IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)
e-ISSN: 2319-2402,p- ISSN: 2319-2399.Volume 9, Issue 2 Ver. II (Feb 2015), PP 42-47
www.iosrjournals.org

The Facilitative Role of Sea Blight (*Suaeda monoica*) in Faunal Recolonisation of Degraded Mangroves at Mwache Creek, Kenya

Awuor Loureen A.[1], Ogendi George M.[1], Bosire Jared O.[2], Kairo James G.[2], Mwihaki Lilian M.[2]

[1]*(Environmental Science Department, Egerton University, Kenya)*
[2]*(Kenya Marine and Fisheries Research Institute, Kenya)*

Abstract: *Mangrove ecosystems' muddy or sandy sediments are known to be home to a variety of epibenthic, infauna and meiofauna invertebrates, but natural and human disturbances along tropical coastlines often affect this peaceful coexistence with little known on factors influencing recovery. This study focused on if facilitation by early colonizing vegetation of mangrove ecosystem might improve faunal recolonisation in a degraded area. Using stratified systematic sampling, transects of naturally growing sea blight, natural mangrove stands, adjacent bare control and open canopy control sites in Mwache Creek in Kenya were compared for environmental variables and faunal abundance and diversity. The findings indicated that interstitial water temperature and salinity (at low tide) were lower, while sediment organic matter was higher in the vegetated compared to bare sites. The bare areas were sandier than the vegetated sites. Faunal (crabs, mollusks and sediment infauna) composition in both control sites differed significantly ($p<0.05$) from the vegetated sites, whereas macroinvertebrate assemblages in sites of naturally growing sea blight resembled natural mangrove stand sites. Fauna species and densities were abundant in the two vegetated sites than in their respective controls. The results suggest that sea blight sites are supporting faunal recolonisation and therefore becoming more akin to the natural mangrove sites, thus supporting use of artificial methods (in areas where natural regeneration has been impeded) as a tool for management in conservation and restoration of the functional integrity of degraded mangrove habitats.*

Keywords: *epifauna, facilitation, recolonisation, sediment fauna, Suaeda monoica/sea blight.*

I. Introduction

Mangrove associated fauna plays a significant role in the structure and functionality of this ecosystems [1], [2], [3] with evidence that the entire community of epifauna and infauna have an impact on organic matter cycling and litter dynamics in these systems [3]. The foraging and feeding activities of mangrove fauna influence the properties and availability of organic matter [3], with large proportions recycled within the forest. Crabs are well known for their leaf litter removal capacity [3] and gastropods, sipunculids, polychaetes, shrimps, prawns [4], [5], [6] and fish as other important detritivores. Crabs and other benthic fauna also influence nutrients dynamics by their burrowing activities. The resulting mixing of sediment materials from this activity, results into significant local changes in microbial decomposition pathways and increase hydraulic conductivity of mangrove sediments [3].

Globally, a lot of restoration and rehabilitation of mangroves have been initiated successfully in various parts of the world including; Thailand [7], Bangladesh [8], Malaysia, Pakistan [9] and Kenya [10] among others. Inspite of the success, most attempts to restore mangroves often fail to achieve the stated goals [11], because; there is a misunderstanding of mangrove forest hydrology or acceptance of the false assumption that simply planting mangroves is all that is required to establish a fully-functional mangrove ecosystem [12].

Facilitation has been noted as a mechanism of succession where an early colonizing species changes the abiotic conditions thereby allowing subsequent species entries into previously intolerable habitats [13]. The amelioration of abiotic stressors such as high temperatures, hyper salinity and drought conditions by pioneer species has been inferred in salt marsh and grassland communities [14] and in mangroves of Florida [13] and Caribbean [15] where this process is thought to facilitate secondary succession. Whereas the findings have supported the idea of positive nursing effect of the pioneer species in degraded areas to plants, it has not been put to test in areas where sedimentation is a recurrent disturbance and in quantifying the effect of these pioneer species to faunal recolonisation in the degraded areas. The focus of facilitation has been in return of the forest, while little is known about the re-establishment of the ecosystem normally expected of undisturbed mangroves.

The objective of this study was to assess the facilitative role played by sea blight in faunal recolonisation of a degraded mangrove ecosystem at Mwache Creek, Kenya as an indicator of ecosystem functioning because of the role fauna component play in the mangrove ecosystem. The hypothesis set for this study therefore was that sea blight (*Suaeda monoica*) leads to recovery in ecosystem functioning in terms of increased faunal recruitment into the sea blight growing sites as compared to bare sites.

