Correlation between Substrates Organic Matter with Number, Size and Age of *Corbicula fluminea*

by

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DECLARATION

I declare that this thesis entitled "Correlation between Substrates Organic Matter with Number, Size and Age of *Corbicula fluminea*" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : _____

Name : NUR AFIQAH BINTI ZULKIFFILEE

Date : _____

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ABSTRACT

C. fluminea is a very popular traditional food for local community in Kelantan. Therefore, raw *C. fluminea* demand in local market is high. However, the sources of this raw clam is keep decreasing due to changes of their habitat and unsustainable harvesting. Therefore, this study is aim to determine the correlation of the organic matter at study area with the age and size of *C. fluminea*. *C. fluminea* and sediment samples collected at two stations with three lines per station by using harvesting tools and plastic bucket. The age of *C. fluminea* identified by calculating its annual rings and Caliper digital used to measure the height and width size of *C. fluminea*. Next, loss on ignition (LOI) analysis used to determine the concentration of organic matter in the sediment samples. The table used to represent the correlation between size and organic matter. Results shows, the composition of *C. fluminae* at all stations show the high collection during May till July with range width and length size is between 13 mm – 20 mm. 99% of *C. fluminea* collected was with age 4 years. Therefore, no correlation with the organic matter found. Based on line graph, a parallel pattern of size and organic matter at all station and line represent the positive correlated between the content of organic matter with the size of *C. fluminea*. This shows that the organic matter sediment might be one of factors that can influence the growth of *C.fluminae*. Therefore, it's recommended to harvest the *C. fluminae* after August to reach size 20mm which suitable size for harvesting and commercialize. Besides that, the organic matter content range from 0.1% to 50% is enough for the growth of *C. fluminae*. A plan and guideline of sustainable harvesting and organic matter control can be plan to ensure the sustainable supply of *C.fluminae* in Kelantan.

Korelasi antara Matriks Organik Substrat dengan Nombor, Saiz dan Umur *Corbicula fluminae*

ABSTRAK

C. fluminae adalah makanan tradisional yang popular bagi orang tempatan di Kelantan. Sehubungan itu, *C. fluminae* mentah mendapat permintaan di pasaran tempatan. Namun begitu, bekalan *C. fluminae* mentah semakin berkurang kerana perubahan habitat mereka dan penuaian yang tidak lestari. Oleh itu, kajian ini bertujuan untuk mengenalpasti korelasi kandungan bahan organikdi kawasan kajian dengan saiz dan umur *C. fluminae*. Sampel bagi *C. fluminae* dan sedimen diambil pada tiga garis di dua stesen menggunakan alat pengokok dan baldi plastik. Umur *C. fluminae* dikenalpasti dengan mengira jumlah "annual ring" pada kulit C.fluminae dan angkup elektronik digunakan untuk mengukur saiz lebar dan panjang C.fluminae. kemudiannya, analisis kadar zat hilang bakar (LOI) dijalankan bagi mendapatkan data kandungan bahan organic di dalam sedimen. Jadual digunakan untuk menunjukkan korelasi di antara kandungan bahan organik, saiz dan umur *C.fluminae*. Keputusan menunjukkan, komposisi *C. fluminae* di semua stesen tinggi pada bulan Mei sehingga Julai dengan saiz di antara 13 mm - 20 mm. 90% daripada penuaian *C. fluminae* adalah berumur 4 tahun. Oleh itu, tiada korelasi dapat ditunjukkan di antara umur dan kandungan bahan organik. Berdasarkan graf garis, corak selari di antara garis saiz *C. fluminae* dan kandungan bahan organik di semua garis bagi setiap stesen menunjukkan korelasi positif diantara kadungan bahan organik dengan saiz *C. fluminea*. Ini menunjukkan bahawa sedimen bahan organik mungkin merupakan salah satu faktor yang boleh mempengaruhi pertumbuhan *C. fluminae*. Oleh itu, disyorkan bulan Ogos adalah bulan yang sesuai bagi penuaian *C. fluminae* bagi memastikan hasil tuaian *C. fluminae* mencapai saiz 20mm iaitu saiz yang sesuai untuk dituai dan dikomesialkan. Manakala jarak kandungan bahan organik diantara 0.1% hingga 50% telah mencukupi bagi pertumbuhan *C. fluminae*. Perancangan dan garis panduan bagi penuaian lestari dan pengawalan kandungan organik boleh dirancangkan untuk memastikan kelestarian bekalan *C. fluminae* mentah di Kelantan.

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LIST OF ABBREBIAPIONS

C. fluminea	*Corbicula fluminea*
LOI	Loss of ignition
OM	Organic matter content
CO2	Carbon dioxide
Ca	Calcium

LIST OF SYMBOL

Mm	Millimeter
m	Meter
%	Percentage
°C	Celcius
g	Gram
+	Plus
−	Minus
=	Equal
&	And

CHAPTER 1

INTRODUCTION

1.1 Background of the Research

Corbicula fluminea(*C. fluminea*) is popularly known as "Etak" in the Kelantanese dialect, can be found living in the sandy bottom of main rivers in Malaysia (Figure 1.1). *C. fluminea* is a very popular food for local and consumed as snack in every single day during watching television, studying and others.

C. fluminea is a hermaphroditic clam self-fertilizing with 1 until 5 years life span. It will start to reproduce about 10 mm shell size which is between the age of 5 until 9 months (Basen, 2012). It is originally from Asian and thus it is also known as Asian clam. The exact population size is not known, but it is very common in its native and introduced ranged. *C. fluminea* has been introduce to the several parts of Africa, Europe, North America, Europe and the Mediterranean (Bódis *et al.*, 2012).

For the habitat, *C. fluminea* can survive in almost any freshwater environment, including permanent brackish and estuarine waters. It is often found in the entrance of rivers or lakes to the sea. The substrate is generally sand, mud or a mixture of the

two. *C. fluminea* has ability to filter particles suspended in water including algae, bacteria, detritus and pedal feeding from the sediment (Basen, 2012).

Freshwater clams growth changes generally among species and populaces, and growth rate affacts numerous other life-history and population traits, including life span, age maturity, fecundity, survival, and generation time (Hastie et al. 2000, Haag 2012). Accordingly, growth data are fundamental in ecological studies and for evaluating the vulnerability of clams populace to habitat corruption, harvesting, and other human effects. Freshwater clams and different bivalves by generally have conspicuous, annual rings in their shells. The rings are undifferentiated from annual growth rings in trees, fish otoliths or scales, and vertebrate teeth (Haag, W. R. 2012).

