

Seaweed Diversity of the Langkawi Islands with emphasis on the Northeastern Region

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ABSTRACT The tally of Malaysian marine algae stands at 377 specific and infraspecific taxa (17 Cyanophyta, 102 Chlorophyta, 186 Rhodophyta and 72 Phaeophyta). Eighty-four taxa of seaweeds (1 Cyanophyta, 25 Chlorophyta, 62 Rhodophyta and 14 Phaeophyta) have been identified from the Langkawi Islands. Commonly found taxa include species of *Padina* (Phaeophyta), *Halimeda*, *Caulerpa*, *Bryopsis* (Chlorophyta), *Gracilaria*, *Acanthophora*, *Asparagopsis*, *Polysiphonia*, and *Hypnea* (Rhodophyta). A relatively high diversity of seaweeds is found in the Langkawi Islands. Biomass is low except for some green seaweed like the *Caulerpa* species, which grow abundantly on the nets of the fish cages in the estuaries. The seaweed flora of Langkawi is quite distinct from that of Peninsular Malaysia and East Malaysia. It may have elements common to the Andaman Sea flora.

ABSTRAK Di Malaysia, terdapat sejumlah 377 taxa spesifik dan infraspecific (17 Cyanophyta, 102 Chlorophyta, 186 Rhodophyta dan 72 Phaeophyta) rumpair laut. Lapan puluh empat taxa rumpair laut (1 Cyanophyta, 25 Chlorophyta, 62 Rhodophyta dan 14 Phaeophyta) telah dikenalpasti di Pulau Langkawi. Taxa rumpair laut yang biasa dijumpai termasuk spesies *Padina* (Phaeophyta), *Halimeda*, *Caulerpa*, *Bryopsis* (Chlorophyta), *Gracilaria*, *Acanthophora*, *Asparagopsis*, *Polysiphonia* dan *Hypnea* (Rhodophyta). Ini menunjukkan bahawa pelbagaian rumpair laut yang tinggi boleh didapati di Pulau Langkawi. Biojisim rumpair laut adalah rendah kecuali beberapa spesies rumpair laut hijau seperti spesies *Caulerpa* yang tumbuh dengan suburnya pada jaring yang dipasangkan pada sangkar-sangkar ikan di muara sungai. Flora rumpair laut yang terdapat di Pulau Langkawi adalah agak berbeza daripada rumpair laut yang terdapat di Semenanjung Malaysia, Sabah dan Sarawak. Flora rumpair laut Langkawi mungkin mempunyai unsur-unsur yang sama dengan flora Laut Andaman.

(seaweeds, checklist, diversity, Pulau Langkawi, Peninsular Malaysia)

INTRODUCTION

Marine macroalgae commonly known as seaweeds, form an important component of the coastal and marine ecosystems, providing feeding, breeding and nursery grounds for the diverse marine and fishery life. Seaweeds, together with the phytoplankton (microalgae) and the seagrasses (marine Angiosperms), serve as the main primary producers in the oceans, contributing to photo-oxygenation of the waters as well as carbon sequestration, thus assisting in the reduction of global warming. Seaweeds inhabit a diversity of niches including coral reefs, estuaries, mangroves and rocky shores. Endangered animals like the dugongs and turtles feed on seaweeds and seagrasses. Seaweeds and seagrass meadows help to reduce wave action

and protect shores from erosion. Seaweeds also help to remove toxic compounds from the water. The many islands of Langkawi with a diversity of niches support the proliferation of seaweed species.

The Seaweed Flora of Malaysia

The first checklist of the marine benthic algae in Malaysia was published in 1991 [1] together with a historical account of the study of marine algae in this region. In 1998 Phang [2] updated the checklist of Malaysian marine algae including additions from Phang [3, 4 and 5] and a new species *Sargassum stolonifolium* described from Penang, west coast Peninsular Malaysia [6].

Recent collections [7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22 and 23] have added on

to the early records of the marine algal flora of Malaysia and Singapore [2]. The present tally of marine algae taxa in Malaysia and Singapore is 377, with 8 families, 17 taxa of Cyanophyta; 13 families, 102 taxa of Chlorophyta; 27 families, 186 taxa of Rhodophyta; and 8 families, 72 taxa of Phaeophyta. The marine algal flora has similarities to the algal flora of the Indo-Pacific region. Coral reefs support the highest diversity of species, followed by rocky shores and sandy-muddy areas.

Fifteen species, including 12 new records of seaweeds were described from the Langkawi Islands, during the University Malaya-Hokkaido University collaboration from 1996 to 1999. The objective of the UM- Algae Research Group during the 2003-04 Scientific Expedition was to document the diversity and distribution of seaweeds in the North-East Langkawi Islands. This forms an on-going inventory of the marine algae of Malaysia and the region.

The specimens are deposited at the Seaweeds and Seagrasses Herbarium established at the Institute of Biological Sciences, Faculty of Science, University of Malaya, which presently houses more than 7000 herbarium specimens collected from Malaysia, and the Herbarium of the Graduate School of Science, Hokkaido University, Japan.

MATERIALS AND METHODS

The North-East Langkawi was selected because little is known of its flora and fauna, in spite of having very interesting geological and biological features. The region consists of a continuum of habitats ranging from the lowland forests to the strand, mudflats, estuaries, mangroves, rocky shores, coral reefs to two islands, Pulau Dendang and Pulau Langun. Scattered cage cultures are also found in the estuaries of Sungei Kilim and Sungei Kisap, where Collections were made during low tide or by snorkelling and scuba. Specimens were cleaned and processed into herbarium, or preserved in formalin for further examination back in the laboratory. All specimens were identified based on morphological and anatomical characteristics, using published keys and taxonomic papers. All specimens are deposited in the University of Malaya Seaweeds and Seagrasses Herbarium.

