## CONTENTS

	PAGE
ACKNOWLEDGMENTS	i
ABSTRACT	ii
ABSTRAK	v
CONTENTS	viii
LIST OF FIGURES	xiii
LIST OF TABLES	xvi
LIST OF APPENDICES	xvii
CHAPTER 1 : INTRODUCTION	1
1.1 Importance of Seaweeds	1
1.2 Importance of Gracilaria Farming	5
1.3 Principal Farming Areas	7
1.4 Gracilaria Farming Prospects In Malaysia	7
1.5 Significance of Research	8
1.6 Identification of Disease Causing Agents	9
1.7 Objective	10
CHAPTER 2 : LITERATURE REVIEW	12
2.1 Gracilaria Farming	16
2.2 Diseases of Seaweeds	19

	2.2.1 Diseases Caused by Environmental Stress	20
	2.2.2 Diseases Caused by Bacteria	22
	2.2.3 Diseases Caused by Fungus	25
	2.2.4 Diseases Caused by Virus	29
	2.2.5 Diseases Caused by Epiphytic Algae	32
	2.2.6 Diseases Caused by Endophytic Algae	36
	2.2.7 Diseases Caused by Other Organisms	39
СН	APTER 3: MATERIALS AND METHODS	41
3.1	Gracilaria changii Abbott, Zhang & Xia	41
3.2	Sampling Sites	42
3.3	Isolation of Disease Causing Organisms	42
	3.3.1 Isolation of Bacteria	44
	3.3.2 Isolation of Fungi	45
	3.3.3 Screening for Virus	46
	3.3.4 Isolation of Algal Epiphytes, Endophytes	
	and Unicellular Organism	46
3.4	Re-infection of Isolates into G. changii Thallus	48
	3.4.1 Bacterial Infection of G. changii	48
	3.4.1.1 Infection of Non-axenic Thallus	
	with Bacteria (Seawater Medium)	48
	3.4.1.2 Infection of Axenic Thallus with	
	Bacteria (Marine Broth Medium)	51

## 3.4.1.3 Identification of the Bacterial Isolates

	Causing Disease Symptoms	53
	3.4.2 Fungal Infection of G. changii Thallus	57
	3.4.3 Viral Infection of G. changii Thallus	57
3.5	The Influence of G. changii Extract on Bacterial Growth	58
	3.5.1 Production of G. changii Extract	58
	3.5.2 Preparation of Bacterial Suspension	58
3.6	The Effect of G. changii Extract on Fungal Growth	60
СН	APTER 4: RESULTS	61
4.1	Isolation and Identification of Organisms	61
	4.1.1 Isolation and Identification of Bacteria	61
	4.1.2 Isolation and Identification of Fungi	64
	4.1.3 Screening for Virus	69
	4.1.4 Description of Algal Epiphytes Isolated from the	
	Surface of G. changii	72
	4.1.5 Identification of an Alga Endophytic in G. changii	90
	4.1.6 Identification of an Unicellular Organism	93
4.2	Re-infection of G. changii with Isolated Microorganisms	96
	4.2.1 Identification of the Three Bacterial Isolates Showing	
	Disease Symptoms in Two Growth Media	101
4.3	Re-infection of Axenic Thalli with Fungi Isolated	
	Farlier from Diseased G. changii Thalli	102

4.4	Re-infection of Axenic Thalli with Virus-like	
	Particles Obtained from Diseased Thalli of G. changii.	105
4.5	Influence of G. changii Extract on Bacterial Growth	105
4.6	Influence of G. changii Extract on Fungal Isolates	105
СН	APTER 5 : DISCUSSION	106
5.1	Bacteria and Gracilaria changii	106
	5.1.1 Bacterial Isolates Associated with	
	G. changii	106
	5.1.2 Agar-degrading Bacteria Associated with	
	G. changii	106
	5.1.3 Bacterial Infection of G. changii	110
	5.1.4 Effect of G. changii Extract on Bacterial Growth	115
	5.1.5 Identification of Two Disease Causing Bacteria	117
5.2	Fungi and Gracilaria changii	119
	5.2.1 Fungal Isolates Associated with G. changii	119
	5.2.2 Fungal Infection of G. changii Thalli	123
	5.2.3 Effect of G. changii Extract on Fungal	
	Isolates of G. changii	125
5.3	Virus and Gracilaria changii	126
	5.3.1 Viral Isolates Associated with G. changii	126
	5.3.2 Viral Infection of G. changii	128
5.4	Algal Epiphytes and Endophytic Algae Associated	
	with Gracilaria changii	120

5.5 All Officential Organism Associated with Gracitaria changit	139
5.6 Disease Symptoms and Associated Organisms	140
5.7 Appraisal of Study	141
CHAPTER 6 : CONCLUSION	146
BIBLIOGRAPHY	151
APPENDICES	179