P.M. SIVALINGAM*: Marine Algal Distribution in Penang Island

Abstract

Investigations of marine algae on the shores of Penang Island over a period of two years indicated that the majority of the identified 44 species of marine algae are confined to the rocky conformation of the shores of Batu Ferringhi directly adjacent to the Batu Ferringhi River. Nevertheless, there is a cosmopolitan species, *Enteromorpha flexuosa* (Wulfen et Roth) J. Agardh in the Chlorophyta. In contrast, the sea lettuce, *Ulva reticulata* Forsskal, exists in very large amounts with the prominency as a food source specifically restricted to the muddy banks of Tanjong Tokong, the Middle Bank and the mud-flat stretching from the mouth of Bayan Lepas River till the mouth of Pinang River indicating indirectly its nutrient specificity for mud-flats. In relevance, the Chlorophyta, *Enteromorpha intestinalis* (Linnaeus) Link, is only found in Boon Siew Bay within the Bay of Telok Bahang. Based on these results, it is suggested that available specific nutrients in the water mass, oceanographic conditions and the resulting habitat suitability might play an important role in determining the distribution of algal forms in Penang Island.

Introduction

Studies of marine algae in the neighbouring countries of Thailand (Gomont, 1901; Reinbold, 1901; Seidenfaden et al., 1968; Egerod, 1971, 1974 and 1975), Indonesia (Gilbert, 1942; Gilbert et al., 1969), Philippines (Gilbert, 1942; Taylor, 1966; Gilbert et al., 1969), Ceylon (Borgesen, 1936; Durairatnam, 1961) and Vietnam (Dawson, 1954; Phamhoa'ng Hô, 1969) are so limited that the area of this science is not exploited as a food source to the fullest extent like most advanced countries. Undoubtedly, this is true of Malaysia too, where studies on phycology is so limited (Khew Khing Ling, 1975; Sivalingam et al., 1976) notwithstanding the fact that the word agar-agar originated from an algal

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product which was made since earlier time in this part of the world. This became an incentive to make a detailed study on the distribution of marine algae in Penang Island and the work was performed from April 1975 till April 1977 and the results are reported here.

