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Seaweed Composition from Bintulu Coast of Sarawak, Malaysia

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Abstract: Species composition of seaweed and distribution were investigated in the coastal waters of Bintulu, Sarawak. The seaweed samples were collected during low tide between May 2011 and May 2012 from the six different stations. In total 54 species of seaweeds were identified from study areas of Bintulu coastal waters. Among them, 23 species were from Rhodophyta with 11 families, 15 species were from Phaeophyta with 2 families and 16 species were from Chlorophyta with 10 families. Seventeen species of seaweeds were recorded from the Tanjung Batu, while 23 species from Pantai Telekom, 14 species from Golden Beach, 26 species from Kuala Similajau, 12 species from Kuala Nyalau and 21 species from Batu Mandi. Seaweeds abundance was high in rocky substrate and Rhodophyta (11 families and 23 species) was the common and highest group of seaweeds in this coastal areas. Present study recorded high diversified seaweed species at the rocky shore area compare to reef area.

Key words: Seaweed, rocky shore, reef area, rhodophyta, chlorophyta, phaeophyta

INTRODUCTION

Marine macro algae or (seaweeds) are taxonomically can be classified under main group namely green algae (Chlorophyta), brown algae (Phaeophyta) and red algae (Rhodophyta). Malaysia has extensively total coastline 4675 km where Sarawak covered approximately 1035 km length at the Borneo Island east of Malaysia. As Sarawak coastline surrounded by coral reefs, rocky shores, sandy area, mudflats and mangroves with high humidity and rich of organic matter tends to seaweeds growth and inhabits a variety of these substratum along the coastline. Most seaweeds tend to growth well at the protected area and some are limited distribute depends on the ability of adaptation in the different marine coastline environment, high temperature, heavy rainfall, large tidal range and high wave-exposed along coastlines (FRC, 2000).

As Malaysia, earlier report for seaweed status was in 1991 and been updated 1998. From the earlier report until recent survey on Malaysian marine algae (1991-2006) recorded the tally of 373 species (Phang, 2006). Nurridan (2004) recorded 19 species of seaweed from Pulau Layang Layang, Sabah and a total of 66 taxa of marine algae checklist from Phang *et al.* (2008) at Perak Island, Jarak Island and the Sembilan Group of Island in the Straits of Malacca. Phang *et al.* (2005) also reported a total 84 taxa of seaweed from the Langkawi Island. In recent years, studies on the distribution and biology of seaweed in Sarawak especially at Bintulu coastal areas have been discovered by few studies (FRC, 2000; Harah *et al.*, 2006, 2007; Wong *et al.*, 2008) and the recent recorded is 35 species of seaweed. Most of the publications on the seaweed around Bintulu coastal water come from rocky shore study areas and not included reef areas. Hence, the present study was conducted from both location of rocky beaches and reef area for checklist the current update of seaweed species around Bintulu coastal water and there might be more seaweed species that have not been reported.

MATERIALS AND METHODS

Sampling areas: Sampling was conducted at rocky shore areas of Pantai Tanjung Batu (N 03°12.705′E 113°02.832′), Pantai Telekom (N 03°18.914′ E 113°06.934′), Kuala Similajau (N 03°32.451′ E 113°17.783′), Kuala Nyalau (N 03°37.990′ E 113°22.298′) and Golden Beach, Similajau National Park (N 03°25.075′ E 113°11.797′) with one fringing reef area of Batu Mandi, Similajau National Park (N 03°21.941′ E 113°07.952′) which located at Bintulu coastal regions (Fig. 1).

