Faculty of Resource Science and Technology

PRELIMINARY STUDY ON SEAWEED COMMUNITY FROM AN INTERTIDAL AREA OF TELOK SERABANG, SEMATAN, SARAWAK

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Bachelor of Science with Honours

(Aquatic Resource Science and Management)

2022

DECLARATION

This project is submitted of the requirement for the degree of Bachelor of Aquatic Resource Science and Management with Honours for Faculty of Resource Science and Technology, University Malaysia Sarawak. I declared that this report is made by my own work except for the information that is taken from some resources as references.

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ACKNOWLEDGEMENT

Thanks be to God for giving me mental strength throughout the completion of this thesis. First and foremost, I want to thank me for believing in me, for doing all this hard work and never quitting. A million thanks to my supervisor, Ts. Mohd Nasarudin Harith, for the invaluable advice, continuous support, and patience from the very beginning to the very end. Also, to Mdm Nuriddan Abdul Han (expert referral) for her immense knowledge and plentiful experience have helped me during my academic research. I would also like to express my gratitude to my beloved mother, Mdm. Lucy, who always prayed for my success and my siblings, Mr. Stallone, Ms. Alexandra, Ms. Eunice, and Mr. Joshua for providing me with limitless moral and financial support. I would like to thank all the FRST staff members that involved directly or indirectly in this study. It is their kind help and support that have made my study and life in the UNIMAS a wonderful time. Finally, to all my friends, without their tremendous understanding and encouragement, it would be impossible for me to complete my study.

Preliminary Study on Seaweed Community from an Intertidal area of Telok Serabang, Sematan, Sarawak

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ABSTRACT

Previously, several seaweed studies have been conducted in Sarawak, but there is still inadequate data of seaweed study in Telok Serabang. In order to address the lack of seaweed information in this area, an assessment of seaweed community from an intertidal environment was conducted at Telok Serabang, Sematan, Sarawak. Six stations along beach were selected to collect seaweed samples. On the basis of morphological characteristics, five genera namely genera *Gracilaria, Padina, Acanthophora, Udotea,* and *Cladophoropsis* were identified. During the entire study period, the Rhodophyta division had the highest percentage (50%) of species composition, with Chlorophyta (33%) and Phaeophyta (17%). Six stations in the intertidal zones of Telok Serabang were selected to collect physicochemical parameter. The temperature of the water ranged from 33.3°C to 40.0°C. The pH ranged from 7.60 to 8.21, and the dissolved oxygen (DO) concentration ranged from 4.0 to 8.2 mg/L. The correlation of pH (r= 0.4996) and DO (r = 0.5889) showes a positive relationship with species diversity, indicating that these factors are important for seaweed growth. As a result, this research could be used in the future to study the composition pattern and seaweed population in the intertidal area of Telok Serabang, Sematan, Sarawak.

Key words: seaweed community, intertidal, morphological characteristics, physicochemical parameter.

ABSTRAK

Sebelum ini, beberapa kajian rumpai laut telah dijalankan di Sarawak, tetapi masih terdapat data kajian rumpai laut yang tidak mencukupi di Telok Serabang. Bagi menangani kekurangan maklumat rumpai laut di kawasan ini, penilaian komuniti rumpai laut dari persekitaran intertidal telah dijalankan di Telok Serabang, Sematan, Sarawak. Enam stesen di sepanjang pantai telah dipilih untuk mengumpul sampel rumpai laut. Berdasarkan ciri-ciri morfologi, lima genera iaitu genera Gracilaria, Padina, Acanthophora, Udotea, dan Cladophoropsis telah dikenalpasti. Sepanjang tempoh kajian, bahagian Rhodophyta mempunyai peratusan tertinggi (50%) komposisi spesies, dengan Chlorophyta (33%) dan Phaeophyta (17%). Enam stesen di zon intertidal Telok Serabang telah dipilih untuk mengumpul parameter fizikokimia. Suhu air berkisar antara 33.3 ° C hingga 40.0 ° C. pH berkisar antara 7.60 hingga 8.21, dan kepekatan oksigen terlarut (DO) berkisar antara 4.0 hingga 8.2 mg / L. Hubungan pH (r = 0.4996) dan DO (r = 0.5889) menunjukkan hubungan positif dengan kepelbagaian spesies, menunjukkan bahawa faktor-faktor ini penting untuk pertumbuhan rumpai laut. Hasilnya, penyelidikan ini boleh digunakan pada masa akan datang untuk mengkaji corak komposisi dan populasi rumpai laut di kawasan intertidal Telok Serabang, Sematan, Sarawak.

