

Changes in macroalgae species composition, assemblage and coverage at an inter-tidal rocky shore

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Abstract—Samplings of macroalgae were undertaken at an inter-tidal rocky shore of Kuala Similajau (Lat. 3°22' 13.9"N, Long. 113°17' 39.1"E), Bintulu, Sarawak during two peaks of wet period; Feb.–Mar. (monthly total rainfall of 514.0 mm, 481.6 mm; average temperature 25.7°C, 26.2°C) and Jul.–Aug. (monthly total rainfall 585.8 mm, 566.2 mm; average temperature 26.3°C, 27.0°C) 2008. This study investigates the changes in macroalgae species composition, assemblage and coverage covering the two peaks of wet period. A total of 23 taxa comprising 7 green, 5 brown and 11 red algae were recorded covering the two peaks of wet period, with red algae being the most diverse division. Comparatively a lower number of macroalgae species occurred during Feb.–Mar. (12 species) compared to the period of Jul.–Aug. (20 species). Several species such as *Ulva clathrata* (Roth) Greville, *Valonia aegagropila* C. Agardh and *Lobophora variegata* (Lamouroux) Womersley ex Oliveira, were absent during the Feb.–Mar. Common species *Anadyomene plicata* C. Agardh, *Sargassum* sp., *Acanthophora spicifera* (Vahl) Borgesen, *Amphiroa fragilissima* (Linnaeus) Lamouroux, *Gelidiella acerosa* (Forsskal) Feldmann & Hamel, *Gracilaria salicornia* (C. Agardh) Dawson, *Hydropuntia edulis* (S. G. Gmelin) P. C. Silva, *Laurencia papillosa* (C. Agardh) Greville and *Laurencia* sp. were present in both periods. *Acetabularia major* C. Agardh, *Cladophora prolifera* (Roth) Kutzing, *Ulva intestinalis* (Linnaeus) Nees, *Padina minor* Yamada, *Ceramium* sp. and *Pterocladia* sp. were only present in the Jul.–Aug. In terms of mean coverage, there is no distinct trend in domination with respect to a particular species between the two peaks of wet period. However, based on the number of mean coverage contributed by the species, categorically this can be represented as Division Rhodophyta > Division Chlorophyta > Division Phaeophyta.

Key words: Bintulu, coverage, Macroalgae species, rocky shore, species composition

Introduction

Kuala Similajau is an estuary area of transition between Similajau River and the South China Sea. The inter-tidal shore of Kuala Similajau has a variety of ecosystems such as seagrass beds and rocky shore. In the tropics, inter-tidal communities particularly the diversity and distribution of macroalgae may vary through time. The dynamics of macroalgal particularly in Kuala Similajau received less attention and thus information on changes in diversity and assemblages of these communities are unknown. In addition, seasonal variations in macroalgae species composition often occurred with varied environments such as exposed coasts, estuaries and oceans that offered different condition for growth and survival of macroalgae. There have been reports on variation pertaining to the composition of macroalgae with respect to locations, e.g. reefs of Florida, USA (Paul and Hay 1986) and inter-tidal area around Port Dickson, Malaysia (Mijan Udin et al. 2007). Exposure to environmental condition such as desiccation, rainfall, temperature, salin-

ity, pH, dissolved oxygen and related nutrients may have effects on the distribution of macroalgae species (Nedumaran and Perumal 2009). Considering Kuala Similajau received heavy rainfall (Fig. 1), the current study aim to assess species

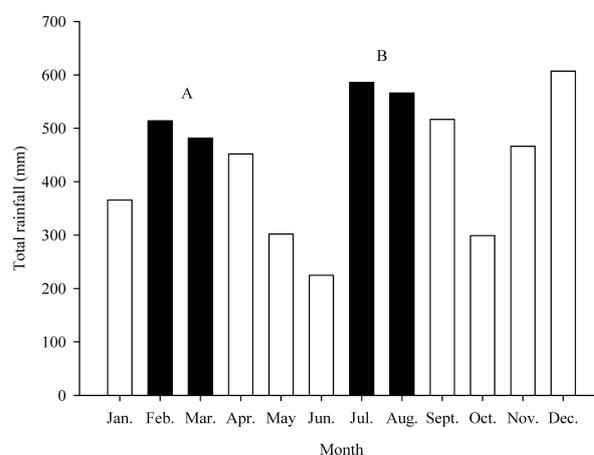


Fig. 1. Monthly total rainfall (mm) in Bintulu for year 2008. The peak wet periods for the macroalgae study were Feb.–Mar. (A) and Jul.–Aug. (B).

composition, assemblage and coverage of macroalgae at the site and related them with the peaks wet periods for the year 2008.

