CHAPTER 3

3. Environmental Parameters

3.1 Introduction

Mangroves grow along shores in almost all estuaries, deltas, backwaters, creeks and other protected areas in the tropics. The distribution of animals within mangrove forest has been defined in terms of habitats (Golley *et al.*, 1962) and in terms of environmental gradients within habitats (Macnae, 1968 and Macnae and Kalk, 1962).

Macnae (1968) concluded that since animals show no marked zonation, but rather a preference for a particular type of habitat, the fauna is in reality associated with mangroves. He found that the distribution of animals depends upon their resistance to water loss, their demand for protection from the surface level of the water table, the degree of consolidation of the soil and the existance of microflora and microfauna or organic debris as a food source (Macnae and Kalk, 1962). Pinto (1987) and Walsh (1967), reported similar results for the mangrove forests of Hawaii and Pagbilao, Philippines respectively, and held the opinion that the zonation of animals depends largely upon salinity differences, oxygen gradients and structure of the substratum.

Salinity as a limiting factor in the distribution of several marine invertebrates is well known. Animals in mangroves habitats acquire a certain degree of euryhalinity as an insurance against fluctuating environment conditions (Delamare-Deboutteville, 1960). Carter (1973) showed that the gross primary productivity of black and white mangroves increased with increasing salinity.

The importance of temperature for animal distribution in mud flats is also emphasized by ecologists. Choudhury *et al.* (1984) found that major groups of macrobenthos including fish and prawn exhibit population fluctuations both at the species level and at the community level, in response to seasonal changes in salinity and temperature.

Tidal inundation also effects the distribution of fauna in mangrove creeks. Temperature and salinity were affected by tides. Temperature was observed to decrease with the incoming tide, but for salinity there was a reverse correlation (de Leon *et al.*, 1989). Different tidal ranges play an important role in the distribution of mangrove species (Nateewathana and Tantichodok, 1984). Another climatic factor that is of importance is rainfall pattern.

This study examined the environmental parameters prevailing in mangrove creeks. Eight measurements of each

parameter were taken randomly at each site during sampling hours. Environmental parameters measured were salinity, dissolved oxygen and water temperature. Rainfall and tidal data were based on those for the town of Klang. Rainfall data were taken from Meteorological Department and tidal data from Tides Table for Malaysia (1992 and 1993).

3.2 Materials and Methods

3.2.1 Water Conditions

(a) Salinity

Salinity at each site was recorded using a refractive salinometer (American Optical Instruments Co.)

(b) Dissolved Oxygen

Dissolved oxygen was recorded using YSI Dissolved Oxygen Meter Model 57.

(c) Temperature

Water temperature was estimated using YSI Dissolved Oxygen Meter Model 57.

3.2.2 Rainfall Patterns

The rainfall data (September 1992 until September

1993) for Port Klang was obtained from the Meteorological Department, Petaling Jaya, Selangor. Port Klang is 4.5 km away from the study area.

3.2.3 Tidal Data

There are two low and two high tides of different heights each day with spring and neap periods per lunar month (Sasekumar, 1974). Tidal graphs were prepared for September 1992 until September 1993, based on Tide Table Predictions for Malaysia (1992 and 1993) at Port Klang.

3.3 Results

3.3.1 Water Conditions

Table 1 showed the environmental parameters recorded during high tide at each study site. Data collected showed that there was not much difference in water conditions between the study sites.

(a) Salinity

Salinity fluctuated in sites I, II and III. Site III recorded a range of 15.0-28.0 ppt., whereas at Sites I and II had the same range of 14.2 to 28.0 ppt. (Table 1).

Table 1 : Environmental parameters of the study sites during high tide in the mangrove creek, Sungai Sementa Kecil, Selangor during 1992 and 1993.

		Site	
Parameter Range	I	II	III
Temperature (^{0}C)	29.0 - 34.0	28.0 - 33.0	29.0 - 33.0
Salinity (s x 10^{-3})	14.2 - 28.0	14.0 - 28.0	15.0 - 28.0
Dissolved Oxygen (D.O. x 10^{-6})	4.5 - 4.6	4.5 - 4.6	4.6

(b) Dissolved Oxygen

Data obtained during this study showed that dissolved oxygen for both Sites I and II were similar and ranged from 4.5 to 4.6 mg/l. Site III recorded a concentration of 4.6 mg/l (Table 1).

