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Research Article

Horizontal distribution of intertidal nematode from Sabah, Malaysia

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ABSTRACT

The aim of this study is to determine the horizontal distribution of nematodes species density, species diversity and feeding types on the intertidal area of Lok Kawi beach, Sabah, Malaysia. The approach taken was to sample the nematodes and measured selected parameters of the hole water from high-water to low-water marks. The results show that the nematode feeding type non selective deposit feeders (1B) and epigrowth feeders (2A) groups, species diversity, evenness, species richness and species number increased towards the low tide level. The height of the beach did not clearly show their influence on the horizontal distribution of the nematodes. Pearson correlation coefficient shows that there is a significant correlation ($R = 0.64$, $p < 0.05$) between the height of the beach and the species diversity of the nematodes. However, the cluster and factor analysis of the stations did not show clearly about the influence of height of the beach on nematodes densities. Therefore, we conclude that there were no definite and universal causative factors, which controlled the horizontal distribution of nematodes species diversity in the intertidal sandy and muddy habitats of the Lok Kawi beach, Sabah.

Keywords: Water parameters, density, diversity, feeding types

INTRODUCTION

Previous studies on horizontal distribution of nematodes have been carried out along salinity gradients in estuaries (Warwick, 1971), across intertidal sandy habitats (Blome,1983) and with increasing water depth both onto the continental shelf and into the deep sea (Tietjen,1976). Most of the studies were carried out in the temperate countries.

Several species groups have been suggested across the sandy intertidal habitats. Firstly, species often restricted to certain zones namely sublittoral fringe guild, secondly, eurytopic species (usually with their distribution centred on the lower shore) and thirdly, species confined to the upper shore (Coull, 1988). Four strata of meiofauna distribution was proposed during low tide on sandy beaches (McLachlan, 1980); namely, (1) a dry sand stratum – near the top of the beach where the upper sand layers are >50% desiccated; (2) a moist sand stratum, which underlies the dry sand stratum and extends seaward. It reaches until the depth of the permanent water table; desiccation is < 50% and oxygen levels are high (>70 % saturation); (3) Water table stratum crossing the beach and lying underneath strata 1 and 2. The sand is always moist and oxygen saturation is 40 to 70%; (4) a low oxygen stratum underneath stratum 3, which may be very deep in high energy beaches, where oxygen tension is < 30% saturated. This pattern can be modified by a variety of factors such as a change in wave action or sediment grain size, change in beach slope, freshwater seepage, tidal amplitude, temperature as it affects desiccation (McLachlan, 1980). Other authors have reported similar patterns from other areas of the world but they use different kind of controlling factors (Pollock & Hummon, 1971).

Studies on horizontal distribution of nematode's community on the intertidal area of Sabah are still limited (Shabdin & Othman, 1999; Shabdin & Othman, 2000; Shabdin & Othman, 2005). Moreover, studies on the ecology of Malaysian freeliving nematodes (to date, have generally) are limited to the higher major taxa (Sasekumar,1994) with the exception for study carried out in Merbok mangrove, Kedah (Somerfield *et al.*,1998). However, the Merbok mangrove study only examined the community level of nematodes at High Water Neap (HWN) and High Water Spring (HWS). The question of how the distribution of species diversity of freeliving nematodes from high water to low water on the intertidal area of monsoonal-maritime-tropical country like Sabah, Malaysia is still unclear.

Therefore the objectives of the present study are; (i) to examine the nematode community structure from Mean High Water Neap (MHWN) to Mean Low Water Neap (MLWN), (ii) to determine the relationship between nematode species diversity, horizontal distribution and physico-chemical parameters of the water in Lok Kawi beach, Kota Kinabalu, Sabah, Malaysia.

METHODOLOGY

Study Area

The general climate of Sabah west coast is monsoonal-maritime-tropical, i.e. generally hot and humid with very heavy rainfall. Seasonal variations in climate and weather are not equated with temperature, as it is relatively high and constant, but due to variations in moisture associated with the northeast and southwest monsoons. The onset and retreat of the monsoons generally follow the same temporal pattern but variations from year to year are not uncommon. The monsoons also vary in strength and constancy from year to year. The northeast monsoon is generally from December and February or early March and southwest monsoon is from late June to early November. There are also successive inter-monsoons from April to May (Meteorological Department Sabah, 1993).

Lok Kawi beach was chosen in the present study because of its accessibility from Kota Kinabalu city which is about 6 km to the south. It is located at 5° 52' N and 116° 2' E. Two habitats, sandy and muddy substratum existed together and thus it would be logistically easier to carry out sampling process. The beach lies in a southwest to north direction and stretching approximately 4.5 km along the Lok Kawi coastline parallel to the Putatan road. The beach extends about 0.6 km out into the shallow foreshore water of the Lok Kawi coast during low tide (Fig. 1).

The northeast of the Lok Kawi beach consists of muddy area. The area is sheltered due to the presence of sandbar in front of it. Scattered patches of the seagrass beds (*Enhalus* sp.) have been found in the area. The southern part of the muddy area is the sand flats. Small isolated patches of coral reefs mostly covered by patches of dead coral rubbles and sand can be seen at the western part of the beach.

