NEMATODE COMMUNITIES DISTRIBUTE IN SEDIMENT PROFILE OF THE RIVER BED

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ABSTRACT

Free living nematodes in the estuarine ecosystem have been studied worldwide as well as in Vietnam. However, so far no study on characteristics of nematode communities characteristics distribute in sediment profile in high accumulation of organic deposition of the riverbed in the condition of lack of water exchange due to damming. This study aims to investigate how nematodes' communities variables such as diversity, sex and feeding structure alter in different 5 layers of sediment deep profile of the river bed. Our studies found for the first time that nematodes' communities not only stay on 10 cm first layers but they can contribute until 50 cm deep in the sediment profile of the river bed. They have good a ability to adapt to the condition of sediment deep, with lower densities in comparison to the first 10cm top layers but they are still quite high diversity. However, our study also recognized that there was not a clear difference in other communities' charactersitics such as the number of species, sex structure and feeding types in 5 sediment deep profiles.

QUẦN XÃ TUYẾN TRÙNG PHÂN BỐ THEO ĐỘ SÂU TRẦM TÍCH CỦA ĐÁY SÔNG

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TỪ KHÓA

Độ sâu
Đa dạng sinh học
Kiểu dinh dưỡng
Cấu trúc giới tính
Cửa sông Mekong

TÓM TẮT

Tuyến trùng sống tự do trong hệ sinh thái cửa sông đã được nghiên cứu nhiều trên toàn thế giới cũng như ở Việt Nam. Tuy nhiên, cho đến nay chưa có nghiên cứu nào đề cập tới khả năng phân bố của chúng theo độ sâu và đặc điểm quần xã của chúng theo từng lớp trong mặt cắt bùn lắng tích tụ nhiều chất hữu cơ dưới đáy sông trong điều kiện thiếu trao đổi nước do đắp đập. Nghiên cứu này lần đầu tiên đặt vấn đề tìm hiểu về khả năng phân bố của tuyến trùng cũng như các đặc điểm quần xã của chúng như sự đa dạng, cấu trúc giới tính và thành phần kiểu dinh dưỡng như thế nào trong 5 lớp trầm tích khác nhau ở đáy sông. Kết quả nghiên cứu của chúng tôi là phát hiện mới, cho thấy rằng chúng không chỉ phân bố ở trong 10 cm lớp trầm tích đầu tiên mà lâu nay phương pháp thu mẫu chỉ giới hạn mà chúng còn có thể xuống sâu tới 50 cm trong trầm tích của lòng sông. Chúng có khả năng thích nghi tốt trong điều kiện trầm tích sâu, với mật độ thấp hơn so với các lớp trên cùng nhưng chúng vẫn có tính đa dạng khá cao. Tuy nhiên, nghiên cứu của chúng tôi cũng nhận thấy rằng không có sự khác biệt rõ ràng về đặc điểm các quần xã khác như số loài, cấu trúc giới tính và kiểu dinh dưỡng trong 5 tầng cắt lớp 10 trầm tích.

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1. Introduction

Estuaries occur at the mouth of rivers where fresh and marine water mixes. These transition zones are characterized by a salinity gradient and are subject to both marine and freshwater influences. To prevent saltwater from intruding into fresh habitat of the paddy field and gardens, damming in the estuarine area was selected. This kind of construction at the estuary strongly influences the river ecosystem. One of the most impacted in the 8 remaining Mekong estuaries is the Ba Lai estuary with a damming impact built across the main stream at the mouth. This has led to a decrease in the ecological quality of the estuaries. Especially, the organic pollution load of the river has increased seriously due to lack of water exchange and accumation which influences strongly to the status of its environmental quality.

