highest individual found was 21 individual/6.25 m^2 at the high tide area on the quadrate of 1700 m.

Transect 3 recorded the highest density at 13 individual/6.25 m^2 on the last point of 1800 m. The low density was at the low tide area and mid tide area with average between 3 to 4 individual/6.25 m^2 in each quadrate.

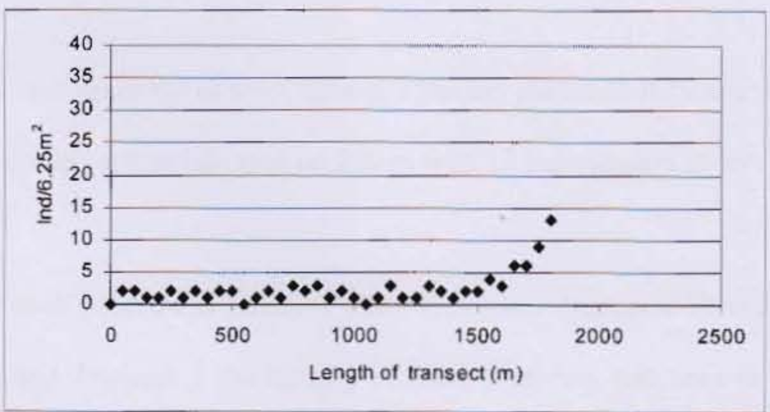
Figure 7 showed the distribution pattern of razor clam within intertidal zone on November that increase from the low tide area to the high tide area.



Transect 1 (T1)



Transect 2 (T2)



Transect 3 (T3)

Figure 7. Density of razor clam (individual/6.25 m^2) along three transects from low tide to high tide area (17 Nov 2005)

4.3.5 Fourth sampling (5 December 2005)

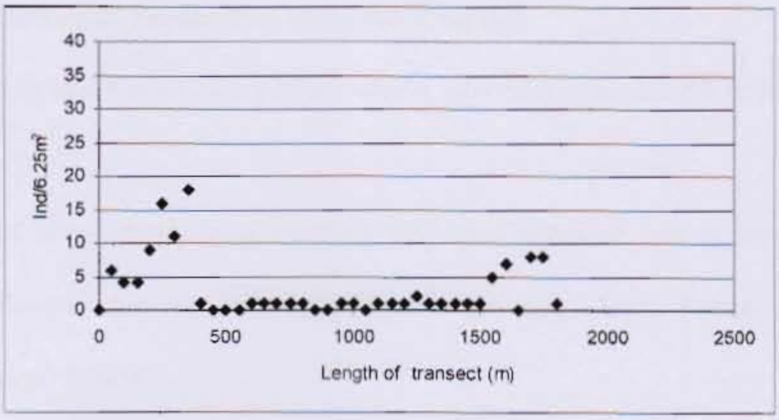
The last sampling at Asajaya Laut was on 5 December 2005. During the sampling the weather was not in the good conditions because December is the rainy season and the mud flat was to muddy and difficult to sample the razor clam. The total individuals found were 368 individual for all transect.

The Transect 1 on December sampling was quite different than other transect in other sampling. The highest density was recorded at the low tide area with 13 individual/6.25 m^2 at 200 m quadrate. At the mid tide area the density of razor clam was low.

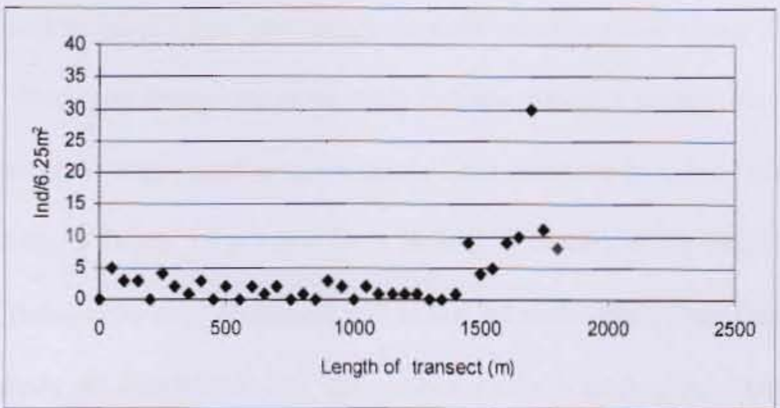
The highest density of razor clam was recorded in the Transect 2 at the high tide area (1700 m) with 30 individual/6.25 m^2. No individual was found at several quadrates along the line.

The density in each quadrate of the Transect 3 has not too much different, but the highest density was recorded at low tide area on 200 m with 13 individual/6.25 m^2.

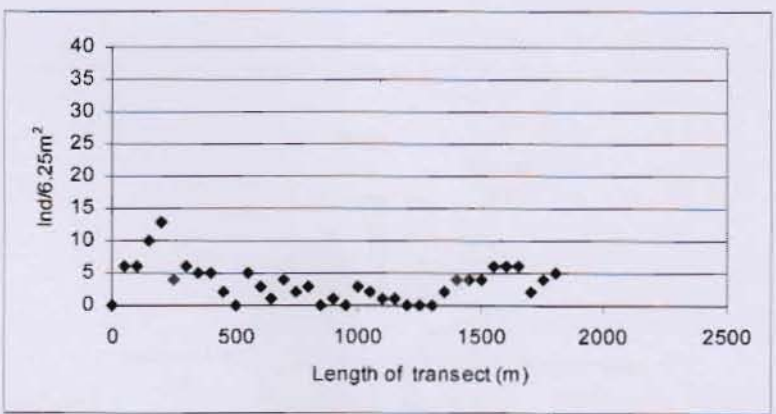
The density in each quadrate at Transect 1 and Transect 3 decreased from low tide area to high tide area and Transect 2 the density increase from low tide area to high tide area (Figure 8).



Transect 1 (T1)



Transect 2 (T2)



Transect 3 (T3)

Figure 8. Density of razor clam (individual/6.25 m^2) along three transects from low tide to high tide area (5 Dec 2005)

4.4 Distributions of Razor Clam along Kuching Bay.

4.4.1 Density and distribution pattern within intertidal zone along Kuching Bay

The density of razor clam along Kuching Bay on December was presented using the percentage of razor clam in each sampling site (Buntal, Muara Tebas, Asajaya Laut, Teluk Delima and Bako).

Figure 9 is a total of razor clam percentage on each sampling side along Kuching bay in December. It show percentage of razor clam density along Kuching Bay which is, 50 percent of razor clam was found at the Asajaya Laut compare to others site, which is 21 percent from Muara Tebas, 19 percent from Buntal, 6 percent form Teluk Delima and 4 percent from Bako. Thereby, abundant individual of razor clam was found at Asajaya Laut in this study of distributions of razor clam along Kuching bay. Beside that, this study also found at Bako consist a low density of razor clam.

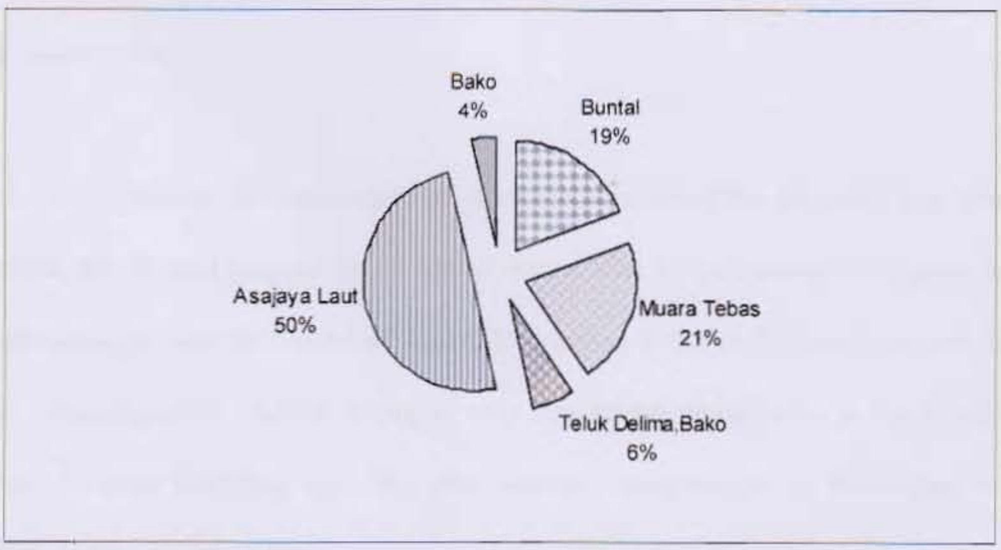


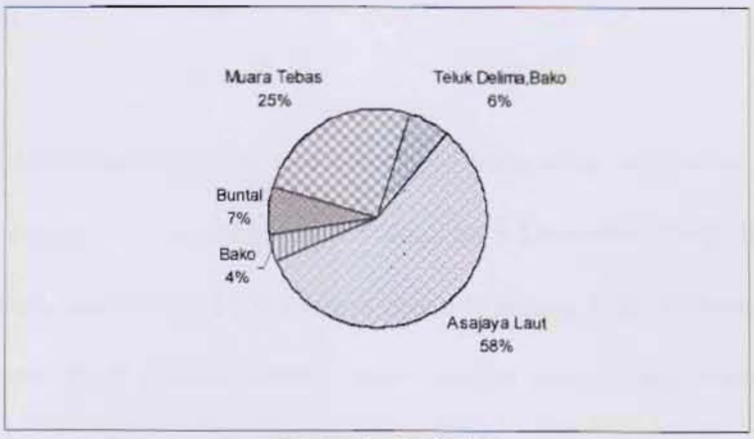
Figure 9. Percentages of total razor clams caught at 5 different study sites along the Kuching Bay in Dec 2005.

The detail density of razor clam species (Ambal Biasa, Ambal Jernang and Ambal Riong) was present in the Figure 10. In each pie chart showed the density of razor clam species according to the sampling site.

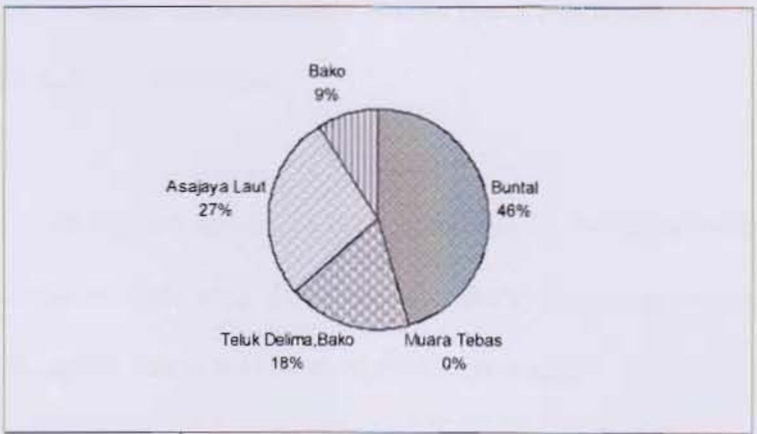
Figure 10 (a) showed the percentage of Ambal Biasa species. This pie chart recorded that the highest percentage of Ambal Biasa was found at the Asajaya Laut with 58 percent and the lowest was found at Bako with only 4 percent. Due to the resulted and the pie chart below, Ambal Biasa species was most dominant at the Asajaya Laut compare to other sampling site. The total number of Ambal Biasa caught on December was 633 individual along Kuching bay.

Figure 10 (b) showed the percentage of Ambal Jernang species. In this chart showed that Ambal Jernang was dominant at the Buntal bay and the percentage recorded was 46 percent. As a lowest density was at the Muara Tebas which is none Ambal Jernang species found there. The total Ambal Jernang caught on December was 11 individual along Kuching bay.

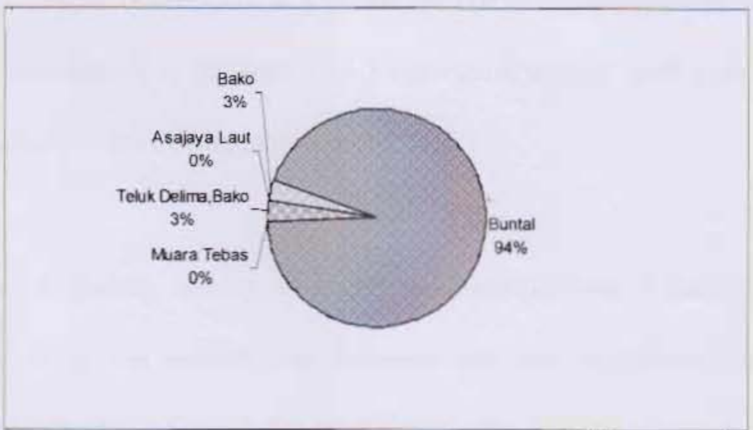
Figure 10 (c) showed the percentage of Ambal Riong along the Kuching bay. Base on that chart, the highest percentage of Ambal Riong was 94 percentages at Buntal bay. It also showed that none individual of Ambal Riong was found at Asajaya Laut and Muara Tebas. Consequently, Ambal Riong is only can found abundantly at the Buntal bay compare to other sampling site. The total Ambal Riong caught on December was 96 individual along Kuching bay.