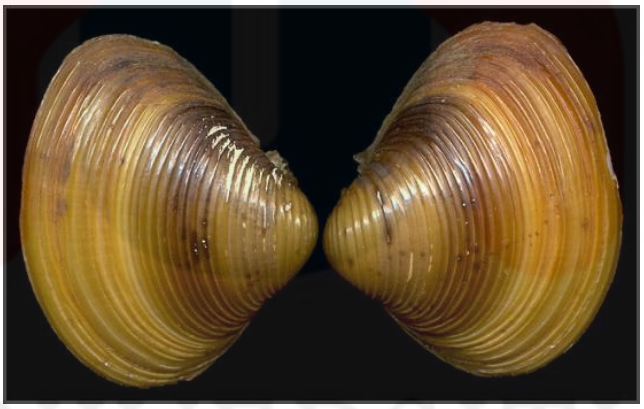

Figure 1.1: *Corbicula fluminea* or locally known as "Etak" is a freshwater clam which can be found at the sandy bottom in rivers of Malaysia

1.2 Problem Statement

C.fluminea have been frequently consumed by Kelantanese people since a very long time ago and as a snack(Aweng ER,2006). The demand of *C. fluminea* is higher than the availability of the *C. fluminea*. In habitat of *C. fluminea* in Lubuk Lepah River, there is water pollution due to the anthropogenic activities. The organic matter of the river was suspected to be influence by the water pollution and thus affecting the growth of the *C. fluminea*. As reported by the previous study Fiordelmondo *et al*(2003), organic matter is essential to provide energy source for the biogeochemical transformation and greatly influences metabolism, growth, feeding strategies and distribution of benthic assemblages (Fiordelmondo *et al.*,2003; Grémare *et al.*,2002).

To date, there is very few study that correlate the organic matter of the sediment with the number, age and size of *C. fluminea*. Hence, current study aims to correlate the organic matter with the age and size of *C. fluminea* in Lubuk Lepah rivers in Kelantan.

1.3 Objectives of the Research:

1. Determine the percentage of organic matter in the sediment that inhabited with *C. fluminea* in Kelantan by using loss on ignition (LOI) analysis.
2. To correlate the number, age and size of the *C. fluminea* with the organic matter in the sediment.

1.4 Scope of study

The research area for this study is at Lubuk Lepah River, Kelantan. The research collect 6 composite sampling sediment and 6 sampling of *C. fluminea.* This study area have 2 point. Each point length 150 m.

1.5 Significant of study

The study of *C. fluminae* to understanding their habitat and growth of environment in rivers Kelantan. This information to help people by harvesting the *C. fluminae* in orderly. People in Kelantan harvesting according themselves when to harvest. They do not know about the growth *C. fluminae*. This to prevent harvest smaller size of *C. fluminae.*

CHAPTER 2

LITERATURE REVIEW

2.1 *Corbicula fluminea*

The *C. fluminea* known as Asiatic clam or mollusk is found all through Asia, North and South America, Europe and parts of Africa. There is a type of freshwater clam and an aquatic bivalve clam in the ecosystem(H. m.,2019).

The *C. fluminea* lean towards a lake or stream that has a sandy soil. In deep water lakes or stream, they are additionally locate underneath in soft silts of water. At the point, fast flowing waters of clam flourishes better in because the currents supply that consistent source of particulate food and the clam consumes (Britton, Joseph C. 1982).

2.1.1Classification

The table 2.1 shows classification of *C. fluminae. C. fluminae* state under binomial name in kingdom of animalia.

Table 2.1: Hiearachy taxonomy *C.fluminea* (Basen T,2012)

Scientific classification	
Kingdom :	Animalia (Basen T,2012)
Phylum :	Mollusca (Basen T,2012)
Class :	Bivalvia (Basen T,2012)
Subclass :	Heterodonta (Basen T,2012)
Order :	Venerida (Basen T,2012)
Superfamily :	Cyrenoidea (Basen T,2012)
Family :	Cyrenoidea (Basen T,2012)
Genus :	Corbicula (Basen T,2012)
Species :	Fluminea (Basen T,2012)
Binomial name :	*Corbicula fluminea* / *C.fluminea* (Basen T,2012)

2.1.2 Taxonomy *C.fluminae*

Asian clams is belong with the genus Corbicula of the family Corbiculidae (Glaubrecht et al. 2003). Inside Corbicula, there is a lot of confusion and discussion regarding to the identification and appropriate naming of a contested number of species as research have concluded up conflicting outcomes (Araujo et al. 1993). Some researchers have refuted the presence of a single animal categories in North America and recommend species contrasts dependent on shell color, shell morphology just as electrophoretic data (Araujo et al. 1993).

Reyna et al. (2013) discusses shell plasticity and the perplexity that outcomes in determining species. Their research had the option to separate *C.largillierti* is a species obviously elite to South America from *C.fluminea* regardless of their overlapping ranges. Different studies decided Asian clams viewed as *C.manilensis* were actually *C.fluminea* and recommend one single species varieties exists in North America (Britton and Morton 1979; Britton and Morton 1986). This confusion has not been resolve and there is no consensus with regards to the correct identification proof and naming of species inside Corbicula.

Given covering distributions of possibly various species and the irregularities of morphological separation, proper naming of species inside Corbicula may not before long be come to. All things considered, an ongoing report recommends that when deciding species inside Corbicula, hereditary information just as biological capacity ought to be considered (Qiu et al. 2001).

Other studies have likewise finished up genetic, physiological and ecological studies are expected to determine the taxonomic issue and include that in light of the fact that Corbicula clams self-treat, the organic species idea may not be promptly applicable (Komaru and Konishi 1999; Komaru et al. 1997). Karatayev et al. (2005) disentangles the types of Corbicula shellfishes in Texas to be only *C. fluminea* for the reasons for their research. Additionally, this research considers the Asian clams species concentrated to be *C.fluminea*.

2.2 Importance of *C.fluminea*

C. fluminea completely dominates the the benthic exhibits, in terms of density and biomass, in rivers, lakes and upper parts of estuaries (Byrne *et al.*,2000) and they known as a standout among the best intrusive species in aquatic ecosystems (Cataldod & Boltovskoy,1999). Its obtrusive achievement is regularly connected with life-history traits that include short life span, fast development growth, early sexual maturity at a shell length of 6–10 mm, high fecundity, free-living juveniles and extensive dispersion ability (McMahon, 1983) .