Studies on estuarine free living nematodes were performed worldwide [1], [2] including Vietnam [3], [4]. Especially, many researches were published recently in the Ba Lai river [5], [6], [7]-[10]. However, so far no study on the characteristics of nematode communities characteristics distribute in sediment profiles in high anthropogenic impact river such as Ba Lai river. Therefore the goal of this study was to investigate how nematodes' communities variables such as diversity, sex and feeding structure in the difference of sediment deep level of the river bed in order to find out their ability to adapt in difficult condition of riverbed evironment to go further on appling them as bioindicator.

2. Methodology

Nematodes samples were collected at 6 selected high deposited stations with coordinators figure 1. Per station, three replicate samples were collected for nematode samples by means of cores of 10 cm² in the surface. Each core, nematode samples were divided in 5 layers: 0-10 cm, 10 -20 cm, 20 – 30 cm, 30 – 40 cm and 40 – 50 cm deep. All nematodes samples were fixed and preserved in the field in 7% neutralized formalin (heated to 60-70°C) in order to facilitate to observe easily under microscopes.

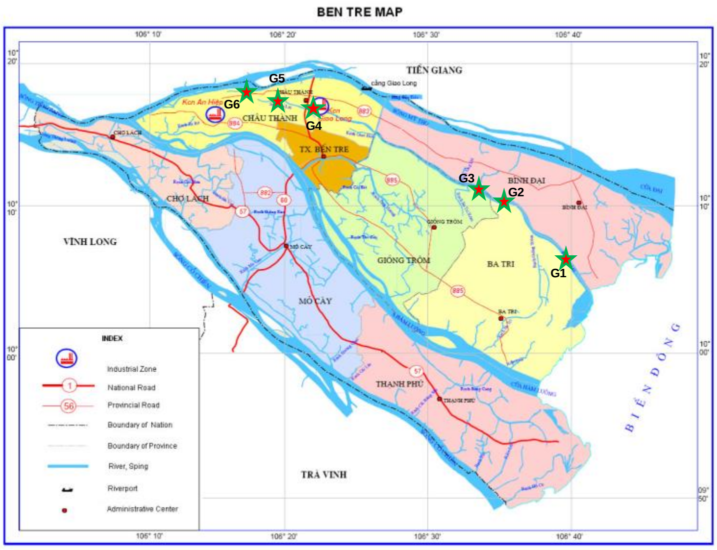


Figure 1. *Sampling station and cordinators of study area in Ben Tre Province*
(Sources: adapted from the Ben Tre Department of Environment and Resources)

In the laboratory, nematode samples were extracted from the sediment fraction using Ludox HS-40 colloidal silica at a specific gravity of 1.18 g.cm-3 and a 38 µm sieve [11] and identified by the picture key on Free living Marine Nematodes part I [12]-[14], Nguyen [15], together with the other articles and NEMYS database (http://nemys.ugent.be/) [16]. The Hill diversity indices were used to calculate biodiversity level by the PRIMER VI software plus PERMANOVA. The nematodes were identified into four feeding categories, based on the structure of the buccal cavity according to Wieser (1953) [17]: (1A) selective deposit-feeders, genera with very small and unarmed buccal cavity, presumed to feed selectively on small particles such as bacteria; (1B) non-selective deposit-feeders, genera with the unarmed buccal cavity of moderate size, which feed less selectively also larger particles, such as diatoms can be ingested; (2A) epistratum (epigrowth) feeders, genera with a medium size buccal cavity, provided with small teeth that are used to attack food particles or to scrape them of solid surface; (2B) predators or omnivores, genera with wide buccal cavity with large teeth or other powerful structure that are used to destroy relatively large food organisms.

All univariate data were tested by ANOVA analysis (parametric test) with assumptions of homogeneity tested by Levene's test and then Posthoc test (Tukey HSD) comparison to find a significant group. In the case of Levene's test is not fulfilled, the Kruskal – Wallis test (non-parametric test) was done and multiple comparisons of mean ranks for all groups applied to recognize significant groups.