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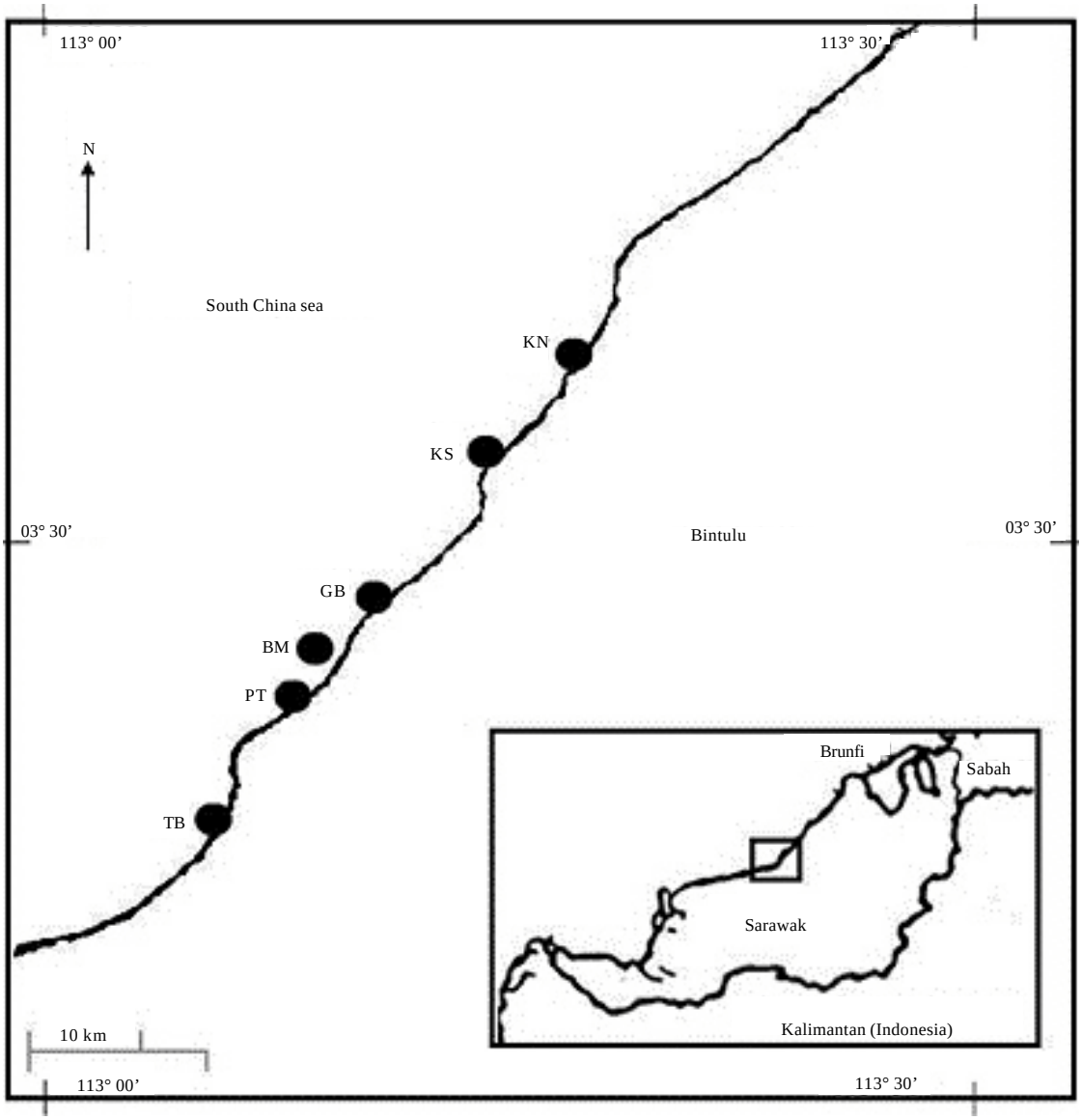

Fig. 1: Map of the sampling sites, TB: Tanjung Batu, PT: Pantai Telekom, BM: Batu Mandi, Similajau National Park, GB: Golden Beach, Similajau National Park, KS: Kuala Similajau and KN: Kuala Nyalau

Sampling technique: Samples were collected during low tide between May 2011 and May 2012 and sampling time based on the tide schedule as described by Rigby *et al.* (2007a, b). Transect line with 30 m long was laid on the rocky shore from the low tide to the high tide area except for Batu Mandi area, which scuba technique has been used to collect the sample during high tide. The 50×50 cm quadrat has been placed at each 10 m on the rocky shore contour for further measurement at the field. Three replicates for transect are chosen randomly along the rocky shore contour. A total of 15 min have been spending for each quadrat for species coverage assessment on the rocky shore area and 30 min for underwater assessment.