II. Study Area

Mwache Creek is one of the two tidal creeks found in Mombasa. It is located (04^{o}3.01`S and 39.06$^{o}$38.06`E) in the upper zone of Port-Reitz, 20Km Northwest of Mombasa city [16] (Fig. 1). Roughly 70% of its total 1,500ha [17] area is covered with mangroves of *Avicenia marina, Rhizophora mucronata, Ceriops tagal* and *Sonneratia alba* [18]. Mangrove associates such as *Suaeda* spp. and some grass spp are also present in the landward degraded sites. The Creek receives freshwater from Mwache River which is seasonal thus no flow during dry seasons between December and March and between July and September [18]. It experiences semi diurnal tide with tidal ranges of 3.2m and 1.4m during spring and neap tides respectively. Other than this, it is ebb dominant in the front water zone and flood dominant in the back water zone.

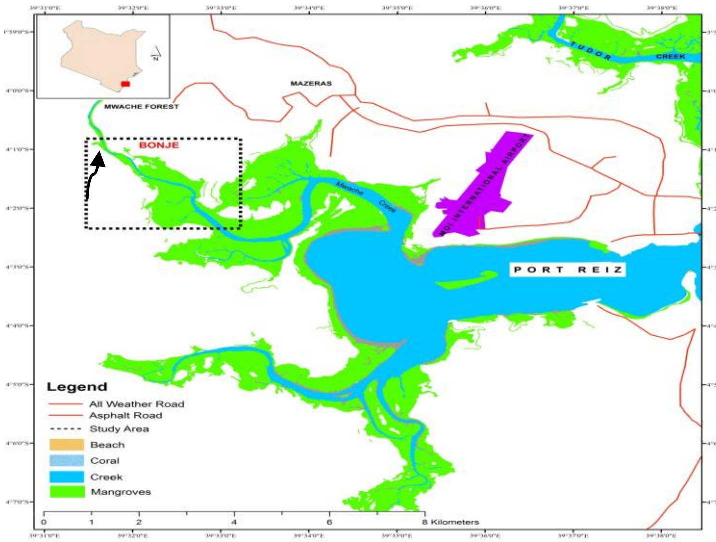

Figure 1. Map of Mwache Creek and the upper area (Bonje) where the study plots were set. All sampling sites and plots were located in the area shown by the arrow.

2.1 Site history

During rainy seasons, Mwache Creek receives freshwater and terriginous sediments from the seasonal Mwache River. Heavy supply of sediments during the Indian Ocean Dipole effect (1997/98 and 2006), led to huge deposition of sediments (106 tonnes) [18] in the wetland leading to massive destruction (smothering of mangrove roots as a result of excessive inputs) of mangrove forest in the upper region (Bonje) [18].

Sedimentation is also compounded by poor land use practices upstream; overgrazing, shifting cultivation, cultivation on steep slopes without application of soil conservation measures among others [18], [19]. In addition to sedimentation, the forest is also facing degradation through high extraction pressure. Further degradation of the forest was as a result of oil spill in 2005, which affected mangroves in Port Reitz, where Mwache creek lies [20]. Assessment of this impacted sites within the creek reveals that the post impact recovery of mangroves is still limited [21], [19].

The vegetated and respective adjacent controls were chosen based on physical proximity, tidal inundation and similarity in site history so as to minimize environmental variation and maximize on paired matching. The two vegetated sites were 250m away from each other and had adjacent open canopies for the mangrove natural stands and adjacent bare/denude sites for the naturally growing sea blight as controls.

III. Materials and Methods

3.1 Environmental factors

Sediment interstitial water samples were randomly collected by digging holes in the soil of 10-15cm at low tide depending on inundation class (10cm for class 1 and 15cm for class 2) using a machete. Salinity and temperature was measured using an optical refractometer (Atago brand) and a pH meter respectively. Three subsamples were taken per quadrant for ten 10m X 10m quadrants chosen for the four different sites. Using forty poles wrapped with dyed plotting papers erected randomly in all the plots of the four different sites and left for 24 hours, height above datum for each point was measured by getting the difference between the day's maximum tidal height (from the tide table) and the recorded height (height to where the dye had been soaked off the plotting papers by the water).

