Songklanakarin J. Sci. Technol.
37 (2), 147-153, Mar.-Apr. 2015

http://www.sjst.psu.ac.th

Original Article

Taxonomic assessment of seaweed community from the coastal areas of Bintulu, Sarawak, Malaysia

Mohd Hafizbillah Zawawi*, Mohd Hanafi Idris, Abu Hena Mustafa Kamal, and Wong Sing King

Department of Animal Science and Fishery, Faculty of Agriculture and Food Sciences,
Universiti Putra Malaysia, Bintulu Sarawak Campus,
Nyabau Road, P.O.Box 396, Bintulu, Sarawak, 97008 Malaysia.

Received: 2 December 2012; Accepted: 17 February 2015

Abstract

Basic taxonomic information forms the important basis for the documentation, resource management and utilization of marine biodiversity such as seaweeds. A taxonomic assessment of seaweeds in the coastal areas of Bintulu, Sarawak, East Malaysia, was conducted monthly from May 2011 to May 2012. Species composition was recorded following NaGISA protocols, direct observation, and SCUBA and snorkeling techniques. A total of 54 species were identified, classified into Rhodophyta (23 species), Chlorophyta (16 species) and Phaeophyta (15 species). The highest abundance was recorded at Kuala Similajau (25 species) while the lowest was recorded at Kuala Nyalau (12 species). As the present study was conducted by examining species collected from both rocky shores and the reef area for the first time, a higher number of species was documented compared to previous studies conducted in the same general area but focusing only on particular habitats. Thirty species found in the current survey represent new records for the locality including some with economic potentials.

Keywords: seaweeds, composition, coastal area, Sarawak, Malaysia

1. Introduction

Seaweeds are large, attached forms of marine algae that show high diversity in rocky shores, where they are often subjected to tides and waves. They comprise more than 90% of all marine plants (Ismail, 1995) and are the most important primary producers in the marine ecosystem (Trono, 1998). Studies on the diversity of seaweeds had been conducted around South-east Asia in countries such as the Philippines (Trono, 1999), Singapore (Lee *et al*., 2009) and Thailand (Prathep *et al*., 2011; Ruangchuay *et al*., 2011). In Malaysia, studies on the composition and diversity of seaweeds had been conducted mainly in Peninsular Malaysia by Ismail (1995), Phang *et al*. (2005), Phang (2006), Phang *et al*. (2008) and Gan *et al*. (2011). There is hardly any study on seaweed diversity in East Malaysia.

* Corresponding author.
Email address: hafizbillah@yahoo.com

Over the last few years, studies on the distribution and biology of seaweed species in the state of Sarawak in East Malaysia have concentrated on the marine flora found in the Bintulu coast. Studies have been limited to areas around the Similajau National Park (Muta Harah *et al*., 2006; Fisheries Research Center, 2000) and adjoining seaweed communities along the rocky shores (Wong *et al*., 2008; Muta Harah *et al*., 2007). The present study was conducted to observe and compare the species composition of seaweeds from the rocky shore areas and the reefs, taken to represent the entire coastal waters of Bintulu. This study presented updated information on the seaweed flora and added some species not previously reported for this particular area.

2. Materials and Methods

Seaweed samples were collected between May 2011 and May 2012 from five rocky shore areas (monthly) namely Tanjung Batu, Pantai Telekom, Golden Beach, Kuala Similajau and Kuala Nyalau and from one fringing reef area of Batu

Mandi (bimonthly), all located along the Bintulu coastal area (Figure 1 and Table 1). Collection was conducted using SCUBA diving and snorkeling technique. All seaweed samples were preserved with 10% formalin in the field and transported back to the laboratory for identification. Herbarium specimens were made of all samples, which are deposited in the museum of Aquatic Biology Laboratory, Department of Animal Science and Fishery, UPM Bintulu Sarawak Campus, Malaysia. Identification of seaweed was done following taxonomic references such as Ismail (1995), Coppejans *et al.* (1997), Trono (1998), Nurridan (2004) and Tsutsui *et al.* (2005).

