# DIVERSITY OF MOLLUSCA IN DISTURBED AND UNDISTURBED MANGROVE ECOSYSTEMS OF TUMPAT, KELANTAN

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# DIVERSITY OF MOLLUSCA IN DISTURBED AND UNDISTURBED MANGROVE ECOSYSTEMS OF TUMPAT, KELANTAN

by

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## DECLARATION

I declare that this thesis entitled "Diversity of mollusca in disturbed and undisturbed mangrove ecosystems of Tumpat Kelantan"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.

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Date : _____

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**Diversity Of Mollusca In Disturbed And Undisturbed Mangrove Ecosystems Of Tumpat Delta Kelantan**

## ABSTRACT

Mangrove forest is one of the most important ecosystems in the world because of its significant role in the environment and fisheries. Molluscs of commercial importance comprise the biodiversity and secondary productivity of mangrove forest. Molluscs were studied in disturbed and undisturbed mangrove ecosystems of Tumpat Delta Kelantan and the study were conducted from October to November 2016. The diversity of mollusca was determined in disturbed and undisturbed area of Tumpat Delta. Molluscs in both sites were collected using dredging method when at high tide and gleaning method when at low tide. The biodiversity indices used in this research are Shannon-Wiener Index (H'), Pielou's Evenness Index (J') and Margalef's Diversity Index ($D_{mg}$) to identify the diversity. Total species collected at disturbed and undisturbed areas were 14 species which is 6 species found in disturbed and 13 species found in undisturbed. Among 14 species of molluscs obtained, 5 species were from class Bivalvia and 9 species from class Gastropoda. The highest value for (H') was represented in undisturbed area which was 1.99. The evenness value (J') was higher in disturbed area that represent 0.26 while undisturbed area was 0.15 but in generally for both area was not well distributed because their value was nearly to the lowest range. $D_{mg}$ value was higher in undisturbed area of mangrove ecosystems with 1.94 while in disturbed area it was recorded 0.82. In term of size, the biggest species for both areas is *Telescopium telescopium* which is 7.62cm that represented in undisturbed area and 6.85cm in disturbed area while the smallest species is *Cerithedia cingulata* which is 1.56cm for disturbed area and 1.6cm for undisturbed area. The difference in growth of molluscs species in ecosystems depends on the quality and quantity of available food resources. It appears that the higher population density has effect on mollusca species growth. Undisturbed area have higher ecosystems diversity compared to the disturbed areas in mangrove ecosystems in Tumpat Delta Kelantan. This study also can be improved by adding more data analysis calculations to get specific information in details and varying the research in effective ways.

**Kepelbagaian Moluska Di Dalam Kawasan Ekosistem Paya Bakau Yang Diganggu Dan Tidak Diganggu Di Delta Tumpat Kelantan**

## ABSTRAK

Hutan bakau merupakan salah satu ekosistem yang paling penting dalam dunia kerana peranannya dalam alam sekitar dan perikanan. Secara komersial moluska mempunyai kepentingan yang terdiri daripada kepelbagaian biologi dan produktiviti hutan bakau.Walau bagaimanapun, moluska dikaji dalam ekosistem bakau terganggu dan tidak terganggu di Tumpat Delta Kelantan dan kajian telah dijalankan dari Oktober hingga November 2016. Kepelbagaian ciri-ciri moluska telah ditentukan di kawasan terganggu dan tidak terganggu di Tumpat Delta. Moluska di kedua-dua tapak telah dikumpulkan dengan menggunakan kaedah pengorekan ketika air pasang dan kaedah memungut ketika air surut. Indeks kepelbagaian biologi yang telah digunakan dalam kajian ini ialah Indeks Kesamarataan Shannon-Wiener (H'), Indeks Kesamarataan Pielou (J') dan Indeks Kepelbagaian Margalef (Dmg) untuk mengenal pasti kepelbagaian moluska. Jumlah spesies yang dikumpul adalah 14 spesies di mana 6 species dikumpulkan dari kawasan terganggu dan 13 species adalah dari kawasan tidak terganggu. Antara 14 spesies moluska diperolehi, 5 spesies adalah dari kelas Bivalvia dan 9 spesies dari kelas Gastropoda. Nilai tertinggi untuk nilai (H') diwakili di kawasan tidak terganggu iaitu 1.99. Nilai kesamarataan (J') adalah lebih tinggi di kawasan terganggu yang mewakili 0.26 manakala kawasan tidak terganggu adalah 0.15 tetapi pada umumnya untuk kedua-dua kawasan itu spesies moluska tidak diagihkan dengan sama rata kerana nilai mereka adalah hampir kepada julat yang paling rendah iaitu 0. Indeks Kepelbagaian Margalef ($D_{mg}$) adalah lebih tinggi di kawasan tidak terganggu ekosistem bakau iaitu 1.94 manakala di kawasan terganggu diwakili 0.82. Spesies yang paling besar bagi kedua-dua kawasan adalah *Telescopium telescopium* yang mana nilainya 7.62cm untuk kawasan yang tidak diganggu dan 6.85cm untuk kawasan yang terganggu manakala spesies paling kecil adalah *Cerithedia cingulata* yang nilanya 1.56cm untuk kawasan yang terganggu dan 1.6cm untuk kawasan yang tidak diganggu. Perbezaan dalam pertumbuhan moluska spesies dalam ekosistem bergantung kepada kualiti dan kuantiti sumber makanan disediakan. Kepadatan penduduk yang lebih tinggi mempunyai kesan ke atas pertumbuhan moluska. Kawasan tidak terganggu mempunyai ekosistem kepelbagaian yang lebih tinggi jika dibandingkan dengan kawasan terbuka dalam ekosistem bakau di Tumpat Delta Kelantan. Kajian ini juga boleh diperbaiki dengan menambah lebih banyak data pengiraan analisis untuk mendapatkan maklumat tertentu secara terperinci dan berbeza-beza penyelidikan dengan cara yang berkesan.

