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HORIZONTAL VARIABILITY OF ORGANIC CARBON IN KERTEH MANGROVE FORESTS, MALAYSIA

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Abstract: Kandungan karbon organik pada tiga transek (TR1, TR2 dan TR3) di permukaan sedimen Hutan Paya Bakau Kerteh telah dianalisis dengan menggunakan kaedah pengoksidaan dikromat basah. Saiz partikel sedimen juga diukur di transek yang sama dengan menggunakan kaedah penyerakan laser – analisis saiz partikel (PSA). Purata kandungan karbon organik di TR1, TR2 dan TR3 masing-masing adalah 3.22 ± 0.19%, 3.87 ± 0.19% dan 4.73 ± 0.59%. Manakala nilai purata saiz partikel adalah 3.99 ± 0.22ϕ, 4.20 ± 0.34ϕ dan 4.69 ± 0.28ϕ. Dalam kajian ini, karbon organik didapati mempunyai hubungan yang signifikan ($P < 0.05$) terhadap partikel saiz, yang mana kandungan karbon organik akan meningkat dengan peningkatan nilai min saiz partikel.

Kata kunci: Hutan Paya Bakau Kerteh, Min Saiz Partikel, Karbon Organik

Abstrak: The organic carbon content at three transects (TR1, TR2 and TR3) in Kerteh Mangrove Forest surface sediments were analyzed using the wet dichromate oxidation method. The sediment particle size at the same transects were also measured with the laser diffraction method – particle size analyses (PSA). The average concentration of organic carbon at TR1, TR2 and TR3 were 3.22 ± 0.19%, 3.87 ± 0.19% and 4.73 ± 0.59%, respectively. Meanwhile their average mean grain size were 3.99 ± 0.22ϕ, 4.20 ± 0.34ϕ and 4.69 ± 0.28ϕ. In this study, the carbon organic showed a significant relationship with the mean sediment size ($P < 0.05$), with the organic carbon content increase with the increase of mean size values.

Keywords: Kerteh Mangrove Forest, Mean Particle Size, Organic Carbon

INTRODUCTION

Mangrove forest is a buffer zone between the coast and the ocean. Mangroves are woody, seed-bearing, highly specialized plants and are found along sheltered intertidal coastlines of estuaries and lagoons. Mangrove trees possess unique adaptations which enable them to thrive in an environment where other plants cannot grow. In terms of their biological and chemical aspects, mangrove forests are highly productive source of organic matter, from which there is a net outwelling of energy that supports the complex estuarine and near shore food

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web (Ewel *et al*. 1998). They play an important role as a filter and natural pollution treatment centre because of the specialty of its root system that manage to control the water quality and trap the sediments as well as particulates which are transported by the current into the oceans from the estuaries (Clark 1997). According to Woodroffe (1992) and Ong (1993), the dynamics of sedimentary carbon in mangrove forests is poorly understood, with no complete budgets on sediment accumulation, mineralization and burial of organic carbon. This is unfortunate because mangrove forests constitute one of the most productive ecosystems along tropical coast, and such information is needed to ameliorate the uncertainty of carbon fluxes, particularly in intertidal habitats that may be greatly affected by the changes in sea-level as a result of climate change (Alongi *et al*. 2001).

Although there have been many studies on the distribution of particulate organic carbon in suspended matter, in sea water and the bottom sediments in South China Sea and adjacent seas (Ichikawa *et al*. 1987; Muller 1977), data on the coastal water and intertidal areas of Malaysia are still limited. In view of the importance of the mangrove to various aspects of the environment, research on the horizontal distribution of organic carbon in sediment was carried out.

MATERIALS AND METHODS

Sampling Sites

The Kerteh Mangrove Forest is located in the Dungun district, on the east coast of Peninsular Malaysia (Fig. 1). The study areas have a diverse ecosystem, with utilizable natural resources, vast array of biological diversity, and coastal and riverine fishing activities. The study area lies in the wet tropics where high rainfall is recorded in the monsoon season which normally begins from the month of November and ends by the month of January. A total of 40 surface sediment samples were obtained in Kerteh River along three transects (TR1, TR2 and TR3). 14 sampling station points along each transect were set up and the surface sediment was obtained by gently scrap the surface sediment using the perspex of approximately 1–2 mm thickness.

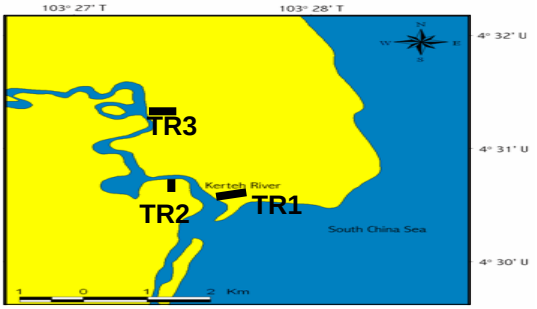

Figure 1: Location of transects (TR1, TR2 and TR3) in Kerteh Mangrove Forest, Malaysia.

Analytical Method

Total Organic Carbon (TOC) Analysis
The organic carbon in this study was determined using the wet dichromate method of Holme and McIntyre (1984). Briefly, about 0.5 g sediment samples were weighted in the tin crucible sample boats and burnt in the furnace for 30 min at temperature 900^{o}C. The samples were then titrated with iron(II) sulfate. The volume of iron(II) sulfate that had been used was recorded. Finally, the percentages of organic carbon that present in the samples were calculated by using a formula as shown below:

$$\% \text{ of organic carbon } = \frac{\left(V_1 - V_2 \times 0.003 \times 100\right)}{\text{Weight of sample (mg)}}$$

where, V_1 is the volume of dichromate and V_2 is the volume of iron(II) sulfate that has been used for titration (ml). The precision assessed by replicate analyses was within 3%. The accuracy was also examined by analyzing, in duplicate a Reference Materials of glucose and the results coincided with the certified values within a difference of ± 3%.