RESULTS AND DISCUSSION

To date 84 taxa (Table 1) of seaweeds have been identified from Langkawi, with 31 taxa recorded during the expedition in April 2003 and 13 additional taxa during the expedition in April 2004. Some of the seaweeds are show in Figures 1 – 26. New records for Langkawi collected in 2003 included *Brachytrichia quoyi*, *Enteromorpha clathrata*, *Boodlea composite*, *Dictyosphaeria cavernosa*, *Caulerpa serrulata*, *Caulerpa sertularioides*, *Halimeda macroloba*, *Halimeda simulans*, *Avrainvillea erecta*, *Pterocladia caerulescens*, *Gracilaria canaliculata*, *Gracilaria manilaensis*, *Gracilaria salicornia*, *Gracilaria tenuistipitata*, *Asparagopsis taxiformis*, *Cryptonemia yendoii*, *Halymenia maculate*, *Ceratiodyton spongiosum*, *Centroceras clavulatum*, *Acanthophora spicifera*, *Dictyota cervicornis* and *Dictyota dichotoma*. *Gracilaria manilaensis* was first recorded in Malaysia from Pantai Merdeka, Kedah and Gelang Patah, Johor [23], also growing on fish cages. Commonly found taxa include species of *Padina* (Phaeophyta), *Halimeda*, *Caulerpa*, *Bryopsis* (Chlorophyta), *Gracilaria*, *Acanthophora*, *Asparagopsis*, *Polysiphonia*, and *Hypnea* (Rhodophyta). A relatively high diversity (84 taxa out of 377 taxa in Malaysia) of seaweeds is found in the Langkawi Islands. Biomass is low except for some green seaweed like the *Caulerpa* species, which grow abundantly on the nets of the fish cages in the estuaries. An interesting observation of the *Caulerpa* species was made. An unidentified species which had been collected some years ago in Sungei Kisap was found to grow abundantly in Sungei Kilim, Kisap, Air Hangat, and especially on the nets of the cage cultures. It is either a new variety or a new species of *Caulerpa*. The local name for this new *Caulerpa* is *lak tud* and it is sold in the market for use as a salad. The fish cages present a very efficient trap of algal spores of species growing in the surrounding mangroves. It was observed that in some cages the seaweeds were left on the nets, presumably to remove nutrients from the water in the cages, thereby reducing eutrophication in the area, as well as to serve as food for the cultured fish. Molecular analysis of this unidentified species, and comparison with other closely related species indicate that the unidentified species has similarities with the

Caulerpa racemosa and *Caulerpa lentillifera* collected from Cape Rachado, Port Dickson, Negeri Sembilan, also along the Straits of Malacca [24].

Table 1. Checklist of Marine Algae (seaweeds) from the Langkawi Islands

NO	Taxa	Collection Number	Date	Location
Division CYANOPHYTA				
Order Stigonematales				
Family Stigonemataceae				
1	<i>Brachytrichia quoyi</i> (C. Agardh) Bornet & Flahault	PSM6471	11-Apr-03	Teluk Tembus, Pulau Dendang
Division CHLOROPHYTA				
Order Ulvales				
Family Ulvaceae				
2	<i>Enteromorpha intestinalis</i> (Linnaeus) Nees	PSM2898-9, 2904	20-Dec-97	Kuah
		PSM6754	6-Apr-04	Sungai Air Hangat
		PSM6799	7-Apr-04	Pulau Beras Basah
		PSM6828	7-Apr-04	Tanjung Rhu
3	<i>Enteromorpha clathrata</i> (Roth) Greville	PSM6489	11-Apr-03	Teluk Cina Mati
		PSM6492	11-Apr-03	Sungai Kilim, near river mouth
		PSM6567	12-Apr-03	Tanjung Rhu (between two rivers)
		PSM6637-6639	13-Apr-03	South of Pulau Anak Cerita
		PSM6646	15-Apr-03	Tanjung Rhu Beach
		PSM6677	5-Apr-04	Teluk Anak Gua Cerita
		PSM6827	7-Apr-04	Tanjung Rhu
Order Cladophorales				
Family Anadyomenaceae				
4	<i>Microdictyon</i> Decaisne	PSM6668	5-Apr-04	Teluk Anak Gua Cerita
Family Cladophoraceae				
5	<i>Chaetomorpha</i> Kutzing	PSM6566	12-Apr-03	Near to North of Tanjung Berangan
		PSM6847-6849	8-Apr-04	Teluk Tembus, Pulau Tanjung Dendang
		PSM6887	8-Apr-04	Pasir Talam Dua Muka
6	<i>Cladophora</i> Kutzing	PSM6488	11-Apr-03	Teluk Cina Mati
		PSM6555-6557	12-Apr-03	Pulau Langun
		PSM6579	12-Apr-03	Pulau Langun, Teluk Dalam
		PSM6583	12-Apr-03	Ayer Hangat Mangrove
		PSM6601	12-Apr-03	Gua Cherita
		PSM6698	5-Apr-04	Teluk Dedap
	PSM6884	8-Apr-04	Pasir Hitam	

7	<i>Rhizoclonium</i> Kutzing	PSM6567	12-Apr-03	Tanjung Rhu (between two rivers)
		PSM6624	13-Apr-03	South of Gua Cherita
Family Siphonocladaceae				
8	<i>Boodlea composita</i> (Harvey) Brand (Syn: <i>Cladophora composita</i> Harvey)	PSM6523	11-Apr-03	Sungai Kilim, near river mouth
		PSM6534	11-Apr-03	Middle Sungai Kilim
9	<i>Cladophoropsis</i> Boergesen		20-Dec-97	Teluk Tama
			20-Dec-97	Pulau Tepor
		PSM6850-6851	8-Apr-04	Teluk Tembus, Pulau Tanjung Dendang
10	<i>Dictyosphaeria cavernosa</i> (Forsskaal) Boerg ex Endlicher	PSM6491	11-Apr-03	Teluk Cina Mati
			6-Apr-04	Pasir Panjang (near Tanjung Kemarong)
		PSM6782		
Family Valoniaceae				
11	<i>Valonia aegagropila</i> C. Agardh		8-Apr-04	Teluk Tembus, Pulau Tanjung Dendang
		PSM6843-6846		
12	<i>Valonia utricularis</i> (Roth) C. Agardh	PSM2907	20-Dec-97	Teluk Ewa
Order Bryopsidales				
Family Bryopsidaceae				
13	<i>Bryopsis</i> Lamouroux	PSM6549-6551, 6523	11-Apr-03	Middle Sungai Kilim
		PSM6712, PSM6699	5-Apr-04	Sungai Kilim
		PSM6756-6757	6-Apr-04	Sungai Kilim
Family Caulerpaceae				
14	<i>Caulerpa peltata</i> (Turner) Lamouroux	PSM2918,7445	22-Dec-97	Pulau Beras Basah
		PSM7462	24-Dec-97	Teluk China Mati
15	<i>Caulerpa racemosa</i> (Forsskaal) J. Agardh	PSM365	9-Feb-86	Tanjung Rhu
		PSM2910-2913	21-Dec-97	Pulau Kentut Besar
		PSM7446	22-Dec-97	Pulau Beras Basah
		PSM7461	24-Dec-97	Teluk China Mati,
		PSM6470	11-Apr-03	Tanjung Dendang
		PSM6497-6498	11-Apr-03	Sungai Kilim, near river mouth
		PSM6535-6537	11-Apr-03	Middle Sungai Kilim
		PSM6607-6609	12-Apr-03	Pulau Gua Cerita
		PSM6642	13-Apr-03	South of Pulau Anak Cerita
		PSM6695	5-Apr-04	Pasir Panjang
		PSM6700-6704	5-Apr-04	Sungai Kilim
			6-Apr-04	Pasir Panjang (near Tanjung Kemarong)
		PSM6781		
		PSM6868	8-Apr-04	Pulau Tanjung Dendang
		PSM6871	8-Apr-04	Teluk Cina (Pulau Dendang)