3. Results and dicussion

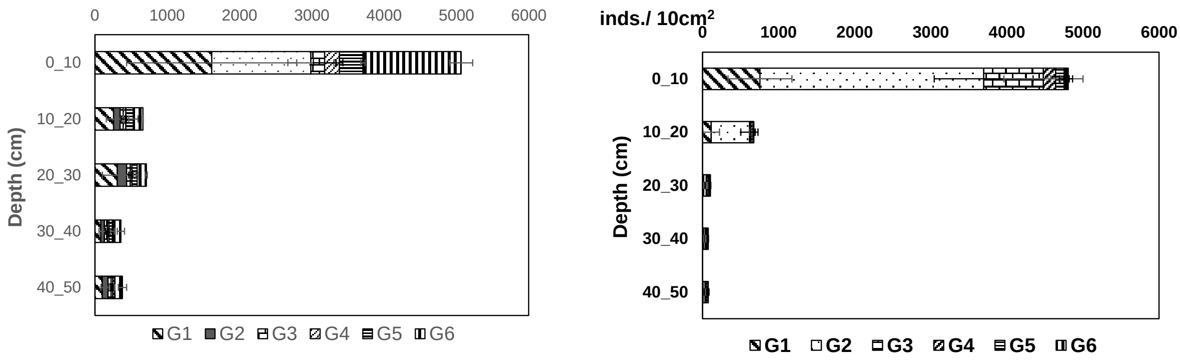
3.1. Densities

There were 227 species, 136 genera and 60 families, 11 orders, 2 classes in both dry and rainy seasons were identified in the Ba Lai estuary. Of those 179 species belonging to 114 genera, 51 families, 11 orders of 2 classes Enoplea and Chromadorea in the dry season. 133 species, 86 genera, 42 families, 11 orders of 2 classes Enoplea and Chromadorea were found in the rainy season.

The density of nematode communities was obviously higher in the top layer (0_10 cm sediment depth) than those underneath layers for all stations in both dry and rainy seasons (Fig. 2a, b). The highest nematode abundance was found at the top layer of station G2 with an average number of 2941.33 ± 650.38 individuals/10 cm^2 (Fig. 2b). In the dry season, the nematode density ranged from 22.67 ± 2.89 individuals/10 cm^2 at the layer 30_40 cm of G4 to 1614.33 ± 1175.78 individuals/10 cm^2 at the top layer of G1 (Fig. 2a). These numbers, in the rainy season, varied between 5.33 ± 2.08 individuals/10 cm^2 at the deepest layer of G3 and 2941.33 ± 650.38 individuals/10 cm^2 at the top layer of G2 (Fig. 2b). In general, the average density of the nematode community in each layer in most stations was higher in the dry season compared to those in the rainy season (Fig. 2a, b). Except for the top layers of G2 and G3, the layers of G2 (10_20 cm) were more nematode individuals in the wet season than in the dry period (Fig. 2a, b). Concerning the station level, in the dry season, the sea-side station (G1) but also the most upstream one (G6) were higher nematode densities than the remaining stations (Fig. 2a). Whereas, in the rainy season, station G2 (more evidenced in the top and second layers) were presented with more nematode number than other stations (Fig. 2b).

In the dry season, Kruskal-Wallis test showed that the nematode densities were significantly different among stations ($p < 0.001$) with group differences between G4 and G1, G2, G6, and between G3 and G1, G6; and among layers ($p < 0.001$) with the top layer differed from the underneath one except for layer 40_50 cm (Table 1). There was also interaction effect between both factors "station" and "layer" on the abundance of nematode communities ($p = 0.001$).

In the rainy season, there was also interaction effect between both factors "station" and "layer" on the abundance of nematode communities ($p=0.001$). Kruskal-Wallis test showed that the nematode densities were significantly different among stations (p: 0.001) with group difference between G2 and G3, G5, G6, and among layers ($p < 0.001$) with the top layer differed from the underneath ones.