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## LIST OF ABBREVIATION

H’ - Shannon-Wiener’s Index

S’ - Species Richness

E’ - Pielou’s Index

sp. - Species

ha - hectare

km - kilometer

## LIST OF SYMBOLS

N - North

E - East

% - Percentage

ln - natural logarithm

# CHAPTER 1

# INTRODUCTION

## 1.1 Background of Study

Mangrove forests are consist of taxonomically diverse, salt-tolerant species of trees and shrubs that grow well in intertidal zones of sheltered tropical and warm-temperate shores and estuaries throughout the world (Yamada et al., 1998).

Furthermore, mangroves also important in recycling nutrients and balancing the estuarine ecosystem because it can provide one of the basic food chain resources through their leaves, wood, roots, and detrial materials for arboreal and near shore marine life. This makes the mangrove areas rich in many species of living organisms (Ronnback et al., 1999).

Mangrove plays an important role both in ecological and socio-economic that act to balance human daily life and other surrounding include aquatic organisms (Bosire et al., 2008). Besides, mangrove plays major role to against climate change that have high potential to reduce the greenhouse gasses phenomena by using the carbon that come from the atmosphere which is already sequestered and stored in mangrove plant (Donato et al., 2011).

Mangroves have a significant ecological role as physical habitat and nursery grounds for a wide variety of marine or estuarine vertebrates and invertebrates. This is because the mangrove is a habitat for endangered and threatened species, and species of special concern like Proboscis Monkey, Nasalis Larratus. Aquatic life utilize mangrove areas as

their living place for their high level of protection against predators, strong wave actions and exposure to the temperature and light (Kathy et al., 2008). These various aquatic life having an interaction with the mangrove ecosystem potentially (Kimirei, 2012).

Resident species like tunicates, crustaceans, molluscs, and fishes spend their entire life cycle either on or among the prop roots systems in mangroves area and the prop root system also provides an important nursery for organisms of crustaceans, molluscs and fishes that develop and spending their adult lives elsewhere (Odum & McIvor, 1990).

In the geological time scale the Molluscs involve were about 600 million years ago during the Cambrian period. The name "Mollusca" was first used by Linnaeus in the year 1757. Molluscs are a heterogenous group of animals with different structural form such as slugs, mussels, octopuses and snails in structurally. The molluscs were known by their shell in majority ways but in some forms the shell is absent (Sam, 1999).

Molluscs species have been classified based on their morphological, anatomical and biological features. Molluscs have colonized all possible habitats from deep sea to high mountains. They are more abundant in the littoral zones of tropical seas. Furthermore, the total populations of Molluscan are Gastropods and Bivalves that constitute in 98% populations. Then, this species mostly inhabit on land, freshwater and marine environments.

## 1.2 Problem Statement

Molluscs is the largest and diverse phylum in the tropical sea. Nowadays, the mollusc species is a highly demanded among the people area in Tumpat Delta but not in undisturbed area which a place that people never explored on that area. Besides, there were less study of mollusc species in this area especially in comparing between disturbed and undisturbed area in Tumpat Delta, Kelantan. Hence, this area has been chosen to study the diversity of molluscs in mangrove ecosystem for disturbed and undisturbed area in Tumpat Delta, Kelantan.

## 1.3 Objectives

Objectives of this study is :-

a) To determine the molluscan diversity in mangrove ecosystem in disturbed and undisturbed area

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Diversity of Mangrove Ecosystem

Mangroves have a significant ecological role as physical habitat and nursery grounds for a wide variety of marine or estuarine vertebrates and invertebrates. This is because the mangrove can be as habitat for endangered and threatened species, and species of special concern. Besides, the aquatic life utilize mangrove areas as their living place for their high level of protection against predators, strong wave actions and exposure to the temperature and light (Kathy et al., 2008). These various aquatic life already have an interaction with the mangrove ecosystem (Kimirei, 2012).

Kelantan Delta which located in Tumpat have experience run-off that due to seasonal rainfall and offshore currents. For example, the coastal morphology in this area regularly modified, include sandbar configuration and hydrographical conditions (Mohd-Suffian et al., 2004). Therefore, mangrove forest is one of the most important ecosystems in the world because of its significant role in the environment and fisheries.

