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MEIOBENTHOS COMMUNITIES FOR DIFFERENT MANGROVE TYPES IN CAN GIO BIOSPHERE RESERVE, VIETNAM

Can Gio mangrove is the first Biosphere Reserve of Vietnam created since 2000, with a total area of 75,740 ha. The major habitat types are rehabilitated mangrove (23,028 ha, in there Rhizophora apiculata with 96.7 %), and naturally regenerating mangrove (7,829 ha). Meiobenthic communities were investigated along Rachoc Creek. The samples were taken within a mud flat (Mud) site and 3 different types of mangrove from mouth to upper reaches of the creek: natural Avicennia (Avi) forest; natural mixed forest of Avicennia and Rhizophora (Mix) and rehabilitated Rhizophora (Rhi) forest during both dry and rainy seasons in. Meiobenthic composition mainly included nematodes, copepods, nauplii, foraminifera, polychaetes, oligochaetes, kinorhynchs, acari, ostracods, and others less abundant group (bivalves, gastropods, insect lavae, turbelaria, amphipods, nemertinea). Meiobenthic densities in Mixed forest were higher than in Avicennia forest or Rhizophora forest. Nematodes were most abundant in all stations and percentages in Mixed forest and Mudflat site were higher than in Avicennia and Rhizophora forests. Meiobenthic density in dry season was higher than in rainy season. Nematode and copepod densities increased, in the meantime nauplius and foraminifera reduced in dry season.
Key words: *Can Gio mangrove, meiofauna, nematodes, seasonal.*

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МЕЙОБЕНТОСНЫЕ СООБЩЕСТВА В МАНГРОВЫХ ЛЕСАХ РАЗЛИЧНОГО ТИПА В БИОСФЕРНОМ ЗАПОВЕДНИКЕ КАН ЗЬО, ВЬЕТНАМ

Мангровые леса Кан Зьо – это первый биосферный заповедник Вьетнама, созданный с 2000 г., общей площадью 75740 га. Основные населяющие его виды – это восстановленные мангровые деревья (23028 га, из которых 96,7 % занимают Rhizophora apiculata) и естественно возобновлённые мангровые деревья, 7829 га). Мейобентосные сообщества исследовались в зал. Ракх Ок. Образцы были взяты на илистой отмели и из трёх различных видов мангровых деревьев от устья до верхних плёсов залива: из натуральных лесов авиценнии (Avicennia); натуральных смешанных лесов авиценнии и ризофоры (Rhizophora) и восстановленных лесов ризофоры в течение как сухого сезона, так и в период сезона дождей. Мейобентосная структура в основном включает в себя нематоды, копеподы, науплии, фораминиферы, полихеты (многощетинковые черви), олигохеты (малощетинковые черви), киноринхи, клещи (Acarus), остракоды (раковинчатые) и другие менее распространенные группы (двустворчатые моллюски, гастроподы, личинки насекомых, турбеллярии, разноногие ракообразные, немертины). Плотность мейобентоса в смешанных лесах была выше, чем в лесах авиценнии и ризофоры. Плотность мейобентоса в сухой сезон была выше, чем в сезон дождей. Плотность нематод и копепод возрастала, в то же время количество науплии и фораминифер сокращалось в сухой сезон.
Ключевые слова: *мангровые леса Кан Гио, мейофауна, нематоды, сезонный.*

I. Introduction

Mangroves provide physical protection for communities in low lying coastal areas, more importantly, they are believed to play a major role in supporting tropical estuarine and coastal food web (Alongi & Christoffersen, 1992), by providing a major source of organic material and acting as nursery grounds and habitats for commercially important brackish water fish species (Robertson & Duke, 1987, Pinto & Punchihewa, 1996). Effort to rehabilitate Can Gio mangrove started since 1978. *Rhizophora apiculata* was chosen as they were fast growing tree and would be able to restore forest cover at the fastest rate, otherwise the tree with the highest commercial value. Since 1984, other tree species, such as *Intsia bijuga, Ceriops tagal, C. decandra, Lumnitzera racemosa, Xylocarpus granatum, Thespesia populnea* were planted on higher land to recover the barren land at higher altitudes (Le Duc Tuan *et al.,* 2002).