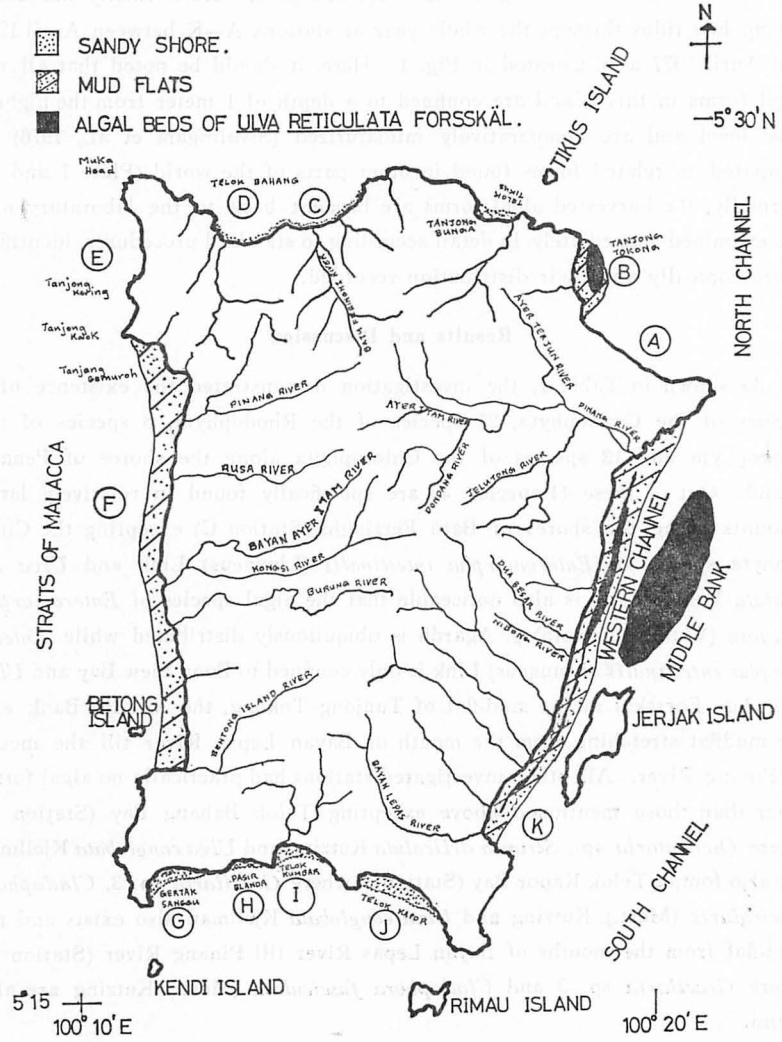

Fig. 1. Map Showing the Details of Penang Island and the Sites of Investigation.

Materials and Methods

Algal forms in Penang Island, an island located between latitudes 5°15′ N and 5°30′ N and longitudes 100°10′ E and 100°20′ E with an area of 110 square miles in the State of Penang, North West Malaysia, were normally harvested during low tides through the whole year at stations A—K between April 1975 and April 1977 as illustrated in Fig. 1. Here, it should be noted that all the algal forms in this island are confined to a depth of 1 meter from the highest tidal level and are comparatively miniaturized (Sivalingam et al., 1976) as compared to related forms found in other parts of the world (Plate 1 and 2). Normally, the harvested algal forms are brought back to the laboratory and are examined immediately in detail according to standard procedures, identified microscopically and their distribution recorded.

Results and Discussion

As shown in Table 1, the investigation demonstrated the existence of 3 species of the Cyanophyta, 21 species of the Rhodophyta, 8 species of the Phaeophyta and 12 species of the Chlorophyta along the shores of Penang Island. Out of these 44 species, 42 are specifically found in relatively large amounts along the shores of Batu Ferringhi (Station C) excepting the Chlorophyta species of *Enteromorpha intestinalis* (Linnaeus) Link and *Ulva reticulata* Forsskal. It is also noticeable that the algal species of *Enteromorpha flexuosa* (Wulfen et Roth) J. Agardh is ubiquitously distributed while *Enteromorpha intestinalis* (Linnaeus) Link is only confined to Boon Siew Bay and *Ulva reticulata* Forsskal in the mud-flat of Tanjong Tokong, the Middle Bank and the mudflat stretching from the mouth of Bayan Lepas River till the mouth of Pinang River. All other investigated stations had practically no algal forms other than those mentioned above excepting Telok Bahang Bay (Station C) where *Oscillatoria* sp., *Struvea delicaluta* Kutzing and *Ulva conglobata* Kjellman are also found, Telok Kapor Bay (Station J) where *Gracilaria* sp. 3, *Cladophora fascicularis* (Mert.) Kutzing and *Ulva conglobata* Kjellman also exists and the mud-flat from the mouths of Bayan Lepas River till Pinang River (Station K) where *Gracilaria* sp. 3 and *Cladophora fasciculata* (Mert.) Kutzing are also found.

Evidently it is to be noticed here why the majority of the algal species are

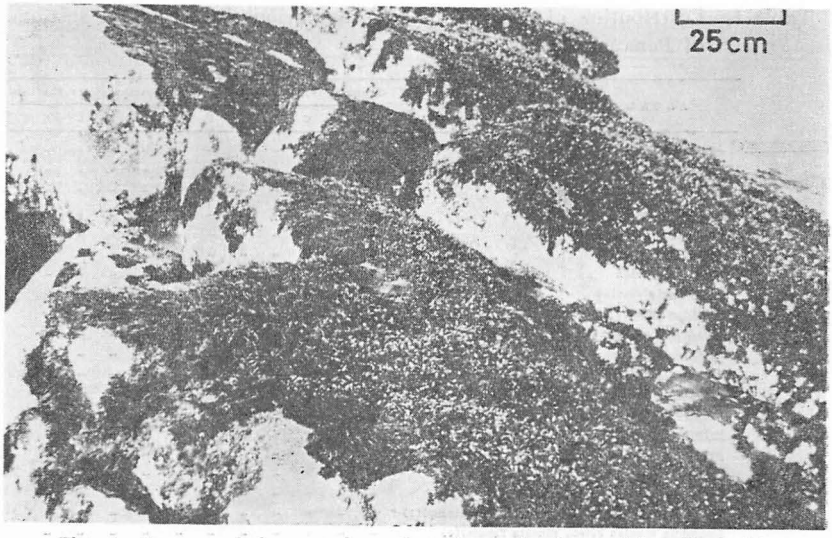

Plate 1. *Sargassum* bed on a rocky conformation at the shores of Batu Ferringhi.