16	<i>Caulerpa serrulata</i> (Forsskaal) J. Agardh	PSM6610-6611	12-Apr-03	Pulau Gua Cerita
		PSM6681	5-Apr-04	Teluk Anak Gua Cerita
17	<i>Caulerpa sertularioides</i> (S.G. Gmelin) Howe	PSM6462-6465	10-Apr-03	Kuala Kubang Badak
		PSM6499	11-Apr-03	Sungai Kilim, near river mouth
		PSM6524-6528	11-Apr-03	Sungai Pinang Karong
		PSM6538	11-Apr-03	Middle Sungai Kilim
		PSM6645	15-Apr-03	Tanjung Rhu Beach
		PSM6692	5-Apr-04	Gua Cerita
		PSM6758-6760	6-Apr-04	Sungai Kilim
18	<i>Caulerpa verticillata</i> J. Agardh	PSM7459	24-Dec-97	Teluk China Mati
		PSM7460	24-Dec-97	Teluk China Mati
19	<i>Caulerpa</i> Lamouroux (<i>Latud</i>)	PSM792	31-May-88	Sungai Kisap
		PSM6502-6503	11-Apr-03	Sungai Kilim, near river mouth
		PSM6529-6533	11-Apr-03	Sungai Pinang Karong
		PSM6539-6543	11-Apr-03	Middle Sungai Kilim
		PSM6619-6620	13-Apr-03	Middle Sungai Kisap
		PSM6705-6711	5-Apr-04	Sungai Kilim
		PSM6761-6767	6-Apr-04	Sungai Kilim
Family Codiaceae				
20	<i>Codium geppiorum</i> O. Schmidt	PSM398	10-Feb-86	Pasir Hitam
21	<i>Codium</i> Stackhouse	PSM6679	5-Apr-04	Teluk Anak Gua Cerita
Family Halimedaceae				
22	<i>Halimeda macroloba</i> Decaisne	PSM6602-6603	12-Apr-03	Gua Cherita
		PSM6615-6618	12-Apr-03	Pulau Gua Cerita
		PSM6627-6628	13-Apr-03	South of Gua Cherita
		PSM6643-6644	13-Apr-03	South of Pulau Anak Cerita
		PSM6667,	5-Apr-04	Teluk Anak Gua Cerita
		PSM6682-6689		
		PSM6694	5-Apr-04	Pasir Panjang
23	<i>Halimeda simulans</i> Howe	PSM6604	12-Apr-03	Gua Cherita
		PSM6612-6614	12-Apr-03	Pulau Gua Cerita
		PSM6626	13-Apr-03	South of Gua Cherita
		PSM6629	13-Apr-03	South of Gua Cherita
		PSM6690	5-Apr-04	Teluk Anak Gua Cerita
Family Udoteaceae				
24	<i>Avrainvillea erecta</i> (Berkeley) A & E.S. Gepp	PSM6625	13-Apr-03	South of Gua Cherita
		PSM6810	7-Apr-03	Tanjung Rhu
25	<i>Avrainvillea lacerata</i> Harvey ex J. Agardh	PSM6678	5-Apr-04	Teluk Anak Gua Cerita
26	<i>Rhipidosiphon javense</i> Montague (Syn: <i>Udotea javensis</i> (Montagne) A. & E.S. Gepp)	PSM7457-7458	24-Dec-97	Teluk China Mati, Pulau Tanjung Dendang
		PSM6472	11-Apr-03	Teluk Tembus, Pulau Dendang
		PSM6481	11-Apr-03	Pulau Dendang (East)

		PSM6490	11-Apr-03	Teluk Cina Mati
		PSM6553-6554	12-Apr-03	Pulau Langun
		PSM6598	12-Apr-03	Gua Cherita
		PSM6641	13-Apr-03	South of Pulau Anak Cerita
		PSM6654	17-Apr-03	Burau Bay
		PSM6680	5-Apr-04	Teluk Anak Gua Cerita
		PSM6697	5-Apr-04	Teluk Dedap
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Division RHODOPHYTA				
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Order Nemaliales				
Family Galaxauraceae				
27	<i>Galaxaura</i> Lamouroux	PSM6691	5-Apr-04	Gua Cerita
28	<i>Galaxaura obtusata</i> (Ellis & Solander) Lamouroux	PSM6783-6786	6-Apr-04	Pasir Panjang (near Tanjung Kemarong)
29	<i>Actinotrichia</i> Decaisne	PSM6833-6834	8-Apr-04	Teluk Tembus, Pulau Tanjung Dendang
Order Gelidiales				
Family Gelidiaceae				
30	<i>Pterocladia caerulescens</i> (Kutzing) <i>Santelices et Hommersand</i> (Syn: <i>Pterocladia caerulescens</i> (Kutzing) Santelices)	PSM6560	12-Apr-03	Teluk Dalam
Family Gelidiellaceae				
31	<i>Gelidiella acerosa</i> (Forskaal) Feldmann & Hamel	PSM402	10-Feb-86	Pasir Hitam
32	<i>Gelidiella pannosa</i> (Feldmann) Feldmann & Hamel	PSM6835-6842 PSM7435	8-Apr-04 18-Dec-97	Tanjung Tembus Pulau Nyior Setali
		PSM7436 PSM7437	18-Dec-97 19-Dec-97	Pulau Pasir Tanjung Datai Besar
Order Gracilariales				
Family Gracilariaceae				
33	<i>Congracilaria</i> Yamamoto	PSM6633	13-Apr-03	South of Gua Cherita
34	<i>Gracilaria canaliculata</i> (Kutzing) Sonder	PSM6484 PSM6599 PSM6562 PSM6586 PSM6650 PSM6669-6672 PSM6769	11-Apr-03 12-Apr-03 12-Apr-03 12-Apr-03 15-Apr-03 5-Apr-04 6-Apr-04	Pulau Dendang (East) Gua Cherita Teluk Dalam Ayer Hangat Pulau Gua Teluk Anak Gua Cerita Sungai Kilim
35	<i>Gracilaria changii</i> (Xia & Abbott) Abbott, Zhang & Xia	PSM 358	9-Feb-86	Tanjung Rhu
36	<i>Gracilaria manilaensis</i> Yamamoto et Trono	PSM 410 PSM6444-6457	10-Feb-86 10-Apr-03	Pasir Hitam Kuala Kubang Badak

