CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

1.1 GENERAL INTRODUCTION

Marine science is a multidisciplinary field in which environmental chemistry has become increasingly important. Environmental chemistry is a mature viable discipline, as it combines the application of chemical principles to the challenges facing human kind today (Manahan, 1991).

Many chemical substances have been identified as pollutants in the marine environment. Heavy metals are one group of these chemicals, which could significantly affect marine resources. Further more, heavy metals can be bioconcentrated or biomagnified in marine organisms at different levels of the food chain in the marine ecosystem (Mhatre, 1991; Lobban and Harrison, 1994; Fereletta *et al.*,1996; Daffa, 1996). Heavy metals are bioconcentrated up the food chain and may ultimately be hazardous to man.

Due to the increase of man's activities all over the world, marine environments have been exposed to many kinds of stress over the last few decades. These stresses may increase the impact on the marine ecosystem and the resources as immediate and observed events or indirectly and after some time (Weetzel, 1992). Heavy metals enter marine ecosystems via two sources, either from natural and/or anthropogenic sources which could be land-based or sea based sources.

Heavy metals in seawater are generally classified into two categories from the biological standpoint, namely essential metals and non-essential metals. Essential metals such as manganese, iron, zinc and copper are considered essential metals, where an organism fails to grow or complete it's life cycle in their absence. On the other hand, essential metals like copper and zinc become toxic once their concentrations exceed those required levels by many folds (Lobban and Harrison,. 1994; Stromgren, 1996(a); 1996(b); Gledhill *et al.*, 1997; Correa *et al.*, 1999). Some metals in seawater that are not essential in the biological functions of the marine organisms are considered non-essential heavy metals. They also become toxic once their concentrations go beyond tolerable levels (El-rays and Ezzat, 1984; Wan and Zaharah, 1993; Lobban and Harrison, 1994).

The tragic disasters of the Minimata (1953-1960) and Nnigata (itai-itai) diseases (1965) caused by mercury and cadmium poisoning respectively have caused a great loss of human lives and serious impairment to many people. Consequently, attention was drawn to the significant harm of heavy metal toxicity.

The toxicity of heavy metals to humans, plants and animals are frequently reported. Numerous studies were conducted and many references have been published on heavy metal toxicity to marine organisms of various trophic levels (Shcheglov and Moiseichenko, 1991; Amado Filho *et al.*, 1997 ; Pistocchi *et al.*, 1997 ;Gledhill *et al.*,1997 ;1999). These studies indicated that, heavy metals could cause significantly adverse effects on the marine resources and environment and ultimately humans. Therefore, studies on the various aspects of heavy metals in

marine environments are becoming areas of increasing concern and viability (Ferelatta *et al.*, 1996)

Studies on heavy metals in marine ecosystems were carried out widely in different aspects, survey of metals in seawater (Powell *et al.*, 1995), in sediment (Balss *et al.*, 1997), in fauna (Moore *et al.*, 1993) and in flora (Riget *et al.*, 1997). On the other hand, many experimental studies concerning heavy metal uptake and metal toxicity have also been conducted (Amado Filho *et al* , 1996.; ;Pistocchi *et al* ., 1997 ; Phang *et al.* 1997).

The use of marine organisms as biological indicators in heavy metal monitoring programs may be advantageous. Biological monitoring expresses the relationship between chemical parameters measured in the biological media to past exposures to chemicals or physical factors (Hee, 1993). By using this technique researchers can overcome certain chemical, analytical and/or environmental problems during seawater and sediment analyses (Rainbow, 1995). However, more studies to confirm the validity of using certain marine biotic species as biological indicators is required, in order to meet the biological indicator criteria (Cairns *et al.*, 1993).