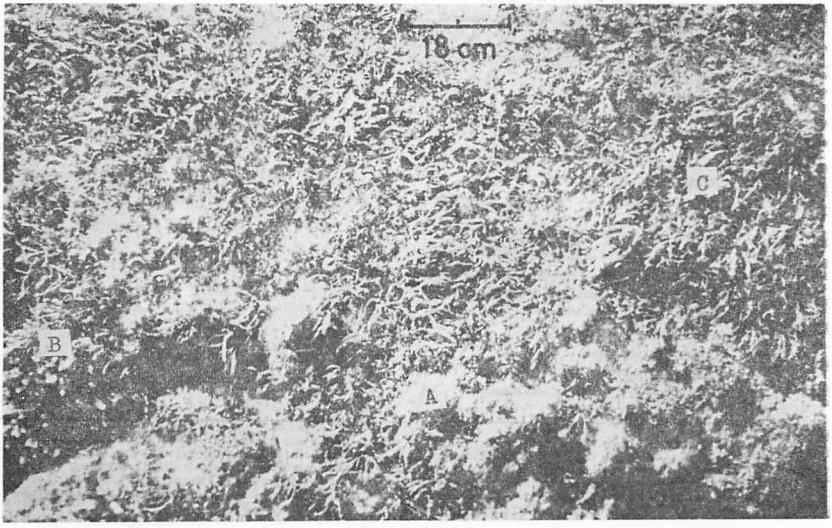

Plate 2. Algal bed showing patches of *Valoniopsis pachynema* (Martens) Boergs (A), *Sarcodia* species (B) and *Gracilaria* species (C) on a rocky conformation at the shores of Batu Ferringhi.

Table 1. Distribution of marine algae at the various investigation stations of Penang Island.