Sediment characteristic analysis
For the sediment characteristic analysis, surface sediment at all sampling points along each transects were collected during low tides. As sedimentological patterns are related to inorganic components of sediment, the organic components were first removed by adding 20% hydrogen peroxide (H_2O_2) solution to the samples. The floc of finer particles was destroyed by adding a dispersing agent (5% calgon solution). Sediments collected composed of mostly (80% by weight) fine sediments, while is still within the detection limit of the laser diffraction machine. Thus, sediment grain size was analyzed using the laser diffraction method only. The grain size is expressed in phi (ϕ) units defined by $\phi = -\log_2 d$ where d is a diameter of grain in mm. The mean, standard deviation and skewness of each sample were calculated by the moments method using equations defined by McBride (1971). The method of moments uses data from every grain plot data to obtain statistical information concerning the sedimentary population.

RESULTS AND DISCUSSION

The decomposition of organic matter in mangrove sediments has been widely studied (Alongi *et al*. 2001). Their sedimentary organic content especially in Malaysia mangroves is not well-known and only a few studies have been documented (Alongi 1998). Details of organic carbon concentration at all transects in Kerteh were shown in bar graph (Fig. 2). Using the one-way ANOVA statistical test, the concentration of organic carbon varied significantly ($P < 0.05$) within the sampling stations of all transects. In this study, TR3 has relatively

higher average percentage of organic carbon content (4.73%) and ranged from 4.03% to 5.92%. Meanwhile, TR2 has average value of 3.87% and ranged from 3.60% to 4.18%, and TR1 has average 3.22% and ranged from 3.05% to 3.85%. However, the overall average concentrations of organic carbon recorded in this study were generally comparable to and/or below the values reported by other scientists in other mangrove areas (Lallier *et al*. 1998; Soto & Paez-Osuna, 2001).

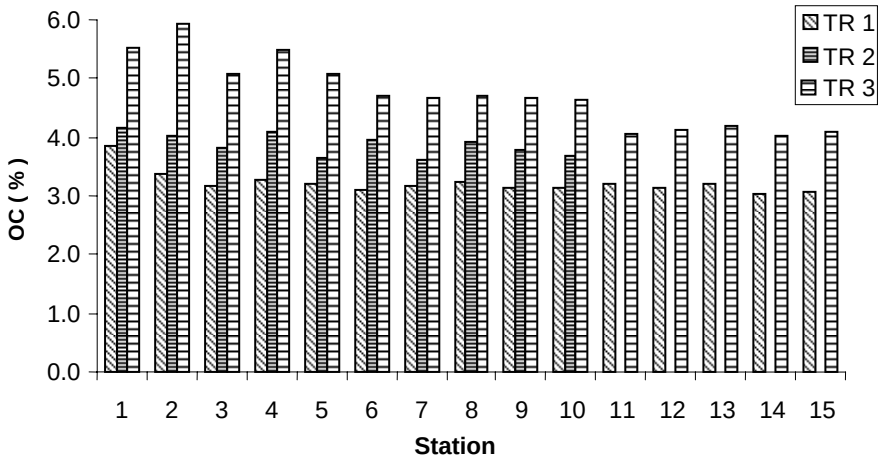

Figure 2: Distribution of organic carbon content TR1 (15 sampling points), TR2 (10 sampling points) and TR3 (15 sampling points) showing a relatively higher value at mangrove areas near river (sampling point 1).

In these study areas, particle mean size ranged from 3.71ϕ to 5.26ϕ with the average of 4.30 ± 0.40ϕ. Those enormous amounts of fine sediments which are transported by the river, increasing the adsorbing surface of organic materials. As reported by Jamil (2002), there was a positive correlation between grain size and the organic carbon concentrations, suggesting the influence of the fine fraction in their incorporation into the sediments. In this study, the organic carbon concentration also shows a strong correlation (r = 0.7) with mean size (Fig. 3). Sediments at TR3 which has relatively higher percentage of silt and clay content than TR1 and TR2, showing relatively higher organic carbon concentrations. This may probably due to the denser of trees and well-developed structure of roots system in TR3. Furthermore, the prevalent hydrodynamics and the presence of mangrove roots, which are well-developed in TR3 will retained this fine fraction. At other transects, the lower organic carbon concentrations were accompanied by a similar increase in the percentage of sands. The high percentage of fine fraction in sediments from other transects was due to the deposition of alluvium which gradually declined from the upper lagoon to the mouth river. The swift river flow allow little fine sediment to deposit but this flow is reduced drastically upon reaching the larger estuary thus allowing finer sediment to be deposited. This may also indicated that the particle transport in the study area is mainly influenced by river discharge.

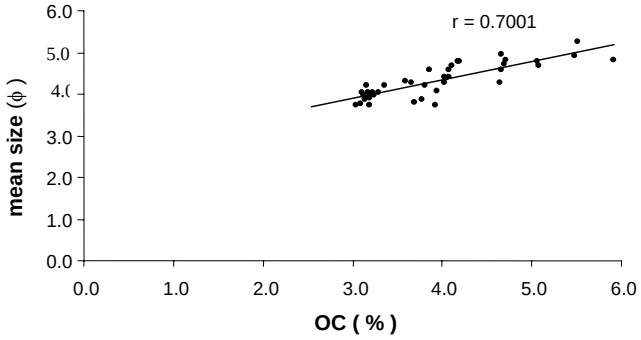

Figure 3: Correlation of organic carbon concentration (%) and mean size (ϕ) in the study area.

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