Materials and Methods

Kuala Similajau is located at Lat. 3°22' 13.9"N, Long. 113°17' 39.1"E. The study site is a wave splash inter-tidal rocky shore interspaced with rocks, boulders, pebbles and sandy-muddy shore. The site provides a wide inter-tidal surface favoring the flourishing of macroalgal community. Samplings were carried out during low spring tides covering two peaks of wet period in February to March (Feb.–Mar.) and July to August (Jul.–Aug.) of 2008 (Fig. 1). Samplings of macroalgae were conducted to obtain data on species composition, coverage, species assemblages using 20 random 50 cm×50 cm quadrat with 25 sub-divisions following the method developed by Saito and Atobe (1970). Macroalgae species, coverage and the corresponding indices (referring to Table 1) in each of the 25 sub-divisions were recorded. The parameter obtained from each quadrat with respect to coverage (expressed as percentage) or C is used to compute for the area in the substrate occupied by the species. For convenience, the index numbers: 5, 4, 3, 2, 1 are used for recording data in the field as in Table 1. $C(\%) = (qn_5 \times c_5) + (qn_4 \times c_4) + (qn_3 \times c_3) + (qn_2 \times c_2) + (qn_1 \times c_1) = (qn_5 \times 3) + (qn_4 \times 1.5) + (qn_3 \times 0.75) + (qn_2 \times 0.375) + (qn_1 \times 0.1875)$; where qn_n is the number of sub-divisions in which a species appeared to have the corresponding coverage area described in the above table. Representative samples of macroalgae were preserved in 5% saline formalin solution for taxonomical identification following the references of Lewmanomont and Ogawa (1995), Trono (1997, 2004) and Tsutsui et al. (2005).

Results and Discussion

Species composition and macroalgal assemblage

A total of 23 species of macroalgae were observed in the two wet periods of the year comprising 7 green algae, 5 brown algae and 11 red algae. Red algae represented the di-

Table 1. Indices of the degree of macroalgae cover and its representative multiplier.

Indices	Degree of algae cover	Multiplier, c_n
5	Covering 1/2–1/1 of substratum surface	3.0
4	Covering 1/4–1/2 of substratum surface	1.5
3	Covering 1/8–1/4 of substratum surface	0.75
2	Covering 1/16–1/8 of substratum surface	0.375
1	Covering less than 1/16 of substratum surface	0.1875

verse division in both periods. Comparatively a lower number of macroalgae species occurred during Feb.–Mar. (12 species) compared to the period of Jul.–Aug. (20 species). Several species such as *Ulva clathrata* (Roth) Greville, *Valonia aegagropila* C. Agardh and *Lobophora variegata* (Lamouroux) Womersley ex Oliveira were absent during the early period. There was an increase in number of species particularly in red algae from Feb.–Mar. to Jul.–Aug. (Table 2).

The macroalgae species composition differed between the two peaks of wet period that corresponded with change in the environment (Fig. 2). Studies on macroalgae indicated that several factors influenced the species composition, growth (with respect to biomass) and distribution in estuarine and marine environments. These are physico-chemical characters of waters (Prescott 1954), suitable substratum (Burns and Mathieson 1972), light and salinity (Thom 1980). In the present study pH, salinity and temperature of the surrounding seawater could not be the possible factors that influenced the

Table 2. Assemblage of macroalgae species in Kuala Similajau during the two peaks of wet period, Feb.–Mar. and Jul.–Aug. ●— present, ★— common species, ⚙— species only present during Jul.–Aug. wet period.

Macroalgae species	Feb.–Mar.	Jul.–Aug.
Green algae (Division Chlorophyta)		
<i>Acetabularia major</i> C. Agardh		⚙
<i>Anadyomene plicata</i> C. Agardh	●	●
<i>Avrainvillea obscura</i> (C. Agardh) J. Agardh		⚙
<i>Cladophora prolifera</i> (Roth) Kützinger		⚙
<i>Ulva clathrata</i> (Roth) Greville	★	
<i>Ulva intestinalis</i> (Linnaeus) Nees		⚙
<i>Valonia aegagropila</i> C. Agardh	★	⚙
Brown algae (Division Phaeophyta)		
<i>Dictyota</i> sp.		⚙
<i>Lobophora variegata</i> (Lamouroux) Womersley ex Oliveira	★	
<i>Padina australis</i> Hauck		⚙
<i>Padina minor</i> Yamada		⚙
<i>Sargassum</i> sp.	●	●
Red algae (Division Rhodophyta)		
<i>Acanthophora spicifera</i> (Vahl) Borgesen	●	●
<i>Amphiroa fragilissima</i> (Linnaeus) Lamouroux	●	●
<i>Ceramium</i> sp.		⚙
<i>Galaxaura oblongata</i> (Eiils & Solandar) Lamouroux		⚙
<i>Gelidiella acerosa</i> (Forsskal) Feldmann & Hamel	●	●
<i>Gracilaria salicornia</i> (C. Agardh) Dawson	●	●
<i>Hydropuntia edulis</i> (S. G. Gmelin) P. C. Silva	●	●
<i>Hypnea cervicornis</i> J. Agardh		⚙
<i>Laurencia papillosa</i> (C. Agardh) Greville	●	●
<i>Laurencia</i> sp.	●	●
<i>Pterocladia</i> sp.		⚙
Total	12	20

