

Fauna of Langkawi Mangrove Forests

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ABSTRACT The mangrove forests in the north-eastern part of Langkawi island are dominated by *Rhizophora apiculata* and *Ceriops tagal*, and cover an area of 1,987 ha that is drained by three major rivers, namely, Sg. Kisap, Sg. Air Hangat and Sg. Kilim. The tree canopy are home of a variety of birds, bats, monkeys and large number insects. The forest floor is colonized by a large variety of benthic invertebrates that live on the sediment surface, within the sediment as well as on the lower trunks of trees. These include 16 species of crustaceans (brachyuran crabs from the families Ocypodidae and Grapsidae) and 12 species of gastropods (Ellobiidae, Cerithiidae and Littorinidae). These invertebrates play an important role in the ecology of the mangrove forests, by consuming organic matter and recycling nutrients. The conservation of these mangrove forests is vital for the existence of coastal fisheries, and marine life in the coastal waters of Langkawi.

ABSTRAK Hutan bakau di bahagian Langkawi Timur Laut di dominasi oleh *Rhizophora apiculata* dan *Ceriops tagal*, yang merangkumi 1,987 ha, meliputi tiga Sungai utama iaitu Sg. Kisap, Sg. Air Hangat dan Sg. Kilim. Kanopi pokok merupakan habitat bagi variasi burung, kelawar, monyet dan juga sebilangan besar serangga. Lantai hutan dikoloni oleh pelbagai invertebrata benthik yang hidup di permukaan, di dalam sedimen, dan juga di bahagian bawah batang pokok. Ini meliputi 16 spesies crustacean (ketam brachyuran daripada famili Ocypodidae dan Grapsidae) dan juga 12 spesies gastropod (Ellobiidae, Cerithiidae dan Littorinidae). Invertebrata ini memainkan peranan penting dalam ekologi hutan paya bakau, yang menggunakan bahan organik dan mengitar semula nutrien. Pemuliharaan hutan paya bakau ini penting untuk kewujudan perikanan persisiran pantai, dan hidupan marin di persisiran pantai Langkawi.

(mangrove forests, *Rhizophora apiculata*, *Ceriops tagal*, crustaceans, gastropods, Northeastern Langkawi)

INTRODUCTION

There are over 3,126 ha of mangrove forests in Langkawi Island, and the major part of it, consisting of 1,987 ha, is located in the northeast part of the island. The main areas of mangrove reserves in the northeast are found in the following locations according to Wan Yusoff and Abdullah [1]: Sungai Kisap (1,336 ha), Gua Cherita (208 ha), Ayer Hangat (402 ha), Pulau Timun (27 ha) and Pulau Langgun (14 ha). The

three major rivers, which drain these mangroves, are Sg. Kisap, Sg. Kilim and Sg. Air Hangat (Figure 1). These rivers or estuaries provide an excellent drainage system for the mangroves to be regularly inundated by seawater during high tides. In the landside and in the midst of the mangrove forest stand massive limestone cliffs that are unique to the mangroves of Pulau Langkawi. Limestone cliffs also border many mangrove inlets or channels (Figure 2).