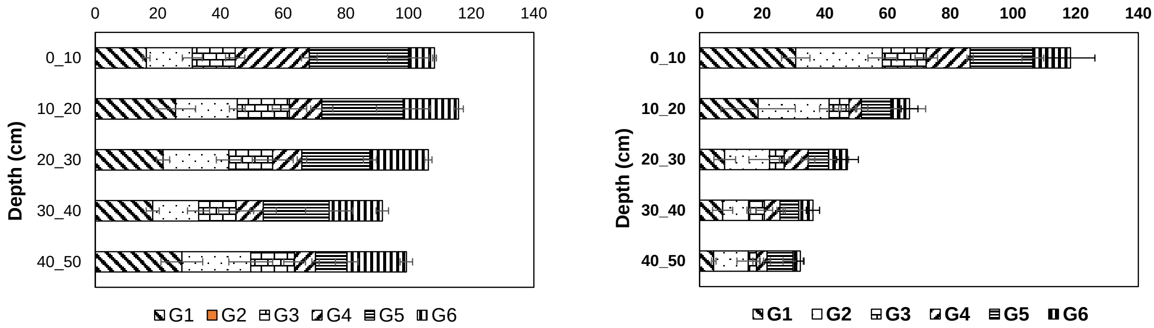
(a) (b)

Figure 2. *The density of nematode communities in the dry (a) and rainy (b) seasons*

3.2. Biodiversity

The number of nematode species ranged from 6.67 ± 1.15 at the deepest layer (40-50 cm depth) of G4 to 31.67 ± 6.66 at the top layer (0_10 cm depth) of G5 in the dry season (Fig. 3a). While in the rainy season, these number varied between 2.33 ± 1.15 at the deepest layer (40-50 cm depth) of G6 and 30.67 ± 4.51 at the top layer (0_10 cm depth) of G1 (Fig. 3b). The richness of nematode assemblage slightly fluctuated among layers of all stations in the dry season, but declined from the top layer downward deeper layers in all station in the rainy season.

The Kruskal-Wallis test found a significant difference in the number of nematode species between stations G1 and G3, G4, and between G4 and G5; and the significant interaction effect between both factors "station" and "layer" on the richness nematode communities (p: 0.001) in the dry season. The number of nematode species in the rainy season was also significantly different between G2 and G3, G4, G6. There was no significant difference between layers either in the dry season or in the rainy season.



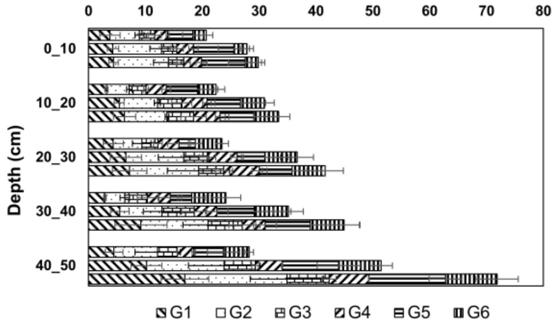
(a) (b)

Figure 3. *The species number of nematodes communities in the dry (a) and rainy (b) seasons*

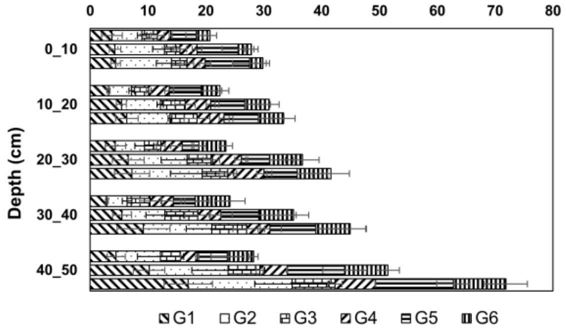
The Hill's indices

In the dry season, N1 indices ranged from 3.95 ± 0.46 at the layer 10_20 cm of G5 to 19.73 ± 7.3 at the top layer of G6. N2 changed between 2.83 ± 0.3 and 14.88 ± 6.35 at the same layer and station. While Ninf varied from 1.85 ± 0.12 at the top layer of G6 to 6.31 ± 0.3 at the layer 30_40 of G5. The Hill's indices were lowest the top layer (0_10 cm depth) of most stations (Fig. 4a). These indices in stations G1 and G6 increased following the sediment depth, from the top layers downward the the deepest layers, however they fluctuated between layers in the remaining stations (Fig. 4a).