***Kata kunci**: populasi rumpai laut, intertidal, ciri morfologi, parameter fizikokimia.*

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DO	Dissolved oxygen
GPS	Global Positioning System
ANOVA	Analysis of Variance
PPT	Part per thousand

1.0 INTRODUCTION

Sarawak is Malaysia's largest state, covering an area of 124,449.51 km^2, and is located in the western region of Borneo Island (Osman, 2009). Sarawak has an equatorial climate. The temperature is relatively uniform throughout the year - within the range of 23°C early in the morning to 32°C during the day. The coasts of Sarawak have a large tidal range of up to 6 meters. The coastal waters are enriched by nutrients from the land and are home to a wide variety of flora and fauna.

Seaweeds contain a high concentration of marine algae, which are abundant along rocky coasts and subjected to tides and waves. Seaweeds and seagrasses are important components of the marine coastal food web and contribute significantly to nutrient cycling processes. They also serve as a physical framework for the various species assemblages (Koch *et al*. 2013; Leopardas *et al*. 2014). Chlorophyta (green algae), Rhodophyta (red algae), and Phaeophyta (brown algae) are the three groups of macro-autotrophs (Koch *et al*., 2013).

Seaweeds contains a number of pigments, such as chlorophylls, carotenoids, and other accessory pigments, which allow it to synthesize organic compounds from simple molecules such as water and carbon dioxide using sunlight as an energy source. Seaweed occupied a variety of habitats namely mangroves, coral reefs, lagoons and rocky shores (Phang, 2006; Harley *et al*., 2012). Naturally, greater diversity of seaweeds is found in the intertidal zone even though fluctuations in salinity, high light intensity, temperature and extreme exposure to dryness at low tides (Martínez *et al*., 2012) characterize this zone as the most stressful habitat (Scrosati & Heaven, 2008a, 2008b; Little *et al*., 2009; Fakoya *et al*., 2011).

Previously, several seaweed studies have been conducted in Sarawak, but there is still inadequate data of seaweed study in Telok Serabang. In order to address the lack of seaweed information in this area, an assessment of seaweed community from an intertidal environment was conducted at Telok Serabang, Sematan, Sarawak. The distribution and abundance of seaweeds, as well as the influence of selected environmental factors on seaweed distribution in this area, were investigated during this study. As a result, this research could be used in the future to study the composition pattern and seaweed population in the intertidal area of Telok Serabang, Sematan, Sarawak.

The primary goals of this study are,

- To assess the composition and diversity of seaweeds in Telok Serabang's intertidal zones.
- To quantify the abundance of seaweeds in Telok Serabang's intertidal zone.

2.0 LITERATURE REVIEW

2.1 What is seaweed?

Marine macroalgae, also known as seaweeds, are macrobenthic forms of marine algae found in the intertidal and shallow subtidal zones. The term seaweed, according to the National Oceanic and Atmospheric Administration (NOAA, 2021), refers to a variety of marine plants and algae that grow in the ocean as well as rivers, lakes, and other bodies of water. It is also one of the photosynthetic organisms occurring in most habitats. It's possessing different type of pigment such as chlorophylls, carotenoids, and other accessory pigment which enable them to synthesize organic compound from simple compound such as water and carbon dioxide in the presence of light as source of energy (Marzuki, 2015). According to Guiry and Guiry (2011), seaweed can be distinguished by their pigments.

2.2 Morphological classification of seaweeds

According to Abbott and Dawson (1978), the vast majority of seaweeds are classified as green algae (Chlorophyta), brown algae (Phaeophyta), and red algae (Rhodophyta), and are technically differentiated by the chemistry of their pigment. Litter *et al*. (1989) supports this conclusion by stating that green, brown, and red algae are named after the major photosynthetic pigments. The vast majority of seaweed is multicellular in nature. It is common for multicellular algae to grow vertically away from the substrate. This practise brings them closer to the light, allowing them to grow large without competing for space and harvesting nutrients from a larger volume of water.