2.2.1 Impacts on environmental ecosystem

Freshwater ecosystems are profoundly defenseless to the effects of worldwide environmental change, including extraordinary occasions, for example, floods and dry seasons. These effects might be affected by the nearness of across the board obtrusive other species, such as the *C.fluminea* (Crooks,2002). *C. fluminea* act as ecosystem engineers will have affect on habitat structure, bio-mineralization, oxygenation and benthic plankton habitat. The food web and the nutrient cycle structure meddling with the community stability (Crooks,2002; Karatayev et al., 2005; 2007; Sousa et al., 2009).

The aggregation of dead shells can increase the roughness bottom enhancing to soft bottoms which can provide protection for benthos against the erosion. The velocity flow decreasing in formed reefs of empty shells and clams (Sousa et al.,2009). An important role that shell production in bivalve species play for cycling carbon dioxide(CO2) and calcium(Ca) (Chauvaud et al., 2003).

2.2.2 Impacts on ecological

Like other invasive mussels for example zebra and quagga mussels. *C.fluminea* is exceptionally effective combine the nutrient and energy flows that in the water segment and base sediment. Then, separating limit a high and populace density, that filters *C. fluminea* through phyto-plankton and different suspended particles in water are also additionally food sources for other organisms filter-feeding. In contrast to zebra, quagga and other mussels because *C. fluminea* likewise utilizes its pedal foot to feed the organic material and tiny organisms which are microbes, protists, meiofauna in the sediment (Hakenkamp et al. 2001).

C. *fluminea* can influence ecosystem of aquatic forms in different ways. In dense populaces especially bivalves, that discharge noteworthy measures of inorganic nutrient, espicially nitrogen. Thus, can animate the green growth algae and macrophytes development(Lauritsen and Mozley 1989, Sousa et al. 2008).

Furthermore, the mortality mass of Asian clam occasions happen in the mid year pursued for the arrival of nutrient through decomposition likewise water quality affect negative. The dead Asian shells clams can likewise give soft sediments on a hard substrate, and making new surroundings of habitat for different species. After that, they lean toward the hard substrates for example, zebra clams (H. m.,2019).

They ought to be noticed that to date, will not many examinations occur on the ecological effects on Asian clam for each biota (McMahon,1999). Mostly investigations look towards after Corbicula attack at the water body but it not practically identical data on biota or ecological pre-invasion conditions (H. m.,2019).

Additionally, ongoing supports for costly and concentrated management action at Lake Tahoe to detect Asian clam reaction exaggerate proof in the scientific writing. For instance, the Asia clams of Lake Tahoe: Preliminary logical discoveries in help of an management plan state that (Wittman et al.,2008):

"Asian clam is known to aggressively out compete native invertebrate communities."

Based on authors report that erroneously interpret and cite the discoveries of *C. fluminea (*Karatayev et al,2003). Karatayev and colleagues consider *C. fluminea* in Texas repository. In spite of the fact that the Asian clam commanded towards absolute animal biomass that up to 95% of the repository sediment. It was not related at decreases in local biodiversity. Indeed, the co-occur was found an inexhaustible populace of local unionid clams (H. m.,2019).

For studies that guaranteeing the Asian clam affects local bivalves the especially Union are regularly episodic and just the spatial circulation of bivalves report after invasion (Strayer,1999). They expect without non-overlapping distribution of *C. fluminea* and local clam demonstrate that *C. fluminea* have out competing the local species(H. m.,2019).

The Strayer (1999) points out, can only one conceivable clarification. *C. fluminea* could likewise lean toward various territory than local clam for example sandy vs. sediment or rock. Local clam have since quite a while ago experienced decreases due to human-induced changes to natural surroundings such as contamination, deforestation, channelization, and hard to produce separated these progressions versus effects the direct of attacking *C. fluminea* that additionally happen to do well in aggravated habitat(H. m.,2019).

Therefore, while it is very conceivable that now and again *C. fluminea* has an immediate, negative effect on local biota, more examinations that screen changes in clam populaces after some time and that straightforwardly assess aggressive co-operations are justified (H. m.,2019).

2.3 Organic Matter

2.3.1 LOI analysis.

The percentage organic matter content (%OM) determine in soil sample using Loss on Ignition (LOI) analysis. The procedure easily and simple to do compared to others method to use for determine % OM. This method does not involve using any chemicals but only use of a muffle furnace for determine (Sarah, 2011). the procedure of LOI calculates % OM is compare the weight before and after sediment sample has been ignited. The sample contains OM before ignition but after ignition the mineral portion that all remains in sediment. The amount of the OM that was available in the sample will known difference in weight before and after ignition represents (Sarah , 2011).

CHAPTER 3

METHODOLOGY

3.1 Study Area

This sample was collected at Lubuk Lepah River, Tumpat, Kelantan.

3.2 Material and Apparatus

3.2.1 Material

The material used in research is zip lock bag for keep the *C. fluminea* and sediment sampling.

3.2.2 Apparatus

The apparatus used in research are the ice box for preserve sampling before put into referigerator. Then, porcelain to keep the sediment sampling for burn in high degree. Next, used furnace to burn a sample in high degree. The sticker needed for labeling. The desiccator prevent the moisture to enter the sample. The used oven safe gloves for safety when hold a hot things. After that, digital caliper for measure the *C. fluminea*. 2mm sieve to filter the sediment after being ground. The mortar and pestle for ground the sediment after burn 24 hours. Microscope for determine the age of *C. fluminea*.

3.3 Sampling of the *C. fluminea*

The sampling of *C. fluminea* carried out six times in Lubuk Lepah River, Tumpat, Kelantan. The *C. fluminea* collected using the dredgers. The collection method of *C. fluminea* is the dredgers pull up from the right side of riverbank for the first line (L1). Then, shift second line (L2) the center of the river from left side riverbank and pull down towards right side riverbank, and lastly the third line (L3) pull up in the left side of riverbank. The collecting *C. fluminea* seal by using a zipper bag and preserved at 4 °C in the ice box prior send to the laboratory.