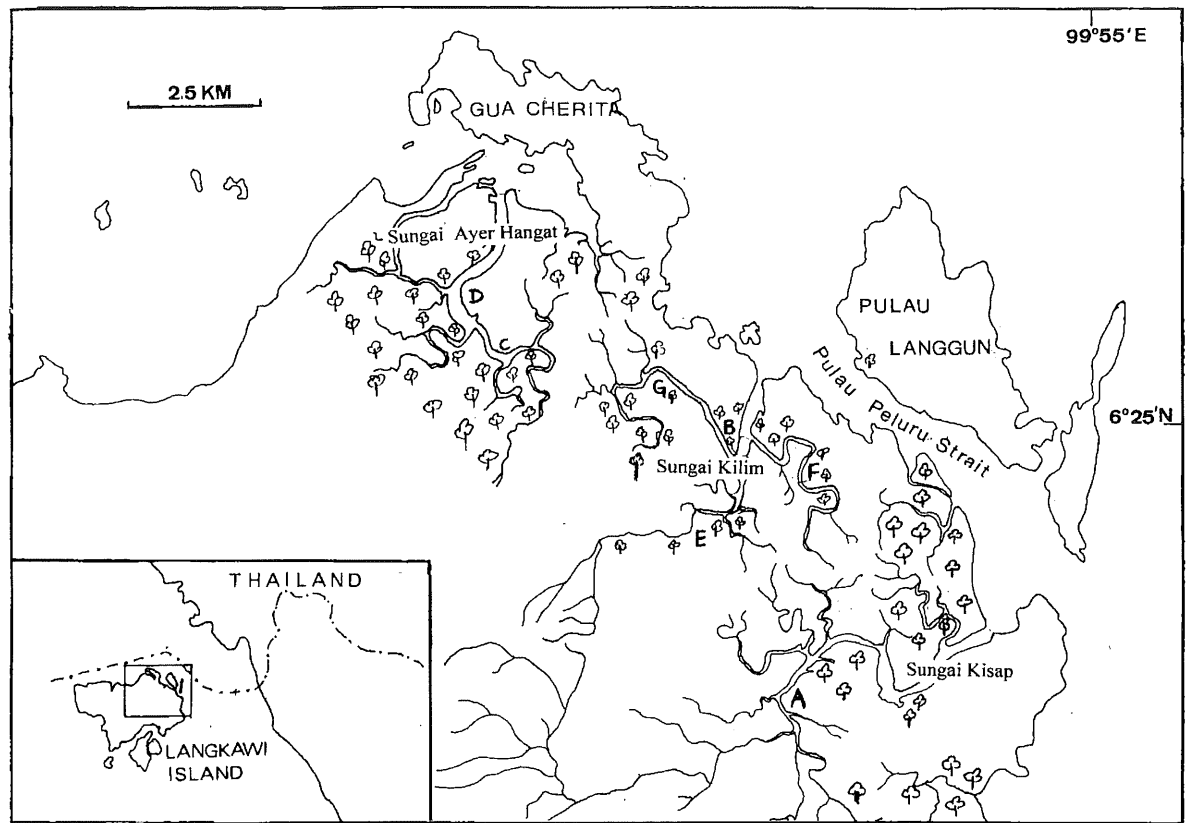


Figure 1. Sampling sites are indicated in the following locations: A (Sg. Kisap), B (Sg. Banjar Kilim), C (Sg. Itau), D (Sg. Air Hangat), E (Sg. Kilim), F (Sg. Banjar and G (Sg. Pinang Karang). Mangroves grow along the banks of the three major estuaries, namely, Sungai Kisap, Sungai Kilim and Sungai Ayer Hangat.

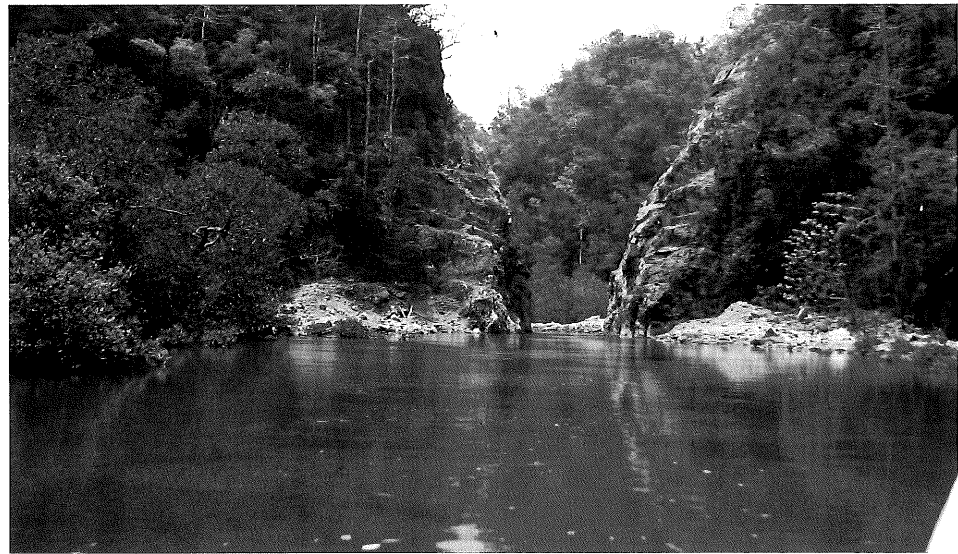


Figure 2. View of the limestone cliffs which had been blasted away to connect Sg. Kilim and Sg. Air Hangat. On the left are some mangrove plants

