Soft sediment communities composition

1. DISCUSSION

5. 1 Comparison of Soft Sediment Communities Composition and Sediment Type from Different Scales

Generally, macrobenthic organisms were found in abundance at Tanjung Bungah. Polychaetes have been observed to dominate in muddy area. Bivalves and gastropod were observed to be dominated in sandy area. Rhoads & Young (1970) noticed that sandy substrates tended to be dominated by suspension-feeders such as bivalves while mud substrates were dominated by deposit-feeders such as polychaetes.

Bivalves and crustaceans had the highest total number of individuals in Tanjung Bungah. This was quite surprising as one would expect to find a higher number of polychaetes in Tanjung Bungah. Many studies in the tropics, however, have shown polychaetes dominated in polluted and muddy areas.

As a whole, sediment type analysis of Tanjung Bungah was found out to be sandy gravel. The sampling area was observed to be a mudflat area. The difference between sediment type analysis and observation might be due to the structure of sediment which was a three-dimensional habitat for a vast number of infauna species (Wilson, 1990).

Previously, Cheng (2013) has also carried out a study in Tanjung Bungah and found out that the sediment type analysis was mainly gravelly sand. The percentage of sand was higher in the previous studies than this current study. The nature of the environment could change dramatically over time periods of hours or days due to the activities of the infauna (Wilson, 1990). It was a normal situation where infauna migrates from one place to another.

Many tubes of polychaetes were observed within 1 m scale. However, the distribution of gastropods In all bays, the single taxon that best correlated with the sediment was spionid polychaetes, but correlations were generally weak (Chapman & Tolhurst,, 2007). An assemblage of tube-builders may stabilize or destabilize sediments depends on animal density, sediment microflora and the strength of ambient flow, with correspondingly divergent effects on other members of the infauna (Luckenbach, 1986). However, macrobenthic analysis showed gastropods dominated in 1 m scale.

At 10 m and 100 m scales, bivalves and crustaceans dominated the area respectively. The habitats differed in the amount of structure on the substratum (pneumatophores, algae or leaf litter), or whether they were continually shaded or not (Chapman and Tolhurst, 2004), each of which have been shown to affect some benthos or properties of sediments (Lee, 1999; Gwyther, 2003; Stutes et al., 2006). Chapman and Tolhurst (2004) had, however, very few data in which the positions of samples of sediment and of samples of benthos were precisely matched and it was only done in one bay, thus the test of relationships was quite weak.

In general, there was no significant correlation between ($P > 0.05$) sediment grain size and macrobenthos. In previous research done by Chapman and Tolhurst (2004) showed that the benthos and sediment differed significantly among different habitats in a mangrove forest, but patterns in benthos were not strongly correlated with patterns in the sediments, despite an assumed association. Many studies do not distinguish between direct effects of grain size and other components of sediments that may be associated with grain size, such as food, or moisture, whereas in this study the components of sediment were partitioned more finely (Chapman & Tolhurst, 2004).

In a more extensive study, the benthos differed among the same habitats in multiple mangrove forests, but the relative strength of differences, plus the taxa that caused differences, varied among three different bays (Tolhurst and Chapman, in review). The two extreme habitats (sun-exposed mudflats with no pneumatophores, leaf litter or patches of macro-algae and shaded mud with these structures) had different benthos in all three bays, with the third habitat (sun-exposed substratum with structures) being intermediate between the others, with the degree of overlap differing among bays. The sediment also changed from the shaded sediment, to the sun-exposed sediment with pneumatophores, algae and litter, to the sun-exposed sediment without these structures. As for the benthos, the degree of difference among habitats, the properties of sediment that caused differences and patterns within individual variables also varied among bays (Tolhurst and Chapman, in review).