	ALGAL SPECIES	Presence (+)/Absence (−) of Algal Species at the Stations										
		A	B	C	D	E	F	G	H	I	J	K
CYANOPHYCEAE:	Lyngbya species	−	−	+	−	−	−	−	−	−	−	−
	Oscillatoria species	−	−	+	+	−	−	−	−	−	−	−
	Pelagothrix clevei Schmidt	−	−	+	−	−	−	−	−	−	−	−
RHODOPHYCEAE:	Acanthophora orientalis J. Agardh	−	−	+	−	−	−	−	−	−	−	−
	Amphiroa species	−	−	+	−	−	−	−	−	−	−	−
	Centroceras species	−	−	+	−	−	−	−	−	−	−	−
	Ceramium species	−	−	+	−	−	−	−	−	−	−	−
	Gelidiopsis species	−	−	+	+	−	−	−	−	−	−	−
	Gelidium amansii LAMOUROUX	−	−	+	−	−	−	−	−	−	−	−
	Gelidium pusillum (Stackhouse)Le Jolis	−	−	+	−	−	−	−	−	−	−	−
	Gracilaria species 1.	−	−	+	−	−	−	−	−	−	−	−
	Gracilaria species 2.	−	−	+	−	−	−	−	−	−	−	−
	Gracilaria species 3.	−	−	+	−	−	−	−	−	−	+	+
	Gratelopia species	−	−	+	−	−	−	−	−	−	−	−
	Hypnea species 1.	−	−	+	−	−	−	−	−	−	−	−
	Hypnea species 2.	−	−	+	−	−	−	−	−	−	−	−
	Hypnea species 3.	−	−	+	−	−	−	−	−	−	−	−
	Jania species	−	−	+	−	−	−	−	−	−	−	−
	Laurencia species 1.(=L. glandulifera Kutsing)(?)	−	−	+	−	−	−	−	−	−	−	−
	Laurencia species 2.(=L. pinnata Yamada)(?)	−	−	+	−	−	−	−	−	−	−	−
	Leveillea jungermannioides (Martens et Hering)Harvey	−	−	+	−	−	−	−	−	−	−	−
	Lithothamnion simulans Foslie	−	−	+	−	−	−	−	−	−	−	−
	Lithothamnion erubescens Foslie	−	−	+	−	−	−	−	−	−	−	−
	Sarcodia species	−	−	+	−	−	−	−	−	−	−	−
PHAEOPHYCEAE:	Chnoospora minima (HERING) PAPENFUSS	−	−	+	−	−	−	−	−	−	−	−
	Colpomenia sinuosa (Roth) Derbes et Soher	−	−	+	−	−	−	−	−	−	−	−
	Dictyota bartayresii Lamouroux	−	−	+	−	−	−	−	−	−	−	−
	Dictyota dichotoma (Hudson) Lamouroux)	−	−	+	−	−	−	−	−	−	−	−
	Padina tenuis Boru	−	−	+	−	−	−	−	−	−	−	−
	Sargassum grevillei J. Agardh	−	−	+	−	−	−	−	−	−	−	−
	Sargassum sandei Reinbold/polycystum (?)	−	−	+	−	−	−	−	−	−	−	−
	Sphacelaria furcigera Kutzing	−	−	+	−	−	−	−	−	−	−	−
CHLOROPHYCEAE:	Bryopsis plumosa (Hudson) C. Agardh.	−	−	+	−	−	−	−	−	−	−	−
	Caulerpa fergusoni Murray	−	−	+	−	−	−	−	−	−	−	−
	Caulerpa racemosa W.v. Bosse var. lacte virens W.v. Bosse	−	−	+	−	−	−	−	−	−	−	−
	Chaetomorpha antenaina (Bory) Kutzing	−	−	+	−	−	−	−	−	−	−	−
	Cladophora fascicularis (Mert.) Kutzing	−	−	+	−	−	−	−	−	−	+	+
	Enteromorpha flexuosa (Wulfen et Roth) J. Agardh	+	+	+	+	+	+	+	+	+	+	+
	Enteromorpha intestinalis (Linnaeus) Link	−	−	−	+	−	−	−	−	−	−	−
	Struvea delicaluta Kutzing	−	−	+	+	−	−	−	−	−	−	−
	Ulva conglobata Kjellman	−	−	+	+	−	−	−	−	−	+	−
	Ulva reticulata Forsskal	−	+	−	−	−	−	−	−	−	−	+
	Valonia fastigiata	−	−	+	−	−	−	−	−	−	−	−
	Valoniopsis pachynema (Martens) Boergs	−	−	+	−	−	−	−	−	−	−	−

*Stations: A: sandy bench from Fort Cornwallis to the tip of Tanjong Tokong; B: Mud flats of Tanjong Tokong; C: sandy shores of Batu Ferringhi with lots of rocky conformation; D: Telok Bahang sandy bay; E: Sandy beach of Pantai Acheh; F: mud flats with mangrove swamps stretching from Tanjong Gemuroh to the mouth of Bentong Island River; G: Sandy beach of Gertak Sanggul; H: Sandy Beach of Pasir Belanda; J: sandy and slightly rocky beach of Telok Kapor and K: mud flats stretching from the mouth of Bayan Lepas River to the mouth of Sungei Pinang.

Table 2. Marine algal species found in East Malaysia along the West Coast of Sabah[1].