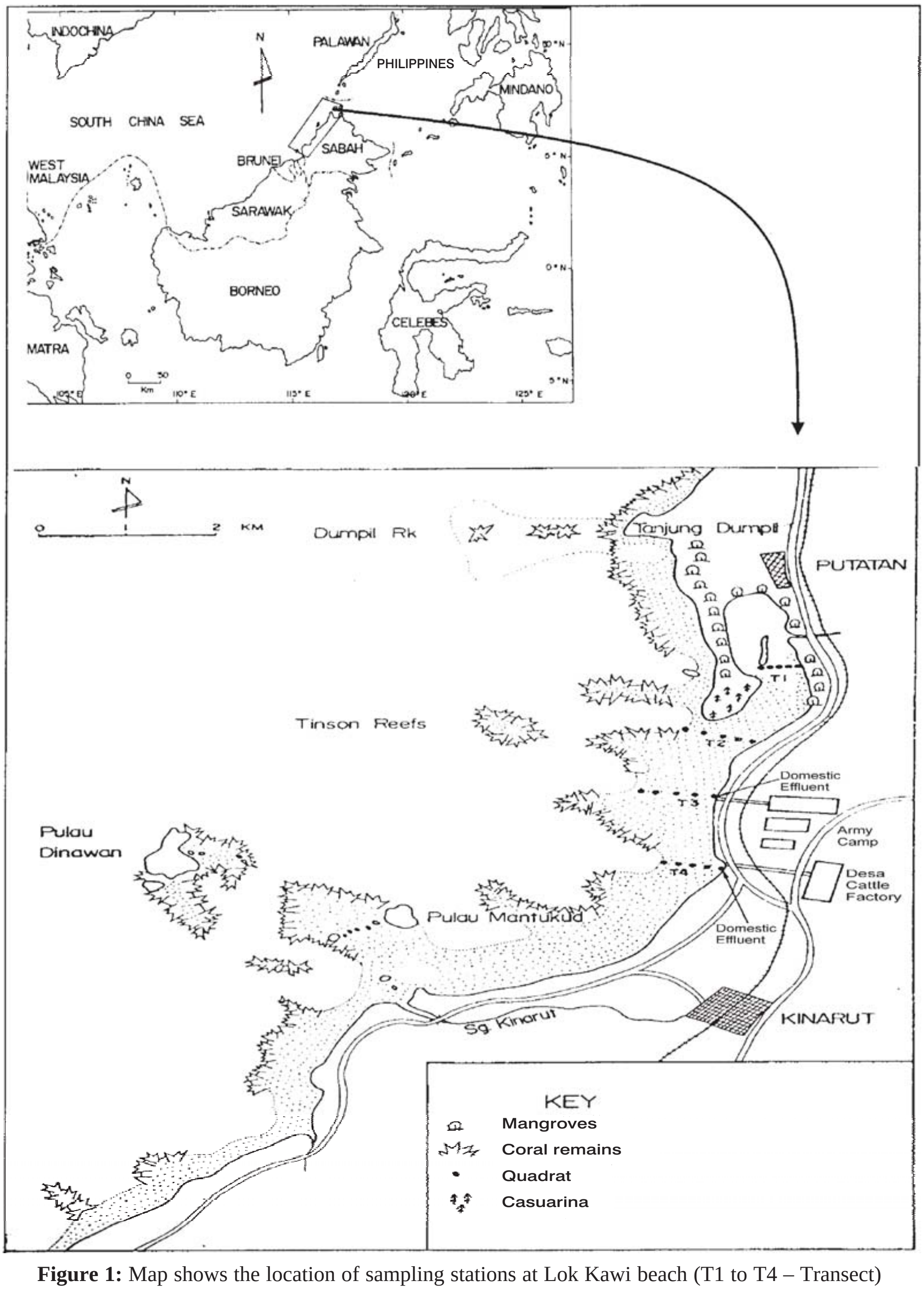

Figure 1: Map shows the location of sampling stations at Lok Kawi beach (T1 to T4 – Transect)

Meiofauna Sampling and Physico-chemical Parameters Measurement

Sampling was carried out on May 1992. Four transects perpendicular to the coastline were set up on the beach during low tide at Lok Kawi beach (Fig. 1). Transect 1 (T1) was in the muddy area (mangrove) while transects 2 (T2), 3 (T3) and 4 (T4) were located on the sandflats.

Five quadrats running from Mean High Water Neap (MHWN) to Mean Low Water Neap (MLWN) were located along the transect generally at height intervals of 0.95 metres measured using a standard surveying technique (Moore,1979). One of these stations was then levelled to the nearest standard Chart Datum point, which in every case was a tide gauge. Height of stations relative to Chart Datum and the tidal constant were calculated from data derived from the local chart and by courtesy of the Marine Department of Kota Kinabalu, Sabah.

