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Flats at Cape Rachado, West Coast Peninsular Malaysia**

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ABSTRACT

Three sites on the fringing coral reef flats at Cape Rachado, West Coast Peninsular Malaysia, were selected for the study of seaweed diversity and abundance. Each of these sites was identifiable with exposure to a particular environmental stress. Site A suffered from heavy loads of total suspended solids (TSS) caused by the removal of its adjoining coastal mangrove stand. Site B, by virtue of its accessibility and location on a popular stretch of beach, received a greater number of swimmers and beach-walkers. Water effluent (sewage) outlets from the various resorts lining the coast were observed at sites A and B. Site C was the least exposed to anthropogenic disturbance because of its location further out, at the face of the promontory. The primary objective of this study was to determine the diversity and abundance of the seaweed community at these three sites in relation to water quality parameters. These included temperature, pH, salinity, DO, ammoniacal nitrogen ($\text{NH}_3\text{-N}$), dissolved orthophosphate (O-PO_4), and total suspended solids (TSS). The sub-objectives were to compare the results of this present study to those of the first study conducted at Cape Rachado in 1987/88, to identify the possible causes of changes, and to make recommendations for the management of the coral reef ecosystem with emphasis on the seaweed community. The method employed in the sampling of seaweeds was the line-transect and systematic quadrat-sampling method. Quadrats were placed systematically along each transect at a distance of 10 m apart. All algal material with holdfasts lying within the 0.09 m^2 quadrat was removed for identification. The phycological analysis in this study was of species composition, species richness, the Shannon index of diversity (H'), the Evenness Index (J), seaweed dry weight biomass, Sorensen's index of similarity (S), seaweed functional morphologic

grouping, species frequency, species dominance and the importance value index (IVI). A total of 81 species was found at Cape Rachado (site A: 54 species; site B: 35 species; site C: 69 species), of which the Rhodophyta constituted the majority. The water quality of site C appears to support a richer, more diverse and evenly spread seaweed community, and with the greatest biomass. In contrast, the seaweed community at site A was the poorest in diversity, evenness and biomass, a condition suggested to be attributed to the high TSS concentration in the waters of this site. *Sargassum baccularia* was the most important species in terms of frequency and dominance at all three sites. The comparative analysis of the survey of 1987/88 and 1998 showed that all sites had changed significantly in terms of seaweed composition, richness, diversity, evenness and biomass, in varying degrees. The clearest change, however, was the significant increase in species richness at all three sites in 1998, thus arguing for a possible general increase or recruitment of seaweed species at Cape Rachado in the past decade. However, the seaweed community of site A had diminished in terms of biomass and species evenness (J), whilst site C had significant gains in both species richness and diversity (H'). *Sargassum oligocystum*, the dominant species found in the survey of 1987/88 was not recorded in the present survey. Instead, *Sargassum baccularia* was found to dominate the seaweed flora in the survey of 1998. In terms of water quality, the high TSS load caused by land clearing at site A a decade ago had not been significantly alleviated, and thus, TSS load control was the most important recommended management step for this site.

ABSTRAK

Tiga buah tapak di terumbu karang pinggiriran Cape Rachado, Pantai Barat Semenanjung Malaysia, telah dipilih bagi tujuan mengkaji kepelbagaian dan kelebatan komuniti rumpair laut. Setiap satu tapak tersebut mengalami tekanan alam sekitar yang tersendiri. Tapak A, akibat daripada penebangan pokok-pokok bakau di kawasan pinggirannya, menerima beban jumlah pepejal terampai (TSS) yang tinggi. Tapak B pula sering dikunjungi oleh para pelawat dan perenang oleh kerana lokasinya di depan sebuah pantai yang popular. Ia juga terletak di bahagian terumbu karang yang amat mudah ketersampaiannya. Tapak C terletak jauh di depan sebuah tanjung dan oleh kerana itu, tidak begitu terdedah kepada gangguan antropogenik berbanding dengan dua tapak yang lain. Objektif utama kajian ini adalah untuk menentukan kepelbagaian dan kelebatan rumpair laut yang ada pada terumbu karang di ketiga-tiga tapak tersebut, berhubungan dengan beberapa parameter kualiti air yang tertentu. Di antara parameter-parameter ini adalah suhu, pH, saliniti, oksigen terlarut, ortofosfat terlarut, nitrogen amoniakal dan jumlah pepejal terampai (TSS). Kajian ini juga mempunyai tiga sub-objektif, iaitu untuk membandingkan hasil-hasil kajian tahun 1998 dengan hasil-hasil kajian awal yang dibuat di lokasi yang sama pada tahun 1987/88; untuk mencari sebab-sebab perubahan yang berlaku; serta membuat cadangan mengenai pengurusan ekosistem terumbu karang Cape Rachado, dengan penekanan ke atas komuniti rumpair laut. Rumpair-rumpair laut telah dikutip dengan menggunakan transek lurus dan persampelan kuadrat secara sistematik. Kuadrat bersaiz 0.09 m^2 diletakkan di sepanjang setiap transek dengan jarak sejauh 10 m di antara setiap kuadrat. Segala rumpair-rumpair laut yang terletak di dalam kuadrat dikutip untuk dikenalpasti di makmal. Analisis fikologi yang seterusnya melibatkan