As a response to the declining coastal water quality in Malaysia due to rapid development during the past two decades, many studies regarding heavy metals in marine environment were carried out (Sivalingam, 1978; 1980; Din, 1992a;

marine environments are becoming areas of increasing concern and viability (Ferelatta *et al*., 1996)

Studies on heavy metals in marine ecosystems were carried out widely in different aspects, survey of metals in seawater (Powell *et al.*, 1995), in sediment (Balss *et al.*, 1997), in fauna (Moore *et al.*, 1993) and in flora (Riget *et al.*, 1997). On the other hand, many experimental studies concerning heavy metal uptake and metal toxicity have also been conducted (Amado Filho *et al* , 1996.; ;Pistocchi *et al* ., 1997 ; Phang *et al*. 1997).

The use of marine organisms as biological indicators in heavy metal monitoring programs may be advantageous. Biological monitoring expresses the relationship between chemical parameters measured in the biological media to past exposures to chemicals or physical factors (Hee, 1993). By using this technique researchers can overcome certain chemical, analytical and/or environmental problems during seawater and sediment analyses (Rainbow, 1995). However, more studies to confirm the validity of using certain marine biotic species as biological indicators is required, in order to meet the biological indicator criteria (Cairns *et al.*, 1993).

As a response to the declining coastal water quality in Malaysia due to rapid development during the past two decades, many studies regarding heavy metals in marine environment were carried out (Sivalingam, 1978; 1980; Din, 1992a;

Ramachandran *et al.*, 1994; 1995). Experimental studies were also, conducted in order to set up appropriate standards and criteria for Malaysian marine environment (Murugadas, *et al.*, 1995; Phang *et al.*, 1997; Melor, 1998). The available data and publications on Malaysian heavy metal studies are however relatively limited (Din, 1995).

1.2 SCOPE OF THE WORK

The present study was conducted to determine the distribution of selected heavy metals, namely copper, zinc, iron and lead in different biotic (seaweed, sea cucumber & soft coral) and abiotic (seawater & sediment) components of the coral reef ecosystem at Cape Rachado, west coast Peninsular Malaysia, with emphasis on the Phaeophyta species, over a period of 14 months. Chelex resin 100(200-400mesh size) was used for the separation and preconcentration of studied metals (Cu, Zn, Fe and Pb) from seawater. Wet digestion techniques were used for digestion of biotic and sediment samples prior to the instrumental analyses. Inductively coupled Plasma-Atomic Emission Spectrometer (ICP-AES) was used for measuring the total metal concentrations in the different samples.

1.3 IMPORTANCE OF THE STUDY

Cape Rachado the study site, is the only remaining fringing coral reef along the west coast of Peninsular Malaysia. The reef represents an interesting ecosystem with diverse flora (Phang, 1985; 1988; 1989; 1995) and fauna (Goh and Sasekumar,

1980). The reef ecosystem, especially the seaweed flora, was shown to be sensitive to development (Phang, 1988; 1995) where increased silt levels led to loss of sensitive species of seaweeds. There is an oil refinery in the vicinity of the study area. There is also a small fishing harbour as well as active recreational fishing and water sports activities. However, no study of heavy metal distribution and bioaccumulation in the coral reef ecosystem has been done. The results of this study will contribute significantly to Malaysian coastal ecosystem characterisation especially with reference to heavy metal pollution. The data is also important for the formulation of the Malaysian marine water quality criteria and standards. The study will also contribute to the development of long term monitoring programs of heavy metals using selected biological indicators.

1.4 AIMS OF THE STUDY

The aims of the study include:

1. A study of the distribution of selected heavy metals in selected biotic (seaweeds, sea cucumber, soft corals) and abiotic (seawater, sediment) components of the coral reef ecosystem.
2. A study to compare heavy metal bioaccumulation based on taxonomic difference in three species of brown seaweed (Phaeophyta); and between the trophic levels (primary producers, deposit-feeder, filter-feeder)
3. Assessment of the effect of environmental parameters on the heavy metal concentration in the various biotic and abiotic components of the two study sites at the coral reef ecosystem.