	PSM6466-6467	10-Apr-03	Kuala Kubang Badak	
	PSM6665	10-Apr-03	Kuala Kubang Badak	
	PSM6731	5-Apr-04	Sungai Kilim	
37	<i>Gracilaria salicornia</i> (C. Agardh) Dawson	PSM6484	11-Apr-03	Pulau Dendang
	PSM6509-6522	11-Apr-03	Sungai Kilim, near river mouth	
	PSM6586	12-Apr-03	Ayer Hangat Mangrove	
	PSM6669-6672	5-Apr-04	Teluk Anak Gua Cerita	
	PSM6730, 6732-6738	5-Apr-04	Sungai Kilim	
	PSM6772-6776	6-Apr-04	Sungai Kilim	
	PSM6751-6752	6-Apr-04	Fish Cagess, Japanese Restaurant	
	PSM6770-6771	6-Apr-04	Sungai Kilim	
38	<i>Gracilaria tenuistipitata</i> Chang et Xia	PSM2935-2937	20-Dec-97	Kuah
	SAP070796- 070797	19-Dec-97	Kuah	
	PSM6655-6661	18-Apr-03	Dataran Lang Bridge, Kuah	
	PSM6893-6897	8-Apr-04	Dataran Lang Bridge, Kuah	
39	<i>Gracilaria</i> Greville	PSM6562	12-Apr-03	Teluk Dalam
Order Bonnemaisoniales				
Family Bonnemaisoniaceae				
40	<i>Asparagopsis taxiformis</i> (Delile) Trevisan	PSM6494	11-Apr-03	Sungai Kilim, near river mouth
	PSM6505	11-Apr-03	Sungai Kilim, near river mouth	
	PSM6547-6548	11-Apr-03	Middle Sungai Kilim	
	PSM6725	5-Apr-04	Sungai Kilim	
	PSM6826	7-Apr-04	Tanjung Rhu	
Order Cryptonemiales				
Family Halymeniaceae				
41	<i>Cryptonemia yendoii</i> Weber-van Bosse	PSM6561	12-Apr-03	Teluk Dalam
	PSM6636	13-Apr-03	South of Pulau Anak Cerita	
	PSM6675-6676	5-Apr-04	Teluk Anak Gua Cerita	
42	<i>Halymenia dilatata</i> Zanardini	PSM2915	21-Dec-97	Pulau Tepor
43	<i>Halymenia durvillaei</i> Bory de Saint Vincent	PSM2895	19-Dec-97	Tanjung Datai
	PSM2953	22-Dec-97	Teluk Genting, Pulau Genting	
	SAP090438	22-Dec-97	Teluk Genting, Pulau Genting	
44	<i>Halymenia maculata</i> J. Agardh	PSM6605	12-Apr-03	Pulau Gua Cerita
	SAP090432	21-Dec-97	Pulau Tepor	
	SAP090433	22-Dec-97	Teluk Genting, Pulau Genting	
Family Peyssonneliaceae				
45	<i>Peyssonnelia Decaisne</i>	PSM6667	5-Apr-04	Teluk Anak Gua Cerita
Order Corallinales				
Family Corallinaceae				
46	<i>Amphiroa fragillissima</i> (Linnaeus)	PSM 399-400	10-Feb-86	Pasir Hitam

	Lamouroux	PSM2905	20-Dec-97	Teluk Ewa
		PSM6468	11-Apr-03	Tanjung Rhu (Jetty)
		PSM6475	11-Apr-03	Teluk Tembus, Pulau Dendang
		PSM6482	11-Apr-03	Pulau Dendang (East)
		PSM6593-6594	12-Apr-03	Gua Cherita
		PSM6622	13-Apr-03	South of Gua Cherita
		PSM6635	13-Apr-03	South of Pulau Anak Cerita
		PSM6693	5-Apr-04	Pasir Panjang
		PSM6832	8-Apr-04	Teluk Tembus, Pulau Dendang
47	<i>Jania</i> Lamouroux	PSM6485	11-Apr-03	Teluk Cina Mati
Order Gigartinales				
Family Caulacanthaceae				
48	<i>Caulacanthus ustulatus</i> (Turner) Kutzing		18-Dec-97	Pulau Pasir
			20-Dec-97	Pulau Burau
			20-Dec-97	Pantai Kok
Family Gigartinaceae				
49	<i>Chondracanthus intermedius</i> (Suringar) Hommersand		18-Dec-97	Pulau Nyior Setali
Family Hypneaceae				
50	<i>Hypnea</i> Lamouroux	PSM6662-6663	10-Apr-03	Kuala Kubang Badak
		PSM6486	11-Apr-03	Teluk Cina Mati
		PSM6508, PSM6549, PSM6552	11-Apr-03	Sungai Kilim, near river mouth
		PSM6544-6546	11-Apr-03	Middle Sungai Kilim
		PSM6576-6578	12-Apr-03	Tanjung Rhu (between two rivers)
		PSM6587-6591	12-Apr-03	Ayer Hangat Mangrove
		PSM6600	12-Apr-03	Gua Cherita
		PSM6623	13-Apr-03	South of Gua Cherita
		PSM6649	15-Apr-03	Tanjung Rhu Beach
		PSM6741	5-Apr-04	Sungai Kilim
		PSM6755	6-Apr-04	Sungai Air Hangat
Order Rhodymeniales				
Family Champiaceae				
51	<i>Champia</i> Desvaux	PSM6882	8-Dec-02	Pasir Hitam, Pulau Langgung
Family Rhodymeniaceae				
52	<i>Ceratiodyctyon spongiosum</i> Zanardini	PSM6621	13-Apr-03	South of Gua Cherita
		PSM6797	7-Apr-04	Pulau Singa Besar, Teluk Sepai
		PSM6802	7-Apr-04	Pulau Beras Basah (near the beach)

Order Ceramiales

Family Ceramiaceae

53	<i>Anotrichium tenue</i> (C. Agardh) Nageli	PSM7452	22-Dec-97	Pulau Singa Besar
		PSM7465	24-Dec-97	Teluk China Mati, Pulau Tanjung Dendang
54	<i>Centroceras clavulatum</i> (C. Agardh) Montagne	PSM6495	11-Apr-03	Sungai Kilim, near river mouth
		PSM6504	11-Apr-03	Sungai Kilim, near river mouth
		PSM6592	12-Apr-03	Gua Cherita
		PSM6739-6740	5-Apr-04	Sungai Kilim
55	<i>Griffithsia schousboei</i> Montagne	PSM7456	23-Dec-97	Pulau Puchong
		PSM7464	24-Dec-97	Teluk China Mati, Pulau Tanjung Dendang
		PSM7463	24-Dec-97	Teluk China Mati, Pulau Tanjung Dendang