Morphological identification: All samples were collected, recorded and kept in zip lock bag for samples identification in the laboratory. All samples collected entire thallus (fronds, stems and holdfasts) and transport to the laboratory for further identification based on the physical morphological characteristic and microscopic structure. The work and identification of seaweed by

Ismail (1995), Coppejans *et al.* (1997), Trono (1998), Nurridan (2004) and Tsutsui *et al.* (2005) were followed. Samples were label, photos and preserved with 10% of formalin for further identification and collection of fresh samples.

RESULTS AND DISCUSSION

A total number of 54 species of seaweed was identified from six different study areas of Bintulu coastal water (Fig. 2); in which 23 species were from Rhodophyta with 11 families, 15 species were from Phaeophyta with 2 families, 16 species were from Chlorophyta with 10 families (Table 1). In this present study, 17 species of seaweed were recorded from Tanjung Batu, 23 species from Pantai Telekom, 14 species from Golden Beach, 26 species from Kuala Similajau, 12 species from Kuala Nyalau and 21 species from Batu Mandi. Rhodophyta division is the largest species can be found compare from Chlorophyta and Phaeophyta.

Previously, FRC (2000) had recorded 31 species (10 Chlorophyta, 5 Phaeophyta and 16 Rhodophyta) of seaweed in Bintulu area, while Harah *et al.* (2006) reported 35 species of seaweed in the coral fragment and rocky shore of Similajau National Park (10 Chlorophyta, 6 Phaeophyta and 19 Rhodophyta). In addition, a total of 35 species (12 Chlorophyta, 8 Phaeophyta and 15 Rhodophyta) of seaweed was also recorded from the rocky shore of Bintulu, Sarawak by Harah *et al.* (2007). Whilst Wong *et al.* (2008) recorded 35 species of seaweed (12 Chlorophyta, 5 Phaeophyta and 18 Rhodophyta) from rocky area of Bintulu. The number of seaweeds recorded was higher in this present study.

Seaweed abundance was high in rocky substrate and Rhodophyta (11 families and 23 species) was the common and highest group of seaweed in this coastal area. In contrast, Wong *et al.* (2008) recorded 9 common species of seaweed from the coastal area of Bintulu, which are mostly come from the family Rhodomelaceae (*Cladophora prolifera*, *Ulva intestinalis*, *Padina minor*, *Sargassum* sp., *Gracilaria salicornia*, *Hydropuntia edulis*, *Acanthophora spicifera*, *Laurencia papillosa* and *Laurencia* sp.). The highest diversity of Rhodophyta algae was observed from Langkawi Island by Phang *et al.* (2005) recorded 84 species of seaweed and high abundance from Rhodophyta with 62 species. In addition, Phang *et al.* (2008) reported most abundance of Rhodophyta with 39 taxa from 66 taxa of marine algae recorded at Perak Island, Jarak Island, Sembilan Group of Island in the