(c) Temperature

Water temperature at Site I ranged from 29.0 to 34.0°C (Table 1). At Site II, it ranged from 28.0 to 33.0°C. Site III showed water temperatures which ranged from 29.0 to 33.0°C. Site I showed the highest water temperature compared to the Sites II and III (33°C).

3.3.2 Rainfall Pattern

The monthly rainfall pattern for the period of sampling is shown in Figure 2. The maximum monthly rainfall recorded in Port Klang was in December 1992 with 297.8 mm. This month also showed the maximum number of rain days (23 days). November 1992 and March 1993 also recorded high monthly rainfall of 263.8 mm and 278.0 mm respectively. Port Klang experienced minimum monthly rainfall in February, May and July 1993 (89.4, 82.7 and 87.3 mm

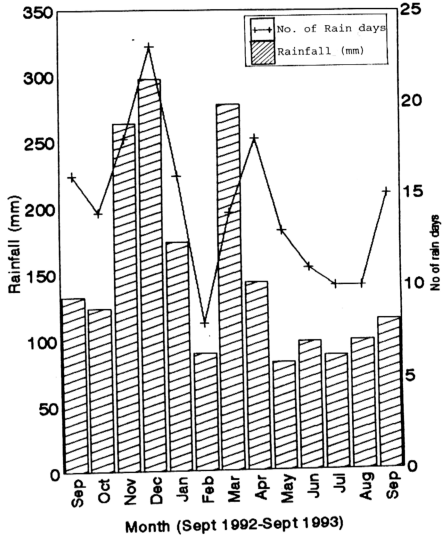

Figure 2.0 : Monthly rainfall and number of rain days for the months during the period of study.

respectively).

3.3.3 Tidal Data

Tidal graphs were prepared for the sampling period as shown in Figure 2.1. August and September 1993 experienced the highest tide levels (5.6 m and 5.8 m respectively). Rest of the months showed tide levels ranging from 4.5 m to 5.3 m. Low tide levels on every sampling occasions ranged from 0.3 m to 1.8 m.

3.4 Discussion

Mangrove environment is characterized by a large amount of organic detritus and an exposure to diurnal and seasonal variation of physico-chemical conditions (Prawin, 1984). Physico-chemical properties of mangrove water contribute to the characteristics of mangrove soils, which in turn influences the distribution of plant species in the forest (Odum and Heald, 1972). This ultimately affects the distribution of fauna as a major consumer (Prawin, 1984).

There were no significant differences in the environmental parameters observed in the three study areas except for dissolved oxygen (Table 2). This parameter

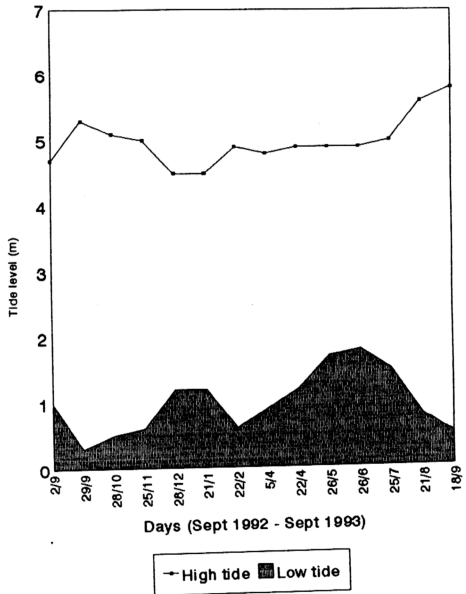

Figure 2.1. Tide levels during sampling days in Sungai Sementa Kecil.

Table 2.0 : Analysis of variance for environmental parameters in three study sites (Sites I, II and III) during 1992 and 1993.

Parameter	F-Ratio	Degrees of freedom	Significance level	N.S/S
Dissolved Oxygen	4.74	2, 21	P(0.02) < 0.05	S
Salinity	0.94	2, 21	P(0.41) > 0.05	N.S
Temperature	1.81	2, 21	P(0.19) > 0.05	N.S

N.S - Not significant

S - Significant

differed between site I and site III and between site II and site III. No differences were found between site I and site II since these two sites showed the similar oxygen's values. Leh and Sasekumar (1989) also recorded similar values for dissolved oxygen in Sungai Sementa Kecil. This parameter did not fluctuate widely.