Family Dasyaceae

56	<i>Dasya iyengarii</i> Boergesen	PSM7439	19-Dec-97	Tanjung Datai Besar	
		SAP093314-093315	19-Dec-97	Tanjung Datai Besar	
57	<i>Dasya malaccensis</i> Masuda et Uwai	PSM7440	19-Dec-97	Tanjung Datai Besar	
		SAP093343	19-Dec-97	Tanjung Datai Besar	
		SAP093350	21-Dec-97	Pulau Tepor	
		PSM7447-7448	22-Dec-97	Pulau Beras Basah	
		SAP093345	22-Dec-97	Pulau Beras Basah	
		(Holotype)			
		SAP093344, 093346-093347	22-Dec-97	Pulau Beras Basah	
		PSM7449	22-Dec-97	Teluk Genting, Pulau Genting	
		SAP093349	22-Dec-97	Teluk Genting, Pulau Genting	
		58	<i>Heterosiphonia crispella</i> (C. Agardh) Wynne	PSM7438	19-Dec-97
SAP094299-094302	19-Dec-97			Tanjung Datai Besar	
PSM7444	21-Dec-97			Pulau Tepor	
SAP094304	21-Dec-97			Pulau Tepor	
PSM7451	22-Dec-97			Teluk Genting, Pulau Genting	
SAP094305-094306	22-Dec-97			Teluk Genting, Pulau Genting	
PSM7453	22-Dec-97			Pulau Singa Besar	

Family Delesseriaceae

59	<i>Taenioma dotyi</i> Hollenberg		29-Dec-97	Pulau Lembu, Pulau Payar
60	<i>Hypoglossum simulans</i> Wynne, Price et Ballantine	PSM7441	20-Dec-97	Teluk Ewa

61	<i>Martensia fragilis</i> Harvey	PSM2934	24-Dec-97	Teluk China Mati, Pulau Tanjung Dendang	
		PSM7466	24-Dec-97	Teluk China Mati, Pulau Tanjung Dendang	
		SAP070895-070896	24-Dec-97	Teluk China Mati, Pulau Tanjung Dendang	
		SAP070889-070894	24-Dec-97	Teluk China Mati, Pulau Tanjung Dendang	
		PSM6478	11-Apr-03	Teluk Tembus, Pulau Dendang	
Family Rhodomelaceae					
62	<i>Acanthophora spicifera</i> (Vahl.) Boergesen	PSM6664	10-Apr-03	Kuala Kubang Badak	
		PSM6459-6461	10-Apr-03	Kuala Kubang Badak	
		PSM6573	12-Apr-03	Tanjung Rhu (between two rivers)	
		PSM6482	11-Apr-03	Pulau Dendang (East)	
		PSM6496	11-Apr-03	Sungai Kilim, near river mouth	
		PSM6506-6507	11-Apr-03	Sungai Kilim, near river mouth	
		PSM6574,	12-Apr-03	Tanjung Rhu (between two rivers)	
		PSM6581-6582			
		PSM6726-6729	5-Apr-04	Sungai Kilim	
		PSM6777-6780	6-Apr-04	Sungai Kilim	
63	<i>Bostrychia tenella</i> (Lamouroux) J. Agardh	PSM7455	23-Dec-97	Pulau Singa Besar	
64	<i>Leveillea jungermanniodes</i> (Herling & G. Martens) Harvey	PSM 6747	6-Apr-04	Pulau Pasir	
65	<i>Polysiphonia scopulorum</i> Harvey	PSM7434	18-Dec-97	Jetty Point, Pulau Bunga	
		SAP070907-070909	18-Dec-97	Jetty Point, Pulau Bunga	
		SAP070910	20-Dec-97	Teluk Ewa	
		PSM7443	21-Dec-97	Pulau Tepor	
		SAP070911-070912	21-Dec-97	Pulau Tepor	
		SAP070913	28-Dec-97	Teluk Gua, Pulau Payar	
66	<i>Polysiphonia</i> Greville	PSM6820-6823	7-Apr-04	Tanjung Rhu	
67	<i>Tolypocladia</i> Schmitz	PSM6479	11-Apr-03	Teluk Tembus, Pulau Dendang	
68	<i>Herposiphonia pacifica</i> Hollenberg	SAP070899-070900	22-Dec-97	Pulau Singa Besar	
		PSM7454	22-Dec-97	Pulau Singa Besar	
		PSM6483	11-Apr-03	Pulau Dendang (East)	
69	<i>Neosiphonia flaccidissima</i> (Hollenberg) M.S. Kim et I.K. Lee	PSM7450	22-Dec-97	Teluk Genting, Pulau Genting	
		cf. <i>Neosiphonia</i>	SAP070906	22-Dec-97	Tanjung Genting, Pulau Genting
		PSM6458	10-Apr-03	Kuala Kubang Badak	
		PSM6477	11-Apr-03	Teluk Tembus, Pulau Dendang	
		PSM6482	11-Apr-03	Pulau Dendang (East)	
		PSM6487	11-Apr-03	Teluk Cina Mati	

		PSM6493	11-Apr-03	Sungai Kilim, near river mouth
Division PHAEOPHYTA				
Order Dictyotales				
Family Dictyotaceae				
70	<i>Dictyota atomaria</i> Hauck	PSM6808	7-Apr-04	Tanjung Rhu
71	<i>Dictyota cervicornis</i> Kutzing	PSM6568-6569, PSM6580	12-Apr-03	Tanjung Rhu (between two rivers)
		PSM6648	15-Apr-03	Tanjung Rhu Beach
		PSM6807	7-Apr-04	Tanjung Rhu
72	<i>Dictyota dichotoma</i> (Hudson) Lamouroux	PSM6570	12-Apr-03	Tanjung Rhu (between two rivers)
73	<i>Dictyota cf. dichotoma</i> (Hudson) Lamouroux	PSM6721-6724	5-Apr-04	Sungai Kilim
74	<i>Lobophora variegata</i> (Lamouroux) Wolmersley ex Oliveira	PSM2894	18-Dec-97	Pulau Tibi
		PSM7433	21-Dec-97	Pulau Kentut Besar
		PSM2931	22-Dec-97	Pulau Beras Basah
		PSM6652	17-Apr-03	Burau Bay
75	<i>Padina boryana</i> Bory de Saint Vincent	PSM2906	20-Dec-97	Teluk Ewa
		PSM2914	21-Dec-97	Pulau Kentut Besar
		PSM6474	11-Apr-03	Teluk Tembus, Pulau Dendang
		PSM6480	11-Apr-03	Pulau Dendang (East)
		PSM6597	12-Apr-03	Gua Cherita
		PSM6630	13-Apr-03	South of Gua Cherita
		PSM6713-6720	5-Apr-04	Sungai Kilim
		PSM6749	6-Apr-04	Tanjung Rhu
		PSM6750	6-Apr-04	Fish Cagess, Japanese Restaurant
		PSM6768	6-Apr-04	Sungai Kilim
		PSM6800	7-Apr-04	Pulau Beras Basah (near the beach)
		PSM6803, 6806	7-Apr-04	Pulau Beras Basah
		PSM6809	7-Apr-04	Tanjung Rhu
		PSM6892	8-Apr-04	Teluk Dalam
76	<i>Padina tetrastromatica</i> Hauck	PSM2929	21-Dec-97	Pulau Beras Basah
		PSM6571-6572	12-Apr-03	Tanjung Rhu (between two rivers)
		PSM6558-6559	12-Apr-03	Pulau Langun
		PSM6565	12-Apr-03	Teluk Dalam
		PSM6595, 6666	12-Apr-03	Gua Cherita
		PSM6632	13-Apr-03	South of Gua Cherita
		PSM6634	13-Apr-03	South of Pulau Anak Cerita
		PSM6804-5	7-Apr-04	Pulau Beras Basah
		PSM6888	8-Apr-04	Pasir Talam Dua Muka
		PSM6890	8-Apr-04	Teluk Dalam
77	<i>Padina</i> Adanson	PSM6653	17-Apr-03	Burau Bay
		PSM6746	5-Apr-04	Pulau Pasir
78	<i>Styopodium</i> (Kutzing) J. Agardh	PSM6596	12-Apr-03	Gua Cherita
		PSM6606	12-Apr-03	Pulau Gua Cerita