	ALGAL SPECIES	Presence (+)/Absence (-) of Algal Forms in investigated areas.			
		Pulau Labuan*	Kota Kinabalu* and its vicinities	Kudat*	Pulau Balambangun*
RHODOPHYCEAE:	Acanthophora species	+	+	-	-
	Champia (parvula)	+	-	-	-
	Champia species	-	-	-	+
	Chrysymenia species	+	-	-	-
	Corallina species	+	-	-	+
	Euchema species	+	-	-	-
	Galaxaura cylindrica	+	-	-	-
	Galaxaura squalida	+	-	-	-
	Galaxaura species	+	+	-	+
	Gracilaria crassa	+	-	-	-
	Gracilaria dura	+	-	-	-
	Gracilaria species	+	+	+	-
	Gratelopia species	-	+	-	-
	Jania species	+	-	-	-
	Laurencia species	+	-	-	-
PHAEOPHYCEAE:	Colpomenia sinuosa	+	+	+	-
	Dictyopteris species	+	-	-	-
	Dictyota atomaria	+	-	-	-
	Dictyota dentata	+	+	-	-
	Dictyota species	+	+	+	+
	Hormophysa triquetra	+	+	+	-
	Hydroclathrus clathratus	+	-	+	+
	Padina commersonii	+	+	+	+
	Padina gymnospora	+	+	+	+
	Padina species	+	+	+	+
	Ralfsia species	-	-	-	+
	Sargassum cinereum	+	+	+	+
	Sargassum duplicatum	+	+	+	+
	Sargassum filipendula	+	+	-	-
	Sargassum tenerrimum	+	+	+	+
	Sargassum species	+	+	+	+
	Turbinaria concoides	+	+	+	-
	Turbinaria species	+	+	+	-
CHLOROPHYCEAE:	Acetabularia cremulata	+	-	-	-
	Anadyomera stellata	+	-	-	-
	Avrainvillea species	+	-	-	-
	Caulerpa sertularoides	-	+	-	-
	Caulerpa species	+	+	-	-
	Chaetomorpha species	+	+	-	-
	Cladophora species	+	+	+	-
	Enteromorpha species	-	+	-	-
	Halimeda discoidea	+	-	-	-
	Halimeda dura	-	-	-	+
	Halimeda opuntia	+	-	-	+
	Halimeda tuna	+	-	+	-
	Halimeda species	+	+	+	+
	Halymenia species	-	+	-	-
	Valonia species	+	-	-	-

1: Data of Khew Khing Ling (1975). *Details of investigated areas,: Pulau Labuan: Layang Beach, Lubok Terunang Beach, Pohon Batu Beach, Membidai Beach, Suangalada Beach, Tanjong Aru Beach and Victoria Off-shore; Kota Kinabalu and its vicinities: Gaya Bay, Kuala Abai, Kota Kinabalu Coastal Areas, Likas Bay, Papur Beach, Pulau Gaya, Pulau Sulong, Sembulan Beach and Tanjong Aru Beach (K.K.); Kudat: Pantai Bak Bak and Pengeraban Beach; Pulau Balambangan: Beach East of Kelangan River.

confined to the shores of Batu Ferringhi. The explanation is difficult but it might be due to the availability of large areas of sandy and rocky conformation of the shore as compared to the other areas which in essence are sandy and muddy in nature, some oceanographic conditions such as currents from the Bay of Bengal and the tidal currents of the Straits of Malacca, and the availability of high nutrient content for their flourishment brought about by river imput from the mainland and the island itself. It should also be noted that the Chlorophyta, *Ulva reticulata* Forsskal, is confined only to the mud-flats facing the North and South Channel of the Straits of Malacca and not in the mud-flat stretching from Tanjong Gemuroh to the mouth of Bentong Island River which is directly exposed to the Indian Ocean. Possibly, this might also be due to the availability of nutrients owing to its exposure to oceanic waters.

In this work, a comparison was made between the algal forms found in Penang Island with those in East Malaysia along the West Coast of Sabah (Table 2., Khew Khing Ling, 1975). This interest has come from the fact that the algal forms found in the tropical zone of this island are in no way similar from the overall aspect to those found in the East Coast of Malaysia.

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要　　約

シバリンガム，P.M.: ペナン島の海藻分布

過去2年余にわたってマレー半島中部のマラッカ海峡側にあるペナン島の海藻の分布を調べ，藍藻類3種，紅藻類21種，褐藻類8種，緑藻類12種，計44種を得た。このうち，島をめぐる全11調査地点にわたって普遍的に見出されたのは *Enteromorpha flexuosa* ただ1種のみで，*Enteromorpha intestinalis*（ボウアオノリ）は St. D のみに，*Ulva reticulata*（アミアオサ）は東岸の St. B と中州を含む St. K に，残りの42種はすべて北岸の岩礁よりなる St. C に集中して見出されたのは，非常に特徴的であった。