Mangrove forests in Langkawi have not been investigated for their fauna, though faunal elements are known to be very similar on a regional scale. Investigations on mangrove fauna have been carried out in Selangor [2], Matang, Perak, and Merbok, Kedah [3]. The environmental conditions prevailing in Langkawi appears different from the Port Klang area in Selangor, in that the island is under the influence of full marine conditions of the adjoining sea, and the substrate appears more sand-mud than fine sediment (clay). Klang mangroves are influenced by low saline waters, as three major rivers, Sg. Selangor, Sg. Klang and Sg. Langat flow into the coastal waters of Selangor. The main objectives of the study are to provide a general description of the mangrove forests and describe the abundance of fauna especially benthic invertebrates.

MATERIALS AND METHODS

Over a period of 3 days, from the 5th to the 7th April 2004, the following locations were visited with student assistants: Sg. Kilim, Sg. Kisap and Sg. Ayer Hangat. As high tides occurred during mid-day and low tides during early morning and after 3.00 pm in the afternoon, sampling was confined to the afternoon for 3 hours.

Initially, two quadrat samples of 20 x 20 x 20 cm of substrate were taken at each site. The quadrat

sample was dug out with a spade, placed on large plastic sheet, and then the animals collected by hand after breaking up the substrate sample into small pieces. A general collection was also taken by walking for 30 minutes, and then collecting all invertebrates seen on the surface or within burrows. After visits to two sites, it was found that quadrat method of sampling took too much time, and it was impossible to cover many sites in a day. Subsequently, it was decided to take only a general collection at each site. At each location, collections were made at two sites, one about 20 metres from the channel or estuarine bank, and another at least 100 metres interior to the first site.

Description of sites

Location A: Sg. Kisap (Figure 1).

The edge or riverbank of Sg. Kisap was colonized by *Rhizophora mucronata*, which were mature trees of 15 metres in height. This zone had a width of only 10 metres (Figure 3). Further inland was a *Ceriops tagal* zone of 15 metres in width, followed by the *Acanthus ilicifolius* bushes forming a zone of 10 metres in width, and further inland was a zone of mixed forest of *Ceriops* and *Rhizophora* (15 metres in height) with thick undergrowth of *Acanthus* and creeper *Derris uliginosa*.

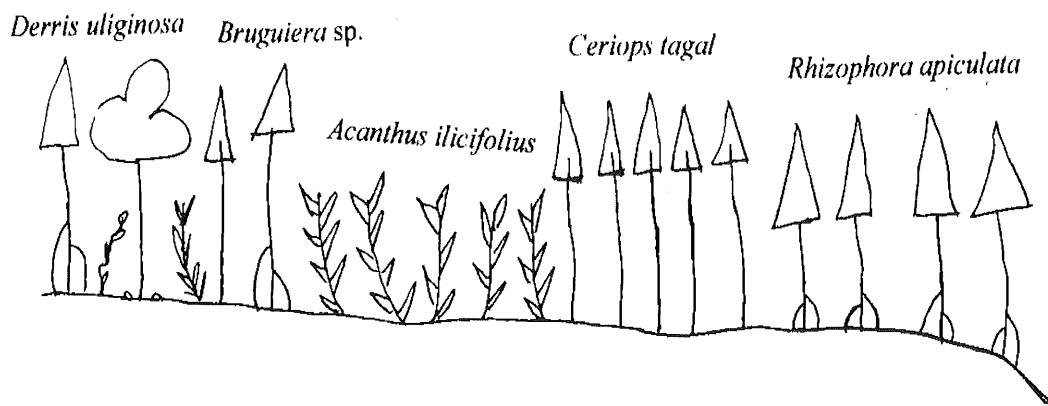


Figure 3. The distribution of plants in the mangroves along the bank of Sungai Kisap. The vegetation from the banks of the river to the land side is as follows: *Rhizophora apiculata*, *Ceriops tagal*, *Acanthus ilicifolius* and mixed forest of *Rhizophora*, *Ceriops tagal*, *Bruguiera* sp., *Acanthus ilicifolius* and creeper *Derris uliginosa*.

The zone of *Acanthus* was unusual as such a pure growth in an undisturbed forest had not been reported elsewhere on the west coast in peninsular Malaysia. The location appeared not subjected to logging. Such a distinct zone of

Acanthus in the mangrove shore has not been observed or commented on in [4] or [5]. Figure 4 shows the leaves and inflorescence of *Acanthus ilicifolius*.