Preliminary meiofauna survey on the Lok Kawi beach shows that the vertical distribution of meiofauna was up to 30 cm depth. In order to minimize sampling error from spatial heterogeneity in species composition and abundance, a subsampling strategy was adopted. At each quadrat, eight 30 cm sediment cores were collected over an area 0.25 metre^2 on the beach using the 7.01 cm^2 transparent tube. The sediment from these cores were put into separate labelled plastic bags and preserved in 5% neutralized seawater formalin. Variance to mean ratios of faunal counts of the first eight random samples taken at the first sampling was not significant at the 5% level (F test). Hence the samples were homogenous and all samples at each tide level and then subsequent ones were drawn from the same parent population.

In the laboratory, meiofauna was extracted from the substrate either by sieving or combination of sieving and centrifuging techniques. Meiofauna samples from sandy habitat were extracted using the sieving method only while samples from muddy habitat were extracted by a combination of sieving and centrifuging techniques (Shabdin, 1985).

The materials retained on the 32 µm sieve then washed into 100 ml specimen bottles. Then the eight cores of extracted sediments (meiofauna in the eight specimen bottles) were pooled together into 1 litre measuring cylinder and made up to 1 litre with freshwater to be subsampled. A simple device used for subsampling is called 'meiofauna subsampler' (Moore *et al.*, 1987). One subsample of 50 ml will generally yield sufficient nematodes for analysis although several subsamples were taken in case of low density. The subsamples were allowed to pass through a 32 µm sieve and rinsed with freshwater to remove salt. The material retained on the 32 µm sieve (sample from sandy habitat) was made concentrated by washing it to the edge of the sieve and then washed it with water from the wash bottle into a grid Petri dish. The subsampled specimens of the nematodes then were scattered in a grid Petri dish. Next, the total number of nematodes in the grid Petri dish was counted under a SV5 Zeiss stereomicroscope. The numbers of organisms were finally converted to densities in units of individuals/10 cm square. Using a fine end of pipette blocked with cotton wool at the other end and the mouth piece, all the nematodes were sucked and transferred to a glass cavity block containing 5% glycerine: 5% pure ethanol: 90% freshwater by volume and left in desiccator for a few days (Platt & Warwick,1983). This would allow the ethanol and water to evaporate slowly leaving the nematodes in pure glycerine. Finally, the nematodes were transferred to a fresh drop of anhydrous glycerine (phenol added) on a slide and a cover slip added, supported by several small glass blocks at both ends. Glyceel was used as a sealant. The nematodes were identified to the species level under a compound microscope. Illustrations of each nematode species were made using a camera lucida and identifications were performed using the key by Platt & Warwick (1983, 1988) and verified by various keys in the literatures.

Environmental parameters of the pore water such as temperature, salinity, dissolved oxygen and pH value were measured *in situ* at each quadrate using Hydrolab Environmental Data System (model SVR-2 – Susonde Unit).

For every quadrat, one core of sediment up to 30 cm depth was taken for particle size analysis. A piston-style corer, marked with permanent marker at every 1 cm was used to sample three cores of sediment for chlorophyll *a* analysis. The sediment for chlorophyll *a* and phaeopigments analyses were put into the cooler box and brought back to the laboratory for further analysis. The standard methods were followed for the analyses of particle size and chlorophyll *a*.

Clustering of the stations using the cluster neighbour-joining methods and Detrended correspondence analysis (Saitou & Ney,1987) of the stations (quadrats) within four transects at Lok Kawi were based on density of 85 nematodes species and the environmental parameter values such as height above chart datum, temperature, pH, salinity, dissolved oxygen, median particle size, percentage silt and clay, chlorophyll *a* and pheopigment.

RESULTS

Environmental Parameters

The variations of environmental factors such as intertidal height, temperature, pH, salinity, dissolved oxygen, median particle size, silt and clay, chlorophyll *a* and pheopigment in Lok Kawi beach are summarized in Table 1. The record of these factors were expressed by following the quadrats sequence from MHWN to MLWN.

Intertidal heights of quadrats were plotted in relation to the Chart Datum and the tidal constants in Table 1. Most of the Quadrats 1 within the four transects were closer to the MHWN level and therefore considered as MHWN quadrats. Their heights above Chart Datum were between 4.50 and 4.60 metres. Quadrats 2, 3 and 4 in all transects were in the range of 3.70 to 2.30 metres above Chart Datum and considered as Mid-Tide Level (MTL) quadrats. Quadrats 5 in all transect were located closer to MLWN and ranged in heights above Chart Datum between 1.40 to 1.60 m.

There was little variation in pore water temperature at the four transects at Lok Kawi beach, this being not greater than about 2.9°C. Temperatures were generally within the range of 28.5 to 31.4°C (Table 1) and close to the temperature of the sea. In general, the pore water temperature within four transects was quite similar. The pH values of pore water within the four transect were ranged from 7.0 to 8.5 and shows the basic pH. The variation of pH is 1.5.

There was a wide variation in pore water salinity at the four transects at Lok Kawi beach but this being not greater than 15.5 Practical Salinity Unit (PSU) (Table 1). The pore water salinity within four transects were ranged from 14.7 to 30.2 PSU. Salinity values at Quadrats 5 and 1, Transect 4 were much lower (14.7 & 17.5 PSU) due to the influence of freshwater intrusion from Desa Cattle drainage after a heavy rainfall in the night before sampling. Both of the quadrates were located close to the Desa Cattle channel on the beach. Similarly, salinity values at Quadrat 1 Transect 2 were also low (16.1 PSU) due to the freshwater seepage from the supralittoral area after a heavy rain in the night before sampling. The salinity at Lok Kawi beach was influenced by freshwater seepage and the salinity values at all transects were found to be lower than the surface sea water adjacent to it.