2.2.1 Chlorophyta

Chlorophyta, also known as green algae, includes a diverse range of morphological types, from simple unicells to highly complex multicellular formations. Green algae, according to Wells (2010), have delicate morphology and turn brown when decomposed. Because the pigments in these plants are similar to those in other plants, they are frequently green in colour. Chlorophyta possess chlorophylls *a* and *b*, β- and γ-carotene, and several xantophylls as accessory pigments (Barsanti and Gualtieri, 2014). Green seaweed has the second most taxa in Malaysian waters and most abundant in shallow tropical waters (Phang, 2006).

2.2.2 Rhodophyta

There are approximately 10,000 species of red algae known. Rhodophyta, or red algae, have a distinct red colour due to the presence of phycoerythrins and phycocyanins, which mask the chlorophyl-a and carotenoids (Teo & Wee. 1983). According to Abbott and Dawson (1978), distinguishing this type of algae is difficult because many of them are green, brown, purple, or even black in nature. They can be found in intertidal, subtidal, and deep waters (Dhalkar & Kavlekar, 2004). This plant contains chlorophyll *a*, chlorophyll *b*, chlorophyll *c*, phycoerythrins, phycocyanins, and carotenoids (Ahmad, 1995).

2.2.3 Phaeophyta

Macroscopic seaweeds make up the vast majority of Phaeophyta (brown algae) members. They have a more complex morphology than other algae (Moris, 1988). Fucoxanthin, a carotenoid pigment, is responsible for the brown or yellow brown colour of the Phaeophyta. The most important photosynthetic pigments are chlorophylls *a*, *c*, β-carotene, violaxanthin, and diatoxanthin. Cell walls are composed of cellulose, alginic acid, and sulphated polysaccharides in varying proportions depending on species and environmental conditions (Mackie & Preston, 1974). Freshwater ecosystems support less than 1% of all known species. Several species can be found in saltmarsh and estuarine habitats. The presence of large unilocular sporangia or clusters of plurilocular sporangia can identify almost all freshwater species (John, 2002). Phaeophyta is divided into four orders, each with five families, twelve genera, and twenty-seven species (Ahmad, 1995).

2.3 Growth and Tolerance

The ecology and physiology of seaweeds are heavily influenced by intertidal water movement (Barr *et al.*, 2008). Extreme water movement also has a negative impact on seaweed detachment or destruction (Lobban & Harrison, 1994). Water mobility, on the other hand, can limit growth by limiting the supply of macronutrients such as phosphorus and nitrogen (Hurd, 2000).

Many intertidal seaweeds have a gradient form of upright thallus and lateral branches to improve photosynthesis performance (Taylor & Hay, 1984). Seaweeds live in the lower intertidal zone, where they are more or less shaded and have a high growth performance in low photon irradiance (Hardy & Guiry, 2003). Intertidal seaweeds, like other plants and animals, have physical stress adaptations because organisms must withstand desiccation, osmotic stress, temperature stress, and UV radiation to survive within the zone (Rawlings, 1999).

The intertidal zone of rocky coasts is typically dominated by a dense population of macro algae with distinct vertical distribution patterns (Davison & Pearson, 1996). Furthermore, organisms found on the rocky beach are much smaller than those found in subtidal and terrestrial environments (Wolcott, 2007). This is because large people are more likely to be harmed by wave action.

Previous research claimed that Phaeophyta dominated the intertidal zone, with Rhodophyta being the least abundant. This is because Rhodophyta species can absorb light at low intensities and thus can withstand limited sunlight. The high diversity of seaweeds can be attributed to habitat heterogeneity, which created suitable niches for seaweed colonisation (Esa *et al*., 2013).

