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RESPOND OF MEIOBENTHOS COMMUNITIES' DISTRIBUTION PATTERNS BY ESTUARINE GRADIENTS IN CUNG HAU ESTUARY, MEKONG DELTA.

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Abstract

I The meiobenthos community in the Cung Hau estuary, Mekong river, were investigated in dry season 2009. The results showed that they consist of 18 taxa. Their meiobenthos density was recorded from 259±126 to 1375±609 inds.10cm^{-2}. Nematode was the most dominant taxa, represented 76.4% in the total. Other subdominant taxa were copepoda, turbellaria and sarcomastigophora. Meiobenthos density was found high value at inland and marine stations according to diversity indices such as **S. H', d** and **N1, N2, N**$_{inf}$ while they showed lower at middle estuary stations. The biological diversity indices were higher in the middle part comparing to the remaining stations

1. Introduction

Meiobenthos is diverse group of benthic metazoan that can pass through a sieve of 1mm mesh size and retained on a sieve of 40-64 m meshes size (Hig-

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gins & Thiel, 1988).The estuarine meiobenthos composition and distribution patterns have been investigated in different habitats from natural, pristine to anthropogenic stressed habitats. The meiobenthos distribution patterns along estuarine gradients at large scale were mainly ruled by abiotic parameters such as sediment composition, salinity, temperature fluctuations and tide action (Li et al, 1996). While, at the micro scale, the meiobenthos distribution patterns were mainly based on food supply, predation competition and reproductive behaviour (Sandulli & Pickney, 1999; Steyaert et al, 2003). Special estuarine characteristics results in different meiobenthos composition. The salinity and sediment grain size effect on meiobenthos horizontal distribution (Alves et al, 2009). The abundance and species richness decrease as one moves from the sea to inland stations (Austen & Warwick, 1989). As the preponderance of species in estuaries is marine, the species richness decreased in relation with decrease of salinity concentration (Coull, 1999). There were some remarkable publications on meiobenthos community in Vietnam (Ngo et al., 2010 and 2013; Nguyen & Nguyen, 2003; Nguyen et al., 2012). The objectives of study are to provide a new data on meiobenthos composition in the Cung Hau estuary following estuarine gradients for future comparative studies. The specific question target is how does the estuarine meiobenthos composition respond to environmental factors, especially based on salinity gradient and sediment grain size along the CungHau estuary?

2. Methodology

2.1 Study area, sampling coordinate and mapping

Meiobenthos samples were collected in March, 2009 by using cores of 3.6 cm diameter (10 cm^2 surface area) and 10 cm high. Three replications per station at four stations along the Cung Hau estuary from sea toward inland stations, respectively as ECH.1, ECH.2, ECH.3 and ECH.4 (Table.1 and Figure.1).

Table 1: The sampling coordinates

Stations	Coordinate	
ECH.1	9°41'38.3"N	106°34'45.6"E
ECH.2	9°44'7.7"N	106°34'3.6"E
ECH.3	9°51'23.38"N	106°28'23.3"E
ECH.4	9°53'32"N	106°26'18.3"E

2.2 Meiobenthos samples in collection and processes

Meiobenthos samples were collected and fixed 7% formalin which was prewarmed at 60oC. The samples were decanted and extracted as shown elsewhere

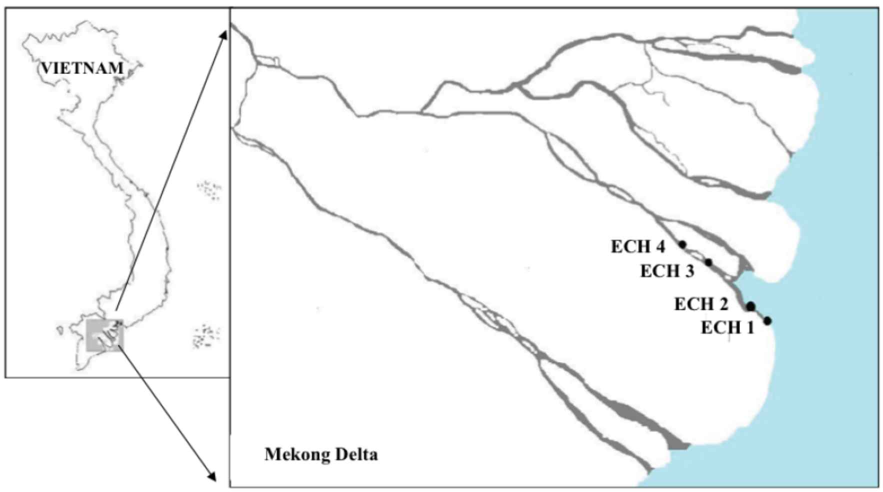

Figure 1: The map of sampling stations in Cung Hau estuary

(Heip et al., 1985) in the laboratory of the Marine Biology Research Group, Ghent University, Belgium for meiobenthos analysing. Meiobenthos taxa were identified to higher level (Higgins & Thiel, 1988).