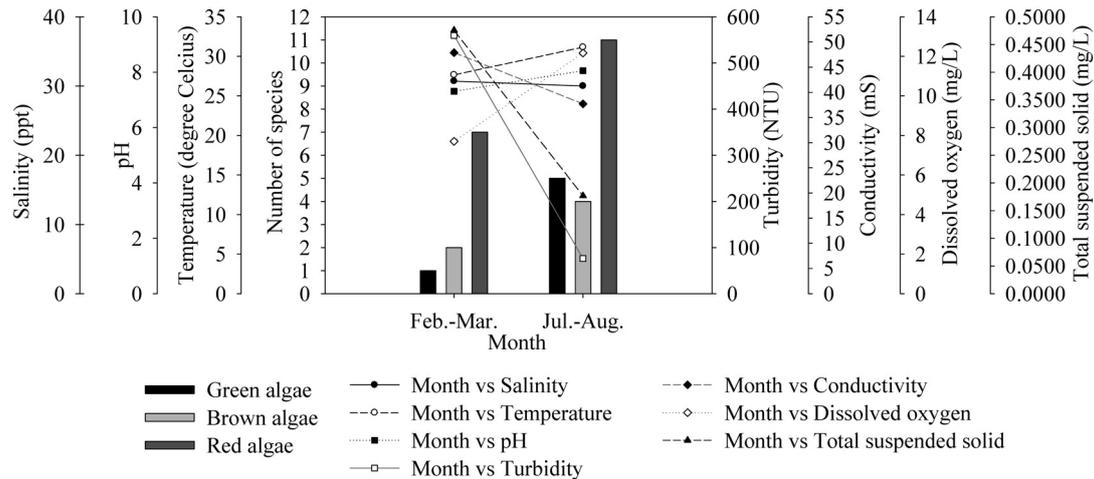


Fig. 2. Fluctuation of seawater parameters at the site and macroalgae species changes during Feb.–Mar. and Jul.–Aug. 2008.

distribution of the macroalgae during the two peaks of wet period as the differences of those environmental factors were non-significant (Fig. 2). However, the turbidity, conductivity and total suspended solid of surrounding seawater of study site showed high values in Feb.–Mar. and decreased values in Jul.–Aug. while dissolved oxygen values showed the reverse trend. The combined effect of high values in turbidity and total suspended solids (Fig. 2) resulted in low light conditions in the months of Feb.–Mar. and thus excluded several macroalgae species (Table 2) from the site. Hence the number of species recorded during the first peak of wet period was comparatively less when compared to the second peak. It has been reported that the presence of species in a certain habitat is also dependent on their ability to adapt or tolerate the synergistic of effects of the different ecological factors in the environment (Alderdice 1972, Newell 1979, Trono 1997, 2004).

Macroalgal coverage

Based on Table 3, the maximum mean coverage in the Division Chlorophyta was represented by *Valonia aegagropila* with 48% and the minimum mean coverage of 0.19% by *Anadyomene plicata* during Feb.–Mar. For the second peak wet period during Jul.–Aug., the maximum mean coverage of 75% was shown by *Ulva intestinalis* which was absent during the previous wet period while the minimum coverage of 0.75% was by *Acetabularia major* and *Cladophora prolifera*.

In the Division Phaeophyta, *Sargassum* sp. attained both maximum and minimum mean coverage of 66.75% and 0.19% respectively during the first peak of wet period while *Padina minor* with 36.75% and 0.19% respectively during the second peak.

In the Division Rhodophyta, *Gelidiella acerosa* had the maximum mean coverage of 57.75% while *Acanthophora spicifera* had the least with 0.19% during Feb.–Mar. However, in Jul.–Aug., *Acanthophora spicifera* scored the maxi-

Table 3. Maximum and minimum coverage (%) for macroalgae during the two peaks of wet period. * Macroalgae species observed outside the sampled quadrat.