The lower value of dissolved oxygen may be due to microbiological oxygen consumption. This may reflect the rate of degradation of suspended organic compounds in the water (Prawin,1984). Consequently, increase in decomposition activities may increase dissolved oxygen consumption by microorganisms (Hynes,1971). Dissolved oxygen from site I and site II did not show any differences. Both sites were located near each other (Table 3). Site III was furthest from the open sea (Fig. 1). The value of 4.6 mg/l was the only record for dissolved oxygen in the site (Table 1). In the tropical seas, a dissolved oxygen level between 0.3-3.0 ppm. is considered too low for marine life. The optimum range should be between 3.5 to 5.0 ppt. However during spawning season, living organisms need more oxygen up to values up to 6.0 ppm. (Saraya, 1984).

Salinities fluctuated widely in sampling areas near the open sea (Prawin, 1984). Water flowed from the river outside the mangrove forest during neap tide would decrease water salinities. Salinity regimes in the Strait of

Table 3.0 : Analysis of variance for dissolved oxygen in three study sites (I,II and III) during 1992 and 1993.

Parameter	F-Ratio	Degrees of freedom	Significance level	N.S/S
Dissolved oxygen	4.74	2, 21	P(0.02) < 0.05	S

N.S - Not significant
S - Significant

Multiple Range Analysis
Method : 95 percent LSD Intervals.

Site	Homogeneous groups
II	X
I	X
III	X

Contrast sites	Limits
I - III	0.4468 *
II - III	0.4468 *

* - denotes a statistically significant difference.

Malacca are related to the seasonal rainfall pattern (Selvarajah, 1961). High dilution after rainfall also reduced salinity (Chong, 1980). Data from Chong (1980) showed that salinities in mangrove inlets showed fluctuations between 21.0 and 32.0 ppt whereas salinities at Pulau Angsa (offshore) ranged from 28.0 to 32.0 ppt. But in this study, salinities in creeks (Sites I and II) nearer the sea showed smaller fluctuations compared to the creek (Site III) in the upper shore where wider salinity fluctuations occurred. Salinity also decreased following heavy rains (Pinto, 1987).

Chong *et al.* (1990) recorded a temperature range of 24.9°C to 27.8°C in mangrove creeks. This range was lower than that obtained in this study. Mariana (1993) recorded temperature ranges of 30°C to 33°C at the edge of mudflats. It is apparent water temperatures at the edge of the mudflat is similar to those in creeks.

Mangrove waters are slightly acidic (Pinto,1987). Boto and Bunt (1981) have shown that mangrove waters are rich in humic acid, fulvic acid, tannins and other polyphenolic substances derived from the litter which contributes to the acidity of the waters (Pinto and Wignarajah, 1980). There is positive correlation between pH and dissolved oxygen (Boto and Bunt, 1981). Environmental factors are only one aspect that determines faunal production especially

juvenile fish in the mangrove waterways. Biological factors such as population characteristics and predation would further affect the occurrence of juvenile fish (Pinto, 1987).

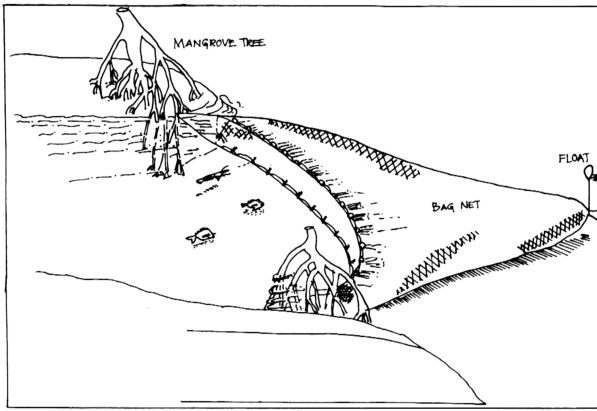

Figure 3.0 : The bagnet used for catching fish and prawns during the receeding tide at the mouth of small creeks.