Mangrove ecosystems are important habitat for at least 1,300 species of animals including 628 species of mammals, birds, reptiles, fish, and amphibians. This species are provide areas to survive for breeding, nesting, foraging (Figure 2.1), and shelter (Figure 2.2) (Odum & McIvor, 1990). However, most invertebrate and some resident vertebrate

species are totally dependent upon mangroves to survive and complete important life cycle functions (Tomlinson et al., 1986).


Figure 2.1 Foraging Animals
(Source : Yeo, 2016)

Figure 2.2 Shelter species under mangroves
(Source : Tim Laman , n.d.)

The class of Gastropod with an estimation of 75000 to 150000 species are mostly come from the marine habitats (Strong et al., 2008) such as mangroves (Vermeij,1973) and terrestrial habitats (Barker, 2001). As we knows, the mangrove ecosystem already explain that the gastropod species were mostly contribute through the feeding resources of waders (Al-Sayed et al., 2008).

## 2.2 Diversity of Molluscs in Mangrove area

Molluscs is the largest and diverse phylum in the tropical sea. Molluscs are highly successful invertebrates in terms of ecology and adaptation and are found nearly in habitats that ranging from deepest ocean trenches to intertidal zones and freshwater to land occupying a wide range of habitats. Molluscs are extremely important factors of many ecological communities that include the biodiversity and secondary productivity of mangrove forest (Sam,1999).

The mollusc species is one of an important link in food chain from primary to tertiary level leading to fish production but an edible source for coastal population. Furthermore, they are used for ornamental trade, pharmacological products and in manufacture of lime and cement. Furthermore, molluscs have colonized all possible habitats from deep sea to high mountains and more abundant in the littoral zones of tropical seas. The other classes of Mollusca are exclusively marine (Sam,1999).

For the gastropods (Figure 2.3), the commonest epifaunal species that exist in the mangrove ecosystems are represented by snails, whelks, cowries, limpets, and their allies. The gastropods are suitably adapted to various macro habitats of the mangrove ecosystems. The mangroves provides ideal conditions for higher productivity of gastropods which in serve as food, particularly the veliger larvae for numerous other animals. This is because of their predatory nature, the gastropods occupy a central role in maintaining the functions and productivity of mangroves.

For the bivalves, this species are grow best in the soft mud and these are two aspects alone partially explain the lack of the data on mangrove bivalves. As will be seen, large number of bivalves have been recorded from the seaward fringe of the mangroves and their status as true mangroves associates is dependable apart from the obvious difficulties of working in a mangrove forest (Murty & Balaparameswara Rao, 1977).


Figure 2.3 The commonest epifaunal species that exist in the mangrove ecosystems are represented. a) *Alycaeinae* sp. b) *Liospiriferina rostrata* c) *Discartemon collingeia* d) *Pinctada margaritifera* e) *Architaenioglossa* sp. f) *Acanthocardia tuberculata*

By using the hand digging method, the bivalve types mostly were collected (Alfred et al., 1997). Furthermore, by hand picking that vertically at every 25cm height that are an arboreal form are collected from the stems, roots, and other parts of the mangrove trees (Sasekumar,1974). Besides, the collection of sample also will be conducted by gleaning during low tide and by dredging at high tide on the intertidal area in mangrove forest (Dolorosa & Dangan-Dalon,2014).

Fishing dredges were used shows as in (Figure 2.4). It is used to collect various species of clams scallops, oysters or crabs from the seabed. These dredges have the form of a scoop made of chain mesh, and are towed by a fishing boat. Careless dredging can be destructive to the seabed. For gleaning process (Figure 2.5), this is the act of collecting by skin diving with the use of air compressor or hand picking in intertidal reef flats during low tide. These activities have been carried out on a daily basis by women, children and even the aged using non-specialized technologies.

Figure 2.4 : Dredger

(Source : STOWAWAY-Portable Scallop Dredge, n.d.)

Figure 2.5 : Gleaning

## 2.3 Disturbed Area

The disturbed mangrove area is defined as an area that has been influenced by encroachment activity such as tree cutting, housing settlement or reclamation of land for agriculture (Wah et al., 2011). In biology, a disturbance is a temporary change in environmental conditions that causes a pronounced change in an ecosystem. Major ecological disturbances may include fires, flooding, windstorms, insect outbreaks and trampling.

Disturbed mangrove area also defined which as (Figure 2.6) there was record of shifting or extensive agriculture, evidence of secondary vegetation, livestock density over carrying capacity or other evidence of human disturbance. The classification reflects about a record of permanent agriculture or urban settlement, removal of primary vegetation or record of desertification or other permanent degradation by human dominated (Hannah et al., 1994)

Figure 2.6 Part of disturbed area mangrove area in Tumpat taken on 17 September 2016

## 2.4 Undisturbed Area

Undisturbed area is an infect or untouched area by any tree disturbing activity except the planting of required landscaping and plantings requires by conditional use zoning requirements. Furthermore, undisturbed area is very peaceful and also unaffected area from human being. In mangrove ecosystem, this area are known by more regeneration of seedlings can be found within this health ecosystem as (Figure 2.7). From the previous study, areas were classified as undisturbed where there was a record of primary vegetation, and where there was no evidence of disturbance combined with very low human population density (Hannah et al., 1994).