The Kruskal-Wallis showed significant differences in N1 between G5 and G3, G4, G6, and between G2 and G4. There were also interaction effects between factors "station" and "layer" in index N1 (p<0.001), with pair-group differences. N2 was only significantly different among stations (p: 0.01) with groups difference found between G5 and G3, G4, G6. While there was a significant difference between G5 and G6 in index Ninf.



(a)



(b)

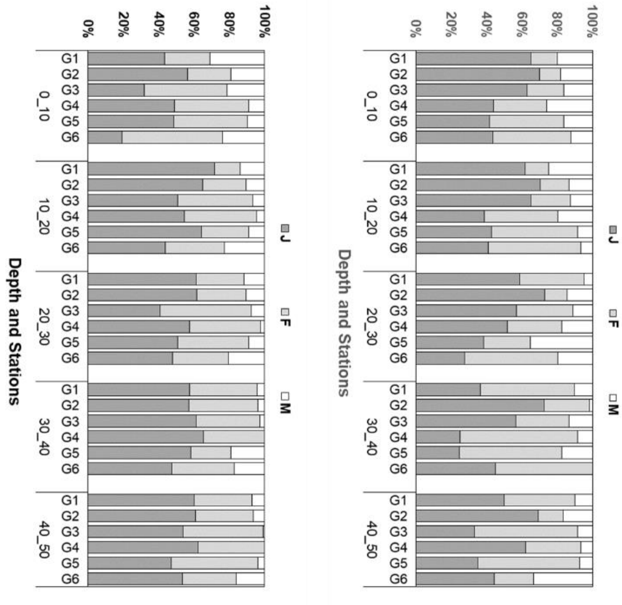
Figure 4. *The Hill's index of nematode communities in the dry (a) and the rainy (b) seasons*

In the rainy season, N1 varied between 2.33 ± 1.15 at the top layer of G6 (0_10 cm depth) and 17.91 ± 6.42 at the deepest layer of G2 (40_50 cm). Also at the same layer and station, N2 ranged from 2.33 ± 1.15 to 13.67 ± 6.32. Ninf fluctuated from 2.28 ± 0.25 at the top layer of G4 to 7.66 ± 4.00 at the layer 40_50 of G2. As in the dry period, these indices seemed to have higher values in the deepest layer. G4 and G3 were lower Hill's indices compared to those in other stations. Statistical analysis did not find an interaction effect between factors "station" and "layers". However the significant effect was found for each factor either "station" on all indices N1, N2, and Ninf; or factor "layer" on N1 and N2.

3.3. The sex structure

In general, the juvenile was the most dominant group in communities in both dry and rainy seasons, except for some layers, the percentage of female group was highest in the communities (Fig. 5a, b). While male nematodes accounted for a very low percentage in the communities (Fig. 5a, b).

In the dry season, the proportion of juveniles ranged from 19.28% total density at the top layer of most upstream station (G6) to 71.59% total density at the layer 10_20 cm of the sea-side station (G1) (Fig. 5a). This group of nematode gender was significantly lower in the top layer compared to each of the underneath layers. At the station level, juvenile nematodes were low in most layers of G6. The percentage of female nematodes varied between 14.45% total density at the layer 10_20 cm of G1 to 56.63% total density at the top layer of G6. This female group fluctuated among stations and layers, with the top layer (0_10 cm depth) was significantly lower percentages compared to the underneath layers (Fig. 5). While the male nematodes were absent at the layers 30_40 and 40_50 cm depth of G4, but presented with the percentage of 31.12% total density at the top layer of G1. The male group, although very low proportion in communities, showed a significantly highest percentage in the top layer (Fig. 5a).