The strongest contributors to these relationships were spionid polychaetes, which were abundant and widespread in Tanjung Bungah. These polychaetes can be either suspension or surface-deposit feeders (Levin, 1984). They can live at large densities, often stabilizing the sediment with their tubes (Thrush et al., 1996). Changes in water-flow associated with pneumatophores and leaf litter may physically interfere with their feeding behaviour in some habitats. Relationships between other species and the sediment were far more patchy, with taxa characteristic of the shaded habitat (amphipods, insect larvae) important correlates with sediment in some bays and those characteristic of the open mud (such as oligochaetes) important in some bays. Thus, whilst some properties of the sediment may be important in determining the structure of the macrofauna, they are not consistently important. Similarly, different organisms may have similar effects upon sediments in different places and/or may respond to these properties in similar ways, while the same species may change response (or effect) from place to place.

The variability in relationships among the benthos also needs to be further understood in terms of ecological structure and function. If many components of benthos respond to (or alter) sediment in similar ways, there may be considerable redundancy in structure of the invertebrate assemblage. Alternatively, different components of the benthos may be responding strongly to aspects of sediment that are not generally incorporated into studies of sedimentary properties. It has been argued that sediment is most influenced by microbes or meiofauna (e. g. Mancinelli et al., 2005), so one might not get strong relationships to macrofauna (Chapman & Tolhurst, 2007).

5. 2 Comparison of Soft Sediment Communities Composition and Physical Parameters

There were no difference in salinity

Table 5. 1: Comparison of Physical Parameters in Tanjung Bungah

Physical Parameter	**References**	
Darif, 2014	Cheng, 2013	
Salinity	22. 8	25. 0
Sediment Temperature (°C)	29. 8	29. 7
pH		

5. 3 Correlation of Soft Sediment Communities and Physical Parameters of Tanjung Bungah

Typically, benthic animals in soft sediments have extremely patchy distributions (e. g. Levin, 1984; Morrisey *et al.* , 1992a; Thrush *et al.* , 1994; Chapman, 1998).

There was a very strong significant correlation between distribution of polychaetes and salinity in Tanjung Bungah. Polychaetes may tolerate a wide range of salinity compared to other macrobenthic groups. This was an accordance with an experiment carried out by Pechenik *et al.* (2007) which found out that polychaete of a species *Hydroides elegans* could tolerate high salinity at 30.

There was a strong significant correlation between distribution of polychaetes and soil temperature in Tanjung Bungah.

Bivalves and crustaceans showed a strong significant correlation ($r = 0.733$ and $r = 0.602$ respectively, $P < 0.05$) between pH. There was a moderate positive significant correlation ($r = 0.555$ and $r = 0.575$ respectively, $P < 0.05$) between distribution of annelids and polychaetes with pH in Tanjung Bungah. The distribution of other macrobenthic groups had no significant correlation ($P > 0.05$).

Spearman’s rho correlation showed a very strong interaction between distribution of bivalves and dissolved oxygen ($P > 0.05$). Crustaceans showed a strong significant correlation ($r = 0.599$, $P < 0.05$) between pH. There was a moderate positive significant correlation ($r = 0.491$, $r = 0.575$ and $r = 0.528$ respectively, $P < 0.05$) between distribution of annelids, gastropods and nemerteans with dissolved oxygen in Tanjung Bungah.

At some scales, variation in diversity or abundances of benthos have been correlated with obvious environmental variables (e. g. duration of inundation; Defeo and McLachlan, 2005), large-scale features of habitat (e. g. density of seagrass plants; Lindegarth and Hoskin, 2001), or characteristics of the sediment (e. g. whether it is sandy or muddy; Gray, 1974). Large benthic animals that bioturbate the sediment while feeding (Van Blaricom, 1982; Commito et al., 1995) or burrowing (Branch and Pringle, 1987; Thrush et al., 1992) can also strongly alter surrounding benthos via disturbance, displacement, or by altering physical conditions of sediments, causing mortality or emigration.