Figure 2.7 Example of undisturbed area of mangrove part in Tumpat

(Source : Raja, n.d.)

# CHAPTER 3

# MATERIALS AND METHODS

## 3.1 Study area

This study was conducted at the Tumpat Delta, Kelantan and it is located on latitude $6^0$11'-$6^0$13' N and longitude on $102^0$9'-$102^0$14'E (Figure 3.1). The sampling was started from October to November 2016. Mangroves of Tumpat are found distributed in several patches consisting of 17 islands with estimated total area of 1200 ha. The Tumpat Delta in Kelantan is a distinctive unit in the northest corner of Malaysia that consist about 1500 $km^2$ in area and flanking the lower course of the broad, meandering the River Kelantan (Shamsudin & Nasir, 2005). There are two different study sites which are disturbed and undisturbed area in mangroves ecosystem in Tumpat Delta, Kelantan. In disturbed area there was a temporary disturbance in environmental conditions and consist of an evidence of secondary vegetation. Undisturbed area was explained by (Hannah et al., 1994) that the undisturbed area was recorded from primary vegetation and no evidence of disturbance combined with very low human population density.


Figure 3.1 : Tumpat Delta in Kelantan

(Modified from: ARZ (2010) ; ShippingMalaysia (n.d.))

### 3.2 Materials

This study used few materials for the collection of molluscs sample on the selected site for disturbed and undisturbed area. Hand gloves was used for hand picking in gleaning process to hold the species when measure the size of samples. For high tides, the net and hand dredges were used to catch the molluscs samples of species. Then, the vernier caliper was used to measure the length of the sample species. A digital camera was used to take picture of mollusca species after the collection sample process.

## 3.3 Methods

This study was conducted in Tumpat Delta and the sampling of molluscs species of bivalves and gastropods were conducted. First, the selection site already chosen by random sampling base on disturbed and undisturbed area. Both areas have five sites each. The sample at each site were collected five times in Tumpat Delta and the sampling data methods used were dredging when high tide and gleaning when at low tide as shown in (Figure 3.2).

### 3.3.1 Dredging

In this study, the method of dredging were used for make sure that the research was collected in high quantity of molluscs species in a short time. Dredging types were used is a net and hand rakes that have the form of a scoop made of chain mesh. It is used to collect various species of clams scallops, oysters or crabs from the seabed.

### 3.2.2 Gleaning

In this research, gleaning process were used at low tide. This process is the act of collecting by skin diving with the use of air compressor or hand picking in intertidal reef flats during low tide. These activities were been carried out on a daily basis by women, children and even the aged using non-specialized technologies. At a low tide, the study area was visited in the morning for the collection of sample from sandy beach and intertidal zone (Vanmali & Jadhav, 2015).

This method process was conducted in five times for both areas and each area have five points recorded. Besides, this method was started early in the morning with gleaning because the water sea level were at the low tide and continued by using a dredging process after the sea water level became increase on the sunset.

By using the hand digging method, most of the bivalve types could be collected (Alfred et al., 1997). Furthermore, by hand picking that vertically at every 25cm height that are an arboreal form were collected from the stems, roots, and other parts of the mangrove trees (Sasekumar,1974).

Once dried shells was separated by their type of species which is bivalves and gastropods, they were kept in the separate plastic bags and recorded base on its collected origins either disturbed or undisturbed area with location tagged by GPS. The collected molluscs specimens were identified by observing the morphological characteristics and special features with reference to available keys for identification of molluscs at sites and brought back to the UMK Jeli Campus. It is mainly identified based on the shell morphology, hinge, interlocking dentition and their shape with referred to standard literature available.

