# CHAPTER FOUR

# DISCUSSION

## 4.1 WATER PARAMETERS OF KLANG STRAIT

Mean water temperatures fluctuated only slightly in Klang Strait and Angsa Bank (Table 1 and Figure 3). The observation corresponds with the study by Soegiarto (1985) for the Straits of Malacca. Differences between the surface and bottom temperatures were less than 1°C. The mean salinity in the offshore stations was quite similar. However, all the stations located off river mouths showed wide fluctuations in salinity (Table 1 and Figure 4) due to the outflow of river water. These results support the observations of other workers that salinity variations in coastal waters are markedly correlated with the seasonal rainfall pattern (Chong, 1993; Lobban and Harrison, 1994). A wide range of turbidity readings was recorded in all the stations (Table 1 and Fig. 5), especially in the stations located near the mouth of the river and close to the mudflat areas. This high variation in the turbidity of coastal waters is due to the high amounts of sediments carried down by the rivers which had also been noted by Soegiarto (1985) and Gomez *et al.* (1990).

## 4.2 SEDIMENT TYPE AND DISTRIBUTION IN KLANG STRAIT

The sediment types in the Klang Strait ranged from sand to clay with most of the samples falling into either silt loam or sandy loam (Table 3). Distribution of the sediment classes during the study period shows that clay and silt percentages decrease towards offshore stations while the sand percentages increase towards offshore stations as shown in Figures 9 and 10.

Sediment parameters such as pH ranged from 7-8 (Table 3 and Figure 12). Mean sediment temperature was 29 °C (Table 3 and Figure 13). Redox potential ranged from −160 to 44 mv. Organic matter content was recorded in the range 2.08 to 11.1 percent (Table 3 and Figure 14). Organic matter percentages were high in the stations located nearshore and decreased toward offshore. These results are close to that of Brandimate and Shimizu (1996) who recorded organic matter in the range of 6 to 11% for near shore sediments of Selangor.

In general, the results shown in Figures 11, 12 and 14 agree with the study by Sagathevan (1989). This study shows that nearshore areas of Selangor coast consist mostly of clay and silt with lesser amounts of sand, and high organic matter. The characteristics of the bottom sediments in the study area are related to the presence of rivers, which are the main sources of sediments.

Based on the results obtained from PCA and cluster analysis (Table 5; Figures 9, 10, 11, 15, 16 and 17), stations that were located near shore close to the coastal mangrove shoreline and river mouths were characterised by the highest percentages of sediment clay, silt and high organic matter, and turbid water with the lowest salinity. The offshore stations located in the northern half of Angsa Bank were characterised by highest content of medium (500-250 μm) and coarse sand (1000-500 μm) substrates with high sediment pH and waters with high salinity and dissolved oxygen. Offshore stations that were located in the southern half of Angsa Bank, just north of the deltaic

The macroinvertebrates comprised 19 prawn, 3 cephalopod, 15 crab, 3 stomatopod and 5 echinoderm species belonging to 3, 3, 6, 1 and 5 families respectively (Table 6).

Seventeen prawn species were recorded and this is higher than the 15 species recorded in the Angsa Bank and Klang Strait by Sasekumar *et al.* (1992), but less than the 20 prawn species recorded in the coastal mud flat waters of Matang, Perak (Chong *et al.*, 1994). The prawn community in Klang Strait was dominated by penaeid prawns; these species in order of importance were *Parapenaeopsis sculptilis, Parapenaeopsis maxillipedo, Penaeus merguiensis, Metapenaeus affinis, Metapenaeus brevicornis, Metapenaeus lysianassa, Parapenaeopsis coromandelica, Parapenaeopsis hardwickii* and *Solenocera subnuda.* Most of these species were similar to those recorded by Chong *et al.* (1990, 1994).

Three species was recorded in the class Cephalopoda, that is, *Octopus* sp., *Sepia esculenta* and *Loligo edulis* (Table 6). All these are common species and appeared in all stations, with the exception of the octopus, which was not recorded in three stations, stations 1, 2 and 12 (Table 22). Octopi are found commonly throughout the ocean and are likely to be an important component of many ecological communities (Hartwick and Thorarinsson, 1978; Ambrose, 1982) and have strong site selection (Mather and O`Dor, 1991).