3. Results and Discussion

A total of 54 species of seaweed were identified from six different study areas of Bintulu coast; 23 species of Rhodophyta (11 families), 16 species of Chlorophyta (10 families) and 15 species of Phaeophyta (2 families) (Table 2). The highest numbers of individual species were recorded from Dictyotaceae (14 species) and one species of seaweed was recorded from each of Anadyomenaceae, Boodleaceae, Polyphysaceae, Siphonocladaceae, Valoniaceae, Ceramiaceae, Corallinaceae, Galaxauraceae, Gelidiellaceae, Phyllophoraceae, Scinaiaceae and Solieriaceae. The abundance of seaweed species varied among stations. The study recorded the highest species number (25 species) from Kuala Similajau and the lowest (12 species) from Kuala Nyalau (Figure 2). This variation could probably be due to the type of substrate, wave condition, the slope of rocky area, structures or activities present near the habitat and meteorological conditions during sampling.

Previously, 31 species (10 Chlorophyta, 5 Phaeophyta and 16 Rhodophyta) of seaweed had been reported in Similajau National Park by Fisheries Research Centre (2000). Studies by Muta Harah *et al*. (2006) recorded 35 species (10 Chlorophyta, 6 Phaeophyta and 19 Rhodophyta) of seaweeds in the coral fragment and rocky shore areas also from Similajau National Park. In addition, another study by Muta Harah *et al*. (2007) recorded a total of 35 species (12 Chlorophyta, 8 Phaeophyta and 15 Rhodophyta) of seaweeds collected from the rocky shore areas in Bintulu, Sarawak. Another study by Wong *et al*. (2008) recorded 35 species of seaweeds (12 Chlorophyta, 5 Phaeophyta and 18 Rhodophyta) from various rocky areas in Bintulu. Compared to the previous studies, a higher number of seaweed species (16 Chlorophyta, 15 Phaeophyta and 23 Rhodophyta) was recorded in the present study.

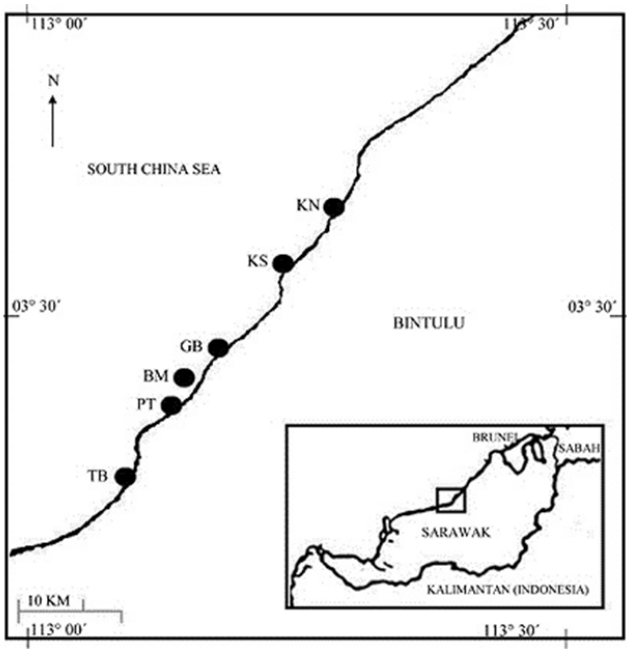

Figure 1. Study area showing the sampling stations at Bintulu coastal area, Sarawak, Malaysia. TB - Tanjung Batu, PT - Pantai Telekom, BM - Batu Mandi, Similajau National Park, GB - Golden Beach, Similajau National Park, KS - Kuala Similajau and KN - Kuala Nyalau

Table 1: Description of seaweed sampling areas in Bintulu coast, Sarawak, Malaysia.

Site	Description
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′) Golden Beach, Similajau National Park (N 03° 25.075′ E 113° 11.797′)	Splash zone and inter-tidal area. Sandy and sometime sandy-muddy. Solid rock predominates. Bedrock exposed to the wave during low tide levels on the seashores.
Batu Mandi, Similajau National Park (N 03°21.941′ E 113° 07.952′)	Fringing reefs. Grows at the fringes of land masses. Rocky shorelines. Top of the reef exposed to the air and wave during low tides.

Table 2. Division, family and species of seaweeds collected from Bintulu coastal areas, Sarawak, Malaysia.