2.3 Data analyses

Meiobenthos data were calculated in Microsoft Excel, Primer v.6 and Statistica v.7 softwares. Biodiversity of meiobenthos was meansured by Shanon - wiener index H', Margalef index - d (species richness), Hill indices, S (total species) and J' (Pielous's evenness) index (Table 2).

(Notes: D - Simpson's dominance (infinite community) (Simpson, 1949); p_i represents the proportion of the i-th taxa in a sample, or $\mathbf{n}_i$ the number, with N individuals and S total species) The MDS analysis (Non-metric Multi Dimensional Scaling analysis) was used to produce 2D graphs in orders to visualize the meiobenthos distribution patterns. The SIMPER analysis (SIMIlarity PERcentages) was used to identify the taxa that are responsible for similarity and dissimilarity between stations. One-way ANOVA was tested for the significant difference between stations. The Principal Component Analysis (PCA) is the statistical procedure based on enviromental parameters that uses orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables.

Table 2: The diversity and dominance indices

Name	Equation	Application	Reference
Shannon's diversity	$H' = -\sum(p_i \ln p_i)$	This widely used and versatile index can be applied for both large and small sample sizes.	Shannon and Weaver (1949)
Hill's diversity	$N_1 = \exp[-\sum(p_i \ln p_i)] = \exp(H')$	An exponential form of Shannon's H', the value of this index can be interpreted as the number of abundant taxa (Ludwig and Reynolds 1988)	Hill (1973)
Margalef's diversity	$DMg = (S-1)/\ln(N)$	Though and is sensitive only to species richness simple to calculate, this index is unaffected by evenness or diominanceand sample size. Thus, its use should be restricted to comparing species richness among large communities	Margalef (1958)
Hill's reciprocal of D	$N_2 = (\sum p_i^2)^{-1} = 1/D$	The reciprocal of Simpson's D, the value of this inbdex can be interpreted as the number of very abundance taxa (Ludwig and Reynolds 1988)	Hill (1973)
Brillouin'sevenness	$J' = H'/\ln S$	Use J' for collections to determine the evenness portion of diversity; J' represent maximum diversity.	Pielou(1966)

(*Notes:*D - Simpson's dominance (infinite community) (Simpson, 1949); p_i represents the proportion of the i-th taxa in a sample, or $\mathbf{n_i}$ the number, with N individuals and S total species)

3. Results and discussion

3.1 Abiotic factors

Salinity showed a slightly clear decrease from ECH.2 toward inland station at ECH.4. However, the lowest salinity measurement was at station ECH.1. The samples were collected at different periods during the tidal cycle which explains the absence of salinity at ECH.1 (Nguyen et al., 2007). A PCA based on abiotic factors indicated the two groups of marine station (ECH.1, ECH.2) and inland stations (ECH.3, ECH.4) (Figure .1). The marine stations contained high proportion of sand, while it was lower at inland stations where the clay and silt proportion were high. The salinity was higher at marine stations. Soil texture indicated two different groups at close the mouth and far from inland stations. High sand proportion appeared at stations ECH.1 and ECH.2, represented about 100% in the total of soil texture, while the lowest value was in ECH.3 and intermediate in ECH.4. The silt proportion was high at inland stations, represented in 56% and 76% at ECH.4 and ECH.3, respectively.

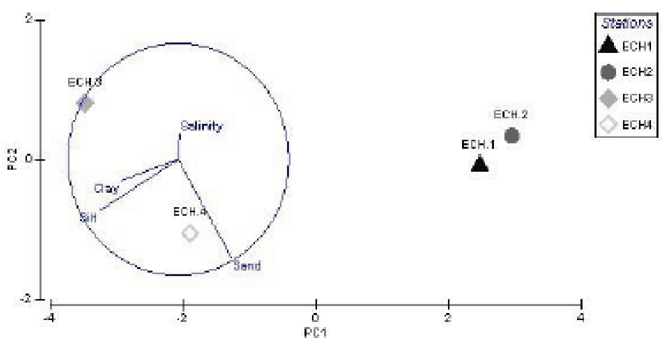

Figure 2: The PCA of abiotic factors at 4 stations along the Cung Hau estuary.

