CHAPTER 1

1. INTRODUCTION

1.1 Mangrove Swamp

Mangroves are trees and shrubs that grow at the edges of the sea and estuary in the tropics. It's also found generally in the sloping shore lines or muddy banks of the estuaries. These swamps border the low-lying tropical and sub-tropical coasts. Mangroves colonize a major part of the world's coastlines between 20^{0}N and 20^{0}S latitudes (McGill, 1958). Schimper (1903) defined mangroves as formations of plants below the high-tide mark, with a muddy intertidal substrate. It is normally inundated daily by the tides for varying periods of time depending on the tidal cycle.

Mangroves are a complex of plant communities fringing sheltered tropical shores. These forests are characterized by luxuriant vegetation and great floral diversity (Srivastava *et al.*, 1980). The various species of plants occur in distinct bands related to tidal levels, soils and other factors. Macnae (1968) distinguished the following zones from the landward to the seaward margins: the landward fringe, zone of *Ceriops*, zone of *Bruguiera*, zone of *Rhizophora*, seaward *Avicennia* fringe and zone of *Sonneratia*. Lugo (1980) and Snedaker (1982) concluded that

zonation patterns in mangroves represent steady state adjustments rather than successional stages.

The typical profile of the mangrove soils is composed of a dark grey or black clayey surface with a thin layer of well decomposed organic materials at uppermost and soft, reduced greyish green or bluish grey mud clay in subsoil which usually occur below 50 cm of the surface (Changprai, 1984; Kurian, 1984; Samingan, 1980). These types of sediments are generally fertile. The black clayey deposit is rich in organic matter (more than 15%) under the canopy of mangroves and considerably more than outside area (Kurian, 1984). Prawin (1984) Snedaker(1970) and Walsh(1967), found that unfiltered mangrove water contained a relatively high concentration of nitrate and phosphate. These minerals are important to support the productivity of the forest.

Current utilization of mangrove areas includes prawn farming, salt production, Nipa palm gardening and mangrove plantations. Mangrove wood is used for making charcoal, as firewood, piling poles, making furniture and fishing stakes. The bark and roots also yield tannin for the dye industry. The leaves and tender shoots are often used as green manures and cattle fodder.

Mangroves do possess some unique features to which some species show special adaptations. Many of the terrestrial and marine animals are merely adapted to either a forest or to a muddy intertidal habitat. However, some terrestrial fauna face problems from such inundation. Their movement across the forest floor may be restricted and their foraging or seeking of prey on the lower levels of the tree trunks may be inhibited. According to Mathias (1974), marine life that depend on the mangroves for their food supply and other needs are crabs, prawns, fishes and cockles.

Tropical mangrove ecosystems are now recognized as one of the most productive ecosystems and possibly plays a vital role in maintaining the adjacent coastal fisheries. Mangroves serve as breeding and nursery grounds for various fish and prawn species and thus as a source of our food (Ong *et al.*, 1982). Gong *et al.* (1984) reported that mangroves in Malaysia consist of 650,000 ha of which 110,000 ha is in Peninsular Malaysia, 366,000 ha. in Sabah and 174,000 ha in Sarawak.

1.2 Mangrove Creeks

Mangrove creeks are defined as narrow inlets of water on the shore. These creeks are small tributaries that drain

into coastal inlets and estuaries (Leh and Sasekumar, 1989). It is the waterways of the mangrove forest and is fringed mainly by trees of *Rhizophora* and *Bruguiera*.

The creeks are often narrow, about 2-5 meters in width and shallow, about 2-3 meters depth (Leh and Sasekumar, 1989). The forest floor beyond the creeks is inundated 12 to 14 times in a month.

The sediment consists mostly of clay and silt and lesser amount of sand (Sagathevan, 1989). The mud is bluish grey in colour and pH is usually near neutral. There can be a drop in pH if the mud is air dried (Sagathevan, 1989).