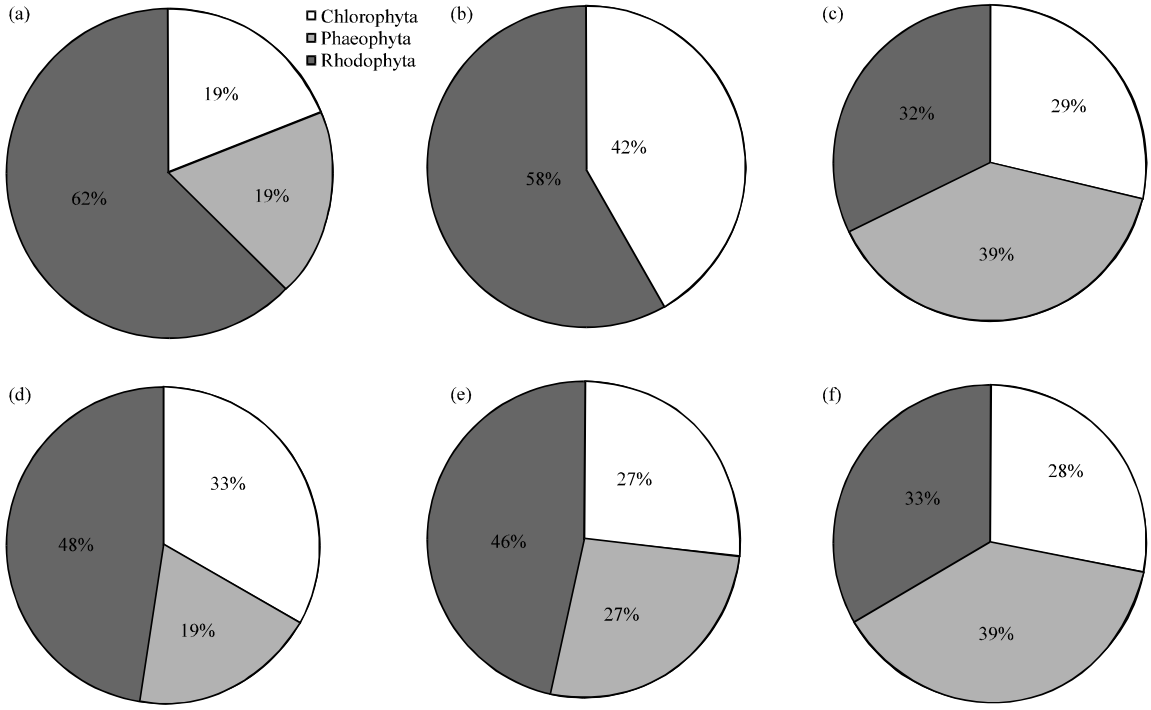

Fig. 2(a-f): Percentage of seaweed abundance from the six sampling sites around Bintulu coastal waters, (a) Tanjung Batu, (b) Kuala Nyalau, (c) Kuala Similajau, (d) Pantai Telekom, (e) Golden Beach and (f) Batu Mandi