3.2. Composition of meiobenthos community

Total of 18 meiobenthos taxa were identified (Table 2). Proportion of dominant groups were Nematode (76.4%), Copepoda (5.4%), Turbellaria (5.5%), Oligochaeta (3.6%), Gastrotricha (3.5%) and Sarcomastigophora (3.7%), represented 98.1% in the total of counted meiobenthos individuals. The results were consistent with that showed in previous published works (Ngo et al., 2013; Nguyen et al., 2013). Meiobenthos density changed from 259±126 to 1375±609 inds.10cm^{-2} (Table 3). The significantly difference (F(3,8)=8.025, p=0.009) in meiobenthos density was found between stations that they showed tendence to decrease from inland station toward estuarine stations. The highest value of meiobenthos density was counted at marine station ECH.1. Taxa as Nematode, Copepode, Turbellaria, Polychaeta, Oligochaeta and others were high in density at marine stations and represented in significant difference between stations.

3.3 The diversity of meiobenthos community

The results on data analysis are presented in the table 4. The meiobenthos diversity were quite low and varied between stations. The d-Margalef index was highest at station ECH.3 (1,35±0,14) and lowest at the station ECH.4 (1,29±0,42). The J' Pielou's and H'(loge) indices indicated significant differences and decreased from the sea toward to inland stations. The total species and species richness at four stations along estuary were not significant differences. The Hill indices (N1, N2 and Ninf) were significantly different between stations indicating the decrease from the sea toward inland stations.

Table 4: The biological diversity indices of meiobenthos communities in Cung Hau estuary

Diversity indices	ECH.1	ECH.2	ECH.3	ECH.4	One-wayANOVA
S (Total species)	10.3 ± 1.50^{ns}	8.33 ± 0.58^{ns}	11.0 ± 1.73^{ns}	9.0 ± 2.65^{ns}	$F(3,8)=1.4$; $p=0.31$
d-Margalef (Species richness)	1.31 ± 0.23^{ns}	1.35 ± 0.14^{ns}	1.33 ± 0.37^{ns}	1.29 ± 0.42^{ns}	$F(3,8)=2.1$; $p=0.18$
H' (Shannon)	0.78 ± 0.14^{b}	1.65 ± 0.19^{a}	1.01 ± 0.22^{b}	0.60 ± 0.09^{b}	$F(3,8)=22.3$; $p=0.0003$
J' (Pielous's evenness)	0.33 ± 0.29^{b}	0.78 ± 0.11^{a}	0.43 ± 0.10^{b}	0.29 ± 0.09^{b}	$F(3,8)=19.4$; $p=0.0005$
Hill indices	**ECH.1**	**ECH.2**	**ECH.3**	**ECH.4**	**One-wayANOVA**
N_1	2.20 ± 0.30^{b}	5.28 ± 1.02^{a}	2.80 ± 0.61^{b}	1.83 ± 0.16^{b}	$F(3,8)=19.1$; $p=0.0005$
N_2	1.51 ± 0.18^{b}	4.36 ± 1.46^{a}	1.70 ± 0.23^{b}	1.35 ± 0.14^{b}	$F(3,8)=9.3$; $p=0.006$
N_{inf}	1.24 ± 0.08^{b}	3.06 ± 1.26^{a}	1.31 ± 0.09^{b}	1.17 ± 0.07^{b}	$F(3,8)=18.3$; $p=0.0006$

3.4. The meiobenthos distribution patterns

An MDS was used to identify the spatial distribution of meiobenthos communities along estuary (Figure 3 and 4). The graph showed clearly different distribution patterns between stations. The value of stress was excellently illustrating the goodness of fit regression. The spatial distribution of meiobenthos composition showed two different groups at marine and inland stations.

