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Epifaunal invertebrate community variation along a salinity-acidity gradient in a tropical estuary

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Introduction

- Investigations on benthic invertebrate communities of estuaries typically focus on soft substratum habitats, much less is known about the structural and functional aspects of the communities of hard substrata. Therefore, studies of hard surface communities are important to completely understand the estuarine benthic diversity.

- Furthermore, hard surface epifaunal organisms interact directly with the estuarine water column, and changes in their community structure are likely to more closely track variations in water chemistry. To date, we have lack of understanding of estuarine system ecology, referring to the interaction of epibenthic community structure and water chemistry, concerns acidification [1, 2].

- While the acidification of sediment components is probably a common feature of all estuarine systems, the persistence of relatively high levels of acidity in the estuarine water column is less common. Information of biotic responses to water column salinity and acidity variation is not only relevant to understanding local ecological phenomena but potentially could contribute to the broader and very concerning context of global acidification of marine systems.

Aims

☞ To present novel descriptive data on the biodiversity contributes to understanding the macrofaunal community which is remarkably poorly known in basic descriptive sense.

☞ To describe the patterns of variation in epibenthic community structure of a highly acidified tropical estuary.

☞ To get an understanding of the community-level effects of marine acidification.

Methods

- 72 epifaunal samples were collected in 2012 (June/July) from four sites at low tide.
- The sites were chosen to cover the entire area (upper to lower) of the estuary reflecting the gradients of salinity and pH (Fig. 1).
- Data were analyzed by using both univariate and multivariate statistical techniques.

Results

❖ 34 taxa identified,and four groups (crustaceans, bivalvia, insecta and polychaeta) together contributed 98 % of total fauna (Fig. 2).Tanaissp. (19.48%) dominant among 8 major taxa/species (Fig. 3).

❖ The overall mean density was 182.28 (±SD106.18) ranged from 94.5 to 335.67 ind./ 100 cm2 the lowest being at site S3 (mid-estuary) and the highest in the site S4 (lower estuary) (Fig. 4).

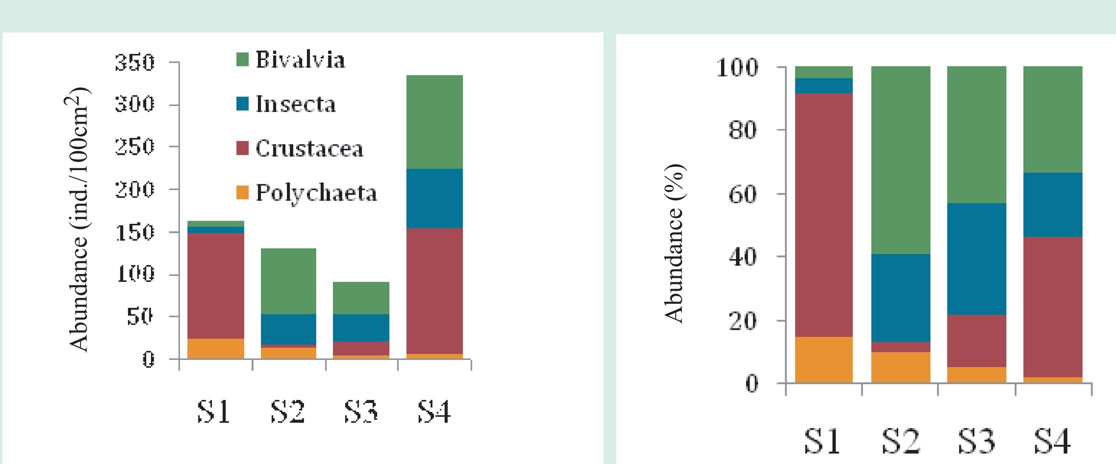

Figure 2.Variation of major taxonomic groups at different sites in the acidified Brunei estuary.