(a) Ambal Biasa



(b) Ambal Jernang



(c) Ambal Riong

Figure 10. Percentages razor clam species caught at different sites along Kuching bay in Dec 2005.

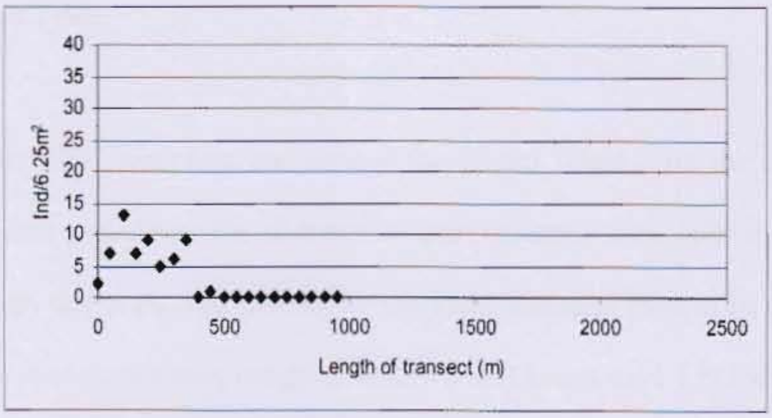
4.4.2 Buntal

At Buntal the distributions pattern and density of razor clam within the intertidal zone showed in the Figure 11. The sampling has done on 3 December 2005. In this sampling three transect were done along 1000 m form low tide area to high tide area. At the Buntal all three the razor clam species Ambal Biasa, Ambal Jernang and Ambal Riong were found here. Ambal Riong was found most abundant than two other species at Buntal in Transect 1 and 2. While in Transect 3 only Ambal Biasa was found. The total razor clams caught at Buntal were 143 individual.

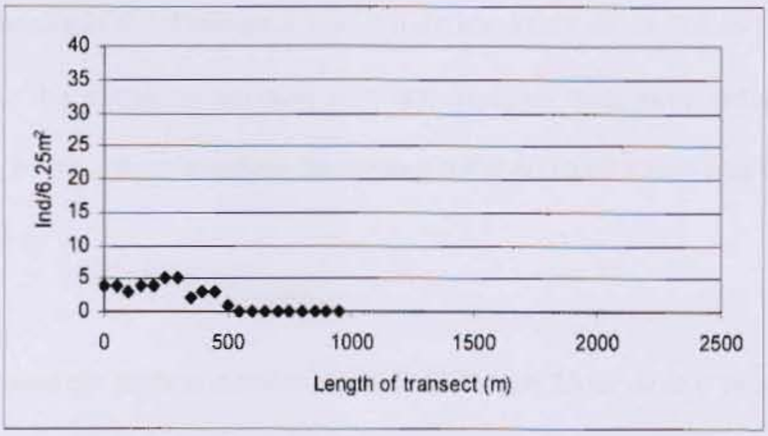
In the Transect 1 the highest density of razor clam was 13 individual/6.25 m^2 which is it was recorded at the low tide area. The table also shows that none individual was found from quadrate along the 500 m to1000 m of the line transect.

The moderately distribution pattern at low tide area (0 to 500 m) was showed in the graph of Transect 2. The density is between 1 to 5 individual/6.25 m^2 and from 500 m to 1000 m there is none individual of razor clam was found.

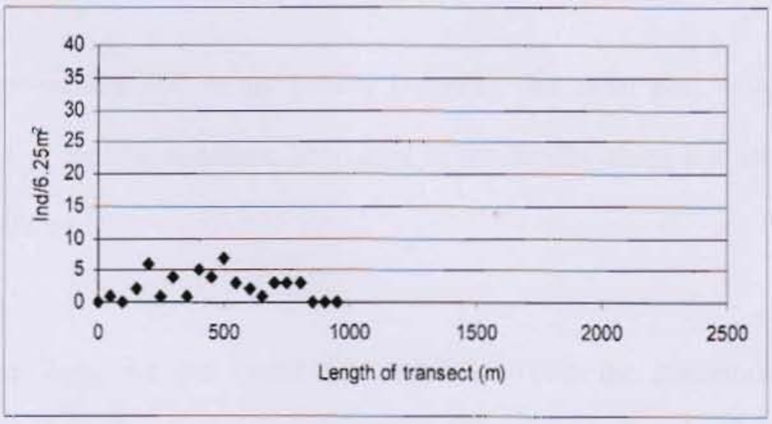
In the Transect 3 highest density of razor clam caught was 7 individual/6.25 m^2 at quadrate of 500 m. It was showed that the razor clam was distribute along this 1000 m transect. There is also have 5 quadrates with none individual were found.



Transect 1 (T1)



Transect 2 (T2)



Transect 3 (T3)

Figure 11. Density of razor clam (individual/6.25 m^2) along three transects at Buntal (3 Dec 2005)

4.4.3 Muara Tebas

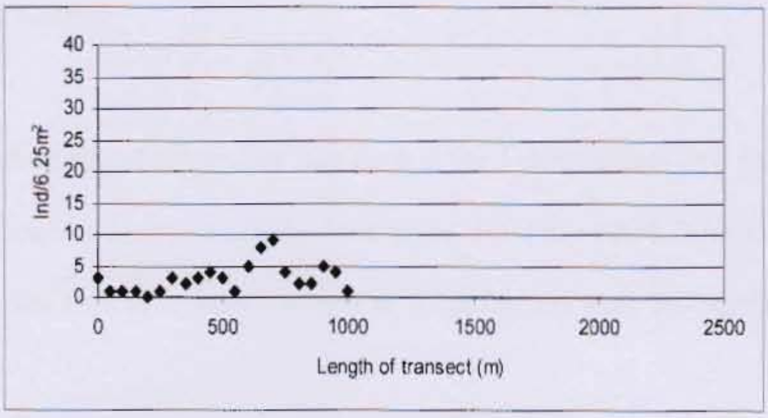
On 4 December 2005, sampling was done at the Muara Tebas. Like the other sampling site, three transect was done. The distance in each transects were 1000 m from the low tide area to high tide area. The pattern for the three transects have done showed in the Figure 12. The total razor clams caught at Muara Tebas beach were 159 individual.

The highest density in the Transect 1 was 9 individual/6.25 m^2 at 700 m from the stated quadrate. From the sampling recorded only one quadrate with none individual found it was at 200 m. In the others quadrate the average of individual found was between 1 to 8 individual/6.25 m^2.

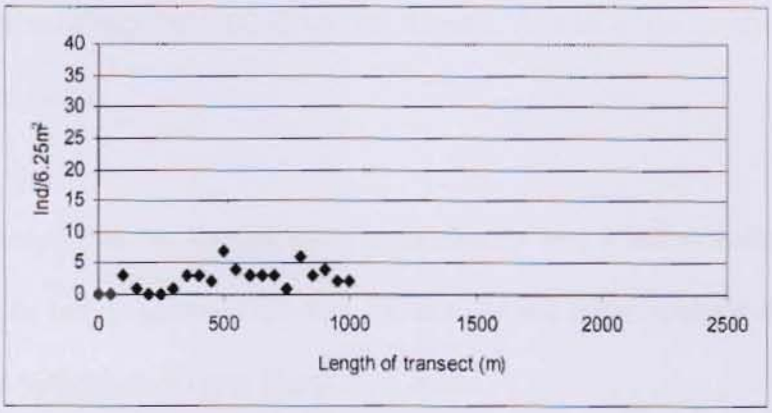
Transect 2 showed the highest density was 6 individual/6.25 m^2 at 800 m quadrate. There is four quadrates identified along transect that have 0 individual/6.25 m^2 recorded.

Transect 3 showed that 700 m the density is higher that other plot. It recorded was 6 individual/6.25 m^2 on that quadrate. The range of the density along this transect was 0 to 6 individual/6.25 m^2.

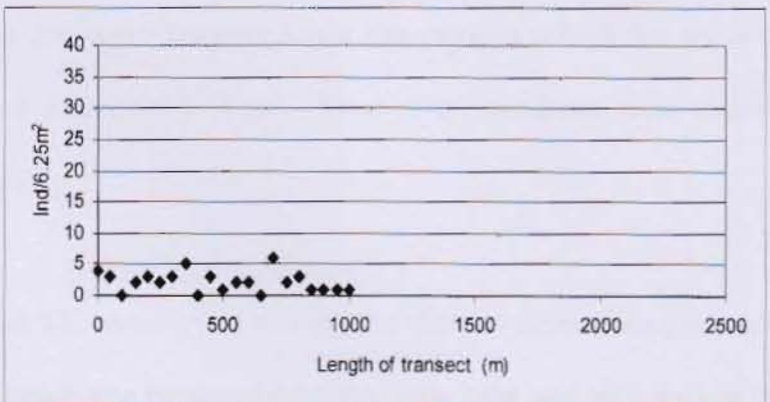
For all transect done, we can found that at Muara Tebas the distribution pattern are moderately along the 1000 m line. Although, the density in the some quadrate was just less than 10 individual/6.25 m2 and there have some of the quadrate in each transect was recorded none individual found.



Transect 1 (T1)



Transect 2 (T2)



Transect 3 (T3)

Figure 12. Density of razor clam (individual/6.25 m^2) along three transects at Muara Tebas (4 Dec 2005)

4.4.4 Teluk Delima

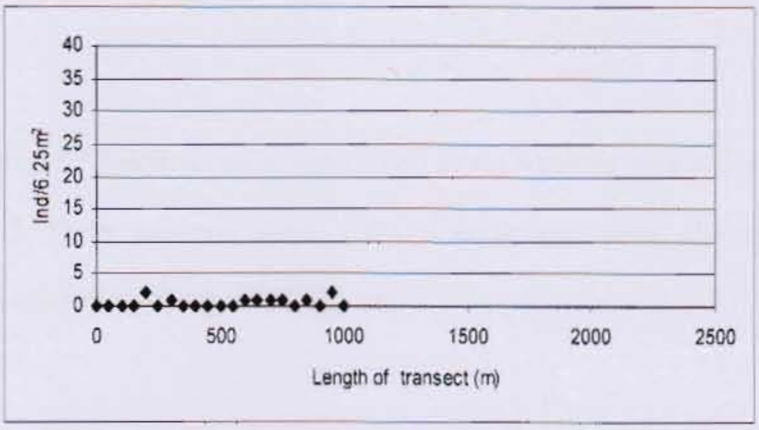
The third sampling site of razor clam was done at the Teluk Delima on 6 December 2005. Three lines transect were successfully done along 1000 m started from low tide area to high tide area. The total razor clams caught at Teluk Delima were 39 individual.

The highest density in Transect 1 was 2 individual/6.25 m^2 found only in two quadrates (200 m and 950 m) along the 1000 meter line transect. Almost of the quadrates have none individual were found.

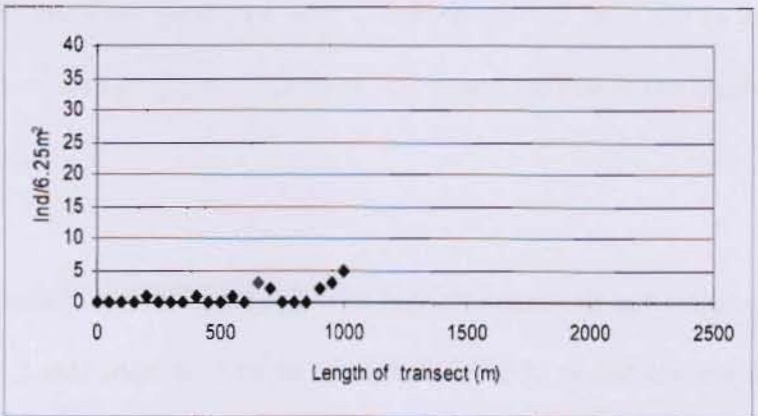
Transect 2 showed that the highest razor clam density was 5 individual/6.25 m^2 at the 1000 m or at the last quadrate of the line transect. At the early quadrate of line transect there was none individual of razor clams were found.