Table 1: Summary of Environmental parameters at Lok Kawi, Sabah (Tran.–transect, TL–tide level, Quadrat, HCD–Height above Chart Datum (m), Tem.–temperature (°C), Sal.–salinity (PSU), DO–dissolved oxygen (mg/l), Med.-median (Ø, particle size), S&C-percentage silt and clay, Chlo.-Chlorophyll *a* (mg/m^3), Pheo–Pheopigment (mg/m^3). MHWN – Mean High Water Neap, MTL – Mid-Tide Level and MLWN – Mean Low Water Neap)

Tran.	TL	Q	HCD	Tem.	pH	Sal.	DO	Med.	S&C	Chlo.	Pheo.
1	MHWN	1	4.55	29.5	7.0	25.8	0.3	2.8	35.9	5.02	3.52
	MTL	2	3.70	29.6	7.0	29.9	0.4	5.2	69.3	4.00	7.87
		3	2.95	30.8	7.1	26.1	0.9	3.0	43.9	3.94	13.88
		4	2.30	30.3	7.5	29.0	0.2	2.6	35.9	3.50	10.75
	MLWN	5	1.40	31.4	7.6	25.5	0.4	2.7	36.6	5.76	7.69
2	MHWN	1	4.60	30.5	7.8	16.1	1.1	1.5	7.4	1.81	7.69
	MTL	2	3.65	30.0	7.8	29.7	1.1	1.2	7.2	5.32	2.20
		3	3.10	29.4	8.0	30.2	1.6	0.9	10.1	3.44	0.75
		4	2.40	29.0	7.9	29.3	2.1	1.1	9.1	3.40	1.12
	MLWN	5	1.60	30.1	7.7	27.7	0.7	1.2	6.5	2.62	1.62
3	MHWN	1	4.60	30.6	7.5	21.9	1.1	1.1	11.3	2.50	2.68
	MTL	2	3.70	30.0	7.8	28.9	1.6	1.4	3.4	4.60	2.15
		3	3.05	29.9	7.8	27.8	1.5	2.2	4.2	1.73	1.36
		4	2.30	29.1	8.5	21.1	0.9	1.5	6.2	2.99	0.15
	MLWN	5	1.55	28.9	8.5	17.5	0.6	2.3	11.4	4.01	5.76
4	MHWN	1	4.50	28.5	7.9	17.5	0.8	1.3	4.1	0.94	0.61
	MTL	2	3.65	29.4	8.0	27.9	0.8	1.1	4.1	0.91	0.40
		3	3.00	29.8	8.0	27.8	0.9	1.4	3.6	4.74	1.97
		4	2.40	29.8	8.2	28.3	0.9	1.4	3.3	7.61	2.40
	MLWN	5	1.60	30.6	7.9	14.7	0.6	2.0	4.4	2.39	1.00

Dissolved oxygen values of the pore water are listed in Table 1. On all transects the values were variables ranging from 0.2 (Transect 1) to 2.1 mg/l (Transect 2). The lowest value were recorded along the mangrove transect (Transect 1). The minimum value (0.2 mg/l) was recorded at Quadrat 4 Transect 1.

Median particle size in Transect 1 ranged from 2.6 to 5.2 ∅ whereas the values in other transects ranges from 0.9 (Transect 2) to 2.3 ∅ (Transect 3) (Table 1). The silt and clay percentages was higher in Transect 1 compared to the other transects. The lowest value in the mangrove transect (Transect 1) was 35.9% whereas the highest value in the sandy transects was only 11.4% (Transect 3).

There was a wide variation in the distribution of chlorophyll *a* in all transects (Table 1) with no horizontal trends apparent. The mean concentration of the four transects ranged from 3.17 (Transect 3) to 4.44 mg/m^3 (Transect 1). The distribution of pheopigment varied along all transects and no horizontal trend was apparent (Table 1). The mean concentration of four transects ranged from 1.28 (Transect 4) to 8.74 mg/m^3 (Transect 1). Most of the values in Transect 1 (mangrove area) were either similar or higher (7.69 to 13.88 mg/m^3) than the other sandy transects (Transects 2, 3 and 4).

Nematode's Distribution

Total density

The maximum nematode's density recorded at Lok Kawi beach was 7,015 (Quadrat 5, Transect 4) and minimum of 413 ind./10 cm square (Quadrat 2, Transect 2) (Table 2). The mean nematode's density ranged from 1,473 (Transect 3) to 3,055 ind./10 cm square (Transect 4). Higher densities of nematodes in the lower half of the beach at Transects 2 to 4. They appeared to be a gradual increase in density from the upper shore towards the lower shore except for Quadrat 1 in Transects 2 and 3 where densities of nematodes were higher than some MTL quadrats. However, no horizontal trend was apparent in Transect 1 (mangrove area).