Table 1: Species of seaweed recorded from Bintulu coastal waters

Division/family	Species
Chlorophyta	
Anadyomenaceae	*Anadyomene plicata* C. Agardh
Boodleaceae	*Boodlea composita* (Harvey) Brand
Bryopsidaceae	*Bryopsis hypnoides* Lamouroux
	Bryopsis sp.
Caulerpaceae	*Caulerpa sertularioides* (S.G.Gmelin) M.A.Howe
	Caulerpa racemosa var. *peltata* (Lamouroux) Eubank
Cladophoraceae	*Chaetomorpha antennina* (Bory) Kutzing
	Chaetomorpha sp.
	Cladophora sp.
Polyphysaceae	*Acetabularia major* G. Martens
Siphonocladaceae	*Cladophoropsis* sp.
Udoteaceae	*Avrainvillea erecta* (Berkeley) A. et E. S. Gepp
	Avrainvillea obscura (C. Agardh) J. Agardh
Ulvaceae	*Ulva intestinalis* Linnaeus
	Ulva lactnca Linnaeus
Valoniaceae	*Valonia aegagropila* C. Agardh
Phaeophyta	
Dictyotaceae	*Dictyopteris jamaicensis* Taylor
	Dictyopteris sp.
	Dictyota dentata Lamouroux
	Dictyota dichotoma (Hudson) Lamouroux
	Dictyota mertensii (Martius) Kutzing
	Dictyota submaritima Va Pham-Hoang
	Dictyota sp.
	Lobophora variegata (J.V. Lamouroux) Womersly
	Padina australis Hauck
	Padina boryaua Thivy
	Padina minor Yamada
	Padina tetrastromatica Hauck
	Spatoglossum vietnamense Pham
	Hormophysa cuneiformis (J. F. Gmelin) P. C. Silva
Sargassaceae	*Sargassum* sp.
Rhodophyta	
Ceramiaceae	*Centroceras clavulatum* (C. Agardh) Montagne
Corallinaceae	*Amphiroa fragilissima* (Linnaeus) Lamouroux
Galaxauraceae	*Galaxaura oblongata* (Ellis and Solander) Lamouroux
Gelidiellaceae	*Gelidiella acerosa* (Forsskal) Feldmann and G. Hamel
Gracilariaceae	*Gracilaria salicornia* (C. Agardh) Dawson
	Hydropnntia edulis (Gmelin) Gurgel et Fredericq
Halymeniaceae	*Halymenia dilatata* Zanardini
	Halymenia durvillei Bory de Saint-Vincent
	Halymenia floresii (Clemente) C. Agardh
	Halymenia maculata J. Agardh
Hypneaceae	*Halymenia* sp.
	Hypnea cervicornis J. Agardh
	Hypnea spicifera (Suhr) Harvey
Phyllophoraceae	*Ahnfeltiopsis* sp.
Rhodomelaceae	*Acanthophora spicifera* (Vahl) Borgesen
	Bostrychia tenella (Lamouroux) J. Agardh
	Laurencia cartilaginea Yamada
