CHAPTER 6

CONCLUSION

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Of the 43 bacterial isolates, two were confirmed as causing disease to *Gracilaria changii*. They were: *Deleya marina and Deleya aesta*. The nature of the experiment using different media and thalli conditions (axenic and non-axenic), suggested that environmental conditions in which *G. changii* was grown may quicken the manifestation of disease symptoms.

Two agar-degrading bacterial isolates were observed in this study. They are most likely to cause disease symptoms in *G. changii* since they are able to liquefy agar which is part of the cells' components. They prove to be fastidious due to the inability to proliferate in Marine Agar 2216E upon subculturing. From the brief physiological description, it may belong to the group *Cytophaga/Flavobacterium.*

Fungi identified from *Gracilaria* thalli include *Penicillium*, *Aspergillus*, *Pestalotia*, *Cladosporium*, yeast-like fungi and *Gliomastix*. The growth of *Pestalotia* sp. along the thalli of *G. changii* when re-infection of the isolated fungus was conducted, indicated the possibilty of this fungus to be a pathogen. Mycelial growth and attachment, with the induction of cyst-like growth within the cell of *G. changii* were observed with infected specimens. Whether the

fungus caused the disease or nutrient depletion led to mycelial attachment and later induction of cyst-like growth, cannot be determined at this juncture. Further confirmatory studies need to be carried out. In order to alleviate the ambiguity of it being an interplay of environmental conditions with fungal infection, pulse feeding of nutrients within a longer period of incubation may be adopted.

Virus-like particles; three hexagonal, two rod-like and one filamentous were observed from 'sickened' *G. changii.* All three types of VLP's are known to occur in plants which possess similar cell composition to that of seaweeds. Re-infection of isolates onto axenic thalli were unsuccessful. Further modes of infection can be investigated.

The extract of *G. changii* did not affect the growth of the isolated bacteria and fungus using the method mentioned in Section 3.5 nd 3.6. The effect of *G. changii* extract on bacteria and fungus can be further investigated using an alternative method.

A checklist of algal epiphytes and endophyte posing a potential danger to the farming of *G. changii* is given in Table 16.

Table 16: A Checklist of Algal Epiphytes and Endophyte

Associated with *G. changii.*

Algal Epiphyte and Endophyte
Cyanophyta
Scytonema ? hofmanii
Scytonema ? polysystum
Lyngbya sp.
Lyngbya ?majuscula
Anabaena oscillariodes
Oscillatoria sp.
Microcoleus sp.
Chlorophyta
Cladophora ?patentiramea
Cladophora fascicularis
Cladophora flexuosa
Ulva sp.
Ulva ? fasciata
Microspora sp.
Chaetomorpha sp.
Chaetomorpha linum
Chaetomorpha antennina
Enteromorpha sp.
Phaeophyta
Ectocarpus sp.
Rhodophyta
Hypnea sp.
Hypnea ? esperi
Ceramium sp.
Polysiphonia sp.
Audouinella sp.
Bacillariophyta
Tabellaria sp.
Achnanthes sp.

Ulva spp. were found in areas of higher salinity (35 ppt) and light intensity which is Sg. Pulai and Panwa Bay, Thailand. *Chaetomorpha linum* was the most abundant species in Morib. The wild populations possess higher diversity of algal epiphytes than farmed conditions. The *Gracilaria* experimental farm in Ban Merbok, Kedah which is periodically harvested for shrimps, fish and *Gracilaria* would possess increased water motion which can limit epiphytic attachment. The diversity and abundance of algal epiphytes would greatly be influenced by water motion, salinity, light, nutrients and other environmental conditions. The balance of these parameters would lead to the optimisation of *Gracilaria* production.

The diatoms *Tabellaria* sp. and *Achnanthes* sp. were present on and in the fissures of *G. changii* thalli. It would be interesting to study the relationship between diatoms and seaweeds as such a study has not been established yet.

Table 17 shows the most likely organisms to cause certain disease symptoms based on the morphology of 'sick' thalli.

Table 17: Organisms Possibly Associated with Disease Symptoms.

Symptoms	Most Probable Cause
Entire bleached thalli/bunch;	Sub-optimal environmental conditions.
Irregular holes and grazed thalli surfaces.	Crustaceans; invertebrates
Regular holes in thallus	Agar degrading bacteria
Galls;spots in thalli	Fungi; virus
Grazed and scratch-like thalli surface	Removal of rhizoids from epiphytic algae by wave action or manual handling
Malformations	Endophytes; fungi
Intermittent whitening;paling of thalli; softening and decay	Bacteria, amoeba, unicellular organisms, virus, fungi

Disease outbreaks in algal crops can also be successfully managed if a wide ranging systems approach is used to reveal complex interactions amongst the various biotic and abiotic components. With the checklist of organisms and disease symptoms, *Gracilaria changii* would-be farmers can take the necessary precautions against disease causers hence nipping the problem in the bud and producing a consistent stock of high quality and quantity.