Broom (1982) showed that the water content of the sediment is more than 50% of total sediment weight. The organic matter content is between 6 and 11%. Marine and terrestrial foragers consumed this organic matter and transferred it to higher trophic levels on land and sea (Sagathevan, 1989). So, the tidal flats are ecological turntables between the adjoining land and sea ecosystems (Reise, 1985).

1.3 Invertebrate Fauna

Invertebrates are important components of the mangrove ecosystem and provide valuable food resources for humans and fish (Sasekumar *et al.*, 1984). In the muddy substrate a rich benthos is found. The estuaries, creeks and channels support phytoplankton. The primary producers serve as nutrient filters and synthesizers of organic matter. They also support a diverse array of zooplankton (Chaudhuri and Choudhury, 1994).

Detritus from mangrove leaves is the primary food source for estuarine life. Decomposers including fungi, bacteria, protozoa and other consumers break down the mangrove litter to produce a variety of organic constituents (Bhowmik *et al.*, 1985).

Extensive studies have been made on the invertebrate fauna. The zooplankton community of tideless shores cover many taxonomic groups including copepods, mysids, lucifers, amphipods, gammarids, cladocera, ostracods, cumacea, hydromedusae, ctenophores and chaetognaths among holoplankters and polychaete larvae, molluscan and echinoderm larvae, crustacean larvae and fish eggs and larvae among meroplankters (Chaudhuri and Choudhury, 1994).

Studies on meiofauna in mangrove shores have been conducted in India (Kondalarao, 1983), South Africa (Dye, 1983a; 1983b) and tropical Australia (Alongi, 1987a; 1987b) and Malaysia (Sasekumar, 1994). Meiofauna in Selangor mangroves consisted predominantly of free-living nematods, harpacticoid copepods, oligochaetes and kinorhynchs. The highest density occurred in the *Avicennia* station, followed by *Rhizophora* station, while the upper shore *Bruguiera* station had the lowest density of meiofauna.

Macroinfauna are the relatively large invertebrates that reside beneath the sediment surface invisible in undisturbed bottoms except for occasional burrow openings and siphon tubes (Wiley *et al.*, 1987). A diverse fauna of macroinfauna and macroepifauna is present in the sediment of the mangrove forests. The distribution and zonation of macroinfauna have been described (Sasekumar, 1974). The common species are cnidarians, nemertines, annelids, polychaetes, isopods, gastropods and crustaceans (Warwick, 1980).

1.4 Vertebrate Fauna

There are terrestrial species such as birds, monkeys and also marine fish which encroach on to the shore at regular intervals. Chaudhuri and Choudhury (1994) found a

large variety of animals in mangroves which included 8 species of amphibians, 57 species of reptiles, 161 bird species and 40 species of mammals.

Over two hundred species of birds have been recorded from Australian mangrove forests (Saenger *et al.*, 1977). Duncan (1984) found more than 20 species of waders in the coastal mudflats of Selangor. More than 8,000 shorebirds were counted on Pulau Ketam intertidal flats (Hawkins and Silvius, 1986). Waders, gulls, herons and other birds visit the tidal flats to forage on the resident benthic macrofauna such as polychaetes, small bivalves, molluscs, small gastropods and small crustaceans (Sagathevan, 1989). The wading and aquatic birds often use mangroves as roosting sites at high tide (Hutchings and Recher, 1983). In tropical regions, some inland bird species use mangroves as refuges during draught conditions and many feed on the marine invertebrates, while others are insect or nectar feeders (Hutchings and Recher, 1983).

Many of the reptiles and mammals use mangroves only as secondary habitats (Cogger, 1979). The reptiles such as pythons and mangrove snake *Myron richardsoni* move freely over the forest floor at low tide and some reptiles feed on crabs or mammals (Hutchings and Recher, 1983).

Mangrove insects show varying degrees of dependence on mangroves, from casual visitors such as grasshoppers, to some butterflies which commonly feed on mangroves (Common and Waterhouse, 1972). Insects are important sources of food for birds and in pollinating some mangrove plant species (Hutchings and Recher, 1983).