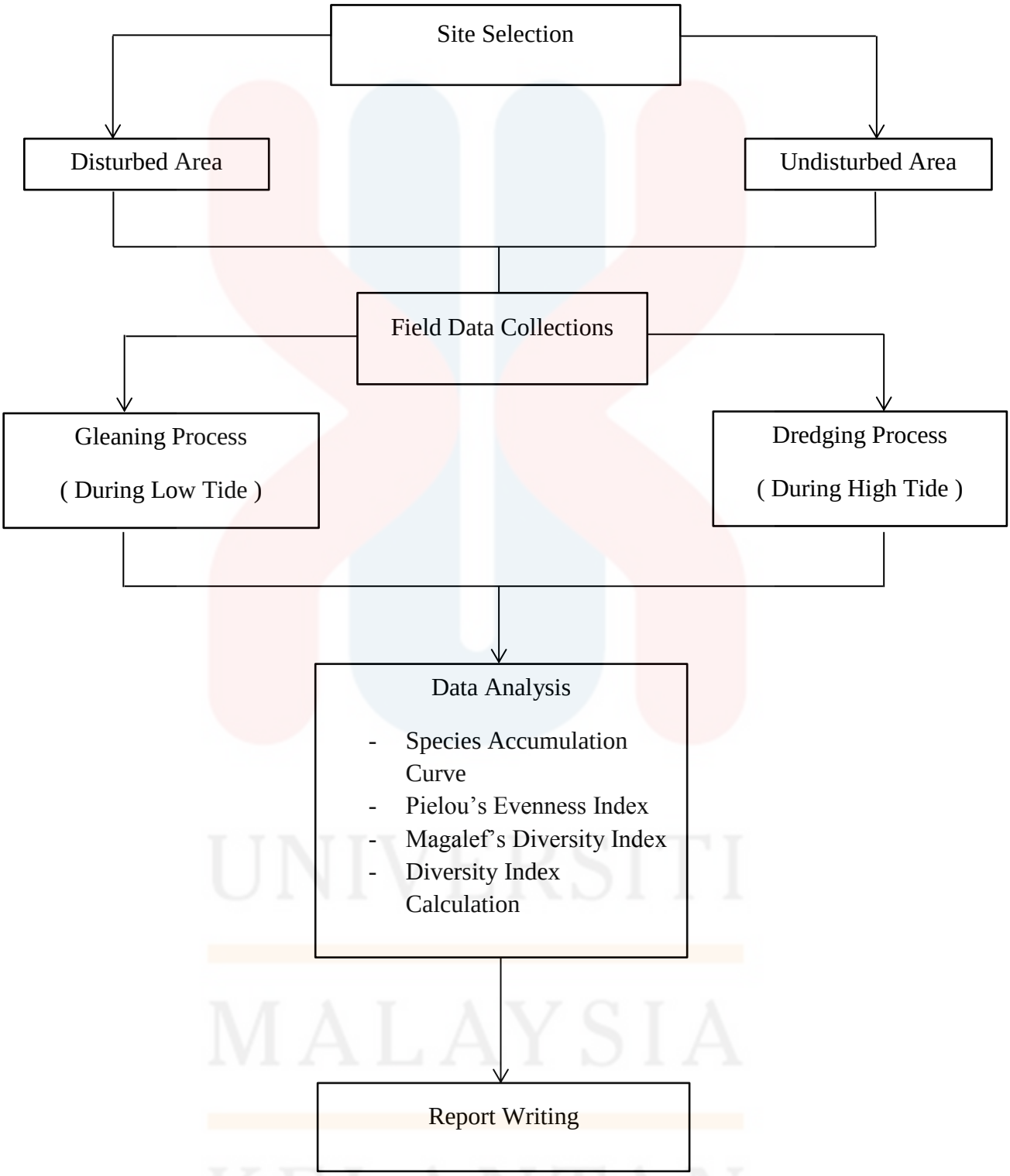



Figure 3.2 Flowchart of methodology in conducting research

### 3.3 Data Analysis

All data collected were analyzed by using species accumulation curves, Pielou's Evenness Index. Shannon-Wiener Diversity Index and Margalef's Diversity Index. Those analysis and indices were used because these formulas were commonly used by the ecologists to analyse both diversity and evenness of species present in the community.

#### 3.3.1 Species Accumulation Curve

By using species accumulation curve, it shows the rate of new species found to calculate the diversity for species richness of sites. These species accumulation curve also used to standardize samples among sites and to estimate the minimum effort required for adequate completeness of inventories (Moreno & Halffter, 2000).

The species richness shows a relatively small proportion of the assemblage has been sampled produces large errors and the result is strongly dependent on the estimator used (Colwell & Coddington, 1994). It is in the hyperdiverse groups of arthropods, nematodes, fungi and microorganisms where these problems of sampling and estimation are most acute.

Species accumulation curve can be calculated from two sets of data. All of the data points or alternatively only those data points where the number of species increase. This generally provided the better estimate of species richness as chosen to use all available data points if no observation method preferred for each site. (Graham et al., 2003).

### 3.3.2 Pielou's Evenness Index

Defining and quantifying evenness is more difficult than quantifying diversity. Ecologists also disagree on a set of properties to characterize evenness. However, one general point of agreement in the literature is that diversity is a compound quantity made up of richness and evenness components, and that these components should be defined so that they are independent of each other (Gosselin, 2006).

Pielou's Index was used to measure the evenness and it was proposed by Sheldon (1969), but its use in ecological literature has been negligible. But, the most commonly used evenness index has been the one proposed by Pielou (1966), e = H/Hmax, with Hmax= InS. Contrary to Hill's (1973) statement, it shares with Hill's continuum of evenness measures the property of remaining constant when the number of individuals of all species is multiplied with a constant factor. Intuitively, this seems to be a necessary property of an evenness index.

$$J' = \frac{H'}{\ln S}$$ ( Equation 3.1 )

Where,

H' = the number derived from the Shannon diversity index

S = species richness (number of species)

### 3.3.3 Diversity Index Calculation

In this study, the Shannon-Wiener Index formula (Equation 3.1) was used to calculate the species diversity of Mollusca and proportion of each species in local community while approximates that show the value of a definite integral by using quadratic polynomials.