Figure 4. Inflorescence of *Acanthus ilicifolius* showing flowers and non-spiny leaves

Location B: Sg. Banjar Kilim

River bank was colonized by few 10 metre tall trees of *R. mucronata*. Other *Rhizophora* trees were only 6 metres. There were also a few *Ceriops tagal*. Further interior there were few tall trees of *Bruguiera gymnorhiza*, a few *Ceriops tagal* and many *R. mucronata*. Seedlings of *Rhizophora* were abundant. The substrate was water-logged and soggy. The presence of pistol prawns was noted, however, none occurred in faunal samples.

Location C

Near the River bank, the forest was dominated by *Ceriops tagal* and *Rhizophora mucronata*, *Acanthus ilicifolius* and some *Derris uliginosa*. Further interior, the forest was highly disturbed by logging, and was dominated by 5 to 6 metre tall *Rhizophora mucronata* and few *Ceriops tagal*.

Location D: Sg. Intau

The forest was dominated by 3 to 4 metre tall *Rhizophora apiculata* and *Ceriops tagal*. The forest is not more than 5 years old.

Location E: Sg. Air Hangat

The Air Hangat Mangrove Forest Reserve consists of *Rhizophora mucronata* and *R. apiculata* and a few *Xylocarpus* and *Avicennia marina*. *Rhizophora* was the dominant vegetation here.

Location E: Sg. Pinang Karang.

Several specimens of oysters were collected from lower trunk of trees, and few crabs from the substrate.

Location F: Sg. Banjar.

A mixed forest of *Rhizophora* spp. and few *Ceriops tagal* prevailed in this locality.

Location G: Near Jetty in Sg. Kilim.

The forest here appeared disturbed with harvesting. There was a distinct mud-cliff, which appears to have been formed as a consequence of strong waves created by boat traffic due to its close proximity to the jetty. There was a rich fauna of crabs living in mud cliff.

RESULTS AND DISCUSSION

The benthic fauna living in the mangroves in Langkawi are very similar those found in mangrove elsewhere on the west coast of

peninsular Malaysia, including the Indo-West-Pacific Region [6]. The similarities are in the presence of gastropods and crustaceans. The fauna may be divided into tree fauna (living on lower trunks), sediment epifauna (on sediment surface) and sediment infauna (living within the substrate in burrows) (Table 1).

Some gastropods may occur, both on the lower tree trunks and on the sediment surface. Among these are air-breathing gastropods ellobiids and *Cerithidea obtusa* and *C. quadrata*, which crawl up the tree trunks to avoid predators that come in at high tide. Below is a list of the common invertebrate fauna.

Some elements of the fauna may be missing from the collections in view of their cryptic behaviour. For example, mud-lobster *Thalassina anomala*, is normally not found in sediment samples, though their characteristic mud mounds topped by fern *Acrostichium aureum* are common in the high shore mangroves. Similar problem may be noted for many species of grapsid crabs that live in deep burrows. These crabs may be observed at

the mouth of burrows, but escape when approached by the investigator. To capture all animals living in mangroves requires collections during day and nights especially during spring tides as the animals are active following tidal inundation. Some grapsid crabs are nocturnal and are easily captured using bright torchlight especially on landside bunds/dykes. Grapsid crabs have a habit of climbing trees to take leaves during nocturnal low tides (Sivasothi *et al.* [7]).

Brachyuran crabs are the main inhabitants of mangroves with a high diversity of crabs from the group Grapsidae. Tan and Ng [8] claimed that there are as many as 76 species of crabs in Singapore, which has only 3,000 ha of mangroves. Malaysia with 300,000 ha of mangrove forests spread over in Peninsular Malaysia and Borneo, should harbour a larger diversity of crabs, based on the island biogeography theory (Townsend *et al.* [9]). Intensive collection methods are required before accurate figures on species diversity can be estimated.