a b

Figure 5. *Gender structure of nematode communities in the Ba Lai estuary in (left) the dry and the rainy (right) seasons*

In the rainy season, juvenile nematode with the proportion ranged from 24.85% total density at layer 30_40 cm of G5 to 73.02% total density at the depth 20_30 cm of G2. Juvenile seemed to have a higher proportion at both layers 0_10 cm and 10_20 cm depth of station G1 and G2, but also at other layers of G2 (Fig. 5b). The Kruskal-Wallis also confirmed significant differences between station G2 and other station G3, G4, G4 and G6. The female group changed between 11.61% total density at the top layer of G2 to 66.67% total density at the layer 30_40 cm of G4. And male nematodes were absent at layer 30_40 cm of G6, but highly presented at the layer 20_30 cm of G5 with 35% total density. There were significant differences in gender groups either juvenile, female, or male between the top layer (0_10 cm depth) with each underneath layers.

The interaction effect of both factors "station" and "layer" was not found for gender groups in both dry and rainy seasons.

3.4. Trophic structure

Group selective deposit-feeders (1B) generally accounted for a higher proportion in comparison to the remaining feeding types in both dry and rainy seasons (Fig. 6 a, b). Especially, this group was extremely dominant in the top layers (0-10 cm depth) with 90.67% total density of station G6 in the dry season and 91.5% total density of station G3 in the wet season (Fig. 6 a, b). Group epistrate-feeders are also highly presented in the communities, especially in the top layer of G1 with 61.39% total density in the dry season and the layer 30_40 cm of G1 with 71.96% in the rainy season (Fig. 6a, b). Those groups 1A and 2B generally presented with a low percentage (even absence) in the communities, although at some layers, the exceptions were found. For example, in the dry season, 1A was the most dominant group at the layers 10_20 cm and 20_30 cm depth of G1 with 60.93% and 50% respectively; and group 2B accounted for the highest percentage of 53.04% at the layer 20_30 cm of G4 (Fig. 6a). 2B group was also exceptionally dominant at the layer 40_50 cm of G4 with 55.71% (Fig. 6b).

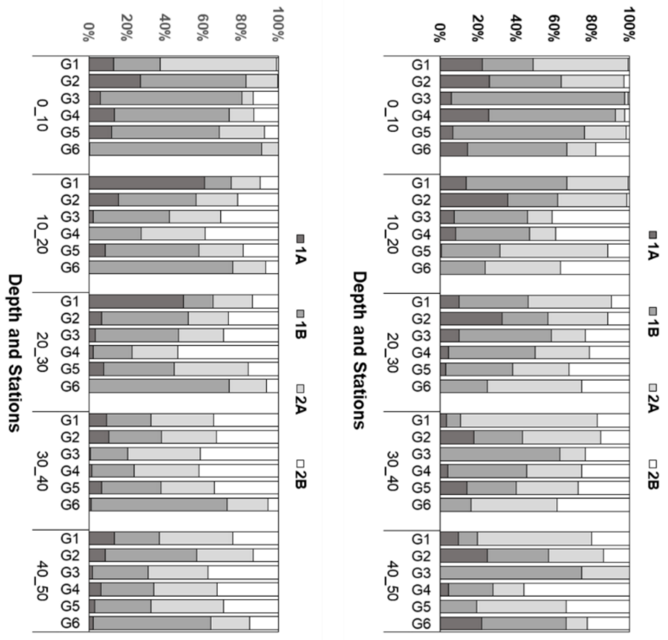
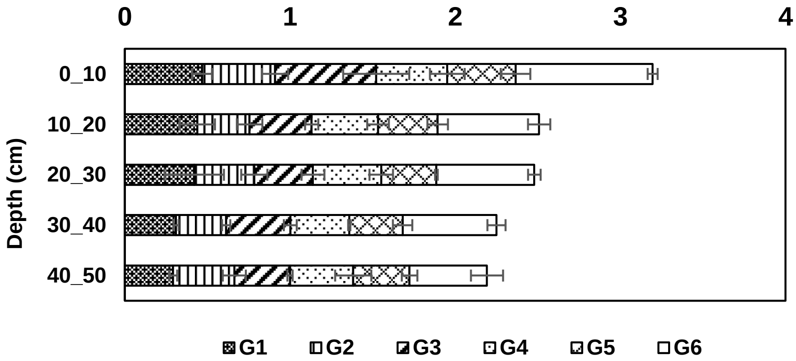