Sediment samples were then taken, down to a depth of 100m using an open face soil corer per plot for the four different sites. Four subsamples of each soil core were collected and taken for laboratory analysis. Samples were oven dried at 60^{o}C for 48 hours until constant weight was obtained for granulometric analysis. About 25 grams was weighed, placed in a beaker and using a combination of sodium hexametaphosphate (to separate the soil particles) and wet sieving, different grain sizes were deduced. Soil organic matter was determined using loss-on-ignition (LOI), a semi quantitative method based on the indiscriminant removal of all organic matter. Oven dried samples were homogenized to fine powder using a mortar and a pestle, passed through a 2mm sieve, weighed and placed in a pre-weighed aluminum crucible. This was set in a muffle furnace for combustion at 450 ^{o}C for 8 hours, cooled in a desiccator and weighed. Organic matter content was determined by equation (1):

$$\frac{initialweight\,(g) - finalweight\,(g)}{initialweight\,(g)} \times 100$$

3.2 Epifauna

In ten plots of 10m X 10m for each of sampling sites (vegetated and their respective adjacent controls), subplots of 5m x 5m were randomly set. Gastropods within each subplot were identified and counted. Additionally, for every plant that fell within each subplot, gastropods were counted upto a height of 2m from the ground. For crabs, both seen crabs and burrows were counted and identified depending on burrow sizes as a measure of density.

3.4 Sediment infauna

In subplots of 5m X 5m set for epifauna counts, three replicate sediment cores per subplot were taken using a hand corer of diameter 6.4 cm to a depth of 10cm into the soil at low tide. In the laboratory, the samples were fixed with formalin before being washed with a gentle jet of tap water over a set of 0.5mm mesh sieves to separate fauna from sediments and detritus. What remained after the sieving was picked by forceps and placed into respective sieve samples. The benthos were then stained using Rose Bengal for ease of identification and counting under a dissecting microscope. Identification was done to taxonomic class level [22].

IV. Results

4.1 Environmental factors

All environmental factors measured varied significantly ($p < 0.05$) amongst the four sites with areas of naturally growing sea blight recording the highest average height above datum at 3.57 ± 0.08m (3.57m-3.58m). Salinity and temperature were highest in the bare sites than the corresponding vegetated and open canopy sites while organic matter content and proportions of silt & clay were highest in the natural mangrove stands than all the other three sites. With exception of height above datum and proportions of silt/clay, all other environmental factors did not differ significantly ($p > 0.05$) between sites of sea blight and those of natural mangrove stand.

Table 1. Site averages (Mean ± SE) of sediment characteristics in plots with matched vegetated and controls.

	Sampling sites			
Parameters	Sea blight	Sea blight bare control	Natural mangrove stand	Open canopy control
Salinity (ppt)	50.4 ± 5.4	84. 8 ± 8.1	39.3 ± 3.5	49.0 ± 4.5
Temperature (^{o}C)	30.6 ± 0.2	32.0 ± 0.3	30.2 ± 0.4	31.7 ±0.2
Organic matter (%)	1.8 ± 1.5	1.3 ± 1.1	2.2 ± 1.4	1.7 ± 1.8
Silt & clay (%)	33.1 ± 3.6	26.4 ± 3.1	64.1 ± 4.9	53. 1 ± 4.7

4.2 Epifauna

4.2.1 Crabs

With the exception of *Cardisoma carnitex*, there was a significant difference ($p < 0.05$) in the density of crab species identified among the four sampling sites. The bare areas recorded the lowest density and diversity of crab species among the sites. No statistical difference ($p > 0.05$) was recorded in the average sum of crab densities (individuals/m^2) between the two vegetated sites and between vegetated sites and their respective controls.

Table 2. Mean ± SE crabs density (individuals/m^2) in the four sampling sites

	Sampling sites			
Species	Sea blight	Sea blight bare control	Natural mangrove stand	Open canopy control
Uca spp,	7.2 ± 0.7	3.1 ± 0.9	55.1 ± 10	34.5 ± 8.8
Perisesarma guttatum	1.2 ± 0.7	0	3.9 ± 0.8	1.8 ± 0.8
Cardisoma carnitex	0	0	4.6 ± 4.6	0.1 ± 0.1
Sum	**8.4 ± 1.4**	**3.1 ± 0.9**	**63.6 ± 15.4**	**36.4 ± 9.7**

4.2.2 Gastropods

Save for *Littoraria*, all other gastropods were abundant in the sea blight sites than the other three sampling sites. Both *Terebralaia* and *Cerithidae* species densities varied significantly ($p< 0.05$) while *Littoraria* densities did not vary significantly, amongst the four sampling sites. The vegetated sites had higher densities of gastropods than their respective control sites. Apart from *Terebralaia*, densities of other species of gastropods did not vary significantly ($p> 0.05$) between the sea blight and the natural mangrove stand sites.