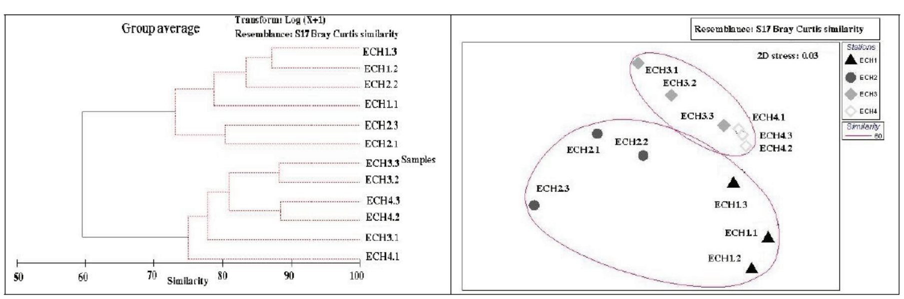

*Figure 3.*The Cluster Similarity and MDS of meiobenthoscummunity

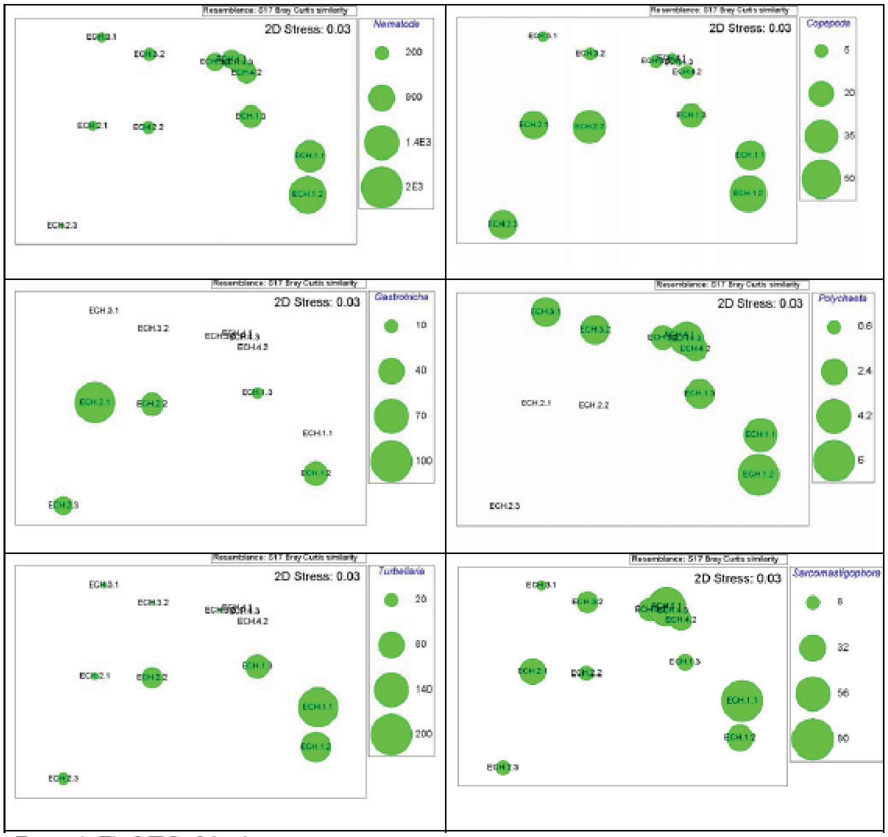

Figure 4 . The MDS of dominant taxa

The SIMPER analysis was used to estimate the similarity and dissimilarity between stations (Table 5). The average similarity within station was quite high due to high nematode individuals counted. The following taxa were the second dominant groups like copepoda, sarcomastigophora and rotifera, respectively from sea toward inland stations. The analysis for dissimilarity showed the subdominant taxa like copepoda, gastrotricha, and turbellaria which were the most responsible for the dissimilarity between stations. Dissimilarity varied between 23,12and 42,83%, but not particular pattern could be identified along the estuarine gradients.

Table 5: SIMPER analysis for meiobenthos community in the Cung Hau estuary

Stations	ECH.1	ECH.2	ECH.3	ECH.4
ECH.1	**83.22%** *Nematode* *Turbellaria* *Copepoda*			
ECH.2	**26.38%** *Nematode* *Tardigrada* *Gastrotricha*	**81.21%** *Nematode* *Copepoda* *Gastrotricha*		
ECH.3	**39.05%** *Turbellaria* *Bivalvia* *larva* *Tardigrada*	**41.54%** *Gastrotricha* *Bivalvia* *larva* *Copepoda*	**83.03%** *Nematode* *Sarcomastigophora* *Rotifera*	
ECH.4	**38.08%** *Turbellaria* *Copepoda* *Gastrotricha*	**42.83%** *Gastrotricha* *Turbellaria* *Copepoda*	**23.12%** *Turbellaria* *Bivalvia larva* *Sarcomastigophora*	**82.11%** *Nematode* *Rotifera* *Sarcomastigophora*

Shaded boxes: percentage of similarity (bold) and taxa that contributed to the similarity in each group.
Nonshaded boxes: percentage of dissimilarity (bold) between stations and taxathat contributed to the total dissimilarity (*cut off percentage*: 90%).

4. Conclusions

The meiobenthos density was high at inland and marine stations, while it was lower at the middle stations. The high density of meiobenthos was found at inland and close to the sea, while it was lower at middle estuary stations. The diversity indices were higher in the middle compared to other stations at inland and closed the sea stations. Our data conclude that the differences in estuarine gradients as salinity and sediment grain size might associate meiobenthos community distribution in Cung Hau estuary and require further investigation.
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