2.4 Importance of seaweeds

Seaweeds have a variety of uses, including human and animal food, soil fertiliser, colloid production, cosmetics, and pharmaceuticals (Krishnaiah *et al*., 2008). Colloids include agar, alginates, and carrageenan. According to Dhargalkar and Velvecar (2008), edible seaweeds were low in calories and lipids but high in protein, minerals, and vitamins. Red and brown algae are commonly used in the production of edible seaweeds (Dawczynski *et al*., 2006).

In addition, seaweeds are frequently used as biomonitors to study environmental contamination (Caliceti *et al*., 2002). Biosorption with seaweeds for agricultural and fishery industries has shown remarkable promise as a treatment for heavy metal contaminated wastewater (Ghimire *et al*, 2007). Because they contain polysaccharide, which has an excellent metal binding capacity, brown seaweeds have the potential to be used for heavy metal biosorption (Senthilkumar *et al*., 2007). According to a study conducted by Neori *et al*. (1996), seaweeds can also be used as alternative biofilters to maintain water quality in land-based mariculture. Seaweed filtration increased aquaculture efficiency and productivity by improving culture conditions (Cahill *et al*., 2010).

3.0 MATERIALS AND METHODS

3.1 Study site

The study was carried out on intertidal area of Telok Serabang, Sematan, Sarawak (Figure 1). For this project, 6 stations were chosen, with a transect line laid for each (Figure 1). The brief information of each location and Global Positioning System (GPS) coordinates were stated in Table 1. Transect line and quadrat technique was implemented for collecting the seaweeds following methods by Dhargalkar and Kavlekar (2004), Uddin *et al*. (2007) and Wong *et al*. (2012).