The highest density in the Transect 3 was also recoded at high tide are at 900 m of 1000 m along with 4 individual/6.25 m^2. Most of the quadrates were identified that none individual found.

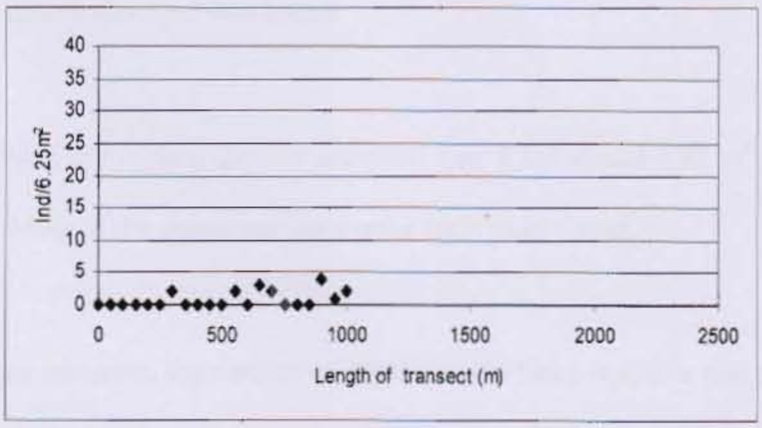
From the Figure 13, was showed that the distribution pattern of razor clam individual at Teluk Delima beach was increased from the water edge plot until the last plot along 1000 m within intertidal zone. All the data was showed in the Appendix 7.



Transect 1 (T1)



Transect 2 (T2)



Transect 3 (T3)

Figure 13. Density of razor clam (individual/6.25 m^2) along three transects at Teluk Delima (6 Dec 2005)

4.4.5 Bako

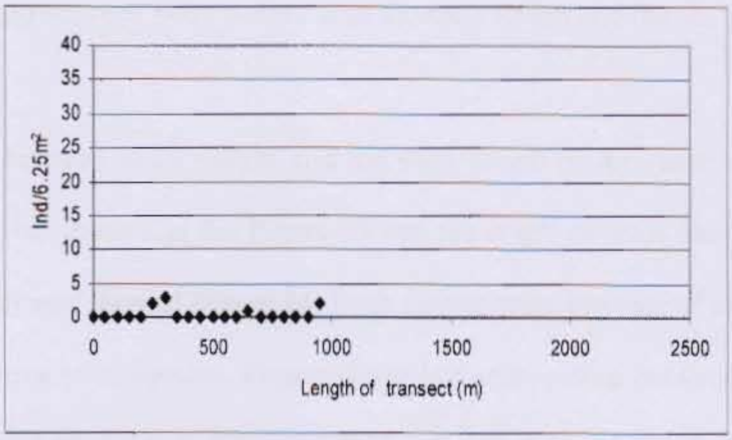
The last sampling for distributions of razor clam along Kuching was at Bako beach on 18 December 2005. Three transects about 1000 m along were done, the total razor clam caught at Bako were 29 individual (Figure 14).

The highest density in the Transect 1 was recorded was 3 individual/6.25 m^2 at the quadrate of 350 m. Two quadrates with 2 individual/6.25 m^2 (300 m and 1000 m). 1 individual/6.25 m^2 was found at quadrate of 700 m and the rest of the quadrates with none individual found.

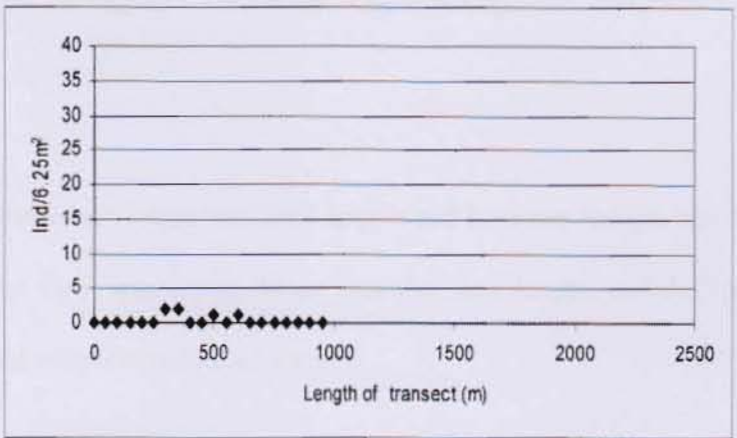
Only 6 individuals found in Transect 2. The highest density of razor clam recorded in the Transect 2 was 2 individual/6.25 m^2 at two quadrates (350 m and 400 m) and another two quadrates were at 550 m and 650 m were recorded of 1 individual/6.25 m^2. On the others quadrate have none individual was found.

Transect 3 showed the highest density recorded was 4 individual/6.25 m^2 at 300 m from low tide level. Most of the quadrates were none individual found.

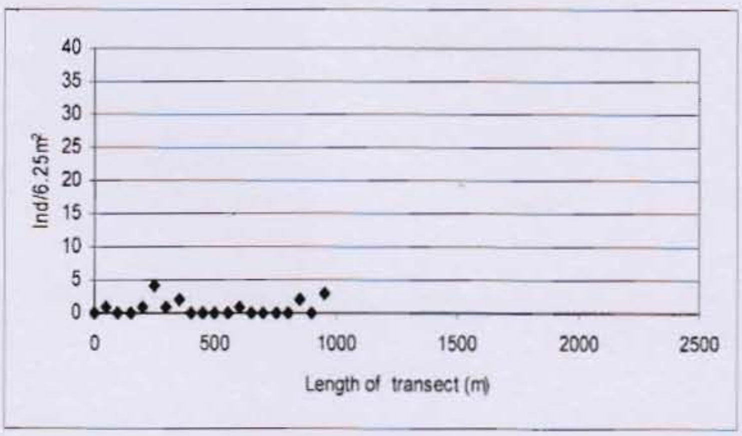
From these three transects, the density of razor clam in Bako was low and the distribution pattern of razor clam along 1000 m within intertidal zone did not show any particular trend.



Transect 1 (T1)



Transect 2 (T2)



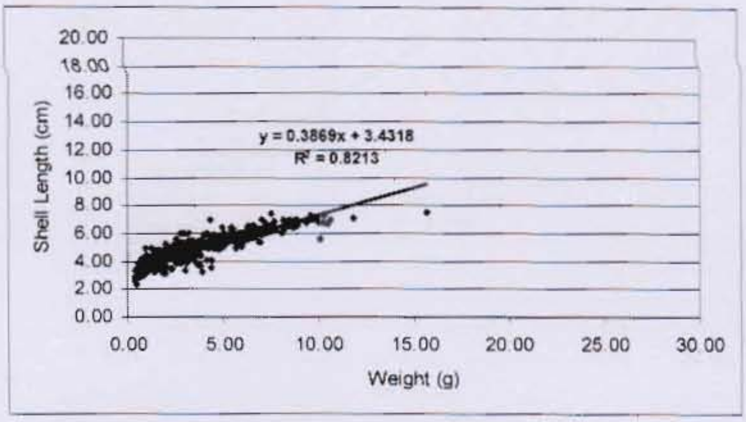
Transect 3 (T3)

Figure 14. Density of razor clam (individual/6.25 m^2) along three transects at Bako (18 Dec 2005)

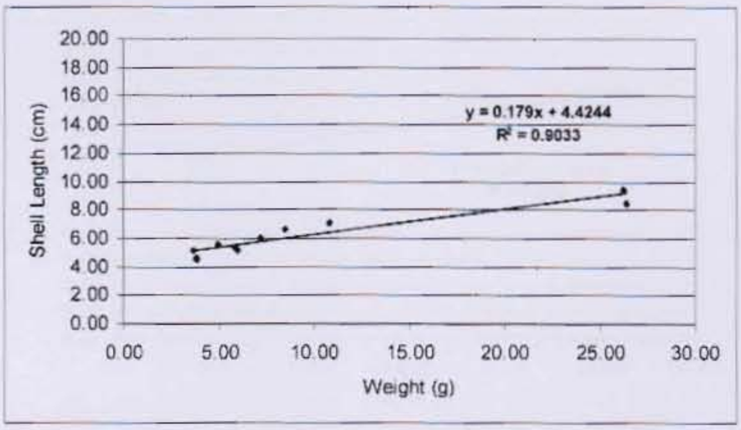
4.5 Relationship between body weight with the shell length and the shell width

The relationship between body weight and the shell length of the razor clam for three different species was showed in the Figure 15 and the graph of razor clam body weight against shell width was showed Figure 16. Both figures were consists of each graph was present of each razor clam species. Figure 15 (a) is a relationship between body weight and shell length of Ambal Biasa. Figure 15 (b) is an Ambal Jernang body weight against the shell length and the Figure 15 (c) is the Ambal Riong body weight and it shell length relationship.

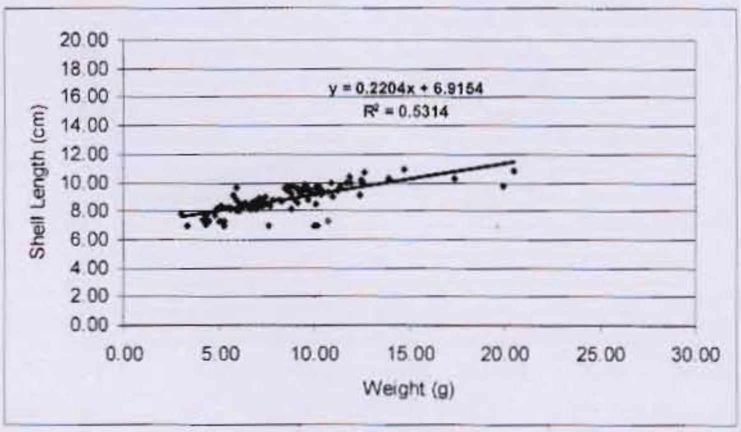
The relationship between weight and shell length and between weight and shell width for all species of razor clam was linear. Mean that the shell length and shell width of razor clam was increased with increasing of weight.



(a) Ambal Biasa

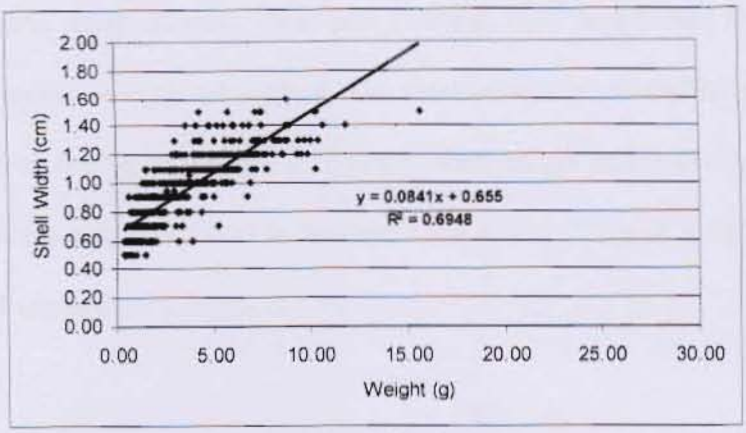


(b) Ambal Jernang

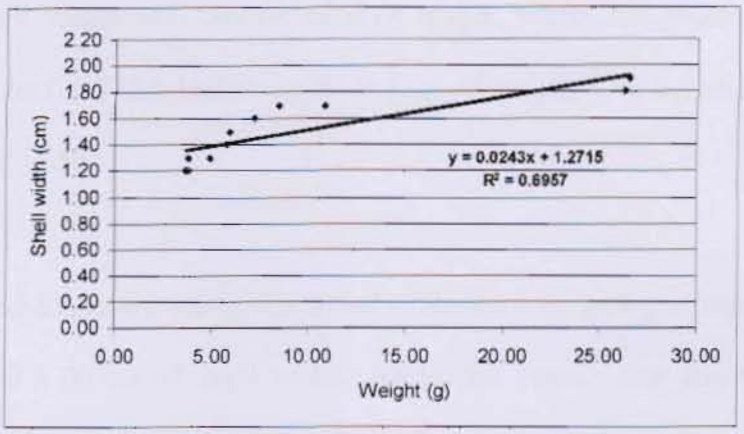


(c) Ambal Riong

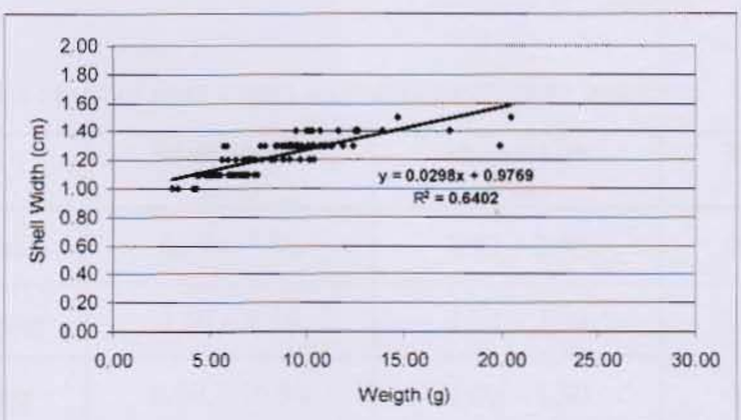
Figure 15. Relationship between body weight (g) and shell length (cm) of razor clam for the three different species



(a) Ambal Biasa



(b) Ambal Jernang



(c) Ambal Riong

Figure 16. Relationship between body weight (g) and shell width (cm) of razor clam for the three different species

Table 5 shows the range of razor clam size (weight, shell length and shell width) that found in all sampling along Kuching bay. The smallest size of Ambal Biasa was found at Asajaya Laut with 0.32 g of weight, 2.27 cm of shell length and 0.43 cm of shell length and the largest size was also found at Asajaya Laut with 15.71 g of weight, 2.27 of shell length and 2.03 cm of shell width.