	Laurencia papillosa (C. Agardh) Greville
	Laurencia similis Nam et Saito
	Laurencia sp.
	Tolypiocladia glomerulata (C. Agardh) F. Schmitz
Scinaiaceae	*Scinaia furcellata* (Turner) J. Agardh
Solieriaceae	*Solieria* sp.

Table 2: Comparison of seaweed species among the different stations of the Bintulu coastal waters

	Location					
Species	TB	PT	GB	KS	KN	BM
Anadyomene plicata	-	+	-	+	-	-
Boodlea composita	-	-	-	-	-	+
Bryopsis hypnoides	-	+	-	+	-	-
Bryopsis sp.	-	-	-	+	+	-
Caulerpa sertularioides	-	-	-	+	-	+
Caulerpa racemosa var. *peltata*	-	-	+	+	-	-
Chaetomorpha antennina	-	+	-	-	+	-
Chaetomorpha sp.	+	+	-	+	+	-
Cladophora sp.	+	-	-	-	-	-
Acetabularia major	-	+	+	+	-	-
Cladophoropsis sp.	+	+	-	-	-	-
Avrainvillea erecta	-	-	-	-	-	+
Avrainvillea obscura	-	-	-	-	-	+
Ulva intestinalis	+	+	+	+	+	-
Ulva lactnca	-	-	-	-	-	+
Valonia aegagropila	-	+	-	+	+	-
Dictyopteris jamaicensis	-	-	-	-	-	+
Dictyopteris sp.	-	-	-	-	-	+
Dictyota dentata	-	-	-	+	-	-
Dictyota dichotoma	-	-	+	-	-	+
Dictyota mertensii	-	-	-	+	-	-
Dictyota submaritima	-	-	-	+	-	-
Dictyota sp.	-	+	-	+	-	-
Lobophora variegata	-	-	-	+	-	-
Padina australis	+	+	+	-	-	+
Padina boryana	-	-	-	+	-	+
Padina minor	+	+	+	+	-	+
Padina tetrastromatica	-	+	-	+	-	-
Spatoglossum vietnamense	-	-	-	-	-	+
Hormophysa cuneiformis	-	-	-	-	-	+
Sargassum sp.	+	+	+	-	-	-
Centroceras clavulatum	+	+	-	-	-	-
Amphiroa fragilissima	-	-	-	+	-	-
Galaxaura oblongata	-	-	-	+	-	+
Gelidiella acerosa	-	-	-	-	+	-
Gracilaria salicornia	+	+	+	+	+	-
Hydropuntia edulis	+	+	+	+	-	-
Halymenia dilatata	-	-	-	-	-	+
Halymenia durvillei	-	-	-	-	-	+
Halymenia floresii	-	-	-	-	-	+
Halymenia maculata	-	-	-	-	-	+
Halymenia sp.	-	-	-	-	-	+
Hypnea cervicornis	+	+	+	-	+	-
Hypnea spicifera	+	+	-	+	+	-
Ahnfeltiopsis sp.	-	-	-	-	-	+
Acauthophora spicifera	+	+	+	+	+	-
Bostrychia tenella	-	+	-	-	-	-
Laurencia cartilaginea	-	-	-	-	-	+
Laurencia papillosa	+	+	+	+	-	-
Laurencia similis	+	+	+	+	-	-
Laurencia sp.	+	+	+	-	+	-
Tolypiocladia glomerulata	+	-	-	-	-	-
Scinaia furcellata	-	-	-	+	-	-
Solieria sp.	-	-	-	-	+	-

