

## Factors Affecting Variability of Heterotrophic and Phototrophic Microorganisms at High Water in a Mangrove Forest at Cape Rachado, Malaysia

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**ABSTRACT** We sampled hourly, surface water in a mangrove forest at Cape Rachado, Port Dickson (in the Straits of Malacca) on four occasions (4 January, 18 April, 25 July and 29 December, 2003). Water level in this intertidal zone was between 0.3 and 1.6 m. Seawater temperature ranged 28 – 33°C whereas salinity ranged 25 – 33. Dissolved oxygen (DO) concentration was low ranging between 110 and 270  $\mu\text{M}$ , and reflected a reducing environment (as shown by the negative redox potential, –40 to –70 mV). Chlorophyll *a* (Chl *a*) varied between 0.80 – 7.0  $\mu\text{g L}^{-1}$  whereas ammonium, nitrite, nitrate, phosphate and silicate ranged 0 – 6.50  $\mu\text{M}$ , 0.10 – 0.80  $\mu\text{M}$ , 0.50 – 4.40  $\mu\text{M}$ , 0 – 6.70  $\mu\text{M}$  and 8.79 – 27.27  $\mu\text{M}$ , respectively. For biotic variables, phototrophic picoplankton abundance was relatively stable, ranging between 1.8 – 14.6  $\times 10^5$  cells  $\text{mL}^{-1}$  whereas bacterial abundance was about one order higher, ranging 0.5 – 28.4  $\times 10^6$  cells  $\text{mL}^{-1}$ . Using principal component analysis, we found that the physical condition of the water could account for both Chl *a* and phototrophic picoplankton variation whereas inorganic nitrogen was important for phototrophic picoplankton. We also showed through nutrient limitation study that phytoplankton was limited by both P and Si. Bacterial abundance correlated significantly with Chl *a* ( $R^2=0.288$ ,  $n=29$ ,  $p<0.01$ ) indicating bacteria–phytoplankton coupling.

**ABSTRAK** Kami menyampel air setiap jam, dari permukaan air paya bakau di Teluk Rachado, Port Dickson (sepanjang Selat Melaka) sebanyak empat kali (4 Januari, 18 April, 25 Julai dan 29 Disember, 2003). Paras air di zon inter-tidal ini adalah antara 0.3 dan 1.6 m. Suhu air laut adalah antara 28 – 33°C manakala saliniti adalah antara 25 – 33. Kepekatan oksigen terlarut adalah rendah, dengan julat antara 110 dan 270  $\mu\text{M}$ , dan menggambarkan keadaan penurunan (seperti yang ditunjukkan oleh potensi redoks negatif, antara –40 dan –70 mV). Klorofil *a* (Chl *a*) adalah antara 0.80 – 7.0  $\mu\text{g L}^{-1}$  manakala ammonia, nitrit, nitrat, fosfat dan silikat adalah antara 0 – 6.50  $\mu\text{M}$ , 0.10 – 0.80  $\mu\text{M}$ , 0.50 – 4.40  $\mu\text{M}$ , 0 – 6.70  $\mu\text{M}$  dan 8.79 – 27.27  $\mu\text{M}$ , masing-masing. Bagi variabel biotik, kelimpahan pikoplankton fototrofik adalah agak stabil, antara 1.8 – 14.6  $\times 10^5$  sel  $\text{mL}^{-1}$  manakala kelimpahan bakteria adalah lebih kurang satu order lebih tinggi, antara 0.5 – 28.4  $\times 10^6$  sel  $\text{mL}^{-1}$ . Menggunakan analisa komponen prinsipal, kami mendapati bahawa keadaan fizikal air boleh menjelaskan variasi pada kedua-dua Chl *a* dan pikoplankton fototrofik. Nitrogen inorganik pula adalah penting untuk pikoplankton fototrofik. Kami juga menunjukkan melalui kajian penghad nutrien bahawa fitoplankton dihadkan oleh kedua-dua P dan Si. Kajian kami juga mendapati ada korelasi signifikan di antara kelimpahan bakteria dengan Chl *a* ( $R^2=0.288$ ,  $n=29$ ,  $p<0.01$ ), menunjukkan kaitan antara bakteria–fitoplankton.

(nutrient limitation for phytoplankton; bacteria–phytoplankton coupling; principal component analysis; Straits of Malacca)