Furthermore, the ecologists also were used this formula for measuring the diversity which takes into account richness of species which is Magalef's Index (Equation 3.3). Species richness as a measure on its own takes no account of the number of individuals of each species present. It gives as much weight to those species which have very few individuals as to those which have many individuals.

Shannon-Wiener Index :

$$H' = -\sum_{i=1}^{s} pi \ln pi$$ ( Equation 3.2 )

Where,

Range is from 0 to Hmax = 0 to ln S

S = species richness (number of species)

pi = total number of individuals in $i^{th}$ species / total number of individuals for all species

ln = natural logarithm

For the calculation of species richness (Gleason, 1922) , the Margalef's Diversity Index formula used :

$$D_{mg} = \frac{S-1}{Log^{e}\ N} \qquad \text{( Equation 3. 3 )}$$

Where,

S = the species richness ( number of species )

N = the total number of dominant species

# CHAPTER 4

# RESULTS AND DISCUSSION

## 4.1 Diversity Analyses

Total species collected at disturbed and undisturbed areas were 14 species which represents 9 families (Table 4.1) .The 14 individuals also represented the class of Bivalvia with 5 species and 9 species from the class Gastropoda as shown in Table 4.2.

Based on the Table 4.1, there were six molluscs species found in disturbed area and thirteen species found in undisturbed area. The value of molluscs species diversity in disturbed area is less diverse with Shannon-Wiener Index (H') that represented 1.54 as compared to undisturbed mangrove area which has a higher value with 1.99. It shows that in undisturbed area were highest number of diversity value which represents for mollusc diversity in Tumpat Delta community and shows the varieties species in Tumpat Delta. Furthermore, this study represents that the molluscs species were diverse in this area.

Besides, Pielou's Evenness Index (J') value for disturbed area was 0.26 and for undisturbed area was represented 0.15. This result shows the evenness value was higher in disturbed area but not well distributed for both ecosystems. This is because the value was closely to the lowest range of evenness index which is 0 to 1. However, for the species richness which is Margalef's Diversity Index ($D_{mg}$) value in undisturbed area was represented 1.94 while the value in disturbed area was 0.82. This value shows that undisturbed area has the richest of molluscs species as compared to disturbed area in mangrove ecosystems in Tumpat Delta

Table 4.1 Diversity Analyses for Disturbed and Undisturbed Area in Tumpat Delta Kelantan

| **Scientific Name** | **Number of Individuals(N)** | **Average size (cm)** | **H '** | **J'** | **$D_{mg}$** |
|---|---|---|---|---|---|
| **Disturbed Area** | | | 1.54 | 0.26 | 0.82 |
| *Faunus ater* | 190 | 5.76 | | | |
| *Cerithidea cingulata* | 53 | 1.6 | | | |
| *Saccostrea cucullata* | 87 | 4.27 | | | |
| *Telescopium telescopium* | 47 | 7.62 | | | |
| *Polymesoda expansa* | 39 | 4.74 | | | |
| *Cerithidea obtusa* | 24 | 3.53 | | | |
| **Undisturbed Area** | | | 1.99 | 0.15 | 1.94 |
| *Faunus ater* | 20 | 5.89 | | | |
| *Cerithidea cingulata* | 31 | 1.56 | | | |
| *Telescopium telescopium* | 10 | 6.85 | | | |
| *Polymesoda expansa* | 36 | 5.38 | | | |
| *Mactra corallina* | 133 | 2.76 | | | |
| *Lutraria lutraria* | 154 | 3.54 | | | |
| *Anadara fultoni* | 23 | 2.74 | | | |
| *Cerithidea obtusa* | 40 | 2.97 | | | |
| *Ellobium aurisjuddae* | 5 | 2.62 | | | |
| *Natica tigrina* | 10 | 2.34 | | | |
| *Cassidula aurisfelis* | 3 | 0.87 | | | |
| *Littoraria carinifera* | 5 | 1.82 | | | |
| *Cassidula nucleus* | 11 | 1.75 | | | |

Table 4.2 Mollusca species for undisturbed and disturbed area in Tumpat Delta, Kelantan

| No | Class | Family | Scientific Name |
|---|---|---|---|
| **1** | Bivalvia | Mactridae | *Mactra corallina* |
| **2** | Bivalvia | Mactridae | *Lutraria lutraria* |
| **3** | Bivalvia | Ostreidae | *Saccostrea cucullata* |
| **4** | Bivalvia | Arcidae | *Anadara fultoni* |
| **5** | Bivalvia | Corbiculidae | *Polymesoda expansa* |
| **6** | Gastropoda | Pachychilidae | *Faunus ater* |
| **7** | Gastropoda | Potamididae | *Cerithidea cingulata* |
| **8** | Gastropoda | Potamididae | *Telescopium telescopium* |
| **9** | Gastropoda | Potamididae | *Cerithidea obtusa* |
| **10** | Gastropoda | Melampidae | *Ellobium aurisjuddae* |
| **11** | Gastropoda | Naticidae | *Natica tigrina* |
| **12** | Gastropoda | Melampidae | *Cassidula aurisfelis* |
| **13** | Gastropoda | Littorinidae | *Littoraria carinifera* |
| **14** | Gastropoda | Melampidae | *Cassidula nucleus* |