3.4 Sampling of Sediment

The sampling of six sediment samples were be carried out. The sediment samples collected manually with an Ekman Grab within the sampling point of *C. fluminea* (Bilos *et al.*, 1998). The sediment samples collected by pushed through the water in order to obtain the sediment layer at a depth of approximately 4 cm at each sampling point and kept into a zip lock bag. The samples placed in the ice box and transported to laboratory (Salah *et al.*, 2012). Each sample was labeled with date and time of collection and site collection.

3.5 Experimental Methods for Determination of Number, Age and Size

3.5.1 Determination of Size

The *C. fluminea* was enumerated in the arrival in the laboratory. The size measurements of the height and width was taken for every *C. fluminea* by utilizing digital calipers based on figure 3.1.

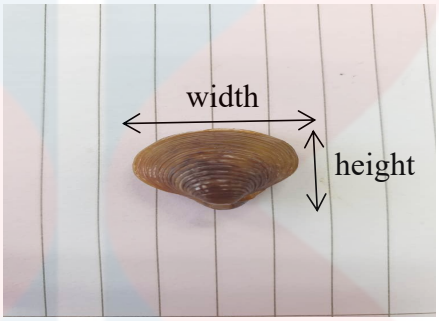

Figure 3.1 : Length and width of *C. fluminae*

3.5.2 Determination of Age

There are two main method to determine the age of the *C. fluminea* by age-group and annual ring method. The different between this method are age-group method that identify by a knowledgeable or studies to determine age while annual ring method were observed under the microscope based on the annual ring of the clam shell (Nakaoka, 1992).

The age group method is accessible in direct information of age, as in human and domesticated animals, isn't within reach. The first is the thing that might be known as age group method. In the event that at any time can be large number of animals of all in sizes are estimated or weighted but typically conceivable for distinguish by a correlation of these sizes and age-groups, because in the same age animals groups. In the present case, the clams in first year is young form a particular

group, from in second year that effectively told . Since, the one year old is the largest sure clearly smaller than the two year old of smallest (California,u.o.,2011).

The distinction in size between the second and third in their year is less yet at the same time adequate to recognize the groups. With each progressive year the distinction turns out to be less checked however via cautious estimations of number of individuals the modes are larger comparing to different age groups might be related to shifting achievement in various species such as the Pismo clam. This method might in the initial years of four or five. Over the strategy stops to be conclusive without corroborative proof from other some source (California,U.O.,2011).

The second method is annual ring method known as concentric growth rings. This one that has been utilized broadly in other groups, outstandingly the fish. As outstanding, the proof rates of growth is unequal at various occasions in scales, otoliths, vertebrae or other harder parts has been translated regarding years. For example, a few spectators comparable zones coming about because of interchange fast and moderate development might be distinguished at the base of the dairy cattle horns (Growth ,1923) and the age determined.

In the clam shell the nearness of comparable rings that been both certified and denied. The method legitimacy, in the term connected towards previously perceived event in the trees of wood can be know the annual too (California,U.O.,2011).

3.6 Experimental Methods for Determination of Organic Matter in Sediment

The collected sediment samples will be dried in drying oven 105 °C for 24 hours. The samples will be ground into powder using mortar and pestle. The ground sediment were sieved with a 2 mm sieve to make sure uniformity of heat penetration. All the porcelain crucibles will be dried in oven for 30 minutes prior to sample loading. The dried crucibles will be initially weighed to the nearest 0.001 g and 5 g of ground sample was placed in the crucible.

After that, the sample will be placed into the furnace (Sutherland,R.A.,1998) with temperature 600 °C. The igniting process will be operated for 5 hours to determine the percent of organic matter. After completion of the igniting process, the samples will be allowed to cool down to around 150 °C. The samples will be then taken from the furnace and cooled in desiccators. Within 30 minutes, the final weight of the crucible with sample will be measured. Percentage of organic matter in the sample will be calculated according to:

$$\% \text{ Organic matter} = \left(\frac{\text{per-ignition weight - post-ignition weight}}{\text{per-ignition weight}}\right) \text{x } 100$$

3.7 Data Analysis

3.7.1 Spear man's Correlation Coefficient

The Spearman rank correlation coefficient is the non parametric version of the Pearson correlation coefficient. Your data must be ordinal, interval or ratio. Spearman’s returns a value from -1 to 1, where:

+1 = a perfect positive correlation between ranks

-1 = a perfect negative correlation between ranks

0 = no correlation between ranks.