Horizontal distribution of nematode species

Considering the horizontal distribution of nematode's species as a whole within all transects and tide levels at Lok Kawi, beach, five groups of species can be observed (Fig. 2). Firstly, the nematode's species distributed from MHWN to MLWN. A total of 24 species were included in this group. Five species were distributed from MHWN to MTL only and considered as the second group. The third group which comprised of 19 species was zoned from MTL to MLWN. The fourth group contained 1 species and its distribution was at MHWN and MLWN. The fifth group of nematode species was distributed either at MHWN or MTL or MLWN only and comprised of 34 species (MHWN: 6 species, MTL: 12 species, and MLWN: 16 species).

Horizontal distribution of nematode feeding types

By considering the horizontal distribution of the nematode feeding type groups as a whole at Lok Kawi beach, four trends can be observed (Fig. 3). The group selective deposit feeders (1A) varied erratically along transect with its density average ranged from 244 to 996 ind./10 cm square. The non-selective deposit feeders (1B) and epigrowth feeders (2A) groups show a clear increase in density towards the lower half of the beach. However, the density of the predators/omnivorous (2B) group seemed to be stable from MHWN to MLWN.

Table 2: Total density of the nematodes in all transects at Lok Kawi beach

Transect	Tide Level	Quadrat	Density
1	MHWN	1	1846
	MTL	2	785
		3	4032
		4	1760
	MLWN	5	4281
2	MHWN	1	4088
	MTL	2	413
		3	447
		4	1181
	MLWN	5	5494
3	MHWN	1	1113
	MTL	2	452
		3	1737
		4	1919
	MLWN	5	2142
4	MHWN	1	554
	MTL	2	1059
		3	2437
		4	4211
	MLWN	5	7015

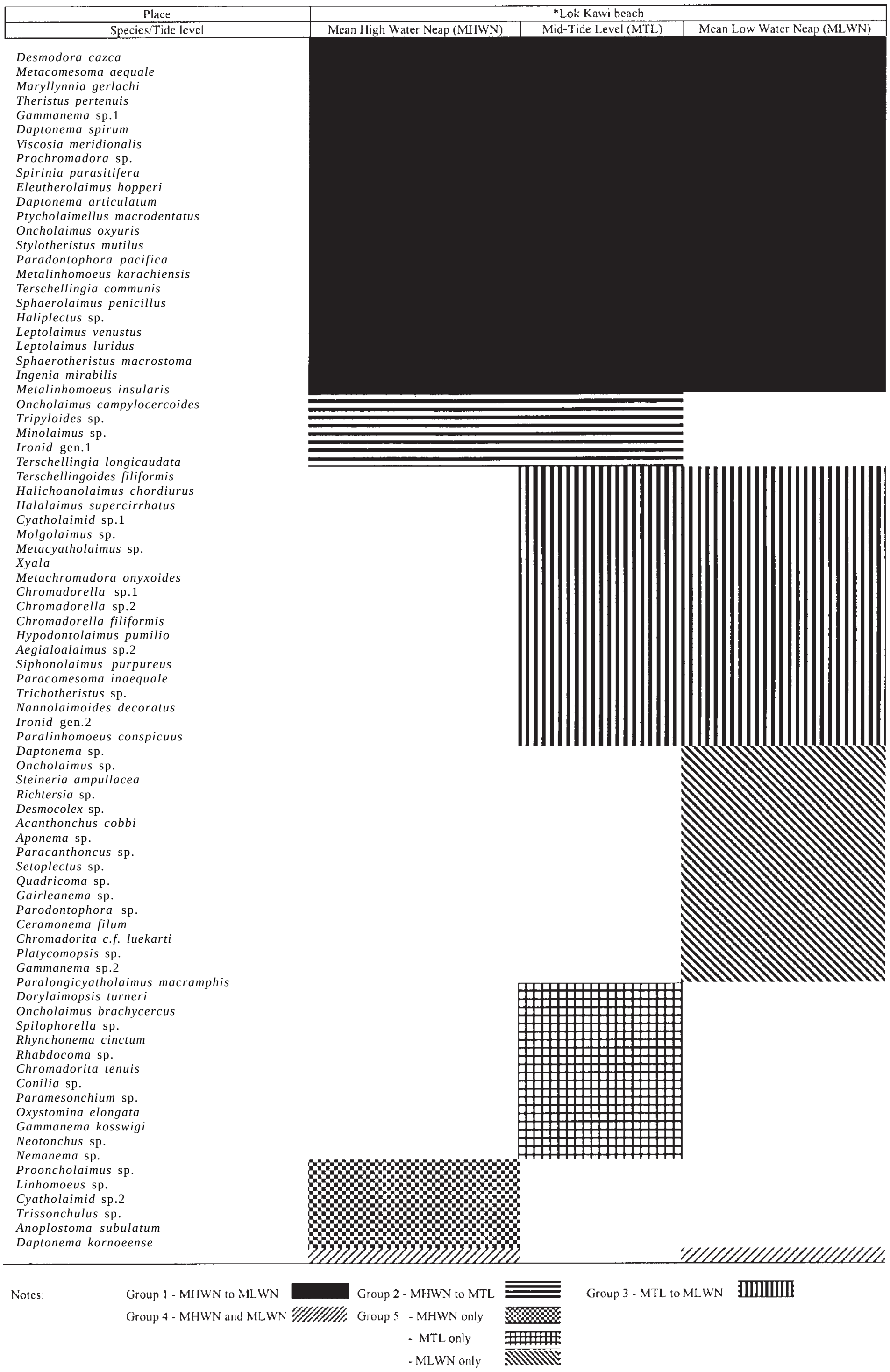

Figure 2: Horizontal distribution of nematodes species in Lok Kawi beach, Kota Kinabalu, Sabah, Malaysia
* *Combination of nematodes distribution in all transects*