❖ Significant variation in the mean density of the most eight abundant taxa among sites (Table 2) and most of these taxa were abundant at only one or two sites, e.g., Tanais sp. at site S1, Xenostrobus sp. at site S2 and S3, Corophium sp. and Mytillidae sp.1 at site S4 (Fig. 3)

❖ The number of taxa occurred in the site 1 ranged between 6 and 14. In site 2, 3-14, site 3, 3-13 and site 4, 8-15 taxa. The values significantly differed between stations (Kuskal- Wallis test: $\chi 2$= 14.496; P= 0.002) (Fig. 4).

❖ The Shannon-Wiener diversity index (H') had the highest value in site 4 (0.76- 1.44) and the lowest in site S2 (0.39- 1.35) (Fig. 4).

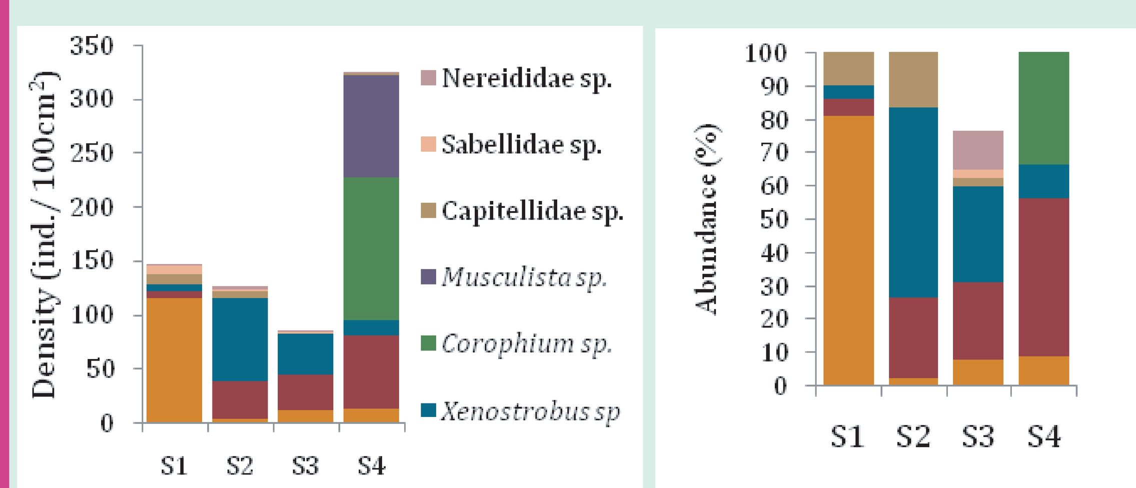

Figure 3.Variation of abundance of eight most dominant species/ taxa at different sites along the acidified Brunei estuary.

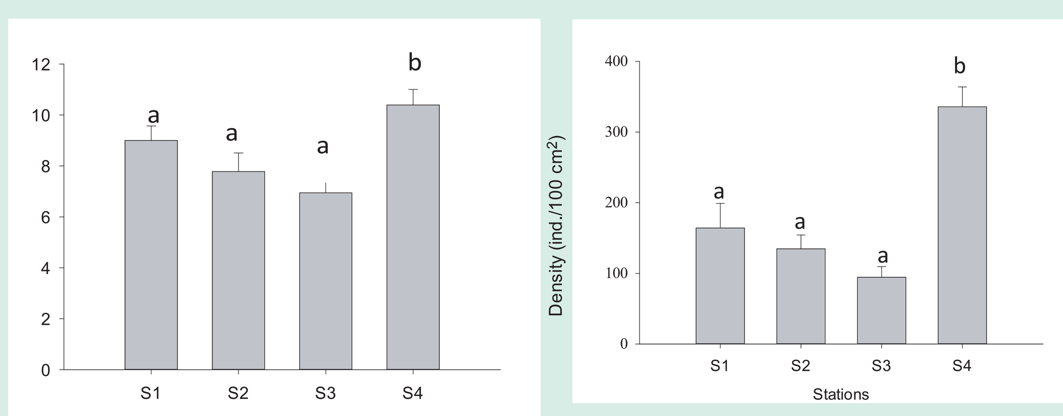

Figure 4.Variation in ecological indices (number of taxa and density; mean ± SE) at different sites along the Brunei estuary.Bars denote standard error of the mean. Unlike letters denote pairs of stations with significant differences by post-hoc comparisons.