1.5 Litter Production In Mangroves

The primary productivity of mangrove trees is high and important to the coastal ecosystems. Dead leaves, twigs, flowers and roots are progressively broken down by microbes and form the basis of the detrital food web. (Chong *et al.*, 1991). Detritus becomes food for animals at higher trophic levels, either directly or indirectly through intermediaries.

The study of Odum and Heald (1975) emphasized the importance of mangrove-derived plant detritus as a source of energy input to coastal food webs. They found dead mangrove trees, twigs and leaves, together with the decomposing dead underground fine roots provide organic detritus primarily for utilization by bacteria and fungi. The latter convert undigestible plant tissue into a protein source for animals of the detritus food chain.

In South Banjar Forest Reserve, Selangor, the mean total litter production was estimated at 4.11 g dry wt. m^{-2} day^{-1} (Sasekumar and Loi, 1983). This value is high compared to Matang Mangrove Forest Reserve in Perak which was 2.66 g dry wt. m^{-2} day^{-1} (Gong *et al.*, 1984). The higher litter fall in Banjar may be due to the estuarine nature of the study site (Sasekumar and Loi, 1983).

The amount of nutrient obtained from litter decomposition in mangrove forest is higher than that of other forest types (Thaiutsa *et al.*, 1978). The productivity in the mangrove swamps is higher as the rich nutrients in the bottom sediments facilitate the luxurient growth of algae and consequently the abundance of the bottom fauna (Kurian, 1984). The fungi especially phycomycetes were prevalent during the initial phases of decay (Aksornkoae and Khemnark, 1984). The meiofauna and macrofauna aid in the decomposition of mangrove's litter. The free-living nematodes play a dynamic role in the food web circuit. They can be directly consumed along with the algae and decaying materials by benthic feeders (Krishnamurthy *et al.*, 1984; Aksornkoae and Khemnark, 1984 and Barnes, 1984).

Macroalgae are ubiquitous in the mangrove environment and are important food for deposit feeders (Aikanathan and Sasekumar, 1994). The number of post-larvae of penaeid

prawns and fishes which feed on the substratum was more under the mangroves where there is greater protection and a higher algal population (Kurian, 1984). This supports the high value that Rajagopalan *et al.* (1980) estimated in the Cochin Estuary where primary production rate was up to 2.0 $gC/m^3/day$. Among the fishes, post larval forms of mullets including *Trypauchen vagina* were the most prominent found in the clayey deposits (Kurian, 1984).

In the mangrove forest, the open pathways of nutrient transport are driven by physical factors such as tides, runoff and rainfall. Biological factors especially leaf fall, decomposition and mineral uptake also play a part. These factors control the rate of import and storage of inorganic and organic compounds in the mangrove forest or export to estuarine or marine ecosystems (Aksornkoae and Khemnark, 1984).

1.6 Mangrove Fisheries

Mangroves are often considered to be important to coastal fisheries as breeding and nursery grounds for fish and prawn species and as a source of food. Robertson and Duke (1987) compared the abundance and species composition of fish and crustaceans in mangroves and other near-shore habitats in Queensland. They concluded that mangroves are

an important nursery for commercially important penaeid prawn species as well as fish species.

1.6.1 Mangrove Fisheries - Fish

The fish fauna of temperate estuaries is often characterized by seasonal use of the estuary as a nursery area by a few dominant, transitory species (Rogers *et al.*, 1984 and Smith *et al.*, 1984). The situation in tropical estuaries is less well known, furthermore they experience more uniform temperatures but usually show a more marked seasonality in salinity (Rodriguez, 1975).

Many studies have pointed out that there are more fish species in tropical and subtropical waters compared to temperate zone waters (Moore, 1978 and Yanez-Arancibia *et al.*, 1980;1985). Studies in subtropical Australian mangroves also indicate fish density is significantly higher than in adjacent waters (Morton, 1990). There are only few detailed studies of the fish communities associated with tropical mangroves.

In Selangor mangroves, Malaysia, 119 species of fish were inhabitants (Chong *et al.*, 1990). Studies of other fish community in tropical mangroves also show a large number of species, eg. Embley Estuary, Australia with 197

species (Blaber *et al.*, 1989), Pagbilao mangroves in Philippines with 129 species (Pinto, 1988), Pichavaram mangroves, South India with 195 species (Krishnamurthy and Jeyaseelan, 1981).