No.	Division/Family	Species
Chlorophyta		
1	Anadyomenaceae	*Anadyomene plicata* C. Agardh, 1832
2	Boodleaceae	*Boodlea composita* (Harvey) Brand, 1904
3	Bryopsidaceae	*Bryopsis hypnoides* Lamouroux, 1809
4		*Bryopsis* sp.
5	Caulerpaceae	*Caulerpa sertularioides* (S.G.Gmelin) M.A.Howe, 1905
6		*Caulerpa racemosa* var. *peltata* (Lamouroux) Eubank, 1944
7	Cladophoraceae	*Chaetomorpha antennina* (Bory) Kutzing, 1847
8		*Chaetomorpha* sp.
9		*Cladophora* sp.
10	Polyphysaceae	*Acetabularia major* G. Martens, 1866
11	Siphonocladaceae	*Cladophoropsis* sp.
12	Udoteaceae	*Avrainvillea erecta* (Berkeley) A. et E. S. Gepp, 1911
13		*Avrainvillea obscura* (C. Agardh) J. Agardh, 1887
14	Ulvaceae	*Ulva intestinalis* Linnaeus, 1753
15		*Ulva lactuca* Linnaeus, 1753
16	Valoniaceae	*Valonia aegagropila* C. Agardh, 1823
Phaeophyta		
17	Dictyotaceae	*Dictyopteris jamaicensis* Taylor, 1960
18		*Dictyopteris* sp.
19		*Dictyota dentata* Lamouroux, 1809
20		*Dictyota dichotoma* (Hudson) Lamouroux, 1809
21		*Dictyota mertensii* (Martius) Kutzing, 1859
22		*Dictyota submaritima* Tak. Tanaka & Pham-Hoang Ho, 1962
23		*Dictyota* sp.
24		*Lobophora variegata* (J.V. Lamouroux) Womersly, 1977
25		*Padina antillarum* (Kutzing) Piccone, 1886
26		*Padina australis* Hauck, 1887
27		*Padina boryana* Thivy, 1966
28		*Padina minor* Yamada, 1925
29		*Spatoglossum vietnamense* Pham-Hoang Ho, 1969
30		*Hormophysa cuneiformis* (J. F. Gmelin) P. C. Silva, 1987
31	Sargassaceae	*Sargassum* sp.
Rhodophyta		
32	Ceramiaceae	*Centroceras clavulatum* (C. Agardh) Montagne, 1846
33	Corallinaceae	*Amphiroa fragilissima* (Linnaeus) Lamouroux, 1816
34	Galaxauraceae	*Tricleocarpa fragilis* (Linnaeus) Huisman & Townsend, 1993
35	Gelidiellaceae	*Gelidiella acerosa* (Forsskal) Feldmann and G. Hamel, 1934
36	Gracilariaceae	*Gracilaria salicornia* (C. Agardh) Dawson, 1954
37		*Hydropuntia edulis* (Gmelin) Gurgel et Fredericq, 2004
38	Halymeniaceae	*Halymenia dilatata* Zanardini, 1851
39		*Halymenia durvillei* Bory de Saint-Vincent, 1828
40		*Halymenia floresii* (Clemente) C. Agardh, 1817
41		*Halymenia maculata* J. Agardh, 1885
42		*Halymenia* sp.
43	Hypneaceae	*Hypnea cervicornis* J. Agardh, 1851
44		*Hypnea spicifera* (Suhr) Harvey, 1847
45	Phyllophoraceae	*Ahnfeltiopsis* sp.
46	Rhodomelaceae	*Acanthophora spicifera* (Vahl) Borgesen, 1910
47		*Bostrychia tenella* (Lamouroux) J. Agardh, 1863
48		*Chondrophycus cartilagineus* (Yamada) Garbary & Harper, 1998
49		*Chondrophycus papillosus* (C. Agardh) Garbary & Harper, 1998
50		*Laurencia similis* Nam et Saito, 1991
51		*Laurencia* sp.
52		*Tolypiocladia glomerulata* (C. Agardh) F. Schmitz, 1897
53	Scinaiaceae	*Scinaia furcellata* (Turner) J. Agardh, 1851
54	Solieriaceae	*Solieria* sp.

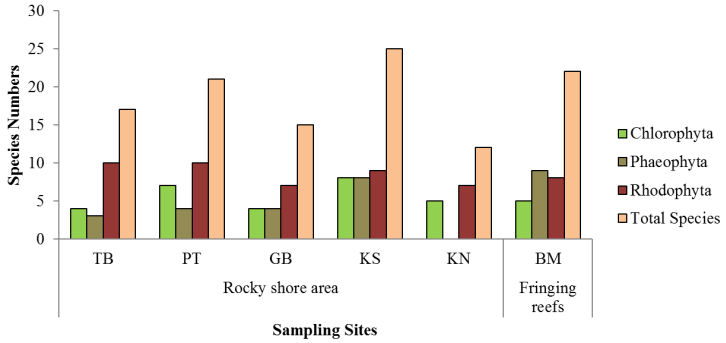

Figure 2: Number of seaweed recorded from six sampling stations around Bintulu coast, Sarawak. TB-Tanjung Batu, PT-Pantai Telekom, GB-Golden Beach, KS-Kuala Similajau, KN-Kuala Nyalau, BM-Batu Mandi.