Macroalgae species	Feb.–Mar.		Jul.–Aug.	
	% cover min	% cover max	% cover min	% cover max
Green algae (Division Chlorophyta)				
<i>Acetabularia major</i>			0.75	75.00
<i>Anadyomene plicata</i>	0.19	0.19	7.50	7.50
<i>Avrainvillea obscura</i> *				
<i>Cladophora prolifera</i>			0.75	2.63
<i>Ulva clathrata</i> *				
<i>Ulva intestinalis</i>			1.50	75.00
<i>Valonia aegagropila</i>	1.50	48.00		
Brown algae (Division Phaeophyta)				
<i>Dictyota</i> sp.*				
<i>Lobophora variegata</i>	0.75	0.75		
<i>Padina australis</i> *				
<i>Padina minor</i>			0.19	36.75
<i>Sargassum</i> sp.	0.19	66.75	0.94	19.31
Red algae (Division Rhodophyta)				
<i>Acanthophora spicifera</i>	0.19	0.75	0.38	60.00
<i>Amphiroa fragilissima</i>	0.75	21.75	3.75	3.75
<i>Ceramium</i> sp.			3.00	3.00
<i>Galaxaura oblongata</i> *				
<i>Gelidiella acerosa</i>	0.75	57.75	0.75	33.00
<i>Gracilaria salicornia</i>	0.75	6.38	0.75	29.25
<i>Hydropuntia edulis</i>	0.75	21.00	0.75	11.25
<i>Hypnea cervicornis</i> *				
<i>Laurencia papillosa</i>	0.94	1.69	0.38	49.50
<i>Laurencia</i> sp.	0.75	51.94	0.38	47.25
<i>Pterocladia</i> sp.			4.50	4.50

imum mean coverage of 60%. The minimum mean coverage was observed for *Acanthophora spicifera*, *Laurencia papillosa* and *Laurencia* sp.

As indicated by the mean coverage, there is no distinct

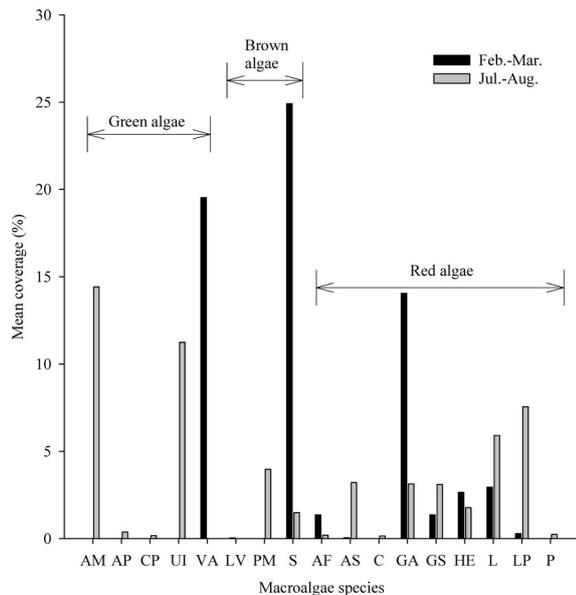


Fig. 3. Mean coverage (%) of macroalgae for Feb.–Mar. and Jul.–Aug. 2008 in inter-tidal rocky shore of Kuala Similajau comprising green algae (AM-*Acetabularia major*, AP-*Anadyomene plicata*, CP-*Cladophora prolifera*, UI-*Ulva intestinalis*, VA-*Valonia aegagropila*), brown algae (LV-*Lobophora variegata*, PM-*Padina minor*, S-*Sargassum* sp.), and red algae (AF-*Amphiroa fragilissima*, AS-*Acanthophora spicifera*, C-*Ceramium* sp., GA-*Gelidiella acerosa*, GS-*Gracilaria salicornia*, HE-*Hydropuntia edulis*, LP-*Laurencia papillosa*, L-*Laurencia* sp.).

trend in domination with respect to a particular species between the two peaks of wet period. The dominations were variable with species and occurred at different times of the year (Lirman and Biber 2000). However, based on the number of mean coverage contributed by the species, categorically this can be represented as Division Rhodophyta > Division Chlorophyta > Division Phaeophyta (Table 3, Fig. 3). This pattern is attributed to a higher number of species in the Division Rhodophyta inhabiting the available hard substrates for attachment. Similarly, in other parts of the world, e.g. shallow warm marine environments of tropical and sub-tropical areas distributed in both inter-tidal and sub-littoral zones, many of the macroscopic marine algae are members of Rhodophyta (Pritchard and Bradt 1984).

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