		PSM6631	13-Apr-03	South of Gua Cherita
Order Scytosiphonales				
Family Scytosiphonaceae				
79	<i>Colpomenia</i> (Endlicher) Derbes & Solier	PSM424	13-Feb-86	Pulau Beras Basah
		PSM6745	5-Apr-04	Pulau Pasir
80	<i>Rosenvingea orientalis</i> (J. Agardh) Børgesen	PSM 355	9-Feb-86	Tanjung Rhu
		PSM 395, 397	10-Feb-86	Pasir Hitam
Order Fucales				
Family Sargassaceae				
81	<i>Sargassum acutifolium</i> Greville	PSM2941	21-Dec-97	Pulau Beras Basah
82	<i>Sargassum</i> C. Agardh	PSM6801	7-Apr-04	Pulau Beras Basah (near the beach)
83	<i>Sargassum dotyi</i> Trono	PSM2886	20-Dec-97	Pulau Beras Basah
84	<i>Turbinaria</i> Lamouroux	PSM 360	9-Feb-86	Tanjung Rhu
		PSM 440	13-Feb-86	Pulau Beras Basah

During the 2004 expedition, the collection sites were revisited and further collections for confirmation were made. Seven taxa which had not been collected in 2003 but were found in 2004 included *Microdictyon*, *Valonia aegagropila*, *Avrainvillea lacerate*, *Galaxaura obtusata*, *Peyssonnelia*, *Leveillea jungermanniodes* and *Dictyota atomaria*. In 2004, visits to various islands in the south, including Pulau Singa Besar, Pulau Bras Basah, Pulau Intan Kecil, Pulau Intan Besar and Pulau Ular were made. The coral reefs of Pulau Singa Besar especially around the jetty, Teluk Sepai, Teluk Botol, Tanjung Ketapang and Tanjung Genting, still supported relatively good coral cover dominated by the massive coral species. However no seaweeds except for small epiphytes were observed. Collection trips made during the University of Malaya- Hokkaido University collaboration also yielded little seaweed taxa from this island. In the 1980's many species of *Sargassum* dominated the reefs but these seaweeds seem to have disappeared. The same observations were made regarding the absence of seaweeds especially the large brown species, from Pulau Bras Basah and Pulau Intan Besar and Pulau Intan Kecil in recent years. The disappearance of the seaweeds from these areas can either be due to increased tourism or some ecological factor, but this can only be confirmed with detailed studies. It was observed that many of the islands in Langkawi had very high cover of barnacles and rock oysters on the rocky sides,

especially about the mean water level. It is interesting to note that seaweeds and the encrusting barnacles and rock oysters were mutually exclusive. These species compete for space and the seaweeds like the larger forms of *Sargassum* and *Halymenia* appear to have lost to the barnacles.

CONCLUSION

There is a rich diversity of seaweeds in the Langkawi islands especially the Northeast Langkawi. The present checklist comprises 84 taxa, with one taxon of Cyanophyta, 25 taxa of Chlorophyta, 49 taxa of Rhodophyta and 12 taxa of Phaeophyta. The seaweed flora of Langkawi is quite distinct from that of Peninsular Malaysia and East Malaysia. Based on the Sorensen's Coefficient of Similarity (S %), at the species level, the seaweed flora of Langkawi has low similarity to seaweed flora of west coast Peninsular Malaysia (S = 0.3521%), east coast Peninsular Malaysia (S = 0.2869%), west Sabah (S = 0.2540%), East Sabah (S = 0.1263%) and Sarawak (S = 0.1522%). At the genus level, the seaweed flora of Langkawi is more similar to west coast Peninsular Malaysia (S = 0.6622%) and east coast Peninsular Malaysia (S = 0.6047%) than to west Sabah (S = 0.4419%), east Sabah (S = 0.2933%) and Sarawak (S = 0.3158%). Comparison of Langkawi seaweeds to the total checklist for Malaysia shows moderate similarity at genus level (S = 0.5683%) and low

similarity at the species level ($S = 0.2705\%$). The seaweed flora of Langkawi offers an interesting assemblage for further studies, especially with regards to tropical marine biodiversity, biogeography as well as to biological indication produce phycocolloids like carrageenan. Other species like *Halymenia* harbour bioactive compounds that could lead to discovery of new drugs. The protection of these valuable marine resources is dependent on the conservation of their habitats.

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of the water quality in the seas surrounding the islands. Several seaweeds of commercial as well as bioprospecting potential were collected. *Caulerpa* species are valued as salad seaweeds, while *Gracilaria*, *Hypnea* and *Acanthophora* and Consultancy, University of Malaya, and the Institute of Biological Sciences, Universiti Malaya; Malayan Nature Society, Langkawi Development Authority, Forestry Department of Kedah, Mutiara Burau Bay Resort Langkawi. Authors wish to acknowledge the assistance of Professor Michio Masuda, Hokkaido University in the identification of Malaysian marine algae.