3.8 Research flow chart

The figure 3.2 is flow chart of research started from sampling to analysis

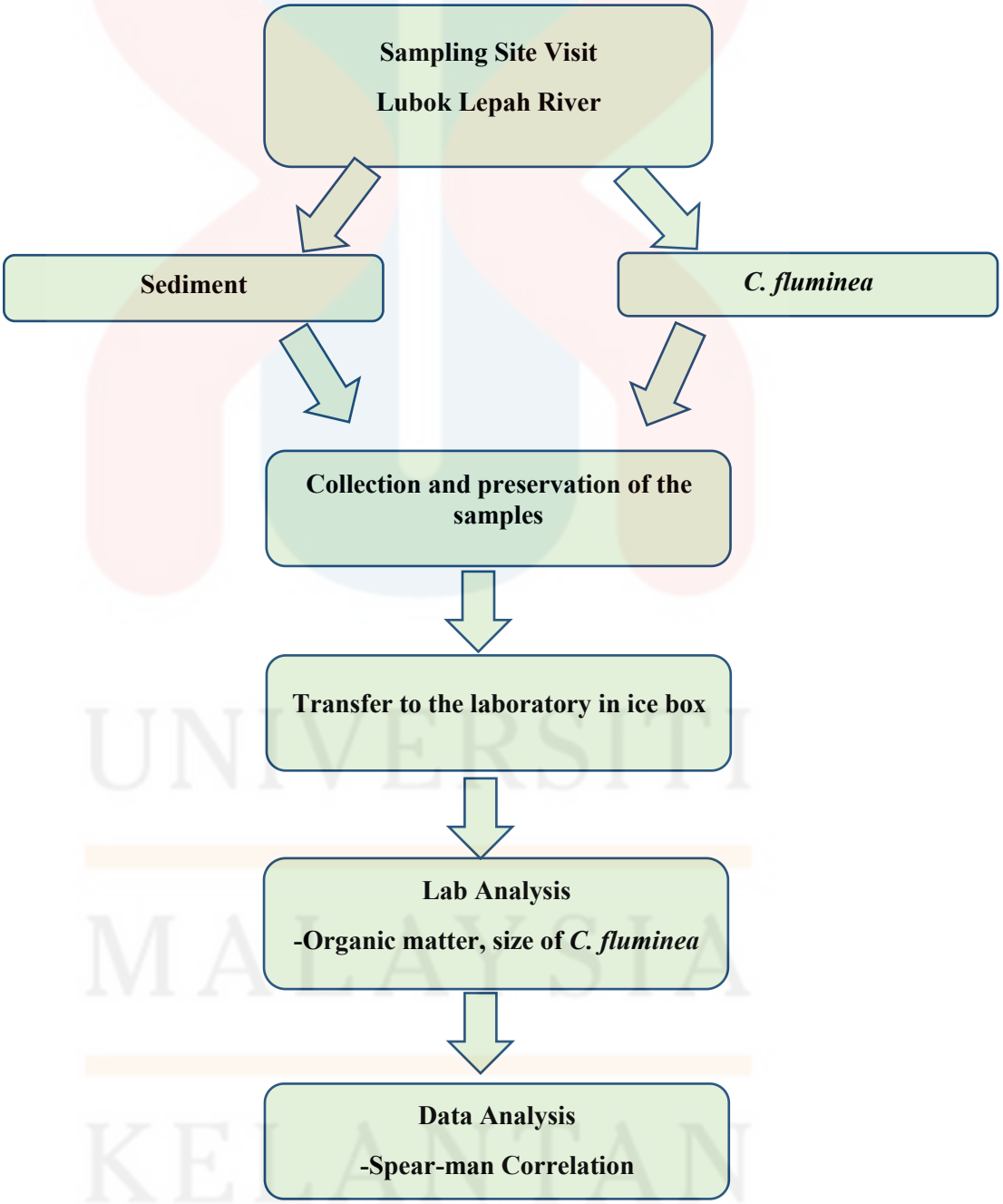

Figure 3.2 : Flow chart of research

CHAPTER 4

RESULT AND DISCUSSION

4.1 Composition and distribution

4.1.1Station and Line *C. fluminea*

In total 2029 individuals has been collected at two stations which is 1024 individuals at Station 1 and 1005 individuals at station 2 based on table 4.1. The highest collection of *C. fluminea* at Station 1 is in May at Line 1 (78) and Line 2 (75). It is a bit different from Station 2 where the highest collection is 73 individuals at Line 2 in May and June. However, Line 3 at Station 2 shows the collection 71 individuals on June.

The collection *C. fluminea* at station 1, on March the highest collection is 51 in L1 while lowest collection is 32 in L3. The highest collection on April in L2 is 55 while lowest collection in L1 is 36. L1 is highest collection 78 while L3 is lowest collection 49 of month May. The month of June is L3 has 49 lowest collection while L2 has 65 highest collection. The July has highest collection on L1 is 72 while lowest collection on L3 is 63. Highest collection on L2 is 69 while lowest collection on L3 is 49 of month August.

Next, the collection *C. fluminea* at station 2 based on table 4.2, on March the highest collection is 33 in L1 while lowest collection is 32 in L3. The highest collection on April in L2 is 52 while lowest collection in L3 is 32. L2 is highest collection 73 while L1 is lowest collection 62 of month May. The month of June is L1 has 59 lowest collection while L2 has 65 highest collection. The July has highest collection on L1 is 72 while lowest collection on L3 is 63. Highest collection on L2 is 69 while lowest collection on L3 is 49 of month August.

Table 4.1 : Month and line *C. fluminea* of station 1

		Station 1						
		Month						
		March	April	May	June	July	August	Total
Line	L1	51	36	78	59	72	65	361
	L2	39	55	75	65	65	69	368
	L3	32	37	65	49	63	49	295
Total		122	128	218	173	200	183	1024

Table 4.2 : Month and line *C. fluminea* of station 2

		Station 2						
		Month						
		March	April	May	June	July	August	Total
Line	L1	33	39	62	59	69	65	327
	L2	29	52	73	73	65	69	361
	L3	32	37	65	71	63	49	317
Total		94	128	200	203	197	183	1005

Figure 4.1 shows that the highest collection is around May (78) and July (72) at Station 1 and May (73) and June (73) at Station 2. It can be seen that the highest collection at Station 1 is in Line 1 and line 2 compared to Line 3. In contrast, the figure 4.2 highest collection for Station 1 is Line 2 and Line 3 compared to Line 1. The graph also shows that the collection of *C. fluminea* start to increasing after 1-2 months from highest collections.