The smallest size of Ambal Jernang was found at Asajaya Laut with 1.90 g of weight, 3.60 cm of shell length and 1.00 cm of shell length. While, the largest size of Ambal Jernang was found at Teluk Delima with 26.43 g of weight, 9.40 cm of shell length and 2.00 cm of shell width.

The smallest size of Ambal Riong was found at Buntal with 3.04 g of weight, 6.90 cm of shell length and 1.00 cm of shell width. While, the largest size was found at Teluk Delima with 20.46 g of weight, 10.90 cm of shell length and 1.50 cm of shell width.

Table 5. The size range of razor clams according to different species

Species	Shell length (cm)	Shell width (cm)	Body weight (g)
Ambal Biasa	2.27 – 7.80	0.43 – 2.03	0.32 – 15.71
Ambal Jernang	3.60 – 9.40	1.00 – 2.00	1.90 – 26.43
Ambal Riong	6.90 – 10.90	1.00 – 1.50	3.04 – 20.46

Base on the study of monthly distribution of clam at Asajaya Laut, patterns of razor clam size distributed within the intertidal zone were showed in the figure 17, 18 and 19. All the figures were showed that small size of razor clams was dominant at the high tide area and the large size of razor clams was found at the low tide area. In additional, the size of razor clam at Asajaya Laut within the intertidal zone would increase in size from the high tide area to the low tide area.

According to the weight range in the figures also showed, the maximum size (15.71 g) of Ambal Biasa was found at low tide area of Asajaya Laut on November in the Transect 3. The minimum size (0.32 g) of Ambal Biasa was found at high tide area of Asajaya Laut on October in Transect 2. Beside that, during the sampling on Asajaya Laut there were also in some quadrates showed in Figure 17, 18 and 19 have very wide range of size.

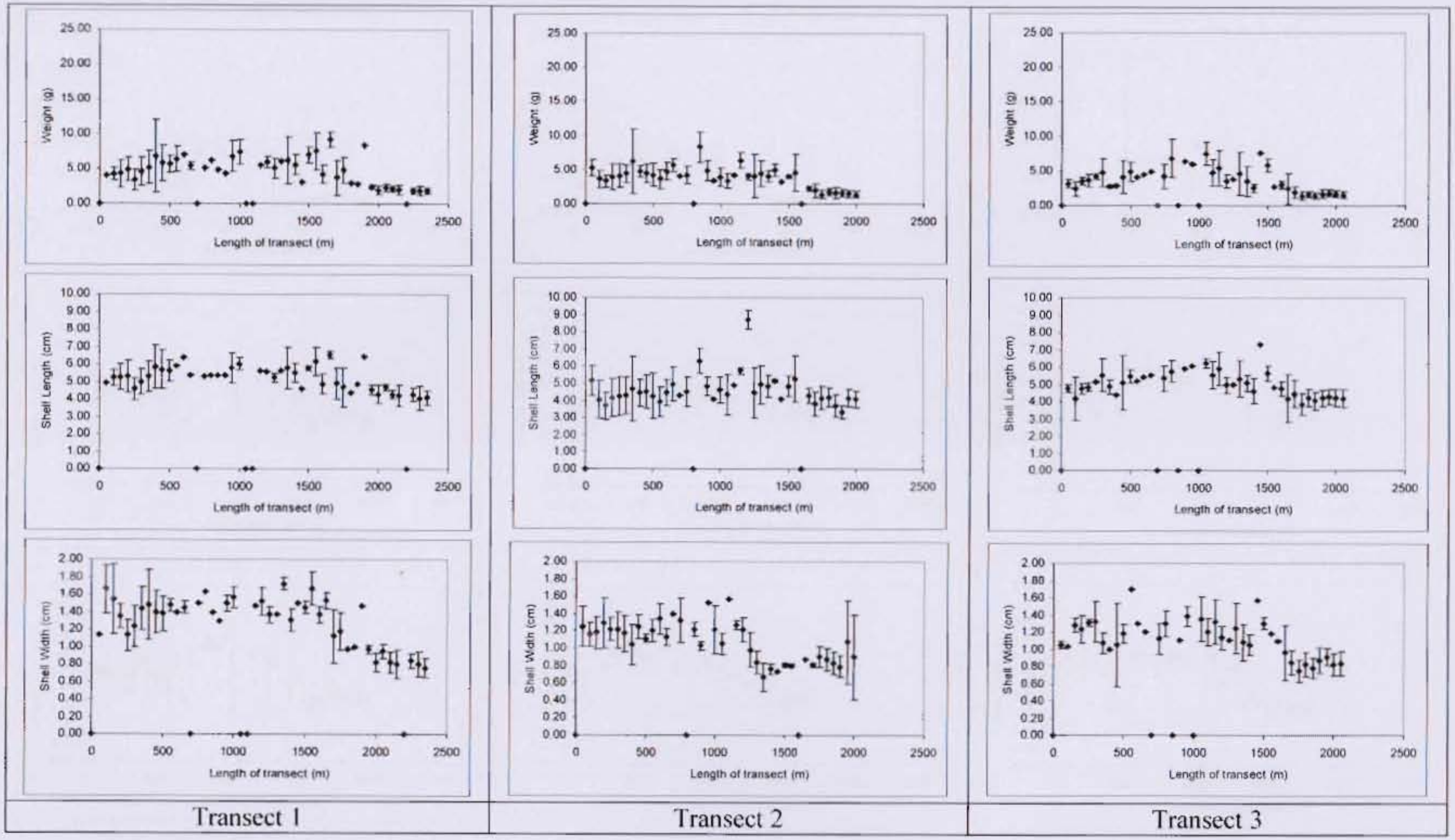


Figure 17. Size of razor clam (weight, shell length and shell width) along each line transect (8 Oct 2005) and symbol on the x-axis show that no individual were found in the quadrate

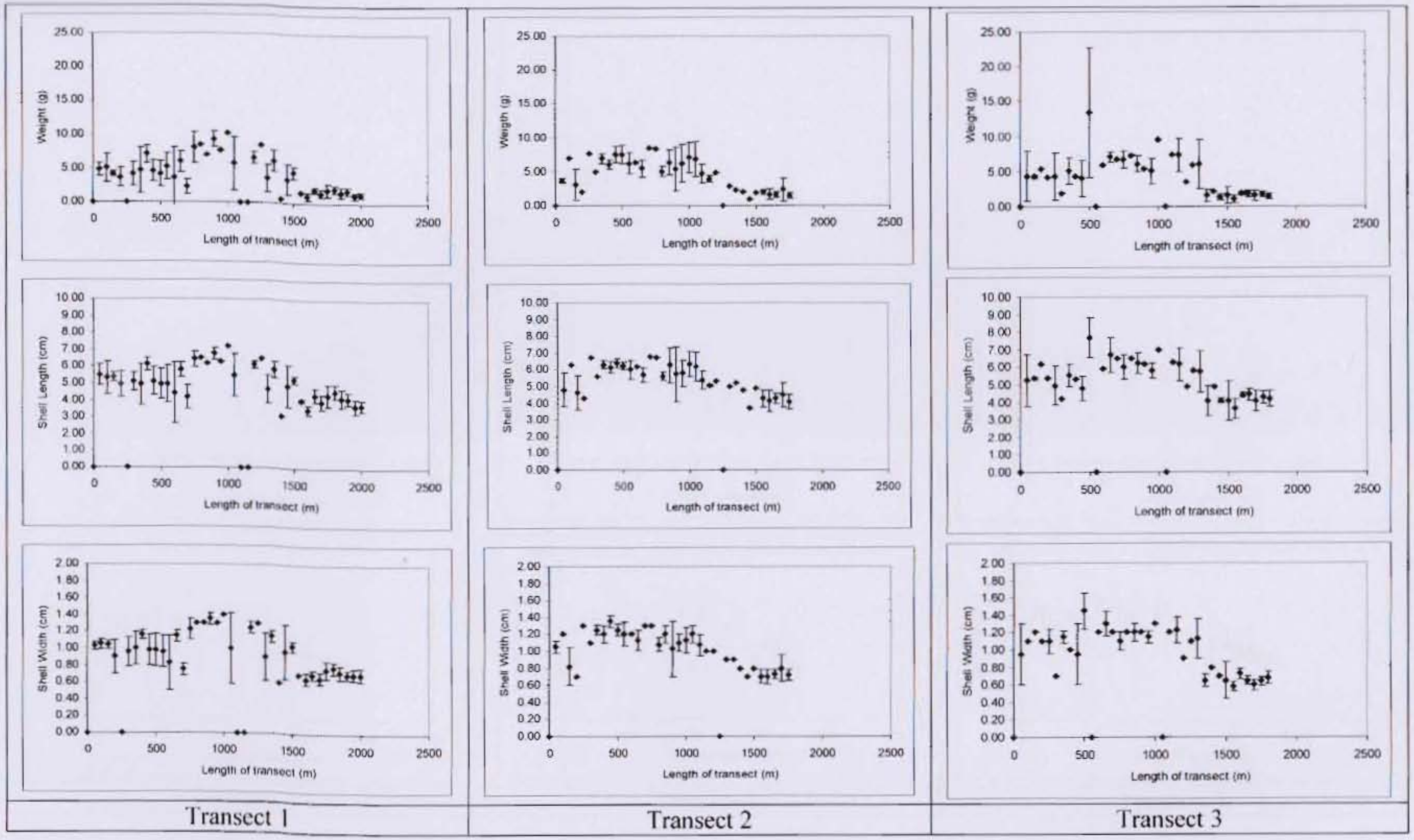


Figure 18. Size of razor clam (weight, shell length and shell width) along each line transect (17 Nov 2005) and symbol on the x-axis show that no individual were found in the quadrate