Table 3. Mean ± SE gastropods density (individuals/m^2) in the four sampling sites

	Sampling sites			
Species	Sea blight	Sea blight bare control	Natural mangrove stand	Open canopy control
Cerithidae	66.7 ± 11.3	1.4 ± 1.7	64.9 ± 18.6	4.2 ± 0.4
Terebralaia	2.3 ± 1.1	0.4 ± 0.2	0.48 ± 0.3	0.08 ± 0.04
Littoraria	2 ± 0.5	0.06 ± 0.1	4.4 ± 1.7	2 ± 1.0
Sum	**71 ± 12.9**	**1.86 ± 1.9**	**69. 8 ± 20.6**	**6.3 ± 1.4**

4.3 Sediment Infauna

The natural mangrove stand and its adjacent open canopy control sampling sites had higher densities and higher number of taxa of sediment infauna than the sea blight and the bare denude sites. There was a significant difference ($p< 0.05$) in densities and in in number of taxa of sediment infauna among the four sampling sites. The vegetated sites had higher densities and diversity than their respective adjacent control sites. *Eleptera* taxon was exclusively found in the sea blight sights while *Tubelleria* and *Polychaeta* taxa were found distributed in all the four sampling sites.

Table 4. Mean ± SE sediment infauna density (nr. m^2) in the four sampling sites

	Sampling sites			
Infauna	Sea blight	Sea blight bare control	Natural mangrove stand	Open canopy control
Brachyura	0	0	73±30	62±21
Caridea	0	0	22±18	0
Copepoda	0	0	257±121	121±67
Cumacea	0	0	13±14	0
Tubellaria	527±142	19±12	10261±921	947±225
Insecta	17±18	0	93±47	33±30
Isopoda	17±18	0	458±42	73±31
Nematoda	0	0	15693±1284	911±89
Oligochaeta	0	0	8296±4332	1235±329
Ostracoda	674±249	0	583±177	425±66
Polychaeta	54±29	17±18	22740±3982	11251±521
polycladida	0	0	0	15±7
Eleptera	234±91	0	0	0
Sum	**1523±547**	**36±30**	**58489±10968**	**15073±1386**

V. Discussion

When compared, the number of macrofauna was highest in the natural mangrove stands than all the other sampling sites. This was similar to observations made when effects of mangrove deforestation on macrofaunal densities was investigated, where high number of fauna were reported in the natural mangrove areas than the deforested/ bare areas [23]. Species diversity, density and distribution of crabs and gastropods respond predictably to disturbance, exploration and management of mangroves [24], [25]. This was exhibited by distribution of crabs and mollusks in this study. Apart from *Uca* spp that was present in all the four sampling sites, most crab species prefer shaded areas for both food and shelter. These crabs dwell on prop roots, beneath dead wood, among rotting vegetation, among other areas [26] and feed on mangrove leaves and seedlings as well as fine plant and animal detritus [27], [28]. When these preferences are placed into consideration, as mangroves offer right substrate consistency for burrows, protection, shelter and shade of dense canopy, so does sea blight, explaining the considerable numbers of crabs in this site than the completely bare areas suggesting that sea blight offers habitat that encourages crabs recolonisation.

High number of mollusks in the natural mangrove stands and sea blight sites was likely to be attributed to the shading effect that these two sites provide. Mollusks prefer moist conditions that are assured under closed canopy [4]. *Cerithidae* spp seemed relatively well adapted to the vegetated sites thus their abundance. The less density of these mollusks in both controls could most likely be attributed to lack of structural complexity and exposure to heat. Epifaunal distribution in an area is always influenced by organic matter and moisture content, an observation that was also made in this study. The near similarity in species and high numbers of epifauna registered in the sea blight sampling site as in the natural mangrove stands sites compared to the low numbers registered in the bare areas suggest that sea blight has potential to support faunal recolonisation and thus enhance ecosystem recovery.

Thirteen different types of sediment infauna taxa were identified from the sampling sites. Of this, the natural mangrove stand sites had the highest numbers of infauna, atleast twelve of the thirteen sighted. Mangrove sediments generally support higher densities of benthic organisms than do adjacent non vegetated sediments [29], [30] which was the case in the bare sites. The presence of significant density of sediment-infauna in the sea blight sites than in the bare areas suggests a recovering ecosystem. Open areas have less fine grained size sediments; do not slow down incoming tide hence less organic deposition [5]. Substrate type, salinity, oxygen, water table level, and organic material are among factors responsible for infauna distribution even in the four sites studied here. These, especially soil organic matter could be most responsible as infauna feed on particulate organic matter (POM).