Figure 1. *Caulerpa racemosa*

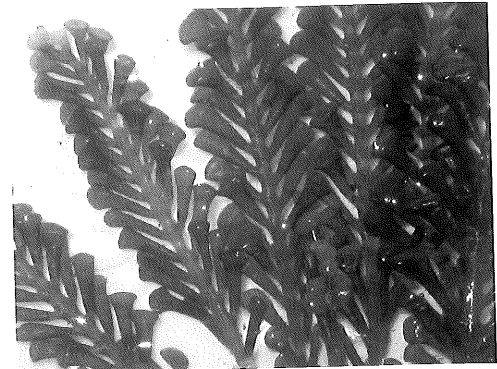


Figure 2. *Caulerpa (lak tud)*



Figure 3. *Caulerpa sertulariodes*

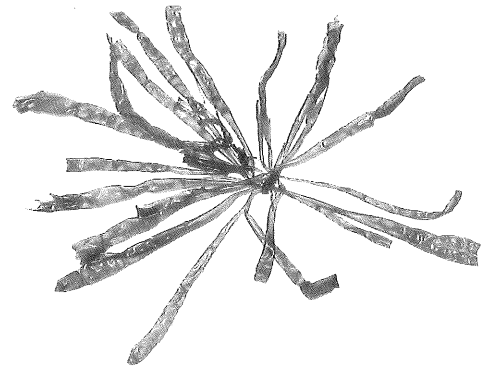


Figure 4. *Enteromorpha intestinalis*

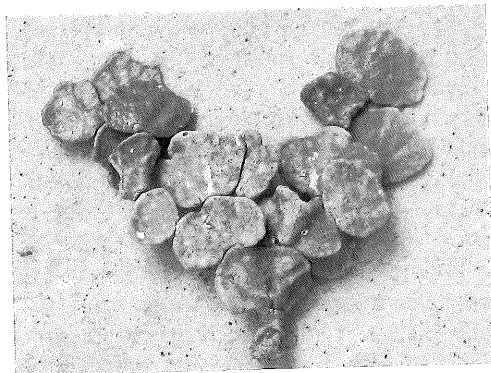


Figure 5. *Halimeda macroloba*

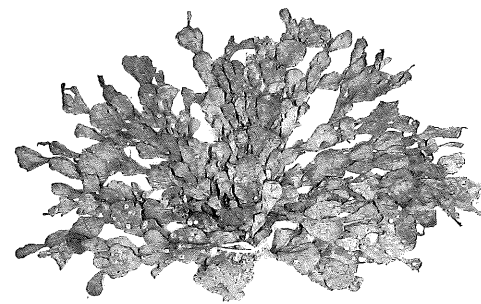


Figure 6. *Halimeda sinulans*



Figure 7. *Chaetomorpha*

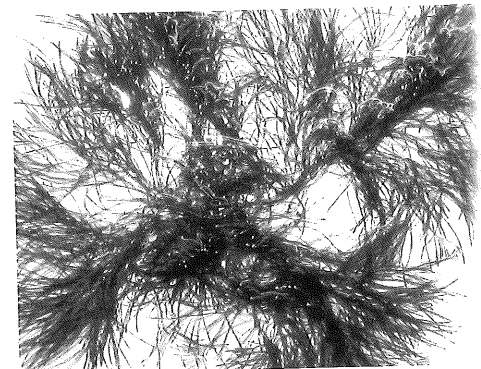


Figure 8. *Bryopsis*

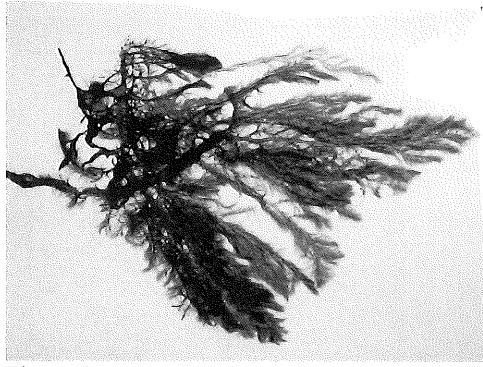


Figure 9. *Asparagopsis taxiformis*

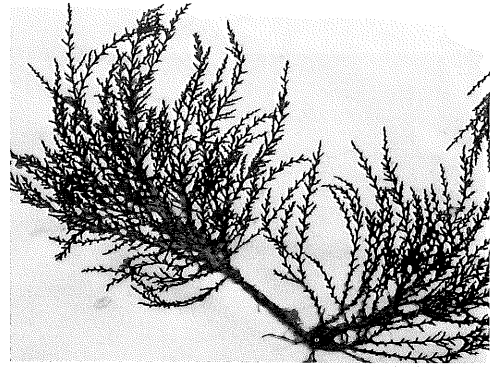


Figure 10. *Acanthophora spicifera*

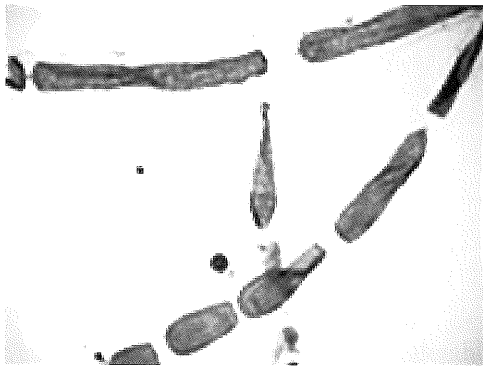


Figure 11. *Anotrichium tenue*

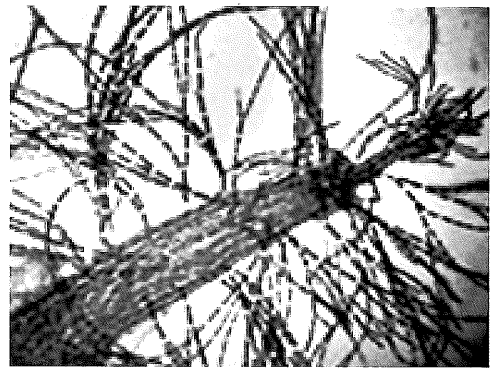


Figure 12. *Dasya malaccensis*

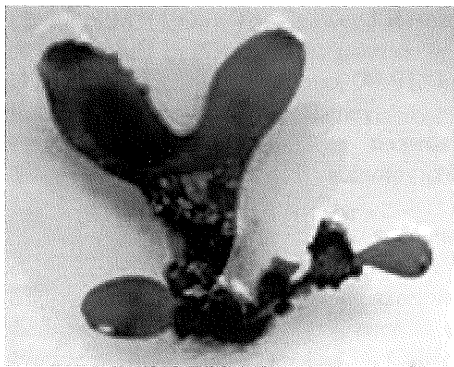


Figure 13. *Cryptonemia yendoi*