Meiobenthos are mobile, sometimes also hapto-sessile animals, smaller than macrobenthos, but large than microbenthos. The size boundaries of meiobenthos are based on the standardized mesh width of sieve 500 μm (1000 μm) as upper and 42 μm (or 63 μm) as lower limit: all fauna passing the coarse sieve, but retained by the fine sieve is considering meiobenthos (Giere, 1993). In 2000, Olafsson *et al.* published a research of influences of spring tide inundation on meiobenthos of hypersaline tropical mangrove sediment. Recently, the first study on ecology of meiofauna in mangrove of the Red Sea was presented by Khalil (2001). In Vietnam there are only few studies concerning meiobenthos including nematodes in the mangroves. These initial studies were only concentrated on identification of free-living nematodes without taking into consideration of meiobenthic community structure as well as forest structure (rehabilitated vs natural forest) and its age (Nguyen Vu Thanh & Doan Canh, 2000; Gagarin & Nguyen Van Thanh, 2004; Nguyen Vu Thanh & Gagarin, 2004; Nguyen Thi Thu *et al*., 2004, Nguyen Vu Thanh *et al*., 2005, Lai Phu Hoang *et al*., 2005 and Gagarin & Nguyen Vu Thanh, 2006).

II. Materials and methods

II. 1. Study area and location: The study was carried out in Can Gio Mangrove Biosphere Reserve, located about 65 km in the south of Ho Chi Minh City with latitude: 10 °22'14''–10 °40'09'' and longitude: 106 °46'12''–107 °00'59''.

II. 2. Sampling and data collection

Sampling times and sites/stations: Meiobenthic communities were investigated in Rachoc (RO) creek in Can Gio Forestry Park area. These creeks flow in nearly right angle direction to Dong Tranh River. Along the creek from the mouth to upper reaches, there are representatives of natural and rehabilitated mangrove forests. On the bank of Dong Tranh River and mouth of the creek there are natural forest with abundance of *Avicennia alba*, in the upper reaches there are rehabilitated forests with single species *Rhizophora apiculata* (since 1978–1982). In between two forest types there are mixed forests. These are also natural regeneration forest, including two main species *Avicennia alba*, *Rhizophora apiculata*, and others such as *Excoecaria agallocha*, *Xylocarpus* spp, *Aegyceras* spp, *Lumnitzera* spp (fig. 1).

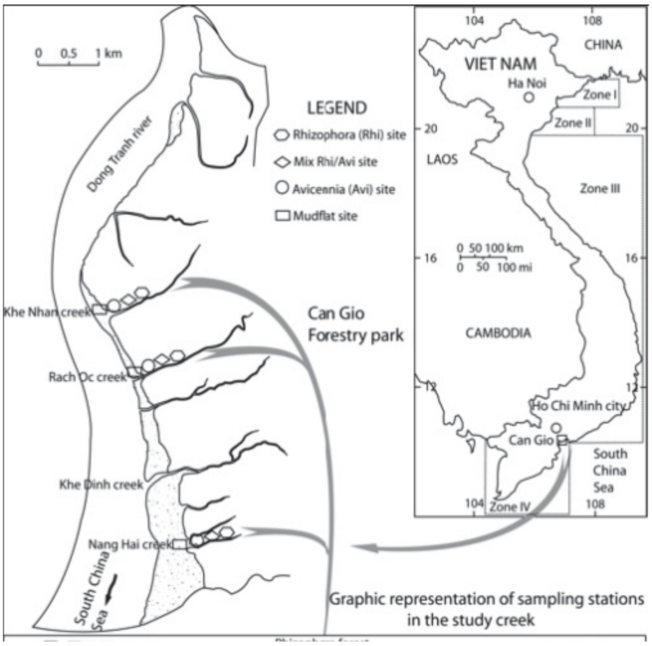

Fig. 1. Map of mangrove zones and sampling sites/stations in Can Gio Mangrove Biosphere Reserve, Ho Chi Minh City of Vietnam

Four sites were selected in range of mangrove forests including mud flat site (Mud) and three types of mangroves: natural Avicennia forest (Avi), natural mixed forest (Mix), rehabilitated Rhizophora forest (Rhi). The samples were collected in both creek banks "a" and "b" at three intertidal stations: low water tide (1), middle water tide (2), high water tide (3); and a station at shallow water subtidal zone "c". In the mud flat (Mud) of a creek, four stations were sampled. (fig. 1).

Sampling, extraction and preparation of permanent slides: Samples were taken by a hand corer of 40 cm length and inner diameter of 10 cm^2 (Ø = 3,5 cm). Sediment was collected to a depth of 10 cm at each sampling station These were preserved in 5 % neutralized formalin heated up to the point of 60–70 °C. Some hydrological parameters of the water were measured such as temperature (T), pH, salinity (NaCl), electric conductivity (EC), dissolved oxygen (DO), turbidity (Tu) at the time of the sampling procedure by the TOA (Model WQC-22A).