❖ Abundance analysis at a coarse taxonomic level (class/order) suggested the existence of three distinct communities along the physico-chemical gradient; the community varied from a tanaid-polychaete dominated one to a mussel-dipteran one, and then a mussel-amphipod-dipteran one, from the landward (with low salinity and low pH) to the seaward stations (with high salinity and high pH) (Fig. 2 &3).

Table 1: Mean (± 1 SE, n=18) density (ind./ 100 cm^2) of the eight most abundant macrofaunalepibionts collected from stations sampled along Brunei estuary. Taxa are listed in order of decreasing abundance. The Kruskal-Wallis test shows highly significant variation (p values in bold) of dominant taxa among sites.

Taxa	S1	S2	S3	S4	χ^2	p
*Tanais*sp.	115.1± 28.03	2.9 ± 0.85	11.3± 4.84	12.6 ± 3.93	29.42	**<0.001**
Chironomidae sp.	6.9 ±1.85	34.8±10.85	32.4 ±9.73	67.5 ±12.13	24.36	**<0.001**
*Xenostrobus*sp.	6.1 ±1.21	77.9 ±11.89	39.3 ±9.52	13.7±4.52	33.07	**<0.001**
*Corophium*sp.	0.00	0.00	0.00	133.9 ±22.62	39.95	**<0.001**
Musculista sp.	0.00	0.00	0.00	95.9±9.56	39.95	**<0.001**
Capitellidae sp.	8.9 ±2.97	6.7 +2.58	0.4 ±0.15	0.2 ±0.22	18.55	**<0.001**
Sabellidae sp.	7.6 ±5.32	0.1 ±0.06	0.2±0.13	0.6±0.20	3.36	0.33
Nereididae sp.	2.7±0.68	4.2± 0.94	0.9±0.25	0.2±0.12	23.83	**<0.001**

❖ The pattern of three distinct communities was somewhat confirmed by a multivariate analysis (Fig. 5 and table 2).

Table 2: One way analysis of similarities showing significant variation in benthic epifauna community structure of three groups found in cluster analysis (A: n=18, B: n=36, C: n=18 see Fig. 5).

	Global R- value	p value
Treatment effect	0.76	<0.001
Pair wise comparison		
A, B	0.551	<0.001
A, C	0.942	<0.001
B, C	0.841	<0.001

❖ The shift from amphipod dominance to polychaete dominance with increasing acidification is consistent with observations of other studies for non-estuarine coastal systems [4].