The abundance of seaweeds was high in the rocky substrate, while Rhodophyta (11 families and 23 species) ha the highest number of species of seaweeds in this coastal area. The present study recorded 12 species of seaweeds commonly can be found in Bintulu coastal waters (*Chaetomorpha* sp., *Ulva intestinalis*, *Padina minor*, *Padina australis*, *Gracilaria salicornia*, *Hydropuntia edulis*, *Hypnea cervicornis*, *Hypnea spicifera*, *Acanthophora spicifera*, *Laurencia* sp., *Chondrophycus papillosus* and *Laurencia similis*). By contrast, Wong *et al*. (2008) recorded 9 common species of seaweeds (*Cladophora prolifera*, *Ulva intestinalis*, *Padina minor*, *Sargassum* sp., *Gracilaria salicornia*, *Hydropuntia edulis*, *Acanthopora spicifera*, *Laurencia papillosa* and *Laurencia* sp.) from the coastal area of Bintulu, most of the species recorded from Rhodophyta. Similarly, high diversity of Rhodophyta was observed from the other regions of Malaysia such as Langkawi, Perak Island, Jarak Island, Sembilan Group of Island and Johor coastal waters (Phang *et al.*, 2005; Phang *et al*., 2008 and Gan *et al*., 2011).

The comparison of seaweed species assembled from six different locations during this study at Bintulu coast is given in Table 3. The highest number of seaweeds was recorded from Kuala Similajau compared to the other locations studied and the lowest was recorded from Kuala Nyalau. This might be due to the nature of the substrate where Kuala Similajau has gradual slope of sandy rocky substrate allowing suitable attachment for seaweeds in the habitat. Seaweeds from Rhodophyta were recorded higher in Tanjung Batu and Pantai Telekom. Phaeophyta was absent in Kuala Nyalau during this study; in contrast, a few Phaeophyta species (*Dictyota* sp., *Sargassum* sp., *Lobophora variegata*, *Padina australis* and *Padina minor*) had been recorded previously in this area by Wong *et al*. (2008). The present study recorded higher number of Chlorophyta species in Kuala Similajau; however, previous study by Wong *et al*. (2008) reported different result, in which Kuala Nyalau was high with Chlorophyta species in the Bintulu coast. The differences might be due to the seasonal pattern during sampling time and a different sampling procedure, which lacked quantitative or transect data.

Total number of seaweed species recorded in the present study differed from the previous seaweed species reported in Bintulu coastal waters, hence, a few new species were identified (30 species) which have not been recorded by previous studies and most of the new species recorded from the reef area (asterisks in Table 3). This difference could probably be due to the habitat differences as the present study integrated the reef area along with rocky shore. Additionally, seasonal changes (wet or dry seasons) and environmental factors could affect on the seaweed ecology (Prathep, 2005). According to Mayakun and Prathep (2005), different numbers of seaweed recorded from the different localities because of habitat complexity. They reported that the biomass of the seaweed communities in certain habitats were related to the ecosystem productivity, therefore, protected area generally increased the habitat complexity and provided greater diversity of seaweeds. Additionally, climate change and global warming are likely to be related to the differences in the composition of seaweed species between studies which were depended on species ability of adaptation in the stressful environment. Seaweed habitats were highly related to the changes in global temperature and ocean chemistry because of climate change strongly affected the abundance of seaweed species that must either tolerate the extreme environment or adapt to new habitat. (Guerra-Garcia *et al*., 2011).

Generally, the diversity and abundance of seaweeds are high in the rocky and hard substrate (Fishery Research Centre, 2000). This is the case for the present study. The intertidal area exposed to the direct sunlight during low tide provides better use of light intensity for photosynthesis and the suitable substrate for the attachment of seaweeds in this coastal area. According to Muta Harah *et al.* (2007), the tidal range in the rocky shore area may also influence the distribution and abundance of seaweeds, which were subjected to air exposure during low tide and affected by desiccation. Besides, Wong *et al.* (2008) stated that higher abundance of seaweed species can be found in mid and low intertidal zones compared to the high intertidal zone.

The present study revealed the richness of the seaweed communities along the Bintulu coast which was represented by the three major seaweed groups, namely

Table 3. Checklist of seaweeds distribution recorded from Bintulu coastal areas, Sarawak.