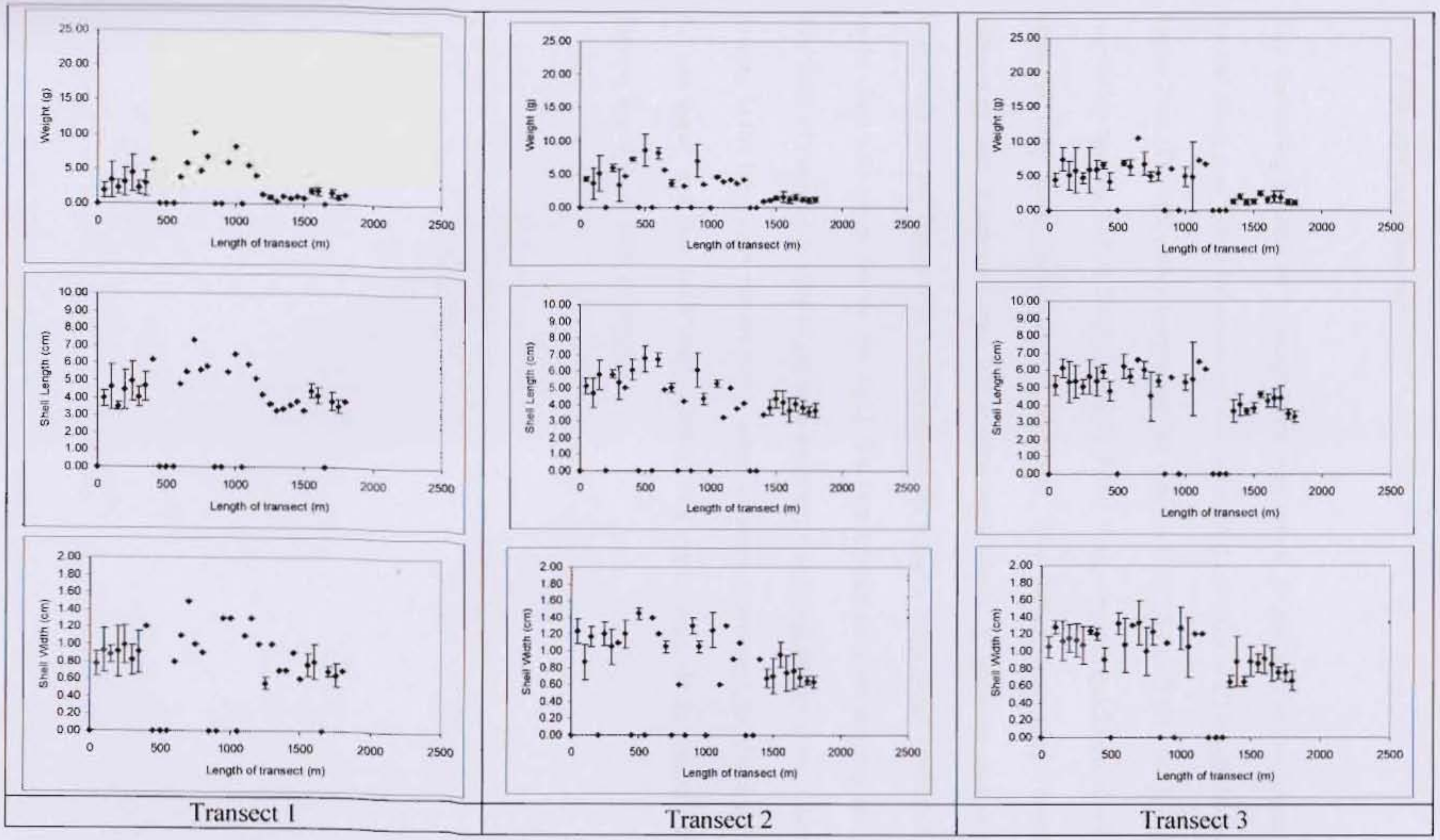


Figure 19. Size of razor clam (weight, shell length and shell width) along each line transect (5 Dec 2005) and symbol on the x-axis show that no individual were found in the quadrate

4.6 Burrowing behaviour

The burrowing behaviour of razor clam was tested *in-situ* and in the laboratory. Only Ambal Biasa was tested by choosing individual that have the shell length between from 5 cm to 7 cm. The laboratory burrowing test was done on 10 Oct 2005 (Table 6) and *in-situ* burrowing test on 20 Oct 2005 (Table 7). First, it was test the quickness moving of razor clam to fully bury itself into the sediment. The fastest burrowing recorded in the laboratory was 2 minutes and the longest took about 32 minutes and at the *in-situ* burrowing test the fastest was 2 minutes and the longest taken about 7 minutes. When the razor clam was place flat on the sand, the foot immediately set digging into sediment. The time of razor clam take to get into sediment was much longer in the laboratory than *in-situ*. In the laboratory observations, after 20 hours experiment the deepest burrow was 7.5 cm depth and two individuals died in this experiment. At *in-situ* test the deepest burrow was 9.9 cm after 10 minute.

Table 6. Laboratory burrowing test (10 Oct 2005)

No. Tank	No. Sample	Weight (g)	Shell length (cm)	Burrow time (minute)	After 20 hour depth (cm)
1	A	8.94	6.70	5	2.9
	B	8.72	6.30	28	4.2
	C	7.29	6.10	15	3.7
2	A	9.79	6.90	7	7.5
	B	7.55	6.00	9	5.2
	C	9.42	6.30	10	3.5
3	A	8.50	6.47	2	DEAD
	B	7.46	6.03	32	DEAD
	C	6.56	6.17	10	1.8

Table 7. *In-situ* burrowing test (20 Oct 2005)

No. sample	Weight (g)	Shell length (cm)	Shell width (cm)	Burrow time (minute)	After 10 min depth (cm)
1	8.41	6.20	1.50	2	7.00
2	6.70	5.80	1.30	4	7.50
3	8.21	6.60	1.60	7	8.50
4	4.49	6.10	1.30	2	9.50
5	8.28	6.70	1.19	2	8.50
6	7.74	6.60	1.18	3	9.90

5.0 DICUSSION

According to Raffaelli and Hawkins (1999) infauna organisms like razor clam most likely escape from the increasing temperature by burrowing themselves deep into the sediment and to avoid the unfavourable conditions (Loh, 2005). In Asajaya Laut and along Kuching bay, the *in-situ* physico-chemical parameters (temperature, salinity, dissolved oxygen (DO) and pH) were determined. The temperature and the salinity recorded was has an obviously deferent result between the September and others three month (October, November and December) which is there was obviously very high temperature and lowest salinity value on September then others month. DO and pH between these four months did not have much different range of value in each others. TSS and BOD_5 also did not shown different value range between the months and high value of chlorophyll-a also recorded on September. On the comparison between the density, September got the lowest individual catch then others month. But, on September there was only one transect done compare to others month was with three transect done, so the comparison can not be make because the differences occur on the sampling method used.

The temperature and the salinity reading on all sites along Kuching bay showed both reading were have same range in value between the months. But, DO and BOD_5 showed high at Buntal that was dominant with Ambal Riong. The chlorophyll-a was lowest at Teluk Delima that with low density of razor clam and the TSS was high reading at Bako which is the area was situated at the kampong Bako river that high human activity like fisheries and tourism activity. Bako is a site that close to the Teluk Delima also recorded low density of razor clam found, this situation may influence by the activity there. The pH value at Muara Tebas show more acidic that other sites because of that site was close to the big river (Sarawak River). The values at Muara Tebas might also be influence by the environment condition during that time, which is sometime there was rainy day or very hot day and the water quality was also influence by the movement of sea water towards land during high tide.

At Asajaya Laut there were two different species found during the sampling time (Sep, Oct, Nov and Dec 2005). Both species are Ambal Biasa (*Solen corneus*) and Ambal Jernang (*Solen viginia*). The most dominant species at Asajaya Laut is Ambal Biasa with 1575 individual compare to Ambal Jernang only 15 individual found during the sampling. This is may be the Ambal Jernang is already extinct because of the harvesting process. Which is, the local people say that Ambal Jernang have high commercial value because of it size in was large than Ambal Biasa at Asajaya Laut.

The distributions pattern at Asajaya Laut was determined within the intertidal zone toward from the low tide area to the high tide area. The distribution pattern on each transects were increase from the low tide area to the high tide area. Due to that, there was high density of razor clam at the high tide level compare to the mid tide area and low tide area. On the other hand, by the study of Loh (2005) at Asajaya Laut and Muara Tebas found that the density was highest at the mid tide area. This happen might be due to the catching activity of razor clam by the local people mid tide and low tide area since size of razor clam found at that both area was more large than the size of razor clam found at the high tide area.

The density of razor clam along Kuching bay were measure on December 2005 during rainy season and there was also found three different species distribute along Kuching bay; Ambal Biasa (*Solen corneus*), Ambal Riong (*Solen sarawakensis*) and Ambal Jernang (*Solen viginia*). In this study showed that the highest density was at Asajaya Laut (50%) and lowest density at Bako (4%). This result is significant with the Asajaya Laut as a most popular place to harvested razor clam.

Along the Kuching bay sampling sites showed the distributions pattern of razor clam was different in each others. At the Buntal beach the razor clam only abundant at the area closed to the water edge about 500 meter to 1000 meter toward to the high tide area. The species are abundant at Buntal is Ambal Riong. It is might be influence by it particle size of the sediment. At the Muara Tebas the on the all three 1000 meter along line transect showed the pattern was quite moderately distribute from the water edge toward, even the density was low with less then 10 individual/6.25m^2. At Teluk Delima and Bako, low density of razor clam was recorded and most of the quadrate in the line transect did not contain any individual. The both sites are close each other and were influent by the water quality from the some resource of Bako River. The limited population density both sites may cause of the impact from the human activity along the Bako River. However, further studies should be carried out to get more accurate data on the density, distribution pattern and other importance ecological data.

The correlations of size of razor clam were showed a linear relationship between shell length and weight and between shell width and weight. Beside that, the distribution pattern of razor clam size within the intertidal zone at Asajaya Laut during three months (Oct, Nov and Dec) were found that the size will increase from the high tide area to low tide area. The large size of razor clams was found at low tide area and small size of razor clam found at high tide area. This pattern may correlate with the environmental factor such as type of sediment, daily tidal range, water current or nature life cycle of razor clam which is the juveniles of razor clam was settle on the high tide area then they will migrate to low tide area as adult and the available source of food due to the feeding time.

The observation of the razor clam burrowing behaviour in this study did not indicate the true result because the experiment is very brief. In the laboratory test there was a lot of bias in observation the burrowing behaviour because the individual tested was already weak due to the stress during the transportation process. The tank used was not really suitable to used because the depth of tank is not enough deep for razor clam to burrow, this also as a factor of stress of razor clam. During the in-situ observation problem in disturbance of predator (gastropod and crab species) that was disturb the razor clam when it tries to burrow into the sediment. Beside that, there is also have others factor that have to note for instance the conditions of the razor clam individual used and the surrounding conditions in the experiment and the method used was have to develop more to get the more accurate data on burrowing behaviour of razor clam.

6.0 CONCLUSIONS

This study is providing useful information about the monthly density and distribution pattern of razor clam *(Solen* spp.*)* in Asajaya Laut in four months (September, October, November and December). The distribution patterns of razor clam at Asajaya Laut within the intertidal zone were distributed from the low tide level to the high tide level with higher density at high tide area and low density at low tied area. Moreover, the razor clam size distribution study at Asajaya Laut showed that the size increase from the high tide area to low tide area.

The sampling on December 2005 (Buntal, Muara Tebas, Asajaya Laut, Teluk Delima and Bako) along Kuching bay of razor clam distribution patterns was show abundant at the Asajaya Laut. There were three different species of razor clam under the *Solen* spp. found; Ambal Biasa (*Solen corneus*), Ambal Riong (*Solen sarawakensis*) and Ambal Jernang (*Solen vagina*). Ambal Biasa was abundant at Asajaya Laut while Ambal Riong was abundant at Buntal an Ambal Jernang has low density at all sampling sites.

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APPENDIX

Appendix I

Monthly razor clam distributions in Asajaya Laut

Appendix 1. Number of razor clam in quadrate on 19 Sep 2005

Quadrate	Distances (m)	Ambal Biasa	Ambal Jernang	Total
Q1	0	11	2	13
Q2	50	2	0	2
Q3	200	0	0	0
Q4	250	4	0	4
Q5	300	10	0	10
Q6	350	10	0	10
Q7	400	13	0	13
Q8	450	18	0	18
Q9	500	28	0	28
Q10	550	18	4	22
Q11	600	25	0	25
Q12	650	16	0	16
Q13	700	12	0	12
Q14	750	14	0	14
Q15	800	1	0	1
Q16	850	6	0	6
Q17	900	2	0	2
Q18	950	11	0	11
Q19	1000	11	1	12
	Total	212	7	219

Appendix 2. Number of razor clam in transect and quadrate on 8 Oct 2005

Quadrate	Distance (m)	No. of individual		
		T1	T2	T3
Q48	0	0	0	0
Q47	50	1	10	4
Q46	100	3	8	2
Q45	150	2	13	4
Q44	200	5	9	5
Q43	250	8	13	3
Q42	300	2	7	3
Q41	350	3	3	4
Q40	400	2	4	1
Q39	450	2	4	2
Q38	500	4	3	9
Q37	550	2	8	1
Q36	600	1	6	1
Q35	650	2	3	1
Q34	700	0	1	0

Q33	750	1	2	3
Q32	800	1	0	4
Q31	850	1	3	0
Q30	900	1	4	1
Q29	950	2	1	2
Q28	1000	3	5	0
Q27	1050	0	2	2
Q26	1100	0	1	4
Q25	1150	1	2	2
Q24	1200	2	3	5
Q23	1250	2	4	1
Q22	1300	1	6	6
Q21	1350	2	3	2
Q20	1400	3	2	2
Q19	1450	1	1	1
Q18	1500	2	4	3
Q17	1550	2	6	1
Q16	1600	2	0	2
Q15	1650	2	2	2
Q14	1700	6	10	5
Q13	1750	3	30	7
Q12	1800	1	22	13
Q11	1850	1	26	8
Q10	1900	1	12	16
Q9	1950	2	11	34
Q8	2000	8	8	30
Q7	2050	4	-	17
Q6	2100	6	-	-
Q5	2150	8	-	-
Q4	2200	0	-	-
Q3	2250	6	-	-
Q2	2300	12	-	-
Q1	2350	7	-	-
	Total	131	262	213