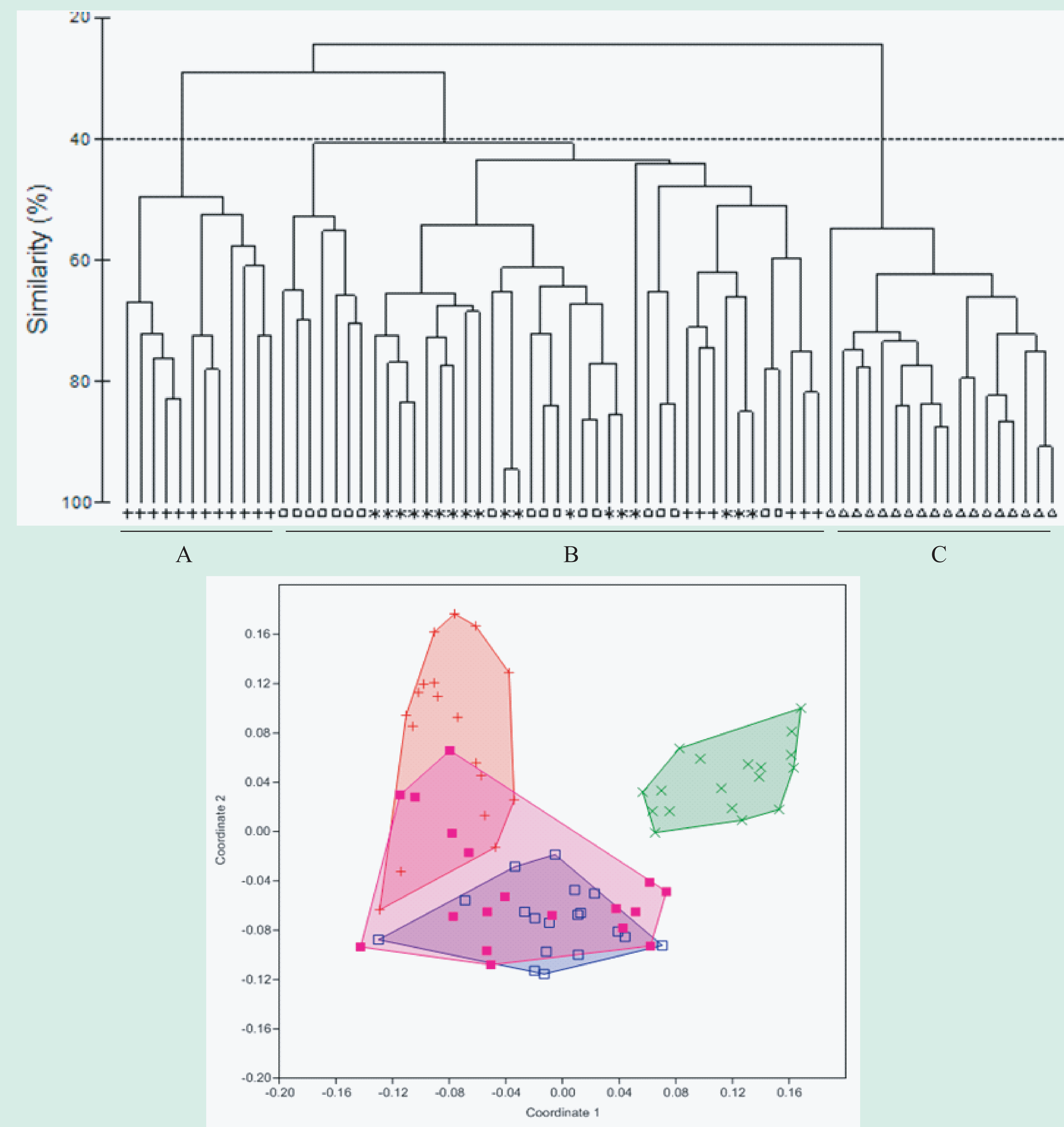

Figure 5.Dendogram (a) and MDS (b) ordination constructed from Bray-Curtis similarities showing spatial variations in epifuanal assemblages in the Brunei Estuary. Data were square-root transformed. Key for the sites: plus sign= site S1, square= site S2, star = site S3, triangle= site S4 (dendrogram) and plus sign, S1; filled square, S2; square, S3; cross sign, S4 (MDS).

Conclusions

✪ This research presents fundamental information for hard-substratum assemblages of old world tropical estuaries.

✪ There was marked a change in the epifaunal diversity along a tropical estuarine system.

✪ The observed variation in community structure coincides with a steep gradient in salinity and pH along the Brunei estuarine system.

✪ Although the determination of individual influences on the community structure of either salinity or acidity was not possible, the study reveals a range of pH resistant species associated with estuarine systems.

✪ Interestingly, the shift in community structure with decreasing pH, corresponds with patterns along full-salinity, benthic inshore acidity gradients, suggesting a possible role of estuarine systems to understanding general effects and forecasting impacts of ocean acidification.

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