Meanwhile, species accumulation curve for both disturbed and undisturbed area was analyzed and plotted using data collected on mollusca species as shown in Figure 4.1 and Figure 4.2. This graph were plotted by using the number of catch sample data at x-axis and against the number of species found in disturbed and undisturbed area of Tumpat Delta at y-axis. For the Figure 4.1 showed that at 23 times number of catch sample curve was reached at their asymptotes and it was considered that this sampling was enough for this study. In Figure 4.2 below showed at 18 times number of catch sample curve was constantly increase and reached the asymptotes that the species richness actually achieve the unit for collection data. Based on both figure shows the species accumulation curve were reach it rate of species diversity richness of sites.

Figure 4.1 Species Accumulation Curve for Undisturbed Area in Tumpat Delta

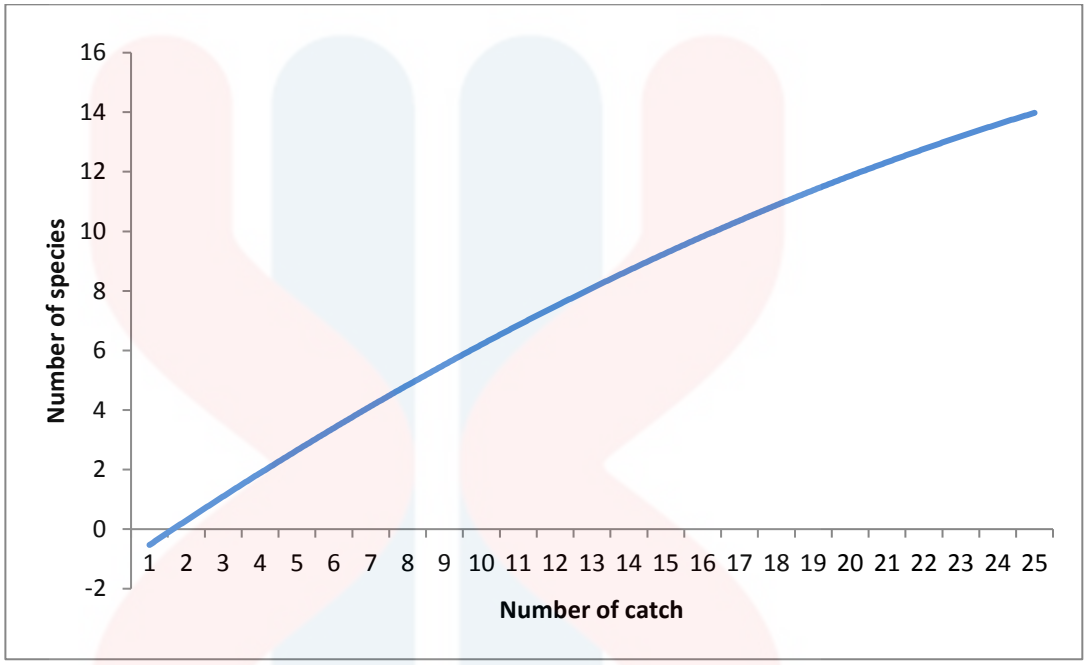
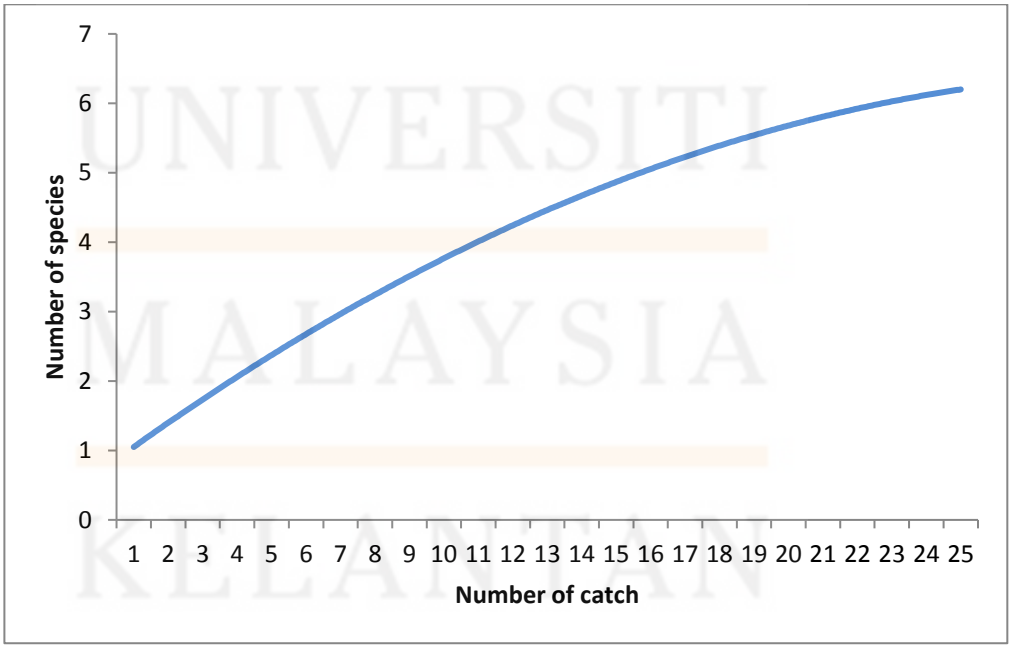



Figure 4.2 Species Accumulation Curves for Disturbed Area in Tumpat Delta.