Species/Location	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 lactuca *	-	-	-	-	-	+
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 antillarum *	-	-	-	+	-	-
Spatoglossum vietnamense *	-	-	-	-	-	+
Hormophysa cuneiformis *	-	-	-	-	-	+
Sargassum sp.	+	+	+	-	-	-
Centroceras clavulatum *	+	+	-	-	-	-
Amphiroa fragilissima	-	-	-	+	-	-
Tricleocarpa fragilis *	-	-	-	+	-	+
Gelidiella acerosa	-	-	-	-	+	-
Gracilaria salicornia	+	+	+	+	+	-
Hydropuntia edulis	+	+	+	+	-	-
Halymenia dilatata	-	-	-	-	-	+
Halymenia durvillei *	-	-	-	-	-	+
Halymenia floresii	-	-	-	-	-	+
Halymenia maculata *	-	-	-	-	-	+
Halymenia sp. *	-	-	-	-	-	+
Hypnea cervicornis	+	+	+	-	+	-
Hypnea spicifera *	+	+	-	+	+	-
Ahnfeltiopsis sp. *	-	-	-	-	-	+
Acanthophora spicifera	+	+	+	+	+	-
Bostrychia tenella *	-	+	-	-	-	-
Chondrophycus cartilagineus *	-	-	-	-	-	+
Chondrophycus papillosus *	+	+	+	+	-	-
Laurencia similis *	+	+	+	+	-	-
Laurencia sp.	+	+	+	-	+	-
Tolypiocladia glomerulata *	+	-	-	-	-	-
Scinaia furcellata *	-	-	-	+	-	-
Solieria sp. *	-	-	-	-	+	-
Total Number of Species	**17**	**21**	**15**	**25**	**12**	**22**

Abb: TB-Tanjung Batu, PT-Pantai Telekom, GB-Golden Beach, KS-Kuala Similajau, KN-Kuala Nyalau, BM-Batu Mandi.+: Present. -: Absent. *: New species recorded.

Rhodophyta, Phaeophyta and Chlorophyta, contributing towards a better knowledge of marine biodiversity in this poorly studied region. In view of recent and rapid economic development activities such as construction and industrialization, the marine communities including seaweeds, might suffer impacts affecting their diversity and abundance. As seaweed communities formed the basis of the marine food chain, some negative effects on fisheries and the marine ecosystem as a whole might occur in the near future. It is therefore recommended that further monitoring of seaweed communities on a regular basis be conducted to improve our ability to predict imminent changes and impacts on these valuable resources.

Acknowledgments

The authors would like to thank Vice-Chancellor, Universiti Putra Malaysia, for encouragement and research facilities. This research was funded by the Ministry of Higher Education, Malaysia (MoHE), under programme Fundamental Research Grant Scheme (FRGS) 5524038 to make this study possible.

References

Coppejans, E., Richmond, M.D., Clerck, O.D. and Rabesandratana, R. 1997. Marine Macroalgae: Seaweeds. In A Guide to the Seashores of Eastern Africa and the Western Indian Ocean Islands, M.D. Richmond, editor. Sida Department for research Cooperation, SAREC, pp. 70-95.

English, S., Wilkinson, C. and Baker, V. 1994. Survey Manual For Tropical Marine Resources. Australian Institute of Marine Science, pp. 235-264.

Fisheries Research Centre (Sarawak). 2000. Seaweed Resource of Sarawak. Available from: http://www.fri.gov.my/friswak/seaweed.html. [September 16, 2011].

Gan, M.H., Siti Aishah, A., Nur Wahidah, A., Amyra Suryatie, K. and Noraien, M.P. 2011. Diversity of seaweed in the vicinity of Johor: With emphasis on the east coast Peninsular Malaysia Expedition II 2006. Proceedings of Universiti Malaysia Terengganu International Annual Symposium, Terengganu, Malaysia, July 11-13, 2011, 429-433.

Guerra-Garcia, J.M., Cabezas, M.P., Baeza-Rojano, E. and Garcia-Gomez, J.C. 2011. Spatial patterns and seasonal fluctuations of intertidal macroalgal assemblages from Tarifa Islan, souther Spain: relationship with associated Crustacea. Journal of the Marine Biology Association of the United Kingdom. 91, 107-116.

Ismail, A. 1995. Rumpai Laut Malaysia. Dewan Bahasa dan Pustaka, pp. 43-248.