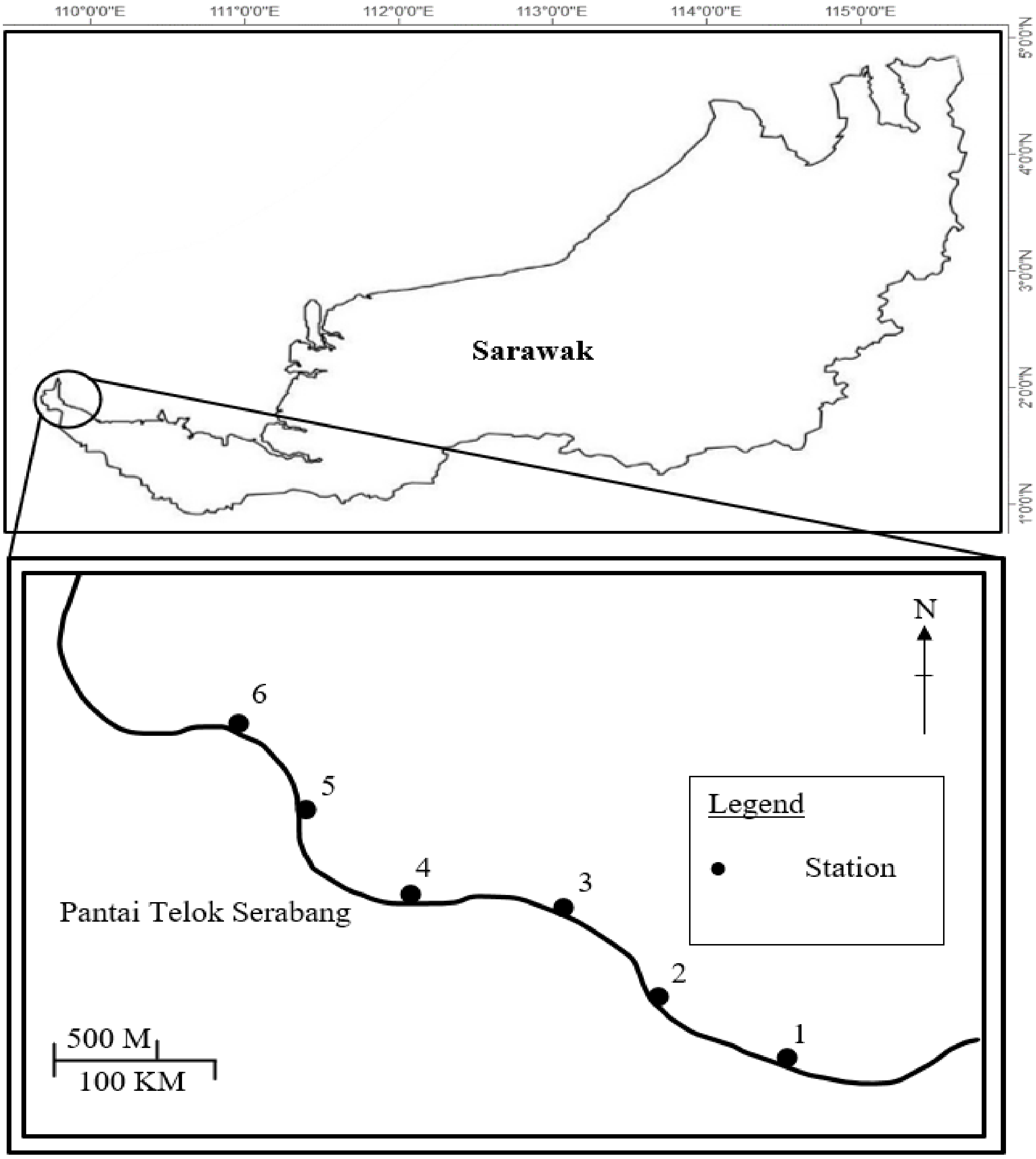

Figure 1: Study site location and stations.

Table 1: Global Positioning System (GPS) coordinates and brief description of sampling stations.

Station	GPS Coordinate	Location description
1	01° 58'40.1'' N 109° 38' 95.8'' E	Rocky shore with intertidal zone of less than 200 m.
2	01° 58'44.9'' N 109° 38'47.8'' E	Sandy beach and rocky shore with intertidal zone of less than 200 m.
3	01° 58'43.7'' N 109° 38'51.9'' E	Muddy and rocky shore (rubble rocks), intertidal zone approximately 200 m.
4	01° 58'43.3'' N 109° 38'51.4'' E	Sandy beach and rocky shore with intertidal zone of more than 200 m.
5	01° 58'43.0'' N 109° 38'50.1'' E	Sandy beach and rocky shore with intertidal zone of more than 200 m.
6	01° 58'43.7'' N 109° 38'48.4'' E	Sandy beach with intertidal zone of more than 200 m.

3.2 Sample collection

A transect line was laid perpendicular from high tide the low tide, a quadrate then was placed at the sampling points in 10 meters apart randomly (Figure 2). The samples within the quadrate were collected using a scalpel. To identify seaweeds, the entire thallus (Figure 3) must be removed from the substrate. Other details about the sample, such as its location, physical characteristics of seaweeds was recorded. The data were obtained for quantitative assessment of abundance.

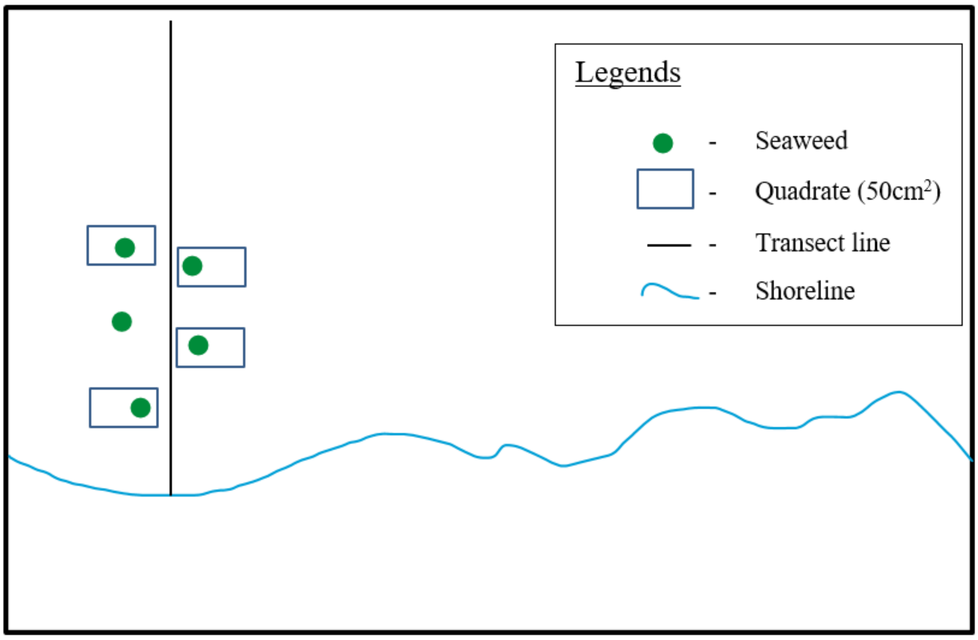

Figure 2: Illustration of transect and quadrat placement.