Tree epifauna	Epifauna	Infauna
<i>Balanus amphitrite</i> (barnacle)	<i>Clibanarius padavensis</i>	<i>Leiochrides australis</i>
<i>Crassostrea cucullata</i> (bivalve)	(hermit crab)	<i>Glycera</i> sp.
<i>Isognomon epihippum</i> (bivalve)	<i>Cerithidea cingulata</i>	<i>Nereis</i> sp.
<i>Littorina scabra</i>	<i>C. obtusa</i>	Isopod
<i>L. undulata</i>	<i>C. quadrata</i>	Nemertine
<i>Nerita articulata</i>	<i>Assiminea brevicula</i>	<i>Wolffogebia</i> sp.
<i>Nerita</i> sp.	<i>Murex capucinus</i>	<i>Ilyoplax</i> sp.
<i>Cerithidea obtusa</i>	<i>Hydatina</i> sp.	<i>Metaplax elegans</i>
<i>C. quadrata</i>	<i>Ellobium aurisjudae</i>	<i>Uca rosea</i>
<i>Ellobium aurisjudae</i>	<i>Cassidula aurisfelis</i>	<i>U. triangularis</i>
<i>Cassidula aurisfelis</i>	<i>Anadara granosa</i> (bivalve)	<i>U. dussumieri</i>
		<i>U. mani</i>
		<i>Uca juveniles</i>
		<i>Chiromanthes eumolpe</i>
		<i>Sesarma versicolor</i>
		<i>Samartium crassum</i>
		<i>Sesarma</i> sp.
		<i>Sesarma juveniles</i>
		<i>Cleistocoeloma merguensis</i>
		<i>Heteropanope glabra</i>
		<i>Xenophthalmus pinnotheroides</i>

Table 1. The common fauna of mangroves in northeast Langkawi. Numbers represent a general indication of abundance in a random collection by two investigators for 30 minutes at each site. N: Nemertine, P: Polychaete, G: Gastropoda, B: Bivalvia, C: Crustacea, F: Fish

Date	Location	GPS Reading	Taxa	No's. collected
5/4/2004	Sg. Kisap Site 1	A N 6°23' 25.1 E 99°51' 52.1	<i>Leiochrides australis</i> (P)	1
			<i>Assiminea brevicula</i> (G)	1
5/4/2004	Rhizophora forest Site 2		<i>Murex capucinus</i> (G)	2
			<i>Nerita articulata</i> (G)	3
			<i>Cerithidea cingulata</i> (G)	2
			<i>Clibanarius padavensis</i> (C)	3
			<i>Cleistocoeloma merguiensis</i> (C)	1
			<i>Uca</i> (juvenile) (C)	2
			<i>Uca rosea</i> (C)	2
			<i>Sarmatium crassum</i> (C)	1
			<i>Chiromantes eumolpe</i> (C)	2
5/4/2004	Upper shore (site 3) Acanthus - <i>Ceriops</i> forest		<i>Nerita articulata</i> (G)	4
			<i>Littorina scabra</i> (G)	2
			<i>Sesarma</i> sp. (C)	3
			<i>Cleistocoeloma merguiensis</i> (C)	1
5/4/2004	Sg. Banjar Kilim Site 2 interior B	N 6°25' 51.3 E 99°52'20.6	<i>Glycera</i> sp. (P)	1
			<i>Nerita articulata</i> (G)	5
			<i>Assiminea brevicula</i> (G)	7
			<i>Sesarma</i> sp. (C)	4
5/4/2004	Sg. Banjar Kilim (Site 2)		<i>Leiochrides australis</i> (P)	2
			<i>Glycera</i> sp. (P)	1
5/4/2004	Site 1 (<i>Rhizophora</i>)		<i>Sarmatium crassum</i> (C)	1
5/4/2004	Sg. Banjar Kilim (Site 1)		<i>Leiochrides australis</i> (P)	3
			<i>Uca triangularis</i> (C)	1
5/4/2004	Sg. Banjar Kilim (Site 2)		<i>Nerita articulata</i> (G)	3
			<i>Cerithidea quadrata</i> (G)	1
			<i>Murex capucinus</i> (G)	2
			<i>Littorina scabra</i> (G)	1
			<i>Periophthalmus</i> sp.1 (F)	1
6/4/2004	Sg. Itau Site 1	C N 6°25' 41.6 E 99°50'20.6	<i>Murex capucinus</i> (G)	5
			<i>Ellobium aurisjudae</i> (G)	2
			<i>Hydatina</i> sp. (G)	1
			<i>Uca rosea</i> (C)	2
			<i>Chiromantes eumolpe</i> (C)	1
			<i>Sesarma versicolor</i> (C)	1
			<i>Sesarma</i> sp.(C)	1
			<i>Sesarma</i> (juvenile) (C)	3
6/4/2004	Sg. Air Hangat Site 1		<i>Leiochrides australis</i> (P)	2
			<i>Wolffogebia</i> sp.1 (C)	1
			<i>Isopod</i> sp (C)	1
			<i>Sarmatium crassum</i> (C)	1
			<i>Sesarma</i> sp. (C)	1