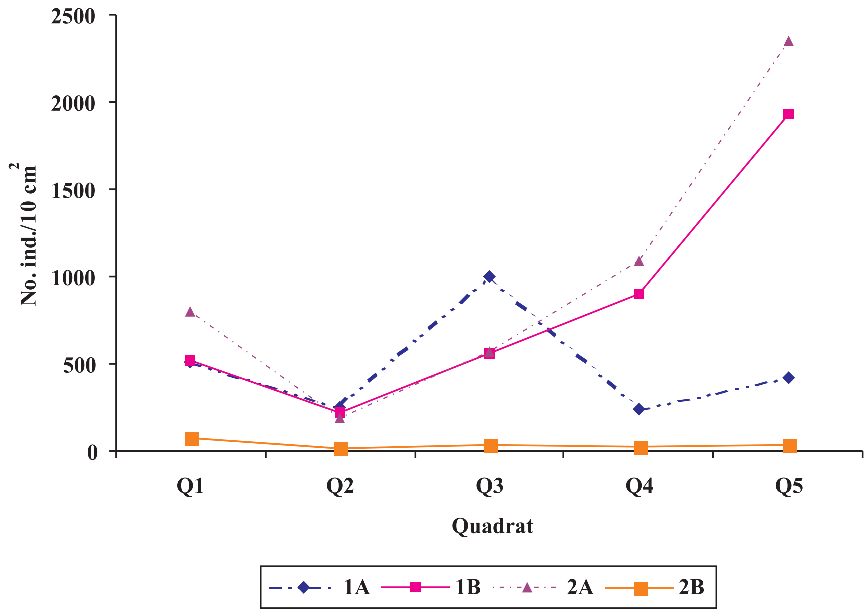

Figure 3: Horizontal distribution of nematodes feeding types (mean values for 4 transects) in Lok Kawi beach (Q1: Mean High Water Neap, Q2 to Q4: Mid-Tide Level, Q5: Mean Low Water Neap, 1A: Selective deposit feeders, 1B: Non selective deposit feeders, 2A: Epigrowth feeders and 2B: Predators/Omnivorous)

Species diversity of nematodes

When considering the horizontal distribution of species number, species diversity, and evenness as a whole at Lok Kawi beach, these values were found to be generally increased towards the low water (Fig. 4).

Statistical Analysis

Pearson correlation analysis results shows that there was a significant correlation between the height above Chart Datum and total nematodes, nematode feeding type non-selective deposit feeders (1B), nematode feeding type epigrowth feeders (2A), nematode species diversity, nematode evenness, nematode species richness and number of nematode species (Table 4).

This shows that the nematode parameters decreases as the beach Chart Datum increases except for the species diversity. Species diversity phenomenon is common due to a higher species density at low tide stations leading to the domination of one or two species so that the species diversity become low if we compared with the stations higher on the beach.

Cluster analysis of the stations (quadrats) within four transects at Lok Kawi beach showed at least two major groups of stations are clustered in the dendrogram (Fig. 5). The first cluster included stations from T2Q5 to T1Q1. One station (T4Q5) is separated from the main 2 clusters. The cluster analysis did not show clearly about the influence of height of the beach on meiofaunal densities. Detrended correspondence analysis of the stations also showed similar results (Fig. 6).

