CHAPTER 1: INTRODUCTION

1.1 ECONOMIC IMPORTANCE OF SEAWEEDS

Seaweeds are used in many countries as a source of food, fertiliser and in industrial applications. The main chemicals commercially obtained from seaweeds are the phycocolloids (polysaccharides of high molecular weight composed of polymers of simple sugars), which are used extensively in the food, cosmetics, and pharmaceutical industries, as emulsifiers and gelling agents. The main phycocolloids extracted from seaweeds are alginate, carrageenan and agar. During the 1980's, the international demand for phycocolloids increased 10-30% per annum. Alginate, carrageenan and agar are extracted annually from about 900, 000 tonnes wet weight of harvested seaweed or 25% of the global seaweed harvest. Alginate is extracted from large brown seaweeds (Phaeophyta) such as *Ascophyllum, Sargassum, Fucus, Laminaria, Macrocystis, Ecklonia* and *Durvillea* while carrageenan is extracted from *Hypnea, Phyllophora, Solieria* and *Gigartina* of the Rhodophyceae. Agar is extracted from *Gelidium, Gracilaria, Pterocladia, Acanthopeltis* and *Ahnfeltia* (Mitchell, 1998).

Red algae were found to have eicosanoid-type natural products (Gerwick *et al.*, 1990) while antitumor activity was found in some of the brown and green algae (Noda *et al.*, 1990). Other properties such as richness in vitamin D of *Fucus vesiculosus*, vitamin E of *Laminarians*, vitamin K of *Sargassum muticum*

and red alga *Delesseria sanguinea* are very important factors for seaweed applications especially in the cosmetic industry. In thalassotherapy (the utilisation of therapeutic value of seawater and seaweed to promote beauty and nourish health), algal paste plays a role in inducing sweating, removal of toxins and as massage creams. Algal bath therapy is used for fat-reducing purposes while algal powders and pulps can be used as base for several cosmetic products (thinning creams, treatment creams, paste, masks, dentifrice, body lotions, and hair setting creams. Bath salts with algae are also sold in the market (De Roeck-holtzhauer, 1991).

In future, the role of seaweeds will expand to pollution abatement and local energy generation utilising the bioconversion of seaweeds using different procedures such as thermal treatment, composting, methanisation, fermentation, chemical treatment (Morand *et al.*, 1990, 1991). Its high capability in nutrient uptake can be utilised in waste water treatment and the recycling of nutrients in the production of renewable bioenergy as reported with *Ulva lactuca* (Houvenaghel and Mathot, 1983) and *Gracilaria* sp. (Harlin *et al.*, 1979).

1.2 IMPORTANCE OF SEAWEED STUDIES

Malaysia has been importing agar from other countries such as Korea, Japan, Hong Kong and China. In order for Malaysia to cope with the increasing

demand for bacteriological agar in the coming years, there is a need to look into its own resources. In Malaysia, *Gracilaria changii* (Xia et Abbott) Abbott, Zhang et Xia (1963) is one of the most abundant agarophytic seaweeds. In 1994, Shafeei *et al.* treated the agar extracted from *G.changii* using acid-alkali and alkali-acid pre-treatment and found that the agar gel strength was 626.62g.cm^{-2} with 16.84% yield and 611.31g.cm^{-2} with 15.70% yield, respectively. They concluded that *G. changii* collected from the Morib mangroves, Malaysia, has the potential to produce good food grade agar. Phang *et al.* (1996) reported that Malaysian *G. changii* has potential commercial application in the agar industry due to its good quality agar and adaptability to the harsh mangrove conditions. In addition, *Gracilaria* in Morib mangroves are found to produce carposporangia throughout the year. Hence, it can provide for the seeding of monofilaments from fertile thalli for the large-scale cultivation of *Gracilaria*, which will supply the raw material for commercial agar production.

However, correct identification is needed to fully utilise this commercial seaweed and enhance the development of *Gracilaria* farming and the agar production industries. In 1993, Bird and Van der Meer emphasised the importance of taxonomic studies in ensuring the correct identification and recognition of the commercially important seaweeds. Conventional classification based on morphological characteristics is problematic among the closely related genera of *Gracilariaceae, Gracilariopsis* and *Hydropuntia* (*Polycavernosa*) (Rice and Bird, 1990). Limited morphological characters as a base to classification

systems and the strong barriers to crossing separate morphologically similar species brought forth the important role of genetic markers in systematic studies of these algal species. The new approaches in molecular biology not only deepen our understanding of the basic knowledge of life histories, speciation, population genetics, biogeography and the phylogenetics of algae (Olsen, 1990), but also assist in resolving phylogenetic and evolutionary relationships. Furthermore, the applications in analysing DNA and resolving the relationships between organisms, including seaweeds have been enhanced by recent technical developments in biochemistry and molecular biology. The nuclear, plastid and mitochondrial DNAs (Deoxyribonucleic acid) are valuable reservoirs of taxonomic characters essential for phylogenetic analysis (Coleman & Goff, 1991; Manhart & McCourt, 1992). Genetic engineering and manipulation can then be carried out to improve the characteristics of algae by modifying their genetic makeup. Hence, enhancing the utilisation of economic seaweed resources and the development of both phycoculture and the seaweed products processing industry (Tseng, 1984). Efficient seeding, increase in growth rate and genetic improvement are ways to optimise the exploitation of a commercial seaweed. Van der Meer (1988) gave an overview of the current application of genetics to marine crops (such as *Porphyra*, *Laminaria*, *Gracilaria*, *Gelidium chondrus* and *Eucheuma*) stating the need to realise the potential of genetic improvement on these marine crops to a much greater extent. This will have important implications for development of algal biotechnology.

1.3 OBJECTIVES

Malaysia is primarily in the 'discovery' and 'understanding' phases of biodiversity studies in the macroalgae. There still remain large geographical and taxonomic gaps in the understanding of Malaysian macroalgae.

Hence, the objectives of this study are: -

1. To use random amplified polymorphic DNA (RAPD) techniques to examine the taxonomic relationships between selected Malaysian *Gracilaria* species.
2. To study the intraspecies relationship between *Gracilaria changii* (Xia et Abbott) Abbott, Zhang et Xia collected from different locations in Malaysia and Thailand.
3. To study the interspecies relationship between *G. changii*, *G. edulis* (Gmelin) Silva and *G. salicornia* (C.Agardh) Dawson.