Appendix 3. Number of razor clam in transect and quadrate on 17 Nov 2005

Quadrate	Distance (m)	No. of individual		
		T1	T2	T3
41	0	0	0	0
40	50	6	2	2
39	100	4	1	2
38	150	5	5	1
37	200	5	1	1
36	250	0	1	2
35	300	8	1	1
34	350	5	4	2
33	400	5	3	1
32	450	9	2	2

31	500	6	2	2
30	550	5	2	0
29	600	3	1	1
28	650	2	3	2
27	700	2	1	1
26	750	3	1	3
25	800	1	6	2
24	850	1	3	3
23	900	2	4	1
22	950	1	3	2
21	1000	1	3	1
20	1050	2	3	0
19	1100	0	3	1
18	1150	0	2	3
17	1200	2	1	1
16	1250	1	0	1
15	1300	2	1	3
14	1350	2	1	2
13	1400	1	1	1
12	1450	3	1	2
11	1500	3	1	2
10	1550	2	4	4
9	1600	2	6	3
8	1650	8	4	6
7	1700	18	21	6
6	1750	16	14	9
5	1800	15	-	13
4	1850	20	-	-
3	1900	16	-	-
2	1950	5	-	-
1	2000	4	-	-
	Total	196	112	89

Appendix 4. Number of razor clam in transect and quadrate on 5 Dec 2005

Quadrate	Distance (m)	No. of individual		
		T1	T2	T3
37	0	0	0	0
36	50	6	5	6
35	100	4	3	6
34	150	4	3	10
33	200	9	0	13
32	250	16	4	4
31	300	11	2	6
30	350	18	1	5
29	400	1	3	5
28	450	0	0	2

27	500	0	2	0
26	550	0	0	5
25	600	1	2	3
24	650	1	1	1
23	700	1	2	4
22	750	1	0	2
21	800	1	1	3
20	850	0	0	0
19	900	0	3	1
18	950	1	2	0
17	1000	1	0	3
16	1050	0	2	2
15	1100	1	1	1
14	1150	1	1	1
13	1200	1	1	0
12	1250	2	1	0
11	1300	1	0	0
10	1350	1	0	2
9	1400	1	1	4
8	1450	1	9	4
7	1500	1	4	4
6	1550	5	5	6
5	1600	7	9	6
4	1650	0	10	6
3	1700	8	30	2
2	1750	8	11	4
1	1800	1	8	5
	Total	115	127	126

Razor clam distributions along Kuching Bay

Appendix 5. Number of razor clam in transect and quadrate on 3 Dec 2005 (Buntal)

Quadrate	Distance	No. of individual		
		T1	T2	T3
1	0	2	4	0
2	50	7	4	1
3	100	13	3	0
4	150	7	4	2
5	200	9	4	6
6	250	5	5	1
7	300	6	5	4
8	350	9	2	1
9	400	0	3	5
10	450	1	3	4
11	500	0	1	7

12	550	0	0	3
13	600	0	0	2
14	650	0	0	1
15	700	0	0	3
16	750	0	0	3
17	800	0	0	3
18	850	0	0	0
19	900	0	0	0
20	950	0	0	0
21	1000	0	0	0
	Total	59	38	46

Appendix 6. Number of razor clam in transect and quadrate on 4 Dec 2005 (Muara Tebas)

Quadrate	Distance	No. of individual		
		T1	T2	T3
21	0	3	0	4
20	50	1	0	3
19	100	1	3	0
18	150	1	1	2
17	200	0	0	3
16	250	1	0	2
15	300	3	1	3
14	350	2	3	5
13	400	3	3	0
12	450	4	2	3
11	500	3	7	1
10	550	1	4	2
9	600	5	3	2
8	650	8	3	0
7	700	9	3	6
6	750	4	1	2
5	800	2	6	3
4	850	2	3	1
3	900	5	4	1
2	950	4	2	1
1	1000	1	2	1
	Total	63	51	45

Appendix 7. Number of razor clam in transect and quadrate on 6 Dec 2005 (Teluk Delima)

Quadrate	Distance	No. of individual		
		T1	T2	T3
21	0	0	0	0
20	50	0	0	0

19	100	0	0	0
18	150	0	0	0
17	200	2	1	0
16	250	0	0	0
15	300	1	0	2
14	350	0	0	0
13	400	0	1	0
12	450	0	0	0
11	500	0	0	0
10	550	0	1	2
9	600	1	0	0
8	650	1	3	3
7	700	1	2	2
6	750	1	0	0
5	800	0	0	0
4	850	1	0	0
3	900	0	2	4
2	950	2	3	1
1	1000	0	5	2
	Total	10	18	16

Appendix 8. Number of razor clam in transect and quadrate on 18 Dec 2005 (Bako)

Quadrate	Distance	No. of individual		
		T1	T2	T3
1	1000	2	0	3
2	950	0	0	0
3	900	0	0	2
4	850	0	0	0
5	800	0	0	0
6	750	0	0	0
7	700	1	0	0
8	650	0	1	1
9	600	0	0	0
10	550	0	1	0
11	500	0	0	0
12	450	0	0	0
13	400	0	2	2
14	350	3	2	1
15	300	2	0	4
16	250	0	0	1
17	200	0	0	0
18	150	0	0	0
19	100	0	0	1
20	50	0	0	0
21	0	0	0	0
	Total	8	6	15

Appendix 9. Total of razor clam between species for every month in Asajaya Laut

Month	Ambal Biasa	Ambal Jernang	Total
September	212	7	219
October	606	0	606
November	392	5	397
December	365	3	368
Total	1575	15	1590

Appendix 10. Number of razor clam (Ambal Biasa) between transect in Asajaya Laut

Month	T1	T2	T3	Total
September	212	0	0	212
October	131	262	213	606
November	194	112	86	392
December	115	127	123	365
Total				1575

Appendix 11. Number of razor clam (Ambal Jernang) between transect in Asajaya Laut

Month	T1	T2	T3	Total
September	7	0	0	7
October	0	0	0	0
November	2	0	3	5
December	0	0	3	3
Total				15

Appendix 12. Number of razor clam along Kuching bay

Date	Study side	total	Ambal Biasa	Ambal Jernang	Ambal Riong
3 Dec 2005	Buntal	143	45	5	90
4 Dec2005	Muara Tebas	159	159	0	0
5 Dec 2005	Asajaya Laut	368	365	3	0
6 Dec 2005	Teluk Delima	44	39	2	3
18-Des-2005	Bako	29	25	1	3
Total		743	633	11	96

Size of razor clams according to species

Appendix 13. Size of Ambal Biasa specimen along Kuching bay

Weight (g)	Shell length (cm)	Shell width (cm)
0.32	2.60	0.50
0.41	2.80	0.50
0.48	2.30	0.60

0.50	3.00	0.60
0.74	3.30	0.60
0.79	3.00	0.70
0.84	3.30	0.70
1.55	4.20	1.10
1.78	4.70	0.80
1.88	3.10	0.60
2.07	4.30	0.90
2.31	4.40	0.90
2.33	3.40	0.70
2.35	4.90	0.70
2.42	4.50	0.90
2.52	5.00	1.00
2.53	4.90	0.80
2.81	4.80	0.90
2.82	4.20	1.00
3.20	4.70	0.90
3.46	4.90	1.00
3.58	4.80	1.00
3.58	5.10	1.00
3.59	4.40	1.40
3.59	4.90	0.80
3.61	5.00	1.20
3.94	5.00	1.00
3.95	5.50	1.00
3.95	5.30	1.10
3.96	5.20	1.10
4.48	5.50	1.20
4.48	5.60	1.20
4.48	5.90	1.20
4.48	5.20	1.10
4.50	5.00	1.00
5.61	5.60	1.10
5.65	4.90	1.20
5.65	5.60	1.20
5.67	5.50	1.10
5.67	5.50	1.30
5.68	5.70	1.00
5.69	5.50	1.30
6.16	5.70	1.40
6.23	6.00	1.10
6.28	6.30	1.20
6.30	6.40	1.20
6.30	5.80	1.10
6.31	6.50	1.20
6.32	6.00	1.20
6.77	6.20	1.20
6.88	6.20	1.40
6.90	5.40	1.00
7.33	6.40	1.30

7.35	6.30	1.20
7.37	6.50	1.20
7.37	6.10	1.30
8.85	6.50	1.60
8.86	6.90	1.30
8.93	6.70	1.40
9.36	6.70	1.20
9.91	7.10	1.20
10.47	6.60	1.30
10.66	7.00	1.40
11.86	7.10	1.40
15.71	7.50	1.50

Appendix 14. Size of Ambal Riong specimen along Kuching bay

Weight (g)	Shell length (cm)	Shell width (cm)
3.04	7.80	1.00
3.39	6.90	1.00
4.16	7.40	1.00
4.89	8.10	1.10
5.05	7.30	1.10
5.95	8.00	1.10
6.07	8.30	1.10
6.08	8.00	1.10
6.17	8.50	1.10
6.98	8.50	1.20
7.08	8.40	1.20
7.08	8.30	1.20
7.85	8.80	1.30
8.15	8.80	1.20
8.31	8.70	1.20
8.84	9.70	1.30
9.02	8.70	1.30
9.08	8.60	1.20
9.10	9.50	1.30
9.60	9.70	1.30
9.65	8.80	1.20
9.72	9.40	1.30
9.77	9.20	1.30
10.00	7.00	1.40
10.70	9.30	1.30
10.85	10.00	1.30
10.99	9.00	1.30
11.23	9.40	1.30
11.87	10.40	1.30
11.88	10.00	1.30
12.37	9.10	1.30
12.64	10.70	1.40
13.91	10.30	1.40

14.68	10.90	1.50
17.36	10.30	1.40
19.92	9.70	1.30
20.46	10.80	1.50

Appendix 15. Size of Ambal Jernang specimen along Kuching bay

Weight (g)	Shell length (cm)	Shell width (cm)
3.71	5.10	1.20
3.86	4.60	1.20
3.87	4.50	1.30
4.97	5.60	1.30
5.85	5.40	1.40
6.00	5.10	1.50
7.23	6.00	1.60
8.49	6.60	1.70
10.82	7.10	1.70
26.21	9.40	1.80
26.43	8.50	1.90

Appendix 16. Average size of razor clam along Transect 1 on 8 Oct 2005

Distance	No. of individual	Weight (g)	stdev	Shell length (cm)	stdev	Shell width (cm)	stdev
0	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
50	1	4.06	±0.00	4.93	±0.00	1.13	±0.00
100	3	4.24	±0.84	5.23	±0.46	1.66	±0.28
150	2	4.29	±1.96	5.27	±0.75	1.55	±0.40
200	5	4.93	±1.72	5.31	±0.93	1.35	±0.14
250	8	3.38	±1.44	4.57	±0.63	1.13	±0.18
300	2	4.61	±2.04	5.00	±0.71	1.23	±0.24
350	3	5.20	±2.32	5.29	±0.88	1.44	±0.25
400	2	6.82	±5.22	5.85	±1.25	1.48	±0.40
450	2	5.81	±2.63	5.70	±1.13	1.40	±0.24
500	4	5.66	±1.23	5.62	±0.58	1.38	±0.20
550	2	6.40	±1.83	5.90	±0.02	1.48	±0.07
600	1	7.05	±0.00	6.40	±0.00	1.40	±0.00
650	2	5.41	±0.57	5.37	±0.03	1.45	±0.07
700	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
750	1	5.13	±0.00	5.30	±0.00	1.50	±0.00
800	1	6.24	±0.00	5.33	±0.00	1.63	±0.00
850	1	4.81	±0.00	5.33	±0.00	1.40	±0.00
900	1	4.37	±0.00	5.33	±0.00	1.30	±0.00
950	2	6.80	±2.27	5.78	±0.87	1.50	±0.09
1000	3	7.45	±1.71	6.02	±0.34	1.57	±0.12
1050	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
1100	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
1150	1	5.55	±0.00	5.63	±0.00	1.47	±0.00