penentuan komposisi spesis, jumlah spesis, indeks kepelbagaian Shannon (H'), indeks keseragaman spesis (J), jisim bio rumpair laut, indeks kesamaan Sorensen (S), kumpulan fungsi-morfologi, frekuensi, kedominan dan indeks nilai kepentingan spesis (IVI). Sejumlah 81 spesis rumpair laut didapati di Cape Rachado (tapak A: 54 spesis; tapak B: 35 spesis; tapak C: 69 spesis). Kebanyakan daripada spesis-spesis ini terdiri daripada jenis Rhodophyta. Kualiti air di tapak C nampaknya dapat menyokong komuniti rumpair laut yang lebih tinggi dari segi jumlah, kepelbagaian (H') dan keseragaman (J) spesis, serta dengan bio jisim yang lebih besar. Komuniti rumpair laut di tapak A pula mempunyai kepelbagaian (H') dan keseragaman spesis (J) yang paling rendah. Jisim bio komuniti di sini juga lebih kecil. Keadaan ini mungkin disebabkan oleh jumlah pepejal terampai (TSS) yang jauh lebih tinggi. *Sargassum baccularia* merupakan spesis rumpair laut yang paling penting dari segi frekuensi dan kedominan di ketiga-tiga tapak kajian ini. Apabila kedua-dua buah kajian 1987/88 dan 1998 dibandingkan, didapati bahawa semua tapak telah mengalami perubahan dari segi komposisi, jumlah, kepelbagaian (H'), keseragaman (J) dan jisim bio komuniti rumpair laut. Perubahan yang paling jelas ialah pertambahan bilangan spesis di ketiga-tiga tapak tersebut sejak 10 tahun yang lalu. Tambahan pula, *Sargassum baccularia* merupakan spesis yang paling dominan di dalam kajian 1998, berbanding dengan *S. oligocystum* yang menjadi spesis dominan di dalam kajian 1987/88. Perubahan-perubahan yang lain termasuklah keadaan komuniti rumpair laut di tapak A yang telah merosot dari segi keseragaman spesis (J) dan bio jisim, manakala tapak C jelas sekali telah mengalami pertambahan di dalam bilangan dan kepelbagaian spesis (H'). Dari segi kualiti air pula, masalah utama adalah masalah kandungan TSS yang tinggi di dalam perairan tapak A. Kandungan TSS di sini tidak berbeza secara statistik daripada kandungan yang tercatat di dalam kajian 1987/88 dan ini

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LIST OF ABBREVIATIONS

Fig.	Figure
DO	Dissolved oxygen
NH ₃ -N	Ammoniacal nitrogen
O-PO ₄	Dissolved orthophosphate
S.D.	Standard deviation
PFD	Photon flux density
ANOVA	Analysis of variance
APHA	American Public Health Association
UV	Ultra violet
PCA	Principal Components Analysis
Max	Maximum
Min	Minimum
Mly	Monthly mean
SG	Sheet group
F	Filamentous group
CB	Coarsely branched group
TL	Thick-leathery group
JC	Jointed calcareous group
C	Crustose group
LOG_PH	pH (log transformed)
LOG_SALT	Salinity (log transformed)
LOG_TSS	TSS (log transformed)
LOG_SP	Species richness (log transformed)
LOG_H	Shannon index of diversity, H' (log transformed)
LOG_J	Evenness index, J (log transformed)
LOG_BIO	Dry weight biomass (log transformed)
875	May 1987
878	August 1987
8711	November 1987
8803	March 1988
GEF/UNDP/IMO	Global Environmental Fund/United Nations Development Program/International Maritime Organization