TB: Tanjnng Batu, PT: Pantai Telekom, GB: Golden Beach, KS: Kuala Similajau, KN: Kuala Nyalau and BM: Batu Mandi, -: Absent, +: Present

the Straits of Malacca where most of the samples collected from rock surface, coral and artificial substrate. Gan *et al.* (2011) stated the Rhodophyta were most diversified species recorded from the Johor coastal waters where rocky shores resulted the high abundance of marine algae assembles. Difference recorded from Nurridan (2004) on seaweed communities at coral reef in the lagoon of Pulau Layang Layang, Sabah with 19 species of seaweed recorded and Chlorophyceae was the most abundance species.

Checklists of seaweed species assemble at six different locations are presented in the Table 2. Kuala Similajau area recorded the highest seaweed species compare to other locations and the lowest was recorded at Kuala Nyalau area. Rhodophyta recorded the higher

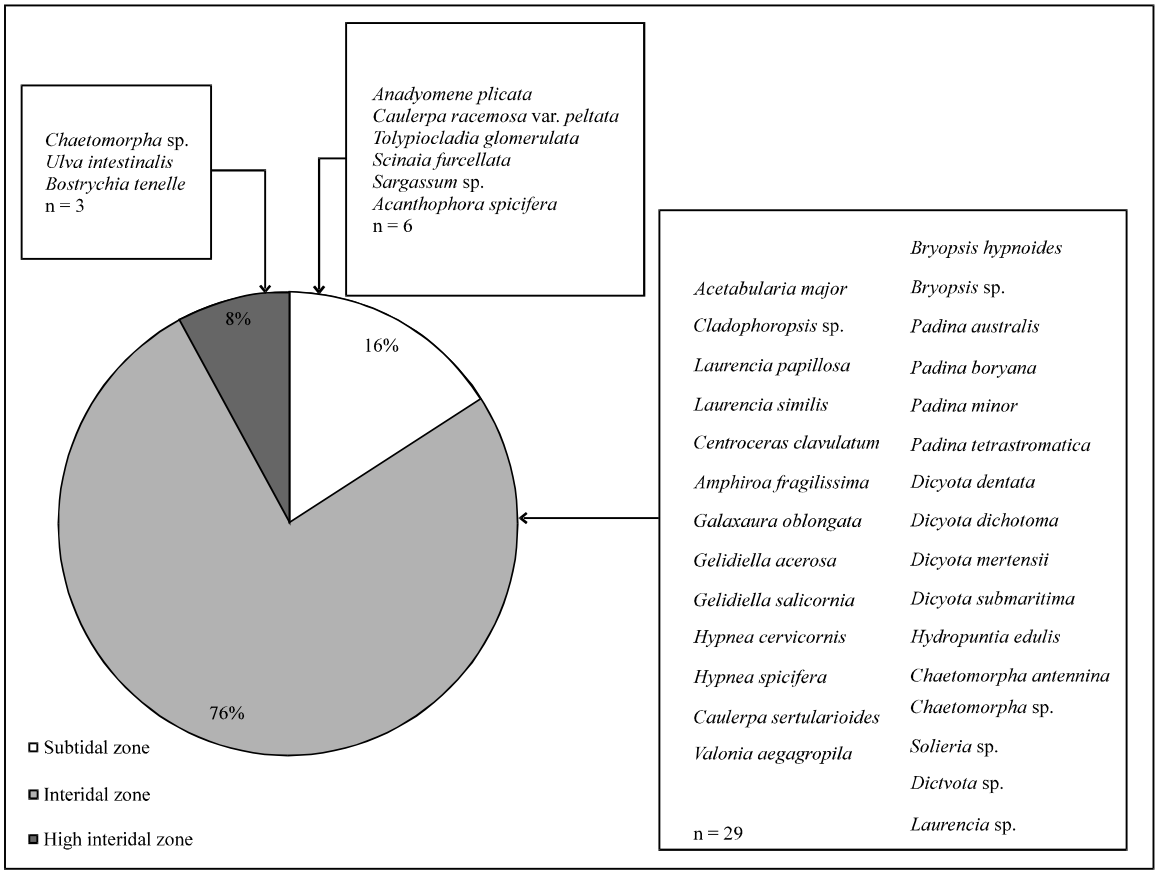

Fig. 3: Summary of seaweed species assemble in the tidal zone of rocky shore area in Bintulu coastal waters

assemble of seaweed species at Tanjung Batu, Pantai Telekom, Golden Beach and Kuala Nyalau area. There was no Phaeophyta recorded from Kuala Nyalau. In contrast, some Phaeophyta species have been recorded by Wong *et al*. (2008) at Kuala Nyalau area. Phaeophyta and Rhodophyta were common at Kuala Nyalau area. But it had shown different at Batu Mandi area where Phaeophyta species was recorded the highest. *Ulva intestinalis*, *Padina minor*, *Gracilaria salicornia* and *Acanthophora spicifera* showed the most common species can be found at five out of six locations of coastal areas.

From this study, it was observed that, the dominance seaweed species was recorded at the intertidal zone with 76% coverage of 29 species, followed by subtidal zone with 16% which cover six species and high intertidal zone with 8% with three species (Fig. 3). It was shown that sea water and sun light plays the important role to the seaweed for photosynthesis and growth in a good condition. Study also recorded the high number of seaweed species existing at Bintulu coastal area ecologically due to the nutrient enrichment and provided suitable hard substrate necessary for seaweed attachment growth. According to Konar (2007), marine communities such macroalgae tends to be high assembling for their biodiversity and hard substrate provided attachment for their growth.

There were different recorded of seaweed species from Bintulu coastal water when compared to previous study by Harah *et al*. (2007) and Wong *et al*. (2008) since both previous study focus on rocky shore based area for macroalgae recorded (Table 3). Hence, present study on seaweed recorded includes both rocky shore area and reef area from Bintulu coastal waters. Seasonality pattern of seaweed assemblages is generally recognized to be a factor affected the species recorded from similar area (Guerra-Garcia *et al*., 2010). Other than environmental factor, temperature tends to be most influenced the seasonal pattern of seaweed communities

Table 3: Comparison of seaweed recorded from present study with previous recorded in Bintulu coastal waters