1200	2	5.94	±0.75	5.57	±0.00	1.52	±0.16
1250	2	5.09	±1.38	5.22	±0.26	1.37	±0.09
1300	1	6.13	±0.00	5.63	±0.00	1.37	±0.00
1350	2	6.19	±3.38	5.77	±1.18	1.72	±0.07
1400	3	5.59	±1.37	5.50	±0.53	1.31	±0.13
1450	1	3.16	±0.00	4.57	±0.00	1.50	±0.00
1500	2	6.96	±1.14	5.77	±0.14	1.45	±0.07
1550	2	7.52	±2.64	6.17	±0.80	1.67	±0.19
1600	2	4.25	±1.32	4.87	±0.57	1.37	±0.09
1650	2	9.21	±1.12	6.55	±0.21	1.53	±0.09
1700	6	3.73	±2.49	4.91	±0.90	1.12	±0.31
1750	3	4.80	±1.77	4.70	±1.11	1.18	±0.22
1800	1	2.91	±0.00	4.37	±0.00	0.97	±0.00
1850	1	2.86	±0.00	4.87	±0.00	1.00	±0.00
1900	1	8.42	±0.00	6.43	±0.00	1.47	±0.00
1950	2	2.42	±0.26	4.55	±0.26	0.97	±0.05
2000	8	1.92	±0.60	4.29	±0.52	0.82	±0.11
2050	4	2.34	±0.52	4.68	±0.21	0.95	±0.08
2100	6	2.18	±0.37	4.29	±0.23	0.82	±0.12
2150	8	2.06	±0.71	4.22	±0.59	0.80	±0.16
2200	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
2250	6	1.91	±0.39	4.29	±0.38	0.84	±0.08
2300	12	1.84	±0.67	4.08	±0.65	0.80	±0.14
2350	7	1.92	±0.43	4.10	±0.41	0.76	±0.11

Appendix 17. Average size of razor clam along Transect 2 on 8 Oct 2005

Distance	No. of individual	Weight (g)	stdev	Shell length (cm)	stdev	Shell width (cm)	stdev
0	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
50	10	5.27	±1.20	5.16	±0.88	1.25	±0.23
100	8	3.58	±1.31	4.05	±1.11	1.16	±0.14
150	13	3.35	±0.88	3.70	±0.77	1.18	±0.19
200	9	3.86	±1.86	4.16	±1.09	1.29	±0.29
250	13	4.07	±1.67	4.24	±1.11	1.22	±0.13
300	7	4.37	±1.25	4.29	±1.07	1.21	±0.21
350	3	6.16	±4.72	4.67	±1.88	1.17	±0.21
400	4	4.71	±0.85	4.44	±0.76	1.04	±0.23
450	4	4.44	±1.30	4.52	±0.99	1.25	±0.14
500	3	4.22	±1.63	4.27	±1.33	1.11	±0.05
550	8	3.59	±1.44	3.94	±0.85	1.20	±0.13
600	6	4.77	±1.24	4.47	±0.76	1.34	±0.18
650	3	5.62	±0.96	4.97	±1.01	1.13	±0.10
700	1	4.00	±0.00	4.30	±0.00	1.40	±0.00
750	2	4.23	±1.32	4.50	±0.85	1.32	±0.26
800	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
850	3	8.32	±2.23	6.31	±0.71	1.22	±0.08
900	4	4.81	±1.49	4.85	±0.55	1.03	±0.05

950	1	3.39	±0.00	4.10	±0.00	1.53	±0.00
1000	5	3.86	±1.32	4.62	±0.76	1.22	±0.28
1050	2	3.38	±1.06	4.35	±1.20	1.05	±0.12
1100	1	4.10	±0.00	4.87	±0.00	1.57	±0.00
1150	2	6.36	±1.17	5.73	±0.19	1.27	±0.05
1200	3	4.01	±0.48	8.70	±0.53	1.21	±0.14
1250	4	4.07	±3.16	4.48	±1.45	0.98	±0.20
1300	6	4.41	±1.91	4.92	±1.08	0.84	±0.13
1350	3	4.08	±0.79	4.84	±0.66	0.67	±0.16
1400	2	4.91	±0.92	5.15	±0.07	0.76	±0.06
1450	1	3.18	±0.00	4.10	±0.00	0.73	±0.00
1500	4	4.00	±0.23	4.83	±0.58	0.81	±0.02
1550	6	4.61	±2.67	5.29	±1.34	0.80	±0.02
1600	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
1650	2	2.22	±0.33	4.30	±0.42	0.87	±0.00
1700	10	1.96	±1.05	3.82	±0.70	0.81	±0.02
1750	30	1.41	±0.64	4.16	±0.68	0.90	±0.12
1800	22	1.75	±0.51	4.20	±0.53	0.87	±0.13
1850	26	1.61	±0.80	3.69	±0.65	0.83	±0.13
1900	12	1.59	±0.52	3.33	±0.36	0.79	±0.12
1950	11	1.49	±0.49	4.15	±0.52	1.07	±0.48
2000	8	1.36	±0.47	4.08	±0.50	0.90	±0.49

Appendix 18. Average size of razor clam along Transect 3 on 8 Oct 2005

Distance	No. of individual	Weight (g)	stdve	Shell length (cm)	stdev	Shell width (cm)	stdev
0	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
50	4	3.15	±0.63	4.74	±0.22	1.05	±0.04
100	2	2.38	±1.06	4.18	±1.25	1.03	±0.00
150	4	3.53	±0.59	4.73	±0.30	1.28	±0.08
200	5	3.59	±0.86	4.83	±0.25	1.23	±0.16
250	3	4.18	±0.40	5.14	±0.05	1.31	±0.04
300	3	4.69	±2.00	5.53	±0.95	1.32	±0.24
350	4	2.76	±0.22	4.84	±0.43	1.07	±0.12
400	1	2.83	±0.00	4.40	±0.00	1.00	±0.00
450	2	4.12	±2.43	5.10	±1.56	1.05	±0.49
500	9	4.93	±1.35	5.47	±0.38	1.18	±0.11
550	1	4.00	±0.00	5.20	±0.00	1.70	±0.00
600	1	4.51	±0.00	5.40	±0.00	1.30	±0.00
650	1	4.82	±0.00	5.50	±0.00	1.20	±0.00
700	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
750	3	4.23	±1.77	5.33	±0.73	1.12	±0.18
800	4	6.78	±2.78	5.75	±0.64	1.30	±0.15
850	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
900	1	6.37	±0.00	5.90	±0.00	1.10	±0.00
950	2	5.91	±0.15	6.05	±0.02	1.38	±0.12
1000	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
1050	2	7.49	±1.70	6.22	±0.26	1.35	±0.26

1100	4	4.70	±1.90	5.53	±0.80	1.20	±0.16
1150	2	5.43	±2.56	5.90	±0.99	1.32	±0.26
1200	5	3.50	±0.99	4.95	±0.46	1.13	±0.14
1250	1	3.85	±0.00	5.00	±0.00	1.10	±0.00
1300	6	4.58	±3.14	5.32	±1.07	1.24	±0.29
1350	2	3.55	±2.19	5.06	±0.44	1.08	±0.21
1400	2	2.52	±0.62	4.62	±0.73	1.05	±0.12
1450	1	7.57	±0.00	7.30	±0.00	1.57	±0.00
1500	3	5.78	±0.91	5.61	±0.43	1.30	±0.07
1550	1	2.65	±0.00	4.80	±0.00	1.18	±0.00
1600	2	2.97	±0.60	4.74	±0.39	1.09	±0.01
1650	2	2.39	±2.19	4.18	±1.39	0.96	±0.32
1700	5	1.94	±0.80	4.45	±0.77	0.84	±0.14
1750	7	1.38	±0.58	3.86	±0.61	0.75	±0.13
1800	13	1.61	±0.45	4.20	±0.49	0.82	±0.14
1850	8	1.40	±0.44	4.03	±0.52	0.78	±0.12
1900	16	1.67	±0.58	4.19	±0.44	0.87	±0.15
1950	34	1.79	±0.46	4.27	±0.43	0.91	±0.10
2000	30	1.64	±0.46	4.20	±0.49	0.82	±0.13
2050	17	1.55	±0.53	4.17	±0.51	0.83	±0.14

Appendix 19. Average size of razor clam along Transect 1 on 17 Nov 2005

Distance	No. of individual	Weight (g)	stdev	Shell length (cm)	stdev	Shell width (cm)	stdev
0	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
50	6	4.87	±0.94	5.51	±0.61	1.03	±0.05
100	4	5.08	±2.10	5.33	±0.98	1.05	±0.06
150	5	4.20	±0.38	5.36	±0.26	1.04	±0.05
200	5	3.69	±1.39	4.96	±0.74	0.90	±0.20
250	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
300	8	4.18	±1.75	5.11	±0.56	0.96	±0.17
350	5	4.71	±3.36	4.94	±1.21	1.00	±0.19
400	5	7.10	±1.29	6.12	±0.36	1.16	±0.05
450	9	4.61	±1.58	5.13	±0.82	0.98	±0.18
500	6	4.15	±1.89	4.97	±0.90	0.98	±0.19
550	5	5.28	±1.94	4.96	±1.10	0.96	±0.19
600	3	3.63	±4.38	4.43	±1.79	0.83	±0.32
650	2	6.01	±1.56	5.80	±0.42	1.15	±0.07
700	2	2.27	±1.11	4.20	±0.71	0.75	±0.07
750	3	8.06	±2.30	6.43	±0.46	1.23	±0.12
800	1	8.44	±0.00	6.50	±0.00	1.30	±0.00
850	1	6.99	±0.00	6.20	±0.00	1.30	±0.00
900	2	9.34	±1.12	6.75	±0.35	1.35	±0.07
950	1	7.71	±0.00	6.30	±0.00	1.30	±0.00
1000	1	10.16	±0.00	7.20	±0.00	1.40	±0.00
1050	2	5.72	±3.91	5.50	±1.27	1.00	±0.42

1100	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
1150	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
1200	2	6.64	±0.91	6.15	±0.21	1.25	±0.07
1250	1	8.45	±0.00	6.50	±0.00	1.30	±0.00
1300	2	3.59	±2.03	4.70	±0.85	0.90	±0.28
1350	2	6.22	±1.51	5.85	±0.49	1.15	±0.07
1400	1	0.65	±0.00	3.10	±0.00	0.60	±0.00
1450	3	3.56	±2.18	4.90	±1.25	0.97	±0.32
1500	3	4.54	±0.87	5.27	±0.21	1.03	±0.06
1550	2	1.59	±0.04	4.05	±0.07	0.70	±0.00
1600	2	1.12	±0.54	3.50	±0.28	0.65	±0.07
1650	8	2.01	±0.43	4.36	±0.40	0.70	±0.05
1700	18	1.54	±0.57	3.98	±0.45	0.66	±0.07
1750	16	1.99	±0.93	4.36	±0.66	0.76	±0.10
1800	15	2.13	±0.53	4.59	±0.40	0.78	±0.07
1850	20	1.67	±0.73	4.20	±0.52	0.73	±0.08
1900	16	1.91	±0.53	4.16	±0.34	0.70	±0.05
1950	5	1.17	±0.45	3.72	±0.43	0.70	±0.07
2000	4	1.32	±0.37	3.78	±0.32	0.70	±0.08

Appendix 20. Average size of razor clam along Transect 2 on 17 Nov 2005

Distance	No. of individual	Weight (g)	stdev	Shell length (cm)	stdev	Shell width (cm)	stdev
0	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
50	2	3.68	±0.29	4.80	±0.99	1.05	±0.07
100	1	7.02	±0.00	6.30	±0.00	1.20	±0.00
150	5	3.11	±2.30	4.60	±1.02	0.82	±0.22
200	1	2.07	±0.00	4.30	±0.00	0.70	±0.00
250	1	7.68	±0.00	6.70	±0.00	1.30	±0.00
300	1	5.00	±0.00	5.60	±0.00	1.10	±0.00
350	4	6.93	±0.78	6.30	±0.24	1.25	±0.06
400	3	6.03	±0.66	6.13	±0.35	1.20	±0.10
450	2	7.50	±1.20	6.40	±0.28	1.35	±0.07
500	2	7.50	±1.34	6.25	±0.21	1.25	±0.07
550	2	6.21	±1.55	6.00	±0.57	1.20	±0.14
600	1	6.37	±0.00	6.20	±0.00	1.20	±0.00
650	3	5.47	±1.24	5.70	±0.44	1.13	±0.12
700	1	8.51	±0.00	6.80	±0.00	1.30	±0.00
750	1	8.35	±0.00	6.70	±0.00	1.30	±0.00
800	6	5.02	±0.72	5.60	±0.24	1.08	±0.08
850	3	6.38	±1.79	6.27	±1.06	1.20	±0.10
900	4	5.36	±3.24	5.73	±1.66	1.03	±0.33
950	3	6.25	±2.77	5.80	±0.78	1.10	±0.10
1000	3	7.08	±2.25	6.33	±0.76	1.13	±0.15
1050	3	6.84	±2.54	6.17	±0.87	1.20	±0.10