6/4/2004	Sg. Air Hangat		<i>Nemertine (N)</i>	1
	Station 2		<i>Littorina scabra (G)</i>	1
			<i>Littorina undulata (G)</i>	1
			<i>Murex capucinus (G)</i>	1
			<i>Nerita articulata (G)</i>	1
			<i>Nerita sp. (G)</i>	1
			<i>Ellobium aurisjudae (G)</i>	1
			<i>Clibanarius padavensis (C)</i>	2
			<i>Sesarmid sp. (C)</i>	2
			<i>Uca sp. (C)</i>	2
			<i>Periopthalmus sp.(F)</i>	4
6/4/2004	Sg. Air Hangat		<i>Leiochrides australis (P)</i>	1
	Site 1		<i>Cleistocoeloma merguiensis (C)</i>	1
			<i>Uca sp.(C)</i>	1
6/4/2004	Sg. Itau (Site 2)		<i>Nerita articulata (G)</i>	2
			<i>Murex capucinus (G)</i>	2
			<i>Assiminea brevicula (G)</i>	6
			<i>Isognomon ephippium (B)</i>	3
			<i>Sesarmid sp.(C)</i>	2
			<i>Uca rosea (C)</i>	3
			<i>Metaplax elegans (C)</i>	1
6/4/2004	Sg. Air Hangat		<i>Cerithidea quadrata (G)</i>	5
	D	N 6°25' 54.0	<i>Cerithidea obtusa (G)</i>	2
	Site 1	E 99°50' 9.5	<i>Ellobium aurisjudae (G)</i>	1
			<i>Nerita articulata (G)</i>	8
			<i>Nerita sp.(G)</i>	1
			<i>Littorina scabra (G)</i>	3
			<i>Littorina undulata (G)</i>	1
			<i>Cassidula aurisfelis (G)</i>	4
			<i>Uca triangularis (C)</i>	1
			<i>Uca (juvenile) (C)</i>	2
			<i>Cleistocoeloma merguiensis (C)</i>	1
			<i>Sesarma sp. (C)</i>	2
			<i>Periopthalmus sp. (F)</i>	1
7/4/2004	Sg. Kilim (near jetty)		<i>Nereis sp. (P)</i>	2
	E	N 6°24' 21.5	<i>Glycera sp. (P)</i>	1
	Mud cliff	E 99°51' 32.4	<i>Petrolithes sp.(C)</i>	4
			<i>Sesarma sp.(C)</i>	1
			<i>Heteropanope glabra (C)</i>	1
			<i>Xenopthalmus pinnotheroides (C)</i>	1
7/4/2004	Sungai Banjar		<i>Cassidula aurisfelis (G)</i>	1
	F	N 6°24' 51.7	<i>Cerithidea obtusa (G)</i>	1
		E 99°52' 21.0	<i>Nerita articulata (G)</i>	3
			<i>Murex capucinus (G)</i>	2
			<i>Cleistocoeloma merguiensis (C)</i>	2
			<i>Uca (juvenile) (C)</i>	2
			<i>Sesarmid (juvenile) (C)</i>	5
			<i>Heteropanope glabra (C)</i>	1
			<i>Periopthalmus sp. (F)</i>	3
7/4/2004	Sg. Pinang Karang		<i>Murex capucinus (G)</i>	1
	G	N 6°24' 18.0		

E 99°51' 10.2	<i>Nerita articulata</i> (G)	2
	<i>Nerita</i> sp. (G)	1
	<i>Cerithidea cingulata</i> (G)	3
	<i>Cerithidea</i> sp. (G)	6
	<i>Crassostrea cucullata</i> (B)	4
	<i>Anadara granosa</i> (B)	1
	<i>Balanus amphitrite</i> (C)	3
<i>Sesarmid</i> (juvenile) (C)	1	

The fauna living in mangroves may be discussed according to various substrate types or characteristics. Beginning from the sea front or estuarine low tide habitats, the lower trunk of trees are colonized by encrusting invertebrates such as oysters, barnacles and gastropods such as *Thais tissoti* and *Littorina* spp. Oysters and barnacles were observed on lower tree trunk near the river bank in Sg. Pinang Karang, a tributary of Sg. Kilim.