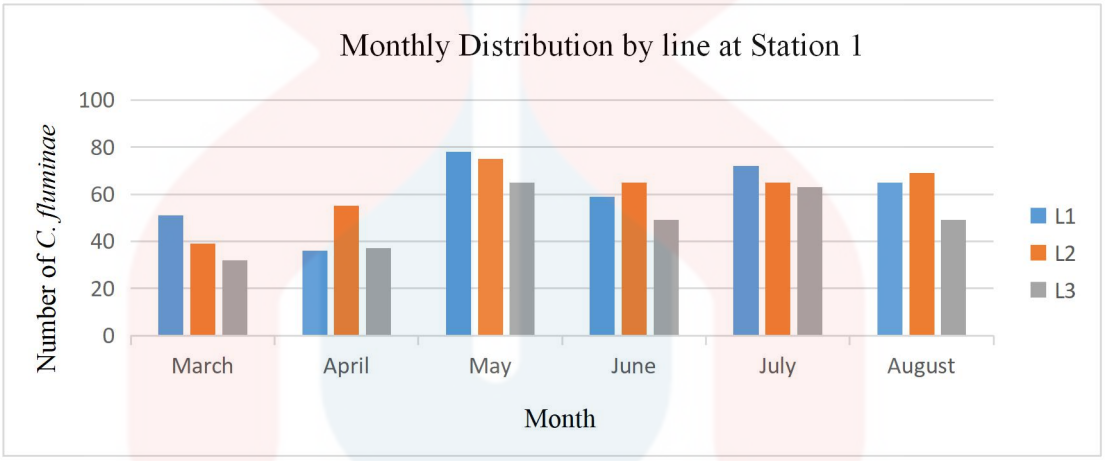

Figure 4.1 : Monthly Distribution of *C. fluminea* at station 1

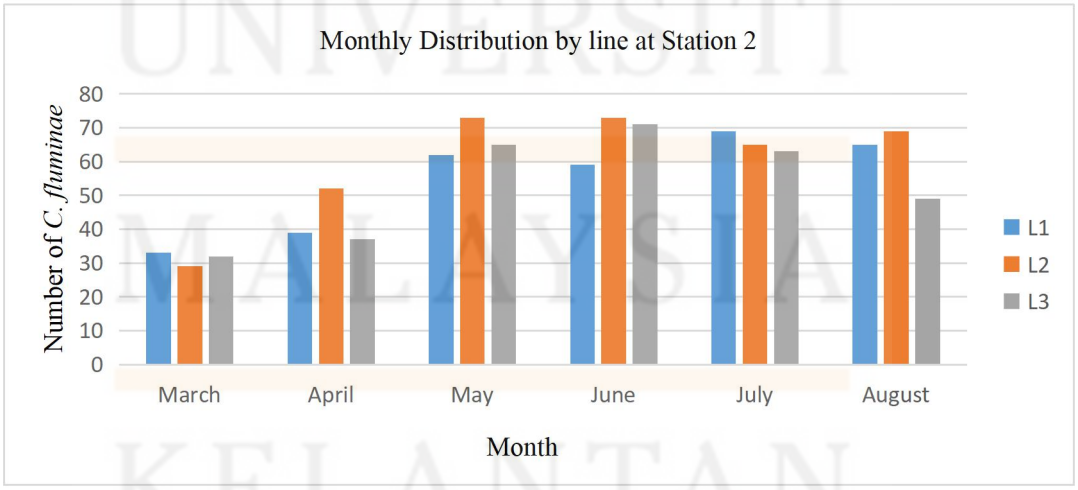

Figure 4.2 : Monthly Distribution of *C. fluminea* at station 2

4.1.2 Age *C. fluminea*

The table 4.3 show range age and month of *C. fluminea*. Base on the table 4.3, all individuals were collected at Lubuk Lepah river mostly range age 3-5. Basen state the clam with a life span of 1 until 5 years (Basen,2012). This show there are harvesting activities at this area where *C. fluminae* die-off happened. The net size might be the cause no juvenile is collected at this area. *C. fluminae* die off happened due to extreme abiotic conditions, including both drought and flooding. As well as high and low temperatures were the primary drivers of mass mortality events. The impacts of mass mortality events include large pulses of nitrogen and increased oxygen stress due to large amounts of soft tissue decomposition, while shells can impact habitat availability and nutrient cycling for *C.fluminea* (Mc Dowell.et.al,2019).

Table 4.3 : Age *C. fluminea*(years)

		Month					
		March	April	May	June	July	August
range_age	3 - 5 years	216	256	418	376	397	366

4.2 Size *C. fluminea*

The size were calculated by using formula (length X width). The dominant range size 200.01 mm - 250.00 mm on July (138). Besides that, the size of *C. fluminea* was depending on food availability and temperatures. The trend of the size classes showed a significant increase of clam of medium size and a significant decrease started from clam with the size of 16 mm to 30 mm. Most of the bivalves including *C. fluminea* tend to burrow themselves in the sediment. Conversely, a juvenile can be easily carried away by the current than bigger individuals (Sousa, 2008). Michael *et al.* (2014) claimed in their assessment, that smaller clams have a high probability to be transported along the water current to the downstream. This might be the reason for the less collection of *C. fluminea* with small size. Table 4.3 shows the variation of clam by size. Tables 4.4 and 4.5 show the measurement for length and width of the clam.

Table 4.4 : Size *C. fluminea* (mm)

		Month					
		March	April	May	June	July	August
range_size(mm)	0.00 - 150.00	4	10	25	15	8	0
	150.01 - 200.00	45	59	121	106	82	40
	200.01 - 250.00	66	76	115	118	138	120
	250.01 - 300.00	59	66	94	92	106	111
	> 300.01	42	45	63	45	63	95

4.2.1 Length *C. fluminea*

Table 4.5 show the range length with month of *C. fluminea*. In range 0.00 - 15.00, the highest sample count is 177 in May while lowest sample count in March which is 65. Then, the range for 15.01 mm - 20.00 mm in August has highest sample count is 272 while in March get lowest sample count is 136. The highest and lowest sample count in range 20.01 mm - 25.00 mm are the month of August and June. In August the count is 17 while in June is 2. One and only of this month May has range > 25.01 mm. Overall range length dominant on August (272) in range 15.01 mm - 20.00 mm. The range 15.01 mm - 20.00 mm is increase in each month.

Table 4.5 : Length *C. fluminea* (mm)

		March	April	May	June	July	August
range_length(mm)	0.00 - 15.00	65	95	177	146	125	77
	15.01 - 20.00	136	155	227	228	264	272
	20.01 - 25.00	15	6	13	2	8	17
	> 25.01	0	0	1	0	0	0

4.2.2 Width *C. fluminea*

Base on Table 4.6 show range width of *C. fluminea*. The highest count is 246 in May while lowest count 101 in March of range 0.00 mm - 15.00 mm. The month of August is 215 has highest count however month of March is 107 has lowest count in range 15.01 mm - 20.00 mm. Range 20.01 mm - 25.00 mm has highest count is 12 in August while lowest count is 1 in June. After that, range > 25.01 mm has one count in August.

Table 4.6 : Width *C.fluminea* (mm)

		Month					
		March	April	May	June	July	August
range_width(mm)	0.00 - 15.00	101	130	246	226	220	138
	15.01 - 20.00	107	124	166	149	173	215
	20.01 - 25.00	8	2	6	1	4	12
	> 25.01	0	0	0	0	0	1

Mostly size *C. fluminea* collected in range 10.01 mm - 15.00 mm and 15.01 mm - 20.00 mm. None in range 0.00 mm - 10.00 mm and 25.01 mm - 30.00 mm were collected in Lubuk Lepah river based on table 4.5 and 4.6. Sousa at al. (2008) classifying adult clams as 10 mm or greater because the sexual maturation usually takes from 3 to 6 months. Within the first 3 to 6 months, the maturation period occurs when the length of shell reaches 6 to 10 mm, and the number of annual reproductive periods can be highly variable (McMahon, 1999). Ordinarily, sexually mature individuals will reproduce twice a year, initially from spring to summer and again in the pre-fall to harvest time (Britton and Morton 1982).