Khan, W., Rayirath, U.P., Sowmyalakshmi S., Jithesh, M.N., Prasanth, R., Hodges, D.M. and Balakrishan, P. 2009. Seaweed extracts as biostimulants of plant growth and development. Journal of Plant Growth Regulation. 28, 386-399.

Lee, A.C., Liao, L.M. and Tan, K.S. 2009. New record of marine algae on artificial structures and intertidal flats in coastal waters of Singapore. The Raffles Bulletin of Zoology. 22, 5-40.

Mayakun, J. and Prathep, A. 2005. Seasonal variations in diversity and abundance of macroalgae at Samui Island, Surat Thani Province, Thailand. Songklanakarin Journal of Science and Technology. 27, 653-663.

Muta Harah, Z., Japar Sidik, B., Raesah, A., Suzalina Akma, A. and Ogawa, H. 2006. Marine Macrophytes: Macroalgae species and life forms from Golden Beach, Similajau National Park, Bintulu, Sarawak, Malaysia. Coastal Marine Science. 30, 243-246.

Muta Harah, Z., Siaw Chia, W., Japar Sidik, B., Arshad, A. and Ogawa, H. 2007. Macroalgae diversity and life forms of inter-tidal rocky shores. Marine Research Indonesia. 32, 163-168.

Nurridan, A.H. 2004. Seaweed and seagrass communities of Pulau Layang Layang, Malaysia. In Marine Biodiversity of Palau Layang-layang Malaysia, M. Mohamed Pauzi, editor. Marine Research Station LayangLayang (MARSAL), pp. 1-14.

Phang, S.M. 2006. Seaweed resources in Malaysia: Current status and future prospects. Aquatic Ecosystems Health and Management. 9, 185-202.

Phang, S.M., Lim, P.E, Ooi, J.L.S., Yeong, H.Y, Ng, W. and Kupper, F.C. 2008. Marine algae of Perak Island, Jarak Island and the Sembilan Group of Islands in the Straits of Malacca. Malaysian Journal of Science. 27, 47-60.

Phang, S.M., Wong, C.L., Lim, P.E., Yeong, H.Y. and Chan, C.X. 2005. Seaweed diversity of the Langkawi Island with emphasis on the northeastern region. Malaysian Journal Science. 24, 77-94.

Prathep, A. 2005. Spatial and temporal variations in diversity and percentage cover of macroalgae at Sirinart Marine National Park, Phuket Province, Thailand. ScienceAsia. 31, 225-233.

Prathep, A., Pongparadon, S., Darakrai, A., Wichachucherd, B. and Sinutok, S. 2011. Diversity and distribution of seaweed at Khanom-Mu KoThale Tai National Park, Nakhon Si Thammarat Province, Thailand. Songklanakarin Journal of Science and Technology. 33, 633-640.

Rigby, P.R., Iken, K. and Shirayama, Y. 2007. Sampling Biodiversity on Coastal Communities: NaGISA Protocol for Seagrass and Macroalgal Habitats. Kyoto University Press, Japan, pp. 7-36.

Ruangchuay, R., Nualcharoen, M., Nualcharoen, P. and Lueangthuwapranit, C. 2011. Diversity of seaweeds on the lower south on Gulf of Thailand coast. Proceeding of 1st International Fisheries Symposium, Terengganu, Malaysia, October 3-5, 2011, 42.

Trono, G.C. 1999. Diversity of the seaweed flora of the Philippines and its utilization. Hydrobiologia. 398/399, 1-6.

Trono, G.C. 1998. Seaweeds. In FAO Species Identification Guide for Fishery Purposes, The Living Marine Resources of the western Central Pacific, K.E. Carpenter, and V.H. Hiem, editor. Food and Agriculture Organization of the United Nations, pp. 20-99.

Tsutsui, I., Huynh, Q.N., Nguyen, H.D., Arai, S. and Yoshida, T. 2005. The Common Marine Plants of Southern Vietnam. Japan Seaweed Association. pp, 16-234.

Vallinayagam, K., Arumugam, R., Kannan, R.R.R., Thirumaran, G. and Anantharaman, P. 2009. Antibacterial activities of some selected seaweeds from Pudumadam Coastal regions. Global Journal of Pharmacology. 3, 50-52.

Wong, S. C., Muta Harah, Z., Japar Sidik, B., Arshad, A. and Ogawa, H. 2008. Macroalgal Communities of Intertidal Rocky shores around Bintulu, Sarawak. Proceeding of the International Symposium, Kuching, Sarawak, Malaysia, November 19-21, 2008, 102-108.