Some species/taxa in the study were found to occur in all comparable sites, in only two sites or in some instances in only one site; as the *Eleptera* taxa that was confined to the sea blight sampling site suggesting that it could be an inhabitant of herbaceous mangrove ecosystem sites. Since faunal species found in the bare sites were also represented in the comparable sea blight, natural mangrove stands and open canopy control sampling sites, it is likely that these taxa are universal in their occurrence, thus not limited to areas with plant cover in the mangrove ecosystem. If the co-occurrence of faunal species/taxa in different sites in the study is a reflection of ecological function equivalency, then the sea blight sites were more akin to natural mangrove stands and their adjacent open canopy sites, emphasizing the nursing role of some herbaceous mangrove associate species (*S. monoica* in this case) in recovery of degraded mangrove systems.

VI. Conclusion

Disturbances; both natural and human induced at the tropical coasts modify mangrove habitats, resulting in the loss of mangrove ecosystems functional attributes. In this case, the support of rich taxa and numbers of investigated fauna, which may then alter the structure and functioning of the ecosystem. This was apparent from the scarcity of epifauna and sediment infauna numbers in the bare sites, whereas the sea blight sites had significantly higher numbers and richer in fauna species recruited. In terms of faunal numbers/densities and species composition, the sea blight sites departed generally from their bare adjacent controls and seemed to be functionally developing towards the original natural forest. This results therefore suggest that sea blight has a positive impact on faunal recruitment, thus supporting artificial mangrove regeneration as a management tool where natural regeneration has been unsuccessful in restoring degraded mangrove systems. However, more similar studies are necessary in the future to support these findings and monitor other recolonisation patterns.

Acknowledgements

Special thanks go to Kenya Marine and Fisheries Research Institute (KMFRI) through Dr. J. Bosire and Dr. J. Kairo for giving me a chance to work under their supervision, my college supervisor Dr. G. Ogendi, all colleagues from Egerton University and KMFRI who assisted in both sampling and laboratory work to make this study a success. The research was financed by Western Indian Ocean Marine Scientists Association (WIOMSA) – Marine Research Grant Program (MARG).

References

[1]. S.Y. Lee, Mangrove macrobenthos: Assemblages, services and linkages, *Journal of Sea Research*, 59, 2008, 16-29.

[2]. F. Dahdouh-Guebas, M. Verneirt, J.F. Tack and N. Koedam, Food preferences of *Neosarmatium meinerti* de *Man* (*Decapoda: Sesarminae)* and its possible effect on the regeneration of mangroves, *Hydrobiologia*, 347, 1997, 83-89.

[3]. E. Kristensen, S. Bouillon, T. Dittmar and C. Marchand, Organic carbon dynamics in mangrove ecosystems: A review, *Aquatic Botany*, 89, 2008, 201-219.

[4]. J.O. Bosire, Ecological recovery of reforested mangroves in Kenya, *doctoral diss*, Vrije Universiteit Brussels, Brussels, 2006.

[5]. J. Schrijvers, D. Van-Gansbeke and M. Vincx, Macrobenthic infauna of mangroves and surrounding beaches at Gazi bay, Kenya, *Hydrobiologia*, 306, 1995, 53-65.

[6]. Sasekumar, V.C. Chong, M.V. Leh and R. D'Cruz, Mangroves as a habitat for fish and prawn, in V. Jaccarani, E. Martens (Eds.), The ecology of mangroves and related ecosystems, *Hydrobiologia*, 247, 1992, 195-207.

[7]. C.D. Field, *Restoration of mangrove ecosystems* (International Society for Mangrove Ecosystems (ISME), Okinawa, Japan, 1996).

[8]. R.R. Lewis, Ecological engineering for successful management and restoration of mangrove forests, *Ecological Engineering*, 24, 2005, 403-418.

[9]. M.T. Qureshi, Restoration of mangroves in Pakistan, in C.D. Field (Ed.), *Restoration of mangrove ecosystems* (International Society for Mangrove Ecosystems (ISME), Okinawa, Japan, 1996) 126-142.

[10]. J.G. Kairo, Community participatory forestry for rehabilitation of deforested mangrove areas of Gazi bay (Kenya), 'A First approach', Final Technical Report, University of Nairobi, 1995.