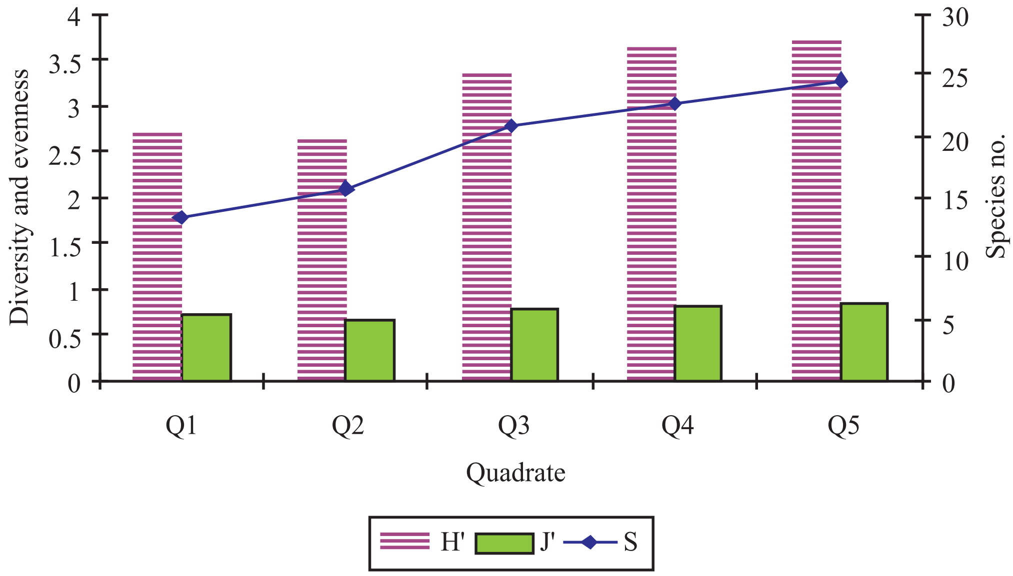

Figure 4: Horizontal distribution (mean values of 4 transects) of Shannon – Weiner diversity index (*H'*), Pielou's evenness (J') and species no. of nematodes (S) (Q1: Mean High Water Neap, Q2 to Q4: Mid-Tide Level, Q5: Mean Low Water Neap)

Table 4: Pearson correlation coefficient of nematodes and beach height

Nematode parameters	Height above Chart Datum
Total nematodes	R = -0.55, *P*<0.05
Nematodes feeding type non-selective deposit feeders (1B)	R = -0.57, *P*<0.05
Nematodes feeding type Epigrowth feeders (2A)	R = -0.61, *P*<0.05
Shannon-Wiener diversity	R = 0.64, *P*<0.05
Pielou's evenness	R = -0.46, *P*<0.05
Nematodes species number	R = -0.63, *P*<0.05

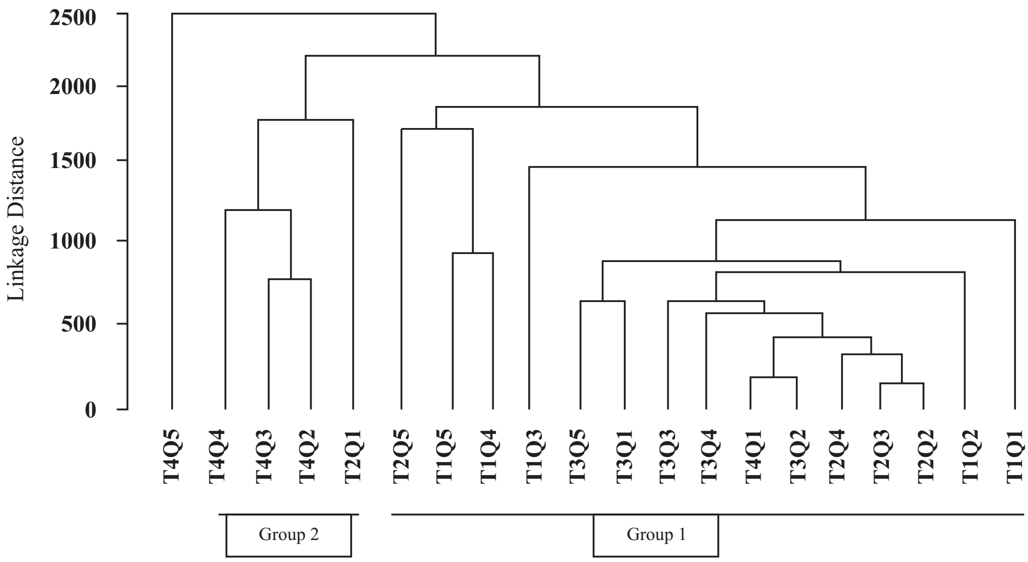

Figure 5: Dendrogram illustrating the similarity of the stations (quadrats) at Mean High Water Neap (Q1), Mid-Tide Level (Q2 to Q4) and Mean Low Water Neap (Q5) T1 to T4 (Transects)

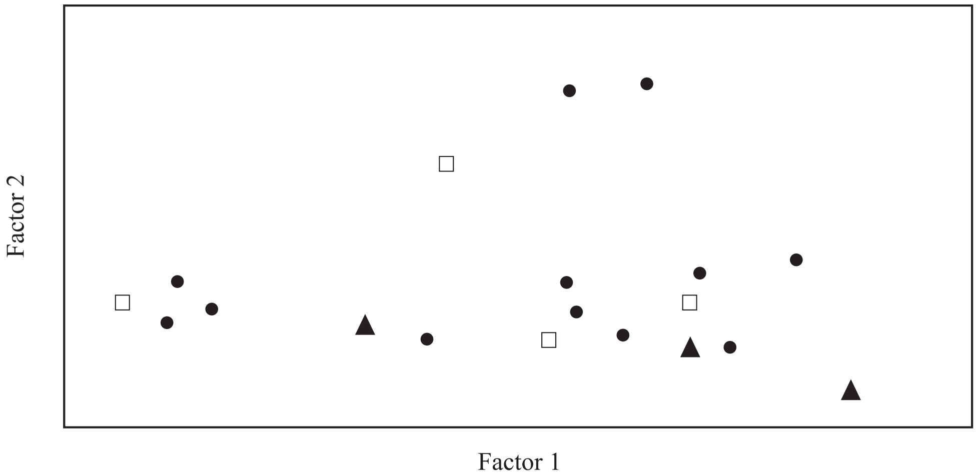

Figure 6: Detrended correspondence analysis of the nematodes species at Mean High Water Neap (□), Mid-Tide Level (●) and Mean Low Water Neap (▲)