A total of 15 species of crabs including two xiphosuran horse-shoe crabs belonging to 6 families were recorded in Klang Strait waters. The mostly common species were *Charybdis variegata, Neodorippe callida* and *Doclea canalifera* (Tables 6 and 7). The species list from the present study has many similarities with the species list in

Singh *et al.* (1994). About 56% fish, 77% prawn and 20% crab species that were recorded during this study have commercial importance in the ASEAN region. They use mangroves and adjacent mudflats as nursery grounds (Singh *et al.*, 1994).

Only three species, *Oratosquilla perpensa, Oratosquilla interrupta* and *Harpisquilla harpax* belonging to the family Squillidae, were recorded in Klang Strait. However, Addyanis (1995) recorded five species in Angsa Bank. *Oratosquilla perpensa* was more common and abundant followed by *Oratosquilla interrupta* and *Harpiosquilla harpax.* This order of abundance differed from the results of Addyanis (1995) who found more *Harpisquilla harpax,* followed by *Oratosquilla interrupta* and *Oratosquilla perpensa.*

There were three different groups in the Echinodermata. The first group was an unidentified sea cucumber tentatively identified as in the Malpodinae, named species A. The second group comprised of sea urchins, which included two species *Lovenia elongata* and *Salmacis dussumieri.* The third group comprising starfishes included two species, *Ophitrichoides nereidina* and *Luidia penangensis* (Table 6). The most abundant Echinodermata species in order of importance were the sea urchin *Salmacis dussumieri,* followed by the malpodid sea cucumber and the starfish *Luidia penangensis.*

A comparison of more formal measures of diversity (H`, H`max, J and D) of fish and macroinvertebrates between stations is presented in Table 4. The stations had similar H` values ranging from 3.37 to 3.99. The values of J were slightly different between stations and ranged from 0.78 to 0.95. The values of D were more different than the other indices and ranged from 8.34 to 11.92. The high diversity of fish and macroinvertebrates in the Klang Strait is probably related to spatial heterogeneity, food abundance and competition as observed for Matang mangrove waters by Yap *et al.*(1995). The high diversity may also be attributed to the diversity of habitats in the area. The comparison of diversity values from different habitats is complicated by the fact that complexity in community structure is closely related to complexity in environment (Gray *et al.*, 1997).

The results of the abundance and biomass are given in Tables 8 - 24. Most species had high abundance but low biomass values, implying that the catches comprised largely of small individuals. Therefore, the shallow waters of Klang Strait particularly the coastal mudflats and Angsa Bank function as a nursery or / and feeding area for juvenile fishes and macroinvertebrates. The present result supported the conclusions of Chong *et al.* (1990) and Sasekumar *et al.* (1992) who worked in the same area.

## 4.4 RELATIONSHIP BETWEEN ABIOTIC FACTORS AND ANIMAL DISTRIBUTION IN KLANG STRAIT

Results of this study analysed using principal component analysis (CCA) have shown that the distribution and abundance of fish and macrobenthic animals in Klang Strait were influenced by abiotic factors such as water depth, salinity, turbidity, dissolved oxygen, sediment type and sediment organic matter (Table 31).

cephalopods, stomatopods and echinoderms in Klang Strait (Tables 4-29, Table 31 and Figures 59-63). Except for prawns, the abundance of these animals was also significantly correlated to the bottom silt content (Table 31).

Depth is one of the limiting factors known to influence fish population size (Thresher, 1983; Moranta *et al.*, 1998 and Tejerina-Garroto *et al.*, 1998). Correlations between depth and abundance of pelagic fish species, prawns, cephalopods, stomatopods and echinoderms were significant (Table 31). The study by Ansell *et al.*(1999) indicated that the abundance and number of prawn and crab species were significantly (negatively) correlated with depth. However, the results of this study indicate that only prawn and not crab species were negatively correlated with depth. This may be due to differences in the species composition between the two studies.