The absence of a pioneer shore or accreting shore in the locations investigated is the reason for the absence of an encrusting fauna of oysters, mytilid bivalves, barnacles, and many *Littorina* spp.

At all other sites, the tree fauna comprised of gastropods such as *Nerita articulata*, *Cerithidea obtusa*, *Littorina* spp. and occasionally the bivalve *Isognomon epihippum*. The bivalve was attached by byssus threads, to the lower trunks of *Rhizophora* stilt roots.

The sediment epifauna in all sites were hermit crab, *Clibanarius padavensis*, and common gastropods like *Assimineia brevicula*, *Cerithidea obtusa*, *C. quadrata*, *Ellobium aurisjudae*, *Cassidula aurisfelis* and *Nerita* spp. The infauna living within the sediment consisted of a large number of crustaceans which included *Uca* spp., *Ilyoplax* spp. grapsid crabs *Sesarma* spp., *Chiromanthes* spp., *Heteropanope glabra* and *Cleistocoeloma merguensis*. The infaunas of polychaetes were predominately *Leiochrides australis*, *Glycera* sp. and *Nereis* sp. The presence of tubicolous polychaete *Diopatra* was noted on stream banks, where tidal inundation is frequent.

The mangrove forest floor is burrowed extensively by mangrove crabs belonging to families, Ocypodidae and Grapsidae. Hogarth [10] states succinctly that the mud is honeycombed with a network of inter-connecting passages. The burrowing activities increase the

surface area exposed to air, and as a consequence increase aeration of the anoxic substrate. Thus, there may be a reduction in concentrations of hydrogen sulphide and ammonium in the sediment.

A large nemertine worm measuring 30 cm in length was found in the soft substrate in Site 2 at Air Hangat (Table 1). It broke into several segments on handling and preservation. Frith *et al.* [11] found several species of nemertea in the sand-mud mangroves as well as in the foreshore sand-flats in Phuket, Thailand.

Mudskippers were common throughout the mangroves, but there were not very abundant, as in the Selangor mangroves. Detailed investigations are required to study their occurrence and distribution in Langkawi mangroves.

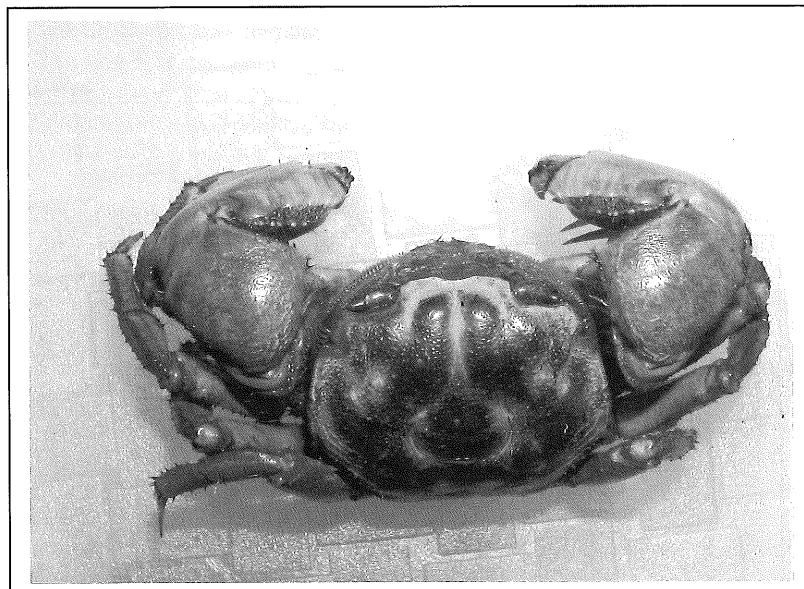
Mangrove forests provide many goods and services to society, including protection of human settlements from tidal waves, provision of a variety of plant products (wood), sediment trapping, and more importantly as nursery for coastal fisheries (Ewel *et al.*, 1998). The conservation of these tidal forests will provide many benefits to the island of Langkawi and its people.