[11]. R.R. Lewis, Ecologically based goal setting in mangrove forest and tidal marsh restoration in Florida, *Ecological Engineering*, 15(3-4), 2000, 191-198.

[12]. R.R. Lewis and G.R. Gilmore, Important considerations to achieve successful mangrove forest with optimum fish habitat, *Bulletin for Marine Science*, 80(3), 2007, 823-837.

[13]. E.C Milbrandt and M.N. Tinsley, The role of salwort (*Batis maritima* L.) in regeneration of degraded mangrove forests, *Hydrobiologia*, 586, 2006, 369-377.

[14]. M.D. Bertness and P.J. Ewanchuk, Latitudinal and climate-driven variation in the strength and nature of biological interactions in New England salt marshes, *Ocecologia*, 132, 2002, 392-401.

[15]. K.L. McKee, J.E. Roth and I.C. Feller, Mangrove recruitment after forest disturbance is facilitated by herbaceous species in the Caribbean, *Ecological Applications*, 17, 2007, 1678-1693.

[16]. J. Kitheka, Suspended sediment transport and exchange in Port-Reitz Creek with focus on the mangrove fringed Mwache wetland Kenya, *MSc. diss*, University of Gothenburg, Sweden, 2000.

[17]. J.O. Bosire, Resilience of mangroves impacted by indirect effects of global climate change: A preliminary assessment, WIOMSA marg II Final Report, 2010, 23p.

[18]. J. Kitheka, G. Ongwenyi and K. Mavuti, Dynamics of suspended sediment exchange and transport in degraded mangrove Creek in Kenya, *Ambio*, 31(7-8), 2002, 580-587.

[19]. J.O. Bosire, F. Dahdouh-Guebas, J.G. Kairo, S. Wartel, J. Kazungu and N. Koedam, Success rates of recruited tree species and their contribution to the structural development of restored mangrove stands, *Marine Ecology Series*, 325, 2006, 85-91.

[20]. J.G. Kairo, J.O Bosire and M. Mohamed, Assessment of the effects of oil spill on the mangrove forests of Port-Reitz, Mombasa, Mangrove System Information Services, Kenya Marine and Fisheries Research Institute, Mombasa, Kenya, 2005.

[21]. J.C. Kaino, Status and recovery patterns of mangrove forests at Mwache Creek, Mombasa, after the El Nino event of 1997/98 and 2006, *MSc. diss*, Egerton University, Kenya, 2013.

[22]. J.H. Day, *A guide to marine life of South Africa shores*, 2nd Edition (Balkema, Cape town, 1974) 300pp.

[23]. E. Fondo and E. Martens, Effects of mangrove deforestation on macrofaunal densities in gazi bay, Kenya, *Mangroves and Salt Marshes*, 2. 1998, 75-81.

[24]. J.O Bosire, F. dahdouh-Guebas, J.G. Kairo, S. Cannicci and N. Koedam, Spatial macrobenthic variation in a tropical mangrove Bay, *Biodiversity and Conservation*, 13, 2004, 1059-1074.

[25]. E.C. Ashton, D.J. Macintosh and P.J. Hogarth, A baseline study on the diversity and community ecology of crabs and the molluscan macrofauna in the Sematan mangrove forest, Sarawak, Malaysia, *Journal of Tropical Ecology*, 19, 2003, 127-142.

[26]. D.W. Frith, R. Tantanasiriwong and O. Bhatia, Zonation and abundance of macrofauna on a mangrove shore, Phuket Island, Southern Thailand, *Phuket Marine Biology Centre research Bulletin*, 10, 1976, 1-37.

[27]. F. Dahdouh-Guebas, S. Cannicci, M. Verneirt, J.G. Kairo and N. Koedam, An exploratory study on gasprid crab zonation in mangrove forests in Kenya, *Wetlands Ecology and Management*, 10, 2002, 179-187.

[28]. F. Dahdouh- Guebas, M. Giuggioli, A. Aluoch, M. Vannini and S. Cannicci, Feeding habits of non-ocypodid crabs from two mangrove forests in Kenya. *Bulletin of Marine Science*, 64, 1999, 291-297.

[29]. G.J. Edgar, The influence of plant structure on the species richness, biomass and secondary production of macrofaunal assemblages associated with Western Australia sea grass bed, *Journal of Experimental Marine Biology and Ecology*, 137, 1990, 215-240.

[30]. Sasekumar and V.C. Chong, Monitoring the coastal environment Part II: Sediment sampling and geotechnical methods, J*ournal of Coastal Research*, 13, 1998, 308-330.