4.3 Organic matter composition

Figure 4.3 shown on station 1 of highest percentage sediment was 49.87% in March at line 1 .The lowest percentage was 0.12% in August at line 2. Based on figure 4.4, the station 2 highest and lowest percentage at line 1 were 7.54% and 0.88% based on graph 4.3. The percentage sediment higher because station 1 was very close to the drainage or flow water while station 2 is far.

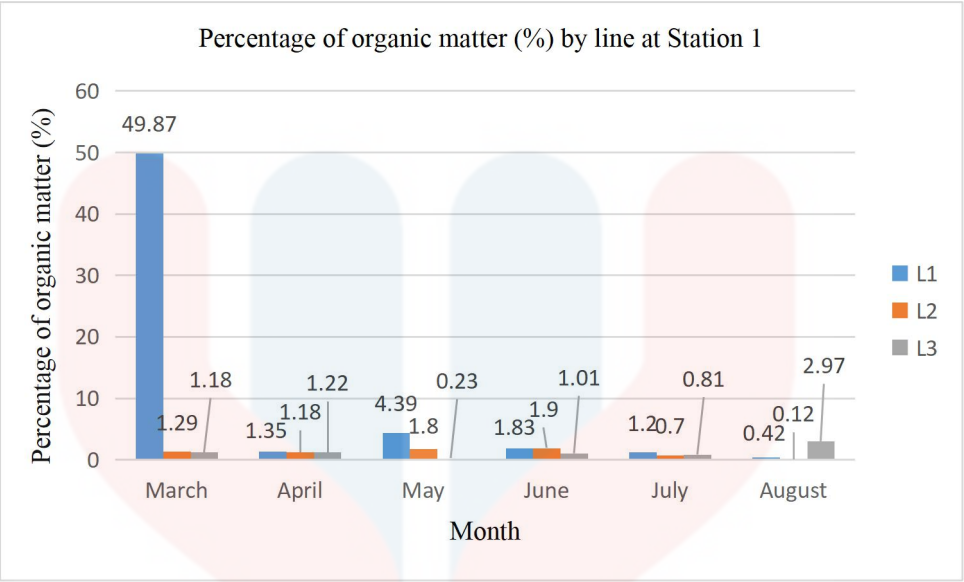

Figure 4.3 : Monthly of percentage organic matter (%) on station 1 at line 1, 2 and 3

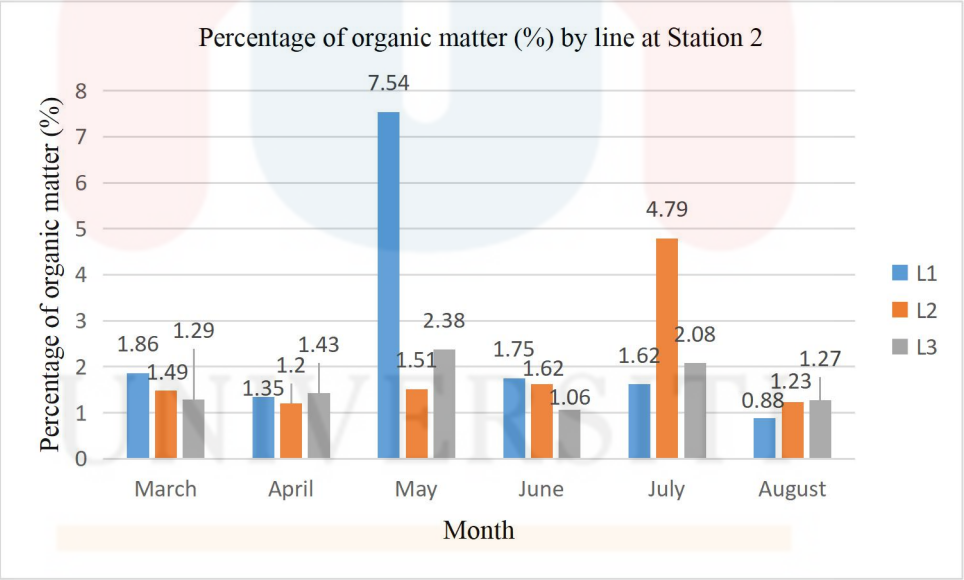

Figure 4.4 : Monthly of percentage organic matter (%) on station 2 at line 1, 2 and 3

4.4 Correlation sediment with age, size and number

The overall number collected of *C. fluminea* based on table 4.6 and 4.7 highest was 78 at station 1 in line1 while lowest is 29 at station 2 in line 3. The number collected higher due at that time there was no people harvested the *C. fluminea* while lowest this maybe caused by the area was the best and easier spot for *C. fluminea* harvesting which is very shallow and easily accessible by local communities or *C. fluminea* die. Besides the area was the spot for *C. fluminea* harvesting which may lead to the small size as the clams had not enough time to develop to the larger size. The shallow nature of the river enables the use of either baskets or clam dredges for the clam collection, which has become the conventional method practiced by the villagers. This was believed to be due availability of nutrients and organic matters in the substrates will influence the number of *C. fluminea* as this species relies heavily on those components as a food source other than phytoplankton (Lauristen,1989).

The number of *C. fluminea* collected at all station and line shows, the decreasing and increasing of organic matter in sediment shows same pattern for number of collection and *C. fluminea* size (width and length). This shows that the organic matter might be one of factors that can influence the *C. fluminea* growth and composition at those stations. This species as they require pedal-feeder using the organic matter available in the sediment as a food source and the sedimentary material is transported to the labial palps by using ciliary tracts on the foot (Hakenkamp cc.et.al,1999, Thorp jh.et.al,1991).

The lowest percentage organic matter (%) is 0.23% on station 1 at line 3 based on table 4.7. This shows that *C. fluminae* can live even the amount of organic matter is little in that area.

Then, the *C. fluminae* is not only depend on 100% organic matter there are another source food for *C. fluminae* such as plankton, algae. C.fluminae may filter a wider range of food sources at a faster rate than native fresh water clams. (Strayer et al. 1999, Hakencamp 2001). For instance, results by Silverman et al. (1997) found that *C. fluminea* are capable of filter-feeding *E. coli* and other bacteria at a higher rate than some native unionid mussels.