The CCA results indicate that turbidity is the only factor, which shows a significant correlation with the abundance of both demersal and pelagic fishes. Turbidity reduces visibility and efficiency of visual predators (Blaber and Blaber, 1980). A study by Tejerina-Garroto *et al.* (1998) indicates that fish community structure in the Araguaia River, Amazon Basin is strongly linked to water transparency and depth.

Dissolved oxygen is one of the important factors regulating species composition and abundance of benthic community (Fraser, 1997). The present study shows a significant correlation between dissolved oxygen and two groups of macroinvertebrates - prawns and crabs.

Many studies have indicated that fish community structure and species distribution can be influenced by water pH, dissolved oxygen and temperature (Welcomme, 1985 and Goulding *et al.*, 1988). However, none of these factors had significant effects on the fish community structure in Klang Strait (Figure 31). These findings are partially consistent with results obtained by Tejerina *et al.* (1998), who found that the fish community structure in the Araguaia River, Amazon Basin was strongly linked to water transparency and depth, but not to water pH, dissolved oxygen and temperature.

Sediment pH shows significant positive correlations with the abundance of pelagic fish and crabs. How sediment pH could affect pelagic fish species is not clear, but its effect is presumably indirect. For instance, sediment pH could have an effect on the food source of pelagic fishes. The life cycle of most benthic species has planktonic larval stages which are food sources to many pelagic fish species (Kennish, 1990). In Selangor waters, planktonic zoeal larvae of fiddler crabs are a source of food for pelagic fish species in estuaries and coastal waters (Macintosh, 1984).

The grain size of the sediment plays an important role as a limiting factor affecting the abundance, biomass and diversity of macrobenthic communities (Ioannis and Anastasios, 1997). The present findings are consistent with this notion. Significant correlations between sediment clay and silt and the distribution and abundance of demersal fish, prawns, cephalopods, stomatopods and echinoderms were obtained. As expected, substrate grain size did not affect the abundance of pelagic fishes (Table 31), but only those animals, which live on or close to the sea bottom.

It is clear from the above discussion that the distribution of fish and benthic macroinvertebrates were primarily determined by the interactions of these organisms and their abiotic environment. This has been suggested by many studies (Roberts and Ormond, 1987; Bourget *et al*., 1994; Carr, 1994; Grigg, 1994; Schlacher, 1998 and Brazeiro and Omar, 1999). Animal interactions with their biotic environment, as for e.g. predators and preys, may be important, but as suggested by Lack, (1954); Cushing, (1990); Errington, (1946); Johannes, (1978) and Bailey and Houde, (1989) are secondary in their effect on animal distribution and abundance, particularly in open waters. The influence of biotic factors is however not within the scope of the present study.

The hypothesis tested in the present study that substrate and water parameters of the Klang Strait influence the distribution and abundance of demersal fish and benthic macroinvertebrates is therefore proven.

**Table 31. Summary of the canonical correspondance analysis results showing the correlations between the species abundance of common taxon with only the statisticaly significant physico-chemical factors ($p< 0.05$) in Klang Strait.**

| C.no | Factors | Pelagic fish | Demersal fish | Prawns | Crabs | Cephalopoda, Stomatopoda and Echinodermata |
|---|---|---|---|---|---|---|
| 1 | Salinity | 0.62 | 0.90 | 0.58 | 0.66 | 0.89 |
| 2 | Clay % | | 0.58 | 0.64 | 0.65 | 0.75 |
| 3 | Organic content | | 0.52 | 0.74 | 0.61 | 0.81 |
| 4 | Silt % | | 0.56 | | 0.58 | 0.65 |
| 5 | Depth | 0.88 | | 0.79 | | 0.82 |
| 6 | Turbidity | 0.41 | 0.58 | | | |
| 7 | Dissolved oxygen | | | 0.71 | 0.67 | |
| 8 | Sediment pH | 0.61 | | | 0.57 | |
| 9 | Fine sand | | | 0.61 | | |
| 10 | Water pH | | | | | |
| 11 | Coarse sand | | | | | |
| 12 | Temperature | | | | | |