Figure 14. *Gracilaria canaliculata*

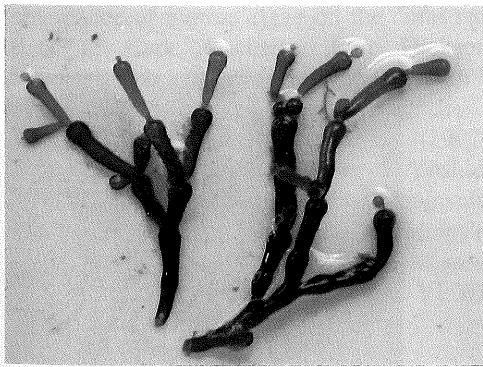


Figure 15. *Gracilaria salicornia*

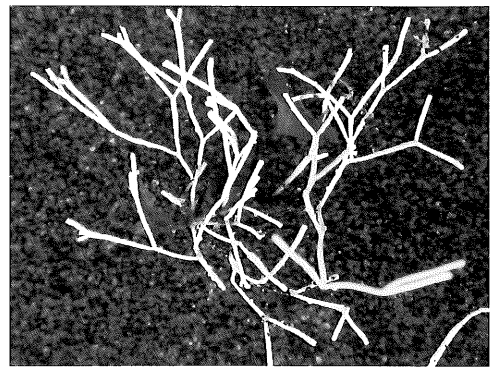


Figure 16. *Jania*

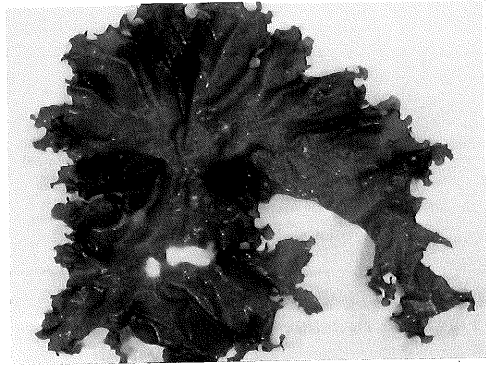


Figure 17. *Halymenia maculata*

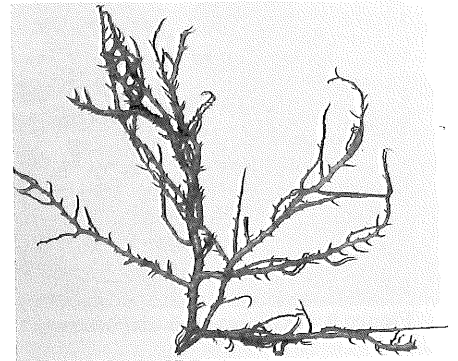


Figure 18. *Hypnea*

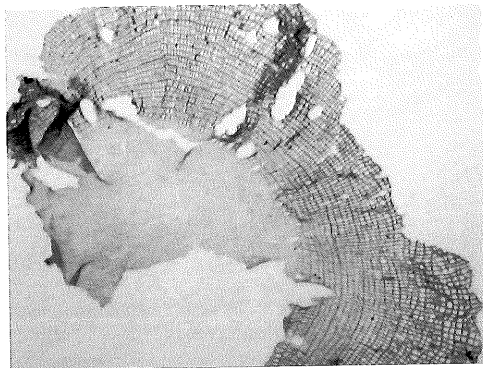


Figure 19. *Martensia fragilis*

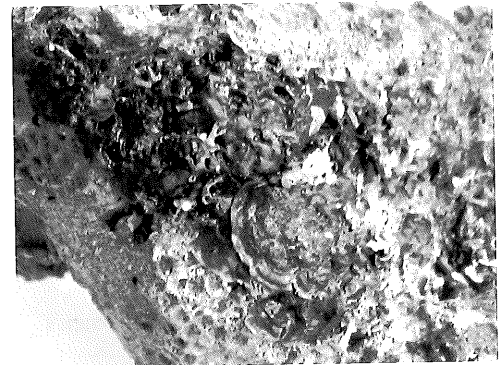


Figure 20. *Peyssonnelia*

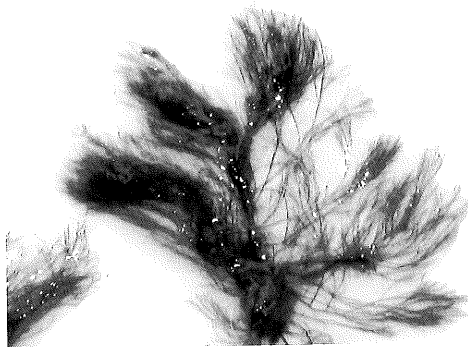


Figure 21. *Polysiphonia scopulorum*

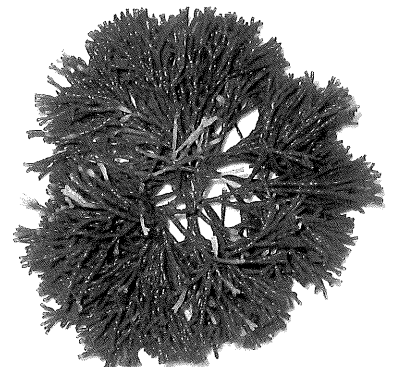


Figure 22. *Galaxaura*

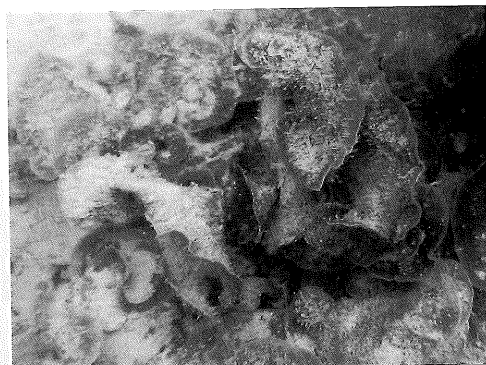


Figure 23. *Lobophora variegata*



Figure 24. *Padina tetrastromatica*

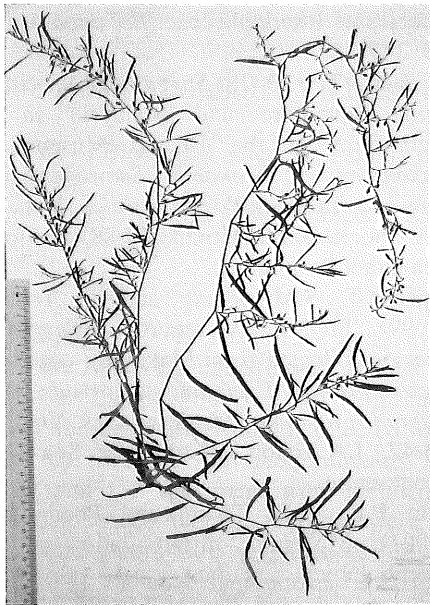


Figure 25. *Sargassum acutifolium*



Figure 26. *Sargassum dotyi*

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