For the mollusca size in disturbed and undisturbed area was shown in Table 4.3. The biggest species between disturbed and undisturbed area was *Telescopium telescopium* species which is 7.62cm and 6.85cm . Meanwhile, the smallest species is *Cerithidea cingulata* species which is 1.56cm and 1.6cm for both area of Tumpat Delta. The differences of molluscs species sizes were depended on their growth rate between individuals of the same species that occupied in different areas.

Table 4.3 Mollusca size between undisturbed and disturbed area in Tumpat Delta, Kelantan.

| SCIENTIFIC NAME | DISTURBED AREA (CM) | UNDISTURBED AREA (CM) |
|---|---|---|
| *Faunus ater* | 5.76 | 5.89 |
| *Cerithidea cingulata* | 1.6 | 1.56 |
| *Saccostrea cucullata* | 4.27 | null |
| *Telescopium telescopium* | 7.62 | 6.85 |
| *Polymesoda expansa* | 4.74 | 5.38 |
| *Cerithidea obtusa* | 3.53 | 2.97 |
| *Mactra corallina* | null | 2.76 |
| *Lutraria lutraria* | null | 3.54 |
| *Anadara fultoni* | null | 2.74 |
| *Ellobium aurisjuddae* | null | 2.62 |
| *Natica tigrina* | null | 2.34 |
| *Cassidula aurisfelis* | null | 0.87 |
| *Littoraria carinifera* | null | 1.82 |
| *Cassidula nucleus* | null | 1.75 |

This also can be attributed to adaptations of different environmental conditions, include the food quantity and quality. In addition, the variation in shell length between conspecifics inhabiting environments with food different food availability and it also has been observed in several gastropods species, such as Potamopyrgus jenkinsi (Dorgelo & Leonards,2001). It means that for disturbed and undisturbed area have a different of surrounding ecosystems. Then, for the disturbed area were having more of food suppliers in higher quality than undisturbed area.

In addition, the molluscs size in disturbed and undisturbed area were already measured by using the t-test in statistical analysis. In the particular result, the value of differences size are not signicant for molluscs species in disturbed and undisturbed area. However, this results show that the mangrove ecosystems area neither disturbed and undisturbed area were not effecting the value size of molluscs species. This maybe the density in disturbed and undisturbed area were similar.

In previous study, by having the higher population densities also effect the growth rate and maximum rate size of gastropods. The intraspecific competition for food or space between individuals of gastropods species may reduce their grow rates (Lafferty, 1993). Many studies have shown how unregulated harvesting and habitat degradation can threaten the molluscan population (Jontila et al., 2014). Besides, to ensure a sustainable supply of harvestable stocks the harvest regulation on specific size of clam and snail to exclude juveniles is needed.

# CHAPTER 5

# CONCLUSION AND RECOMMENDATIONS

## 5.1 CONCLUSION

From this study, there were 14 number of mollusca species found and 5 species were from Bivalve class and 9 species from Gastropods classes. Furthermore, mostly species was obtained comes from Gastropods classes. Most number of Bivalves belonged to the Mactridae family while Gastropods determined were from Potamididae and Melampidae family. In mangrove ecosystems for disturbed and undisturbed area were successfully determined using the various indices calculation which is Shannon-Weiner Diversity Index, Pielou's Evenness Index, Margalef's Diversity Index and Species Accumulation Curve. For Shannon-Weiner Diversity Index and Margalef's Diversity Index was higher at undisturbed area and Pielou's Evenness Index as higher at disturbed area in mangrove ecosystem of Tumpat Delta. In each diversity calculations it can be concluded that the undisturbed area have a higher ecosystems diversity compared to the disturbed area in Tumpat Kelantan. Besides, both area was not well distributed due to their value that closest at the lower range. The species accumulation curve also shows that the curves already reach sufficient species in Tumpat Delta ecosystems after the curve become flat continuously.

## 5.2 RECOMMENDATIONS

In order to complete this study, there were several limitation that need of considerations. The time of data collection must follow the tide schedule. Otherwise, boat cannot reach the specific area and data will not collect successfully. This is because to maintain the number of diversity results become more accurate and detail. In addition, it is suggested that more study should be conducted in this area in the future. Besides, long time monitoring is necessarily in order to monitor the data sampling in mangrove forest. Meanwhile, these study can be improved by add more data analysis calculations to get specific information in details and varying the research in effective ways. Hence, it is necessary to document the biodiversity of molluscs in the study area. The awareness programs need to be introduced to the local communities with the aim to set up the importance of molluscs species conservation and sustainable their utilization species in future.

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