1100	3	4.70	±1.37	5.37	±0.55	1.07	±0.12
1150	2	3.95	±0.52	5.05	±0.07	1.00	±0.00
1200	1	4.89	±0.00	5.30	±0.00	1.00	±0.00
1250	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
1300	1	2.76	±0.00	5.00	±0.00	0.90	±0.00
1350	1	2.33	±0.00	5.20	±0.00	0.90	±0.00
1400	1	1.98	±0.00	4.80	±0.00	0.80	±0.00
1450	1	0.90	±0.00	3.70	±0.00	0.70	±0.00
1500	1	1.83	±0.00	4.90	±0.00	0.80	±0.00
1550	4	1.99	±0.34	4.28	±0.53	0.70	±0.08
1600	6	1.66	±0.74	4.13	±0.63	0.70	±0.09
1650	4	1.63	±0.40	4.28	±0.31	0.73	±0.05
1700	21	2.36	±1.66	4.50	±0.72	0.80	±0.16
1750	14	1.44	±0.42	4.09	±0.41	0.72	±0.06

Appendix 21. Average size of razor clam along Transect 3 on 17 Nov 2005

Distance	No. of individual	Weight (g)	stdev	Shell length (cm)	stdev	Shell width (cm)	stdev
0	0	0.00	±0.00	0.00	±0.00	0.00	0.00
50	2	4.33	±3.54	5.25	±1.48	0.95	0.35
100	2	4.25	±0.21	5.35	±0.07	1.10	0.00
150	1	5.35	±0.00	6.20	±0.00	1.20	0.00
200	1	4.20	±0.00	5.40	±0.00	1.10	0.00
250	2	4.28	±3.36	4.95	±1.10	1.10	0.14
300	1	1.87	±0.00	4.20	±0.00	0.70	0.00
350	2	5.11	±1.87	5.55	±0.64	1.15	0.07
400	1	4.24	±0.00	5.30	±0.00	1.00	0.00
450	2	4.04	±2.52	4.80	±0.71	0.95	0.35
500	2	13.41	±9.30	7.70	±1.13	1.45	0.21
550	0	0.00	±0.00	0.00	±0.00	0.00	0.00
600	1	5.85	±0.00	5.90	±0.00	1.20	0.00
650	2	7.08	±0.78	6.70	±0.99	1.30	0.14
700	1	6.71	±0.00	6.50	±0.00	1.20	0.00
750	3	6.73	±1.21	6.00	±0.70	1.10	0.10
800	2	7.29	±0.08	6.50	±0.00	1.20	0.00
850	3	6.11	±1.09	6.23	±0.61	1.20	0.10
900	1	5.36	±0.00	6.20	±0.00	1.20	0.00
950	2	5.09	±1.82	5.80	±0.42	1.15	0.07
1000	1	9.48	±0.00	7.00	±0.00	1.30	0.00
1050	0	0.00	±0.00	0.00	±0.00	0.00	0.00
1100	1	7.35	±0.00	6.30	±0.00	1.20	0.00
1150	3	7.33	±2.31	6.17	±0.93	1.23	0.15
1200	1	3.53	±0.00	4.90	±0.00	0.90	0.00
1250	1	5.93	±0.00	5.80	±0.00	1.10	0.00
1300	3	6.03	±3.54	5.73	±1.18	1.13	0.23

1350	2	1.55	±0.91	4.10	±0.85	0.65	0.07
1400	1	2.12	±0.00	4.90	±0.00	0.80	0.00
1450	2	1.37	±0.42	4.10	±0.14	0.70	0.00
1500	2	1.64	±1.22	4.10	±1.13	0.65	0.21
1550	4	1.07	±0.48	3.63	±0.57	0.58	0.05
1600	3	1.89	±0.24	4.43	±0.15	0.73	0.06
1650	6	1.82	±0.43	4.45	±0.36	0.65	0.05
1700	6	1.55	±0.68	4.08	±0.58	0.60	0.06
1750	9	1.70	±0.39	4.28	±0.35	0.64	0.05
1800	13	1.50	±0.36	4.22	±0.44	0.68	0.07

Appendix 22. Average size of razor clam along Transect 1 on 5 Dec 2005

Distance	No. of individual	Weight (g)	stdev	Shell length (cm)	stdev	Shell width (cm)	stdev
0	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
50	6	1.89	±1.04	3.97	±0.46	0.77	±0.14
100	4	3.36	±2.49	4.63	±1.28	0.93	±0.25
150	4	2.34	±1.01	3.50	±0.24	0.88	±0.10
200	9	3.05	±2.04	4.46	±1.15	0.91	±0.29
250	16	4.37	±2.62	4.95	±1.12	0.99	±0.22
300	11	2.33	±0.95	4.05	±0.55	0.82	±0.17
350	18	2.91	±1.85	4.67	±0.84	0.91	±0.24
400	1	6.35	±0.00	6.20	±0.00	1.20	±0.00
450	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
500	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
550	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
600	1	3.75	±0.00	4.80	±0.00	0.80	±0.00
650	1	5.72	±0.00	5.50	±0.00	1.10	±0.00
700	1	10.25	±0.00	7.30	±0.00	1.50	±0.00
750	1	4.69	±0.00	5.60	±0.00	1.00	±0.00
800	1	6.73	±0.00	5.80	±0.00	0.90	±0.00
850	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
900	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
950	1	5.94	±0.00	5.50	±0.00	1.30	±0.00
1000	1	8.24	±0.00	6.50	±0.00	1.30	±0.00
1050	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
1100	1	5.47	±0.00	5.90	±0.00	1.10	±0.00
1150	1	4.05	±0.00	5.10	±0.00	1.30	±0.00
1200	1	1.34	±0.00	4.20	±0.00	1.00	±0.00
1250	2	0.96	±0.28	3.65	±0.07	0.55	±0.07
1300	1	0.42	±0.00	3.30	±0.00	1.00	±0.00
1350	1	1.08	±0.00	3.40	±0.00	0.70	±0.00
1400	1	0.80	±0.00	3.60	±0.00	0.70	±0.00
1450	1	1.11	±0.00	3.80	±0.00	0.90	±0.00
1500	1	0.74	±0.00	3.30	±0.00	0.60	±0.00

1550	5	1.84	±0.38	4.42	±0.41	0.76	±0.13
1600	7	1.83	±0.57	4.15	±0.46	0.80	±0.20
1650	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
1700	8	1.57	±0.62	3.83	±0.51	0.69	±0.06
1750	8	0.98	±0.30	3.55	±0.40	0.65	±0.13
1800	1	1.28	±0.00	3.80	±0.00	0.70	±0.00

Appendix 23. Average size of razor clam along Transect 2 on 5 Dec 2005

Distance	No. of individual	Weight (g)	stdev	Shell length (cm)	stdev	Shell width (cm)	stdev
0	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
50	5	4.24	±0.39	5.12	±0.47	1.24	±0.15
100	3	3.58	±2.35	4.70	±0.87	0.87	±0.21
150	3	5.09	±2.65	5.80	±0.89	1.17	±0.12
200	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
250	4	5.94	±0.50	5.83	±0.26	1.20	±0.14
300	2	3.34	±2.40	5.30	±0.99	1.05	±0.21
350	1	4.70	±0.00	5.00	±0.00	1.10	±0.00
400	3	7.24	±0.31	6.10	±0.61	1.20	±0.17
450	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
500	2	8.61	±2.45	6.75	±0.78	1.45	±0.07
550	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
600	2	8.17	±0.86	6.70	±0.42	1.40	±0.00
650	1	5.65	±0.00	4.90	±0.00	1.20	±0.00
700	2	3.60	±0.52	5.00	±0.28	1.05	±0.07
750	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
800	1	3.19	±0.00	4.20	±0.00	0.60	±0.00
850	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
900	3	7.05	±2.49	6.07	±1.01	1.30	±0.10
950	2	3.46	±0.04	4.35	±0.35	1.05	±0.07
1000	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
1050	2	4.63	±0.25	5.25	±0.21	1.25	±0.21
1100	1	3.91	±0.00	3.20	±0.00	0.60	±0.00
1150	1	4.22	±0.00	5.00	±0.00	1.30	±0.00
1200	1	3.67	±0.00	3.75	±0.00	0.90	±0.00
1250	1	4.14	±0.00	4.10	±0.00	1.10	±0.00
1300	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
1350	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
1400	1	0.98	±0.00	3.40	±0.00	0.90	±0.00
1450	9	1.13	±0.21	3.84	±0.47	0.68	±0.11
1500	4	1.43	±0.27	4.33	±0.50	0.70	±0.21
1550	5	1.62	±0.85	4.14	±0.71	0.96	±0.15
1600	9	1.16	±0.54	3.68	±0.72	0.74	±0.21
1650	10	1.52	±0.47	4.01	±0.40	0.76	±0.21
1700	30	1.24	±0.32	3.83	±0.41	0.69	±0.11

1750	11	1.06	±0.40	3.57	±0.29	0.65	±0.05
1800	8	1.20	±0.45	3.66	±0.44	0.63	±0.07

Appendix 24. Average size of razor clam along Transect 3 on 5 Dec 2005

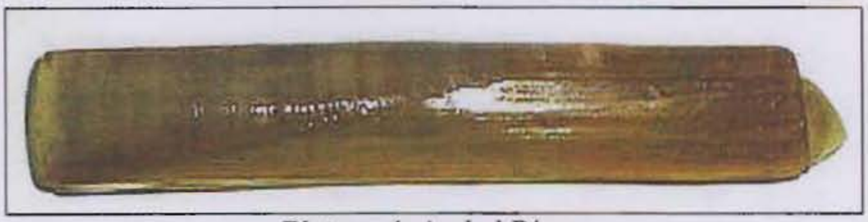
Distance	No. of individual	Weight (g)	stdev	Shell length (cm)	stdev	Shell width (cm)	stdev
0	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
50	6	4.47	±0.96	5.13	±0.56	1.05	±0.12
100	6	7.41	±1.67	6.13	±0.55	1.28	±0.08
150	10	5.06	±2.10	5.33	±1.18	1.12	±0.23
200	13	5.81	±3.28	5.35	±0.93	1.15	±0.16
250	4	4.68	±0.80	5.03	±0.43	1.13	±0.19
300	6	5.90	±3.29	5.62	±1.01	1.07	±0.22
350	5	5.89	±1.38	5.35	±0.81	1.24	±0.05
400	5	6.58	±0.47	5.94	±0.39	1.20	±0.07
450	2	4.18	±1.27	4.80	±0.57	0.90	±0.14
500	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
550	5	6.86	±0.42	6.24	±0.70	1.32	±0.13
600	3	6.27	±1.12	5.67	±0.40	1.07	±0.32
650	1	10.47	±0.00	6.60	±0.00	1.30	±0.00
700	4	6.78	±1.71	6.03	±0.49	1.33	±0.26
750	2	4.92	±0.79	4.50	±1.41	1.00	±0.28
800	3	5.31	±1.04	5.40	±0.36	1.23	±0.15
850	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
900	1	6.02	±0.00	5.60	±0.00	1.10	±0.00
950	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
1000	3	4.91	±1.44	5.30	±0.44	1.27	±0.25
1050	2	4.87	±5.06	5.50	±2.12	1.05	±0.35
1100	1	7.23	±0.00	6.50	±0.00	1.20	±0.00
1150	1	6.74	±0.00	6.10	±0.00	1.20	±0.00
1200	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
1250	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
1300	0	0.00	±0.00	0.00	±0.00	0.00	±0.00
1350	2	1.30	±0.36	3.65	±0.64	0.65	±0.07
1400	4	1.96	±0.40	4.03	±0.62	0.88	±0.29
1450	4	1.25	±0.38	3.63	±0.17	0.65	±0.06
1500	4	1.28	±0.30	3.83	±0.30	0.88	±0.17
1550	6	2.44	±0.35	4.60	±0.18	0.86	±0.11
1600	6	1.58	±0.48	4.25	±0.39	0.91	±0.17
1650	6	2.02	±0.78	4.39	±0.53	0.85	±0.19
1700	2	1.90	±0.89	4.40	±0.71	0.75	±0.07
1750	4	1.20	±0.35	3.49	±0.30	0.75	±0.10
1800	5	1.12	±0.34	3.35	±0.32	0.66	±0.11

Appendix II

Picture 1. Different species of razor clam

Picture 2. Ambal Biasa

Picture 3. Ambal Jernang



Picture 4. Ambal Riong