Mangrove creeks generally harbour many species of fish. For example, Alligator creek, North Queensland is inhabited by 128 species of fish (Robertson and Duke, 1990) and Tudor creek, Kenya by 83 species (Little *et al.*, 1988). A total of 40 species of fish belonging to 24 families were found in the Sungai Sementa Kecil inlet (Leh and Sasekumar, 1989).

1.6.2 Mangrove Fisheries - Prawn

Crustaceans are among the important users of mangrove forests and have been classified as nekton species. Nekton are actively swimming pelagic organisms. The decapod crustacea are the most widespread and the important members of this group are penaeid shrimps (Wiley *et al.*, 1987).

Mangrove mudflats are utilized during flood tides by many periodic foragers from the inshore waters. Macnae (1974) demonstrated that major prawn fisheries occurred only in waters bordering mangrove shores. There is strong evidence from recent studies that the abundance of food in

muddy substrates or sand-mud substrates associated with mangrove waters provide a condusive environment for the growth of prawns (Chong *et al.*, 1990). *Peneaus indicus, Penaeus monodon, Metapenaeus dobsoni* and *Metapenaeus affinis* were present at Cochin Estuary, in greater abundance on clayey deposits which were rich in algae and detritus (Kurian, 1984).

Many early studies showed that mangrove waterways are important nursery areas for prawns (Chong, 1980; Macnae, 1974; Odum and Heald, 1972). More recently Chong *et al.* (1990) confirmed that coastal mangrove mudflats are important nursery areas for commercially important prawn species. A study from Sementa, Selangor found that certain species of penaeid prawns including *Penaeus indicus, Penaeus merguiensis, Penaeus penicillatus, Metapenaeus brevicornis* and *Metapenaeus affinis* are dependent on mangrove forests for shelter during their juvenile stages (Chong *et al.*, 1990; Sasekumar, 1991 and Sasekumar *et al.*, 1992).

There has been a positive correlation between the commercial yield of prawns and the extent of mangrove forests (Sasekumar and Chong, 1987; Turner, 1977). The migrating behaviour of prawns seems to be an important adaptation since it is possible for the prawns to exploit unlimited food resources and space and at the same time, reduce intraspecific competition. Hall (1962) reported 53

species of penaeid prawns in Malaysian waters and many occurred together in the same area. In Selangor coastal waters 20 species of penaeid prawns are known. Fourteen species of prawns were present in the Klang Strait and Angsa Bank whereas eight species of prawns are common to mangrove creeks, estuaries and mudflats (Chong *et al.*, 1991). Four species of prawns, *Penaeus penicillatus, Penaeus merguiensis, Penaeus monodon* and *Macrobrachium* sp. were identified in the Sungai Sementa Kecil inlet. These prawns contributed about 8.6% of the wet weight of the total catch in the inlet (Leh and Sasekumar, 1989).

According to the Annual Fisheries Statistics 1989, about 73,000 tonnes of the total marine capture fisheries landings on the west coast of Peninsular Malaysia were attributed to penaeid prawns. Perak and Selangor accounted for about 41% and 33% of the total penaeid prawns landings on the west coast of Peninsular Malaysia respectively. Even though penaeid prawns contributed to only about 15% of the total marine fish landings on the west coast of Peninsular Malaysia, their economic value is proportionately much higher than the finfish landed. The wholesale value was RM 326.3 million, which accounted for about 40% of the wholesale value of the marine fish landed on the west coast of Peninsular Malaysia.

1.7 Objectives Of Study

This study investigates the distribution of fish and prawns in three mangrove creeks. The aim of this study are (1) to identify the fish and prawn species that occur in mangrove creeks during high tide, (2) to estimate the biomass of fish and prawns in these creeks, (3) to investigate the feeding habits of common fish species entering the creeks and (4) to identify the trophic status of fish community occurring in the habitat.