DISCUSSION

The density of nematodes in the mangrove and sandy sediments varied considerably both on a global and local scales (Dye,1983; Hodda & Nicholas, 1985; Alongi, 1987; Olafsson, 1995). This variation is within the recorded range from other intertidal habitat. Several authors have found significant differences in tropical meiofaunal densities among intertidal positions in mangrove and sandy areas with highest abundance at low water stations (Dye, 1983; Hodda & Nicholas, 1985; Alongi, 1990; Sasekumar, 1994) although Dye (1983) found that meiofauna in highest number at mid-water level. The similar result was also known in certain areas (Moore, 1979). Animal tolerant to higher temperatures, lower values of water saturation and oxygen tension, appeared to occupy higher tidal levels (Rao & Misra, 1983). Alongi (1990) concluded that physical factor (temperature, grain size, salinity, infrequent tidal inundation limiting dispersal) accounted for the differences observed rather than biological variables. In the present study, Pearson correlation showed that the species density and diversity of the nematodes were influenced by the height of the beach, however clustering and Detrended correspondence analysis did not clearly show the influences of this factor. Therefore, in this case the conclusion by Coull (1988) that there were no unequivocal and universal causative factors controlling the nematode's species density on the sandy and muddy intertidal habitats in a tropical country like Malaysia can be supported.

The study of nematode species zonation across the intertidal habitat have been conducted both in temperate and tropical regions (Moore, 1979; Coull, *et al.*, 1979; Alongi, 1987). Three groups of species have been suggested across the sandy intertidal habitats. Firstly, the species often restricted themselves to sublittoral fringe guild, secondly, eurytopic species where their distribution are centred on the lower shore and thirdly, the species that confined to the upper shore only (Coull, 1988). The current study found that five groups of nematode's species were distributed horizontally along the intertidal height. The species distributed from MTL to MLWN or found only at MTL were considered as stenotopic species. These species possibly prefer a more stable condition towards low-tide zone. However, the species that were distributed from MHWN to MLWN were considered as eurytopic and able to tolerate to the changes in the environmental parameters while the species that were restricted in distribution to a certain tide level such as between MHWN and MTL can only tolerate desiccation during exposure on the beach (Tengku Balkis, 2000; Farizah, 2001; Shabdin, 2006).

Deposit feeders nematodes usually outnumber other feeding guilds in the Australian mangrove (Hodda & Nicholas, 1986). In Lok Kawi beach, the non-selective deposit feeder (1B) was dominant in both the mangrove (T1) and sandy sediment (T4) transects. The epigrowth feeders (2A) were dominant in other sandy sediment transects (Transects 2 and 3). The current finding is in accordance with the general trend for the proportion of epistrate feeders to be higher in the more sandy sediments and for deposit feeders to dominate in finer sediments (Hodda & Nicholas, 1986; Olafsson, 1995). However, the non-selective deposit feeders were also dominant in one of the sandy transects (Transect 4). This finding had deviated from the general trends. The non-selective deposit feeders (1B) were able to ingest particles of a wider size range including benthic diatoms (Platt & Warwick, 1983). The occurrence of maximum chlorophyll *a* value recorded at Quadrat 4, Transect 4 explains this situation.

Based on several studies in India (Fell *et al.*, 1975; Krishnamurthy *et al.*, 1984) predatory nematodes were more abundant in the tropics than in other intertidal areas. The results of this study do not support the generalization that predatory fauna is more abundant in tropical sediments. The deposit feeders were abundance in the mangrove and one of the sandy sediment transects (Transect 4) in Lok Kawi beach. It appears that the proportion of nematodes feeding groups is as variable in the tropical sediments as in other intertidal areas. The non-selective deposit feeders (1B) and epigrowth feeders (2A) groups increased in density towards MLWN. This is possibly due to the more stable condition towards low-tide level (Tietjen, 1977, Shabdin, 2006).

When the nematode's diversity values were compared, one trend is apparent. The diversity, species richness, evenness and number of species increased towards the low-tide level. Pearson correlation coefficient shows that there is a significant correlation between the height of the beach and the species diversity of the nematodes and this is possibly due to the stable condition towards low-tide level. However, the cluster and Detrended correspondence analysis of the stations did not show clearly the influence of height of the beach on meiofaunal densities. The different of results between both analyses were due to the nature of analysis. Cluster and factor analysis of the stations within four transects were based on density of 85 nematodes species and the values of physico-chemical parameters which compared to the Pearson correlation analysis that only calculated based on the total density of nematodes and the physico-chemical parameters values. However, the results of the cluster – factor analysis are more reliable due to the more accurate results obtained as compared to the Pearson correlation analysis (Moore, 1983).

Therefore, we conclude that there were no definite and universal causative factors, which controlled horizontal distribution of freeliving nematode in the intertidal sandy and muddy habitats of the Lok Kawi beach.

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