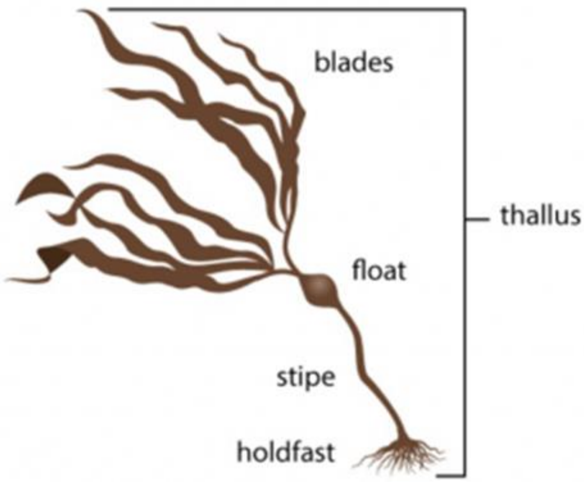

Figure 3: Parts of thallus (Byron Inouye)

3.3 Preservation of seaweed

Dhargalkar and Kavlekar (2004) recommended using 4% formalin for wet preservation. Before preserving seaweeds, foreign materials such as sand particles, soil, or epiphytes were removed. In the field, samples were wrapped and tied together in bundles according to stations and placed in a polythene bag.

For dry preservation to prepare herbarium, fresh seaweeds specimen was cleaned from sand particles, rocks, shells, mud and other adhering materials and epiphytes (Dhargalkar and Kavlekar, 2004). All collected specimens were labelled, and photos of the samples, as well as the location, date, substrate, and colour, were taken.

3.4 Seaweed identification

Seaweed identification were based on taxonomic references from Teo & Wee (1983), Littler *et al.* (1989), Ahmad (1995), Dhargalkar and Kavlekar (2004), Nurridan (2007) and Wells (2010). The morphology of size, form, branch of thallus, and type of hold fast, according to Uddin *et al.* (2007), are the significant characters for identification. Flagella, according to Ahmad (1995), is one of the characteristics for identification (number, type and insertion).

3.5 Quantitative assessment of abundance

A statistical consideration was quantitative assessment of abundance, which includes density, frequency, species richness and species diversity (Dhargalkar and Kavlekar, 2004). Statistical considerations were used to create a more realistic picture of seaweed dynamics and structure.

3.5.1 Density

The density was calculated by adding the number of individuals of each species to the total area sampled. Dhargalkar and Kavlekar (2004) stated the formula for the calculation.

$$D = n/A$$

Where; **D** = density

n = total number of individuals of the species

A = total area sampled

3.5.2 Frequency

The frequency was the number of samples in which the species occurred divided by the total number of samples taken (Dhargalkar and Kavlekar, 2004).

$$F = j/k$$

Where; **F** = frequency

j = number of samples in which species occur

K = total number of samples

3.5.3 Species Richness

Molur and Singh (2009) proposed the Margalef's richness index to calculate species richness (S).

$$DMg = S-1/\ln N$$

Where; **S** = total number of species

N = the total number of individuals of all species

3.5.4 Species Diversity

The number of species and the relative abundance of individuals within each species are used to calculate species diversity. The Shannon-Weiner Index were used, as suggested by Molur and Singh (2009).

$$\mathbf{H' = - \sum(Pi)\ (log2\ Pi)}$$

Where;

H = Shannon-Weiner Index of species Diversity

I = i^{th} species

Pi = proportion of i^{th} species calculated as; total no. of individuals of species 'i' / total no. individuals of all species.