Species	Present study	Wong *et al.* (2008)	Harah *et al.* (2006)
Anadyomene plicata	+	+	+
Bryopsis indica	-	-	+
Boodlea composita	+	-	-
Bryopsis hypnoides	+	-	-
Bryopsis sp.	+	-	-
Caulerpa sertularioides	+	+	+
Caulerpa racemosa var. *peltata*	+	+	-
Chaetomorpha antennina	+	+	-
Chaetomorpha sp.	+	-	-
Cladophora fuliginosa	-	-	+
Cladophora prolifera	-	+	-
Cladophora sp.	+	-	-
Codium sp.	-	-	+
Acetabularia major	+	+	+
Acetabulari parvula	-	-	+
Cladophoropsis sp.	+	-	-
Avrainvillea erecta	+	-	-
Avrainvillea obscura	+	+	-
Halimeda macroloba	-	+	-
Udotea javensis	-	-	+
Ulva intestinalis	+	+	-
Ulva lactuca	+	-	-
Ulva clathrata	-	+	-
Ulva prolifera	-	+	-
Valonia aegagropila	+	+	+
Valonia ntricularis	-	-	+
Dictyopteris jamaicensis	+	-	-
Dictyopteris delicatula	-	-	+
Dictyopteris sp.	+	-	-
Dictyota dentata	+	-	-
Dictyota dichotoma	+	-	+
Dictyota mertensii	+	-	-
Dictyota submaritima	+	-	-
Dictyota sp.	+	+	-
Lobophora variegata	+	+	+
Padina australis	+	+	+
Padina boryana	+	-	-
Padina minor	+	+	-
Padina sp.	-	-	+
Padina tetrastromatica	+	-	-
Spatoglossum vietnamense	+	-	-
Hormophysa cuneiformis	+	-	-
Sargassum paniculatum	-	-	+
Sargassum sp.	+	+	-
Porphyra sp.	-	+	-
Ceramium affine	-	-	+
Ceramium gracillimum	-	-	+
Ceramium sp.	-	+	-
Champia compressa	-	-	+
Champia sp.	-	+	-
Centroceras clavulatum	+	-	-
Amphiroa fragilissima	+	+	+
Cheilosporum jungermaunioides	-	-	+
Cheilosporum acutilobum	-	+	-
Jania decenssato-dichotoma	-	-	+
Sporolithon sp.	-	+	-
Galaxaura oblongata	+	+	+
Gelidiella acerosa	+	+	+
Gracilaria salicornia	+	+	-
Gracilaria sp.	-	-	+
Pterocladia sp.	-	+	-
Hydropuntia edulis	+	+	-
Halymenia dilatata	+	-	+
Halymenia durvillei	+	-	-
Halymenia floresii	+	-	+
Halymenia maculata	+	-	-
Halymenia sp.	+	-	-
Hypnea cervicornis	+	+	+

Table 3: Continue

Species	Present study	Wong *et al.* (2008)	Harah *et al.* (2006)
Hypnea spicifera	+	-	-
Hypnea pannosa	-	-	+
Hypnea spinella	-	-	+
Ahnfeltiopsis sp.	+	-	-
Acanthophora spicifera	+	+	+
Bostrychia tenella	+	-	-
Bostrychia sp.	-	+	-
Laurencia cartilaginea	+	-	-
Laurencia papillosa	+	+	-
Laurencia similis	+	-	-
Lanrencia corymbosa	-	-	+
Laurencia perforate	-	-	+
Lanrencia sp.	+	+	+
Leveillea jungermannioides	-	+	+
Tolypiocladia glomerulata	+	-	-
Scinaia furcellata	+	-	-
Solieria sp.	+	-	-
Gelidiopsis intricata	-	+	-
Total	54	35	35

-: Absent, +: Present

(Branco *et al*., 2008). According to Prathep (2005), variation and different diversity of macroalgae were affected from seasonal pattern and sites of study areas, hence the percentage of macroalgae assemble highly influence by the degree of wave exposure during wet seasons.

CONCLUSION

The present study revealed that Bintulu coastal areas highly diversified with macroalgae species there might be need to be conserve and monitoring for reliable potential used in some industries seems these seaweeds known as natural bio-renewable sources. However, further observation or knowledge of seaweed assembles due to environmental factor and seasonal pattern need to be monitoring for more information and understand on seaweed diversity.

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