Table 4.7 : Correlation on station 1

Station 1					
Month	Line	Number	Average length (mm)	Average width (mm)	Percentage organic matter (%)
March	L1	51	16.80	15.78	49.87
	L2	39	15.37	14.56	1.29
	L3	32	16.81	15.74	1.18
April	L1	36	15.34	14.37	1.35
	L2	55	16.27	15.64	1.18
	L3	37	15.09	14.67	1.22
May	L1	78	15.52	14.66	4.39
	L2	78	15.52	14.66	4.39
	L3	65	14.90	14.02	0.23
June	L1	59	15.22	13.86	1.83
	L2	59	15.22	13.86	1.83
	L3	49	15.81	14.87	1.01
July	L1	72	16.51	15.80	1.2
	L2	65	15.66	14.38	0.7
	L3	63	15.69	14.95	0.81
August	L1	65	16.67	16.00	0.42
	L2	69	16.60	15.81	0.12
	L3	49	16.71	15.97	2.97

Table 4.8 : Correlation on station 2

Station 2					
Month	Line	Number	Average length (mm)	Average width (mm)	Percentage organic matter (%)
March	L1	33	15.37	14.58	1.86
	L2	29	17.12	16.02	1.49
	L3	32	16.46	15.48	1.29
April	L1	39	15.35	14.48	1.35
	L2	52	16.42	15.61	1.2
	L3	37	15.23	14.82	1.43
May	L1	62	15.91	15.09	7.54
	L2	73	17.12	14.86	1.51
	L3	65	14.99	14.07	2.38
June	L1	59	15.23	14.07	1.75
	L2	73	16.01	15.39	1.62
	L3	71	15.65	14.94	1.06
July	L1	69	16.61	15.90	1.62
	L2	65	15.66	14.38	4.79
	L3	63	15.69	14.95	2.08
August	L1	65	16.36	16.03	0.88
	L2	69	16.64	16.05	1.23
	L3	49	16.64	16.10	1.27

CHAPTER 5

CONCLUSION

5.1 Conclusion

The research was able to propose determine the percentage of organic matter in the sediment that inhabited with *C. fluminea* in Kelantan by using loss on ignition (LOI) analysis. In this study, the percentage of organic matter at Lubuk Lepah River is in range 0.1% to 50%. The total 2029 individuals of *C. fluminea* collected was dominant with size 200.01 mm - 250.00 mm. The table shows the percentage of organic matter influence the size and number of *C. fluminea* collected at those two station. Then, to correlate the number, age and size of the *C. fluminea* with the organic matter in the sediment. The correlation sediment between age, size and number is not effected but the effect at the station because the different station give the different result because station 1 was closed to the drainage than station 2.

Meanwhile, the best collected *C. fluminea* were found with length and width around 15.01 mm - 20.00 mm. If collect in range 0.00 mm - 10.00 mm which may lead to the small size as the clams had not enough time to develop to the larger size. The month that suitable to eat or harvest *C. fluminea* or 'Etak' is on May because based on result 4.5 and 4.6.

5.2 Recommendations for further studies

The recommendation for this research are to test the sediment, size, age and number *C. fluminea* at other place and compare the differences in Kelantan. Next, add on parameter for organic matter such as phytoplankton, benthos, algae and others. There are many type of sediment need to identify for the *C. fluminae.*

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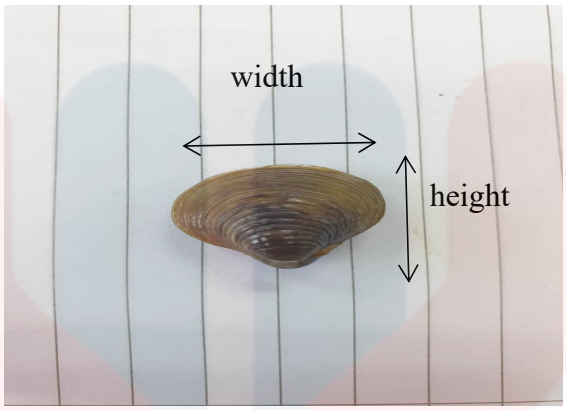
APPENDICES

APPENDIX A Figure of *C.fluminea*

APPENDIX B Length and width *C.fluminae*



APPENDIX C Result of *C. fluminae*

Station	Line	Month	Average size	Mean age	Sediment (%)	Number	Average length	Average width
1	1	March	270.53	4	49.87	51	16.8	15.78
1	1	April	224.01	4	1.35	36	15.34	14.37
1	1	May	231.95	4	4.39	78	15.52	14.66
1	1	June	213.73	4	1.83	59	15.22	13.86
1	1	July	264.38	4	1.2	72	16.51	15.8
1	1	August	270.19	4	0.42	65	16.67	16
1	2	March	226.56	4	1.29	39	15.37	14.56
1	2	April	257.44	4	1.18	55	16.27	15.64
1	2	May	261.15	4	1.8	75	16.41	15.69
1	2	June	227.97	4	1.9	65	15.66	14.38
1	2	July	227.97	4	0.7	65	15.66	14.38
1	2	August	266.13	4	0.12	69	16.6	15.81
1	3	March	267.79	4	1.18	32	16.81	15.74
1	3	April	223.91	4	1.22	37	15.09	14.67
1	3	May	213.15	4	0.23	65	14.9	14.02
1	3	June	238	4	1.01	49	15.81	14.87
1	3	July	237.36	4	0.81	63	15.69	14.95
1	3	August	270.65	4	2.97	49	16.71	15.97
2	1	March	226.8	4	1.86	33	15.37	14.58
2	1	April	225.52	4	1.35	39	15.35	14.48
2	1	May	244.14	4	7.54	62	15.91	15.09
2	1	June	217.2	4	1.75	59	15.23	14.07
2	1	July	267.27	4	1.62	69	16.61	15.9
2	1	August	265.62	4	0.88	65	16.36	16.03
2	2	March	278.91	4	1.49	29	17.12	16.02
2	2	April	260.15	4	1.2	52	16.42	15.61
2	2	May	259.19	4	1.51	73	17.12	14.86
2	2	June	249.67	4	1.62	73	16.01	15.39
2	2	July	227.97	4	4.79	65	15.66	14.38
2	2	August	270.58	4	1.23	69	16.64	16.05
2	3	March	259.38	4	1.29	32	16.46	15.48
2	3	April	228.12	4	1.43	37	15.23	14.82
2	3	May	215.3	4	2.38	65	14.99	14.07
2	3	June	236.65	4	1.06	71	15.65	14.94
2	3	July	237.36	4	2.08	63	15.69	14.95
2	3	August	271.52	4	1.27	49	16.64	16.1