3.5.5 Species Evenness

Species evenness measures the variation in the abundance of individuals per species within a community (McGinley, 2008). Molur and Singh's (2009) Pielou's index of evenness (J') was used to calculate the species evenness.

$$\mathbf{J' = H'/ \ln S}$$

Where;

H' = Shannon-Weiner diversity index

S = total number of species

3.5.6 Statistical analyses

One way ANOVA and correlation tests were used in Microsoft Excel to determine the significance difference of quantitative assessment of abundance and the relationship between seaweed diversity and environmental parameters. All tests were statistically significant at the p-level of 0.05.

3.6 Selected *In-situ* Water Quality Parameters

Measurements of water quality parameters were done before the time of low tide as in the tide tables. Water quality parameters namely temperature, turbidity, pH, dissolved oxygen (DO) and salinity was measured and recorded. The measurements were done in triplicates. The pH water and temperature of the water was measured using a pH meter (EXTECH, SDL 100), dissolved oxygen meter (EXTECH, DO 210). Salinity reading was determined using a refractometer, and turbidity was determined using turbidity meter (EXTECH, TB 400).

4.0 RESULT

4.1 Species composition

Telok Serabang intertidal area is dominated mostly by division Rhodophyta (50%), followed by division Chlorophyta (33%), and finally by division Phaeophyta (17%). Five genera were recorded by all sampling stations. Six species from five genera have been identified, including two from *Gracilaria* and one each from *Udotea*, *Cladophoropsis*, *Acanthophora*, and *Padina*.

Gracilaria had two species (84% of *Gracilaria* sp. and 4% of *Gracilaria arcuata*), *Acanthophora* had one (1% of *Acanthophora* sp.), *Udotea* had one (3% of *Udotea flabellum*), *Cladophoropsis* had one (1% of *Cladophoropsis* sp.), and Padina had one (7% of *Padina minor*).