Overall, the present study and that of Morrissey *et al.* consistently suggest that temporal fluctuations in density and species richness data over days and weeks are very low and that temporal fluctuations over monthly, seasonal and low inter-annual scales are generally less than spatial variation over distances of hundreds of metres. We conclude that few studies conducted at a single site with spatial extent < 1 km are likely to provide general ecological insights, no matter over what time scale (< 3 years) the study was conducted because patterns a few kilometres away are probably quite different. In general, ecological models appear to be better tested by increasing the spatial extent of a study rather than by concentrating on temporal effects within a small area.

5. 4 Comparison of Soft Sediment Communities Composition and Pore Water Quality Parameters

Nutrient contents were found to be higher in pore water than those of the water column (Slomp *et al.* , 1998). Many benthic organisms are in direct contact with sediment pore water instead of surface pore water, thus, the accurate measurement of nutrient concentrations in sediment pore waters is useful (Simpson *et al.* , 2005).

Variability in mediating factors and direct or indirect effects operating on different spatial and temporal scales have made the impact assessment of nutrient enrichment on benthic assemblages becomes complex (O’Brien *et al.* , 2009). An increase in ammonia and phosphate concentrations in the pore water would stimulate an increase in benthic microalgae growth mediated by the presence of the bioturbating lugworm (O'Brien *et al.* , 2009).

The highest distribution of macrobenthic organisms were found at Site E. The concentration of nitrite and ortho-phosphate at Site E were relatively low compared to Site A. These nutrients if high in concentration might inhibit macrofauna distribution and abundance. Negative effects of nutrient enrichment on fauna are often attributed to anoxic sulï¬ dic sediment conditions (Gray *et al.* , 2002)

Negative effects of nutrient enrichment on fauna are often attributed to anoxic sulï¬ dic sediment conditions (Gray *et al.* , 2002). Documented negative responses have occurred over long periods of enrichment, up to 15 years, and have resulted in reduced species diversity (Macleod *et al.* , 2004) and decreases in numbers of polychaete and amphipod species (Sarda *et al.* , 1996; Savage *et al.* , 2002). S

Spatial patterns in the benthos and in the sediments in these three different habitats in mangrove forests in Sydney Harbour were predicted to covary, both across increasing spatial scales within habitats and among different habitats, because of reported close associations between benthos and properties of sediment and the large environmental differences among the three habitats studied. For example, variation in benthos has been related to grain-size (Gray, 1974), microalgae (Connor and Edgar, 1982), nutrients (Lee, 1999) and carbohydrates (Underwood and Paterson, 1993). In addition, there are reported relationships between properties of the sediment and/or benthos and the overlying water column (Wiltshire et al., 1998) and structures, such as pneumatophores, may affect watermovement, or the sediment directly (Gwyther and Fairweather, 2002). Leaf litter and mats of benthic macroalgae may shade the sediment, or add nutrients or habitat (Lee, 1999; Chapman et al., 2005). Nevertheless, relationships between macrofauna and many properties of sediments are variable, with some studies showing no or weak relationships (Pinckney and Sandulli, 1990; Wu and Shin, 1997; Barnes and Villiers, 2000).

5. 5 Correlation of Soft Sediment Communities Composition and Pore Water Quality Parameters

5. CONCLUSION

To avoid the degradation of organisms, sorting process is recommended to be carried out a few days after preservation. Alternatively, the samples can be fixed with 10% formalin solution. However, using formalin can be very hazardous.

For sorting process, the samples should be re-checked to increase accuracy of the data. Expertise on the organisms is required to minimize or reduce error during identification.

Further investigations are needed to reconfirm the factors influencing soft sediment communities' distribution and abundance. Since sediment chlorophyll *a* and pore water quality do not affect they can be removed from the analysis. I would like to suggest total organic content and photosynthetic biomass (PAM) to be carried out in future due to its high probability of influencing soft sediment communities' abundance and distribution. The scales should be increased to a few kilometres instead of using small scales.