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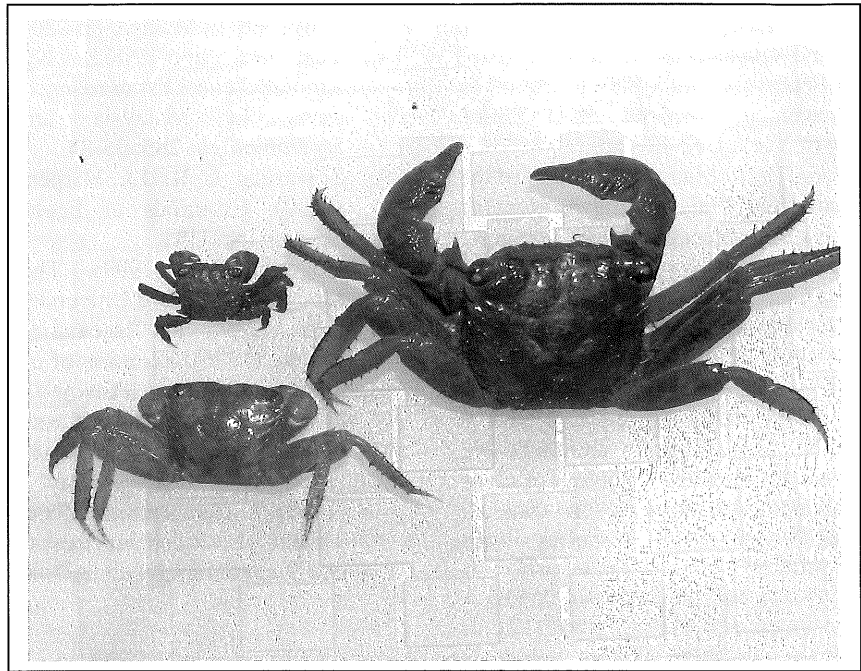
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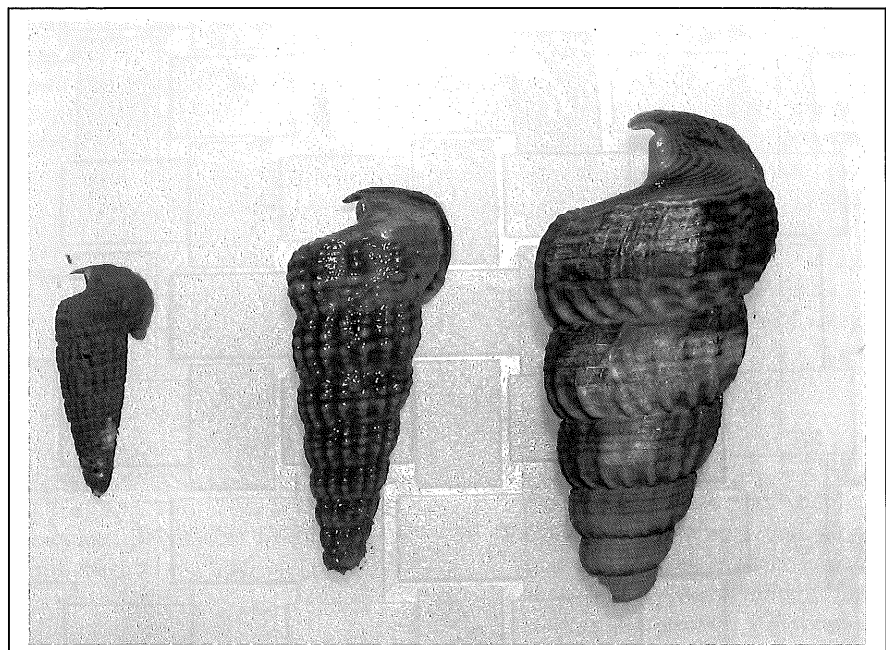
Appendix: Common elements of the Langkawi mangrove fauna



Grapsid crab, *Sarmatium crassum*, Carapace width: 50 mm



Three species of grapsid crabs
Top left: *Cleistocoeloma merguensis*
Bottom left: *Chiromanthes eumolpe*
Middle right: *Sesarma versicolor*



Three species of *Cerithidea*
Extreme left: *C. cingulata*
Middle: *C. quadrata*
Extreme right: *C. obtuse*