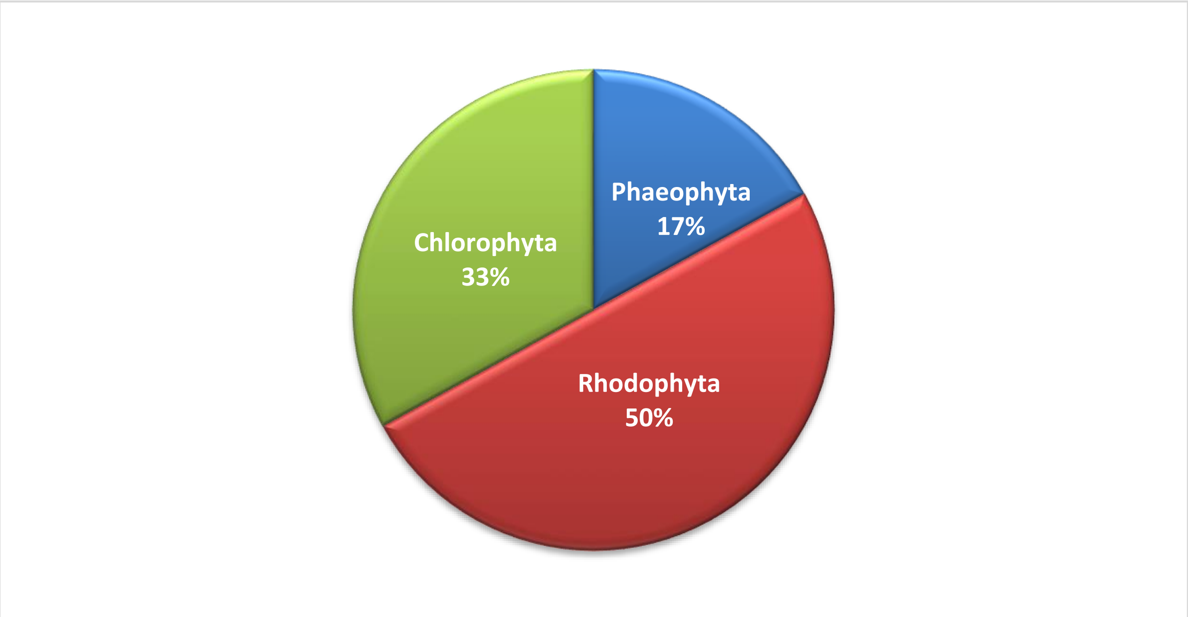

Figure 4: Percentage cover based on seaweed division

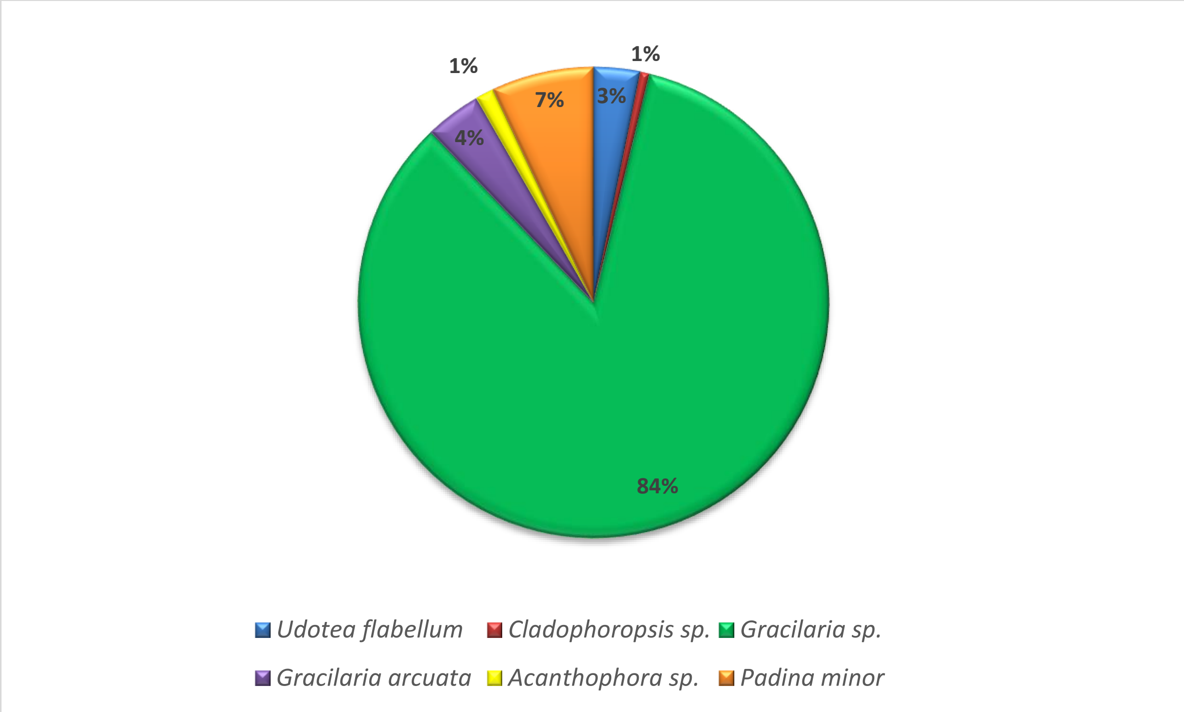

Figure 5: Percentage cover based on total number of individuals of all species

Table 2: Presence (+) of species and total number of species per station and (-) indicate absence.

Division	**Species**	**Station**					
		1	2	3	4	5	6
Chlorophyta	*Udotea flabellum*	-	-	-	-	+	-
	Cladophoropsis sp.	-	-	+	-	-	-
Rhodophyta	*Gracilaria sp.*	+	+	+	+	+	-
	Gracilaria Arcuata	+	-	-	-	-	-
	Acanthophora sp.	-	-	+	-	-	-
Phaeophyta	*Padina Minor*	+	-	+	-	-	-
	Number of species	3	1	4	1	2	0

Gracilaria sp. (Figure 7a) was found the best represented species, as it were present in five stations from a total of six sampling stations. The least represented species are *Udotea flabellum* (Figure 6a) which only found in station 5, *Cladophoropsis* sp. (Figure 6b) found in station 3, *Gracilaria arcuata* (Figure 7b) only found in station 1, and *Acanthophora* sp. (Figure 7c) which was only found in station 3.