Figure 6. *Percentages of feeding guilds of nematode communities in the Ba Lai estuary in (a) the dry (left) and the rainy (right) seasons*

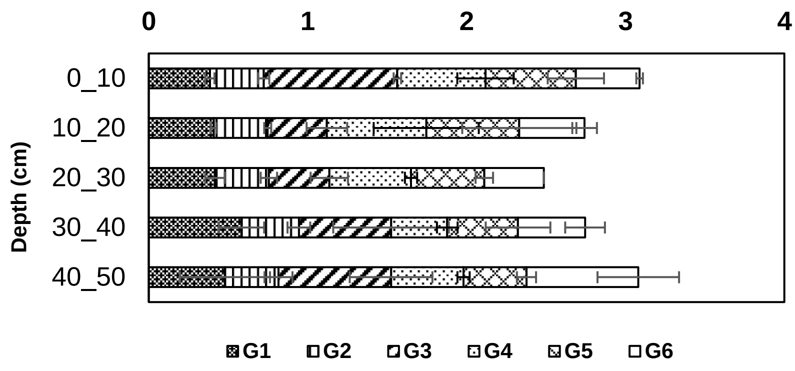
Kruskal-Wallis analysis found significantly different groups among layers, among stations for groups 1A, 1B and 2A in both dry and rainy seasons. Group 2B was only significant different between station G6 and either G1 or G3. However, the interaction effect between factors "station" and "layer" was not found for any feeding guild either in dry or rainy seasons.

Trophic diversity index

Trophic diversity indices (TD) ranged from 0.29 ± 0.02 at the layer 40_50 cm of G1 to 0.83 ± 0.03 at the top layer (0_10 cm) of G6 in the dry season (Fig. 7a). These indices gradually decreased from top layer downward the underneath layers at the most stations. Indeed, non-parametric Kruskal-Wallis test showed significant differences between the top layer and either layer 30_40 cm and 40_50 cm depth. The indices were higher in the most layer of station G6 compared to those in other stations (Fig. 7a). Kruskal-Wallis analysis also confirmed the significant differences between station G6 and each remaining stations.



(a)



(b)

Figure 7. *Trophic index of nematode communities in the Ba Lai estuary in (a) the dry and (b) the rainy seasons*

In the rainy season, these indices fluctuated between 0.34 ± 0.08 at the layer 40_50 cm of G2 to 0.84 ± 0.02 at the top layer of G3 in the rainy season (Fig. 7b). They seemed to be higher in some layer of station G2 compared to those in stations G3 and G4 (Fig. 7b). Kruskal-Wallis analysis also confirmed the significant differences between station G2 and either G3 or G4. There was no significant difference between any pair-layers about TD in this season. The interaction effect between both factor "layer" and "station" was only found in the rainy season (p: 0.04).

4. Conclusion

Therefore, our research results contribute a new insight at the first time of nematodes' communities distributes in the condition of 50 cm deep in the riverbed sediment profile. They have good ability to adapt in the condition of sediment deep, with lower densities in comparison to the fist 10 cm top layers but they are still quite high diversity. However, there were not clear diffence in other communities charactersitic such as number of species, sex structure and feeding types in 5 sediment deep profile. This study will help to understand further how free living nematodes can move and resist in the hard environment. This will be a significant evidence to consider for nematodes sampling methods and applying them for biomonitoring.

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