Decantation and Ludox extraction: The sediments were sieved through 1mm mesh size (to separate the coarse shells and plant remains from the sediment). The samples then were rinsed with tap water in a 5 litre beaker. After settlement (10 seconds) the supernatant was poured through a 63μm. The rinsing and decantation were repeated 10 times until the water became clear. After decantation, the sample consisting of a small amount of material was carefully washed bringing the extracted portion of the sediment to one side of the sieve. Then it was washed into a large beaker using Ludox (Heip *et al*., 1985). At least 3 times the sample volume of Ludox solution was added, and stirred. Then it was left to settle for at least 40 minutes. Finally, the supernatant was carefully poured through a 40μm sieve. This process was repeated 3 times. The extracted fauna was washed thoroughly with tap water and then preserved with FAA (Formalin Acid Acetic) solution in a suitable container.

Data analysis: The extracted meiobenthos were categorized into the different higher taxonomic groups (nematodes, polychaete, copepods,...) under a stereomicroscope based on works of Higgins & Thiel (1988) and Giere (1993). Univariate measures were statistically tested using SPSS 13.0 software package. Differences of meiobenthic densities and biodiversity indexes between sites/stations were tested using one-way analysis of variance (ANOVA), based on lg(x+1) transformed data.

III. Results

III.1. Abiotic factors

Temperatures changed not much from 28 °C to 30,7 °C at different stations and seasons. Dissolved oxygen index (DO) varied among stations and seasons. DO trended to reduce from Rhizophora site to Avicennia site. pH index was nearly similar at three study stations. In the dry season, pH was a little higher than in the rainy season. The result of salinity showed that salinity increased from Avicennia site to Rhizophora site. Comparison of salinity between 2 seasons, result showed that salinity increased quite much from the rainy season to the dry season. In the rainy and dry seasons, turbidity index (Tu) also increased from Avicennia site to Rhizophora site. In contract, turbidity index decreased from Avicennia site to Rhizophora site in the rainy season.

III. 2. Changes in meiobenthic abundance

III. 2. 1. Total meiobenthos

In the dry season, average meiobenthic density was 2803 ind/10 cm^2, increased drastically approximately 30 % in comparison with density in the rainy season. Increased density was main in Mixed and Mudflat sites with 3129 and 3420 ind/10 cm^2 (average density increased 43-48%) (tabl. 1). Density of meiobenthos in Mudflat site was significantly higher than in Rhizophora and Avicennia sites. On the other hand, meiobenthic density in Mixed site was higher than in Rhizophora and Avicennia sites, but not significantly different among Rhizophora, Mixed and Avicennia sites ($P>0,05$) (fig. 2,A). Among Mudflat stations, meiobenthic density in station Mud-4 was higher significantly than in Mud-2 and Mud-3 ($P<0,05$).

Table 1

Meiobenthic composition in Rachoc Creek in the dry season 2013

Order	Station	Meiobenthic composition										
		Ne	Co	Na	Po	Ol	Ki	Ac	Os	Fo	Ot	Sum
1	RO-Mud-1	3455	68	27	7	13	0	2	2	7	28	3608
2	RO-Mud-2	1823	35	20	8	5	0	2	10	10	55	1968
3	RO-Mud-3	2717	140	30	13	5	2	0	0	7	71	2985
4	RO-Mud-4	4908	113	27	3	5	3	0	7	0	50	5117
	Ave Mud	3226	89	26	8	7	1	1	5	6	6	3420
	Percentage	94,3	2,6	0,8	0,2	0,2	0	0	0,1	0,2	0,2	100
5	RO-Avi-a1	2867	70	27	7	3	7	10	3	18	57	3068
6	RO-Avi-a2	1145	70	22	0	3	3	5	13	22	47	1330
7	RO-Avi-a3	1175	103	35	8	5	13	2	3	15	65	1425
8	RO-Avi-b1	5093	85	57	7	7	10	8	5	20	55	5347
9	RO-Avi-b2	2657	102	53	8	2	12	8	10	13	76	2941
10	RO-Avi-b3	1837	153	38	3	0	15	3	12	25	56	2143
11	RO-Avi-c	412	15	3	2	0	0	5	0	13	39	489
	Ave Avi	2169	85	34	5	3	9	6	7	18	57	2392
	Percentage	90,7	3,6	1,4	0,2	0,1	0,4	0,2	0,3	0,8	2,4	100
12	RO-Mix-a1	3682	137	57	3	7	0	23	2	22	50	3982
13	RO-Mix-a2	3313	65	17	5	0	5	2	0	20	74	3500
14	RO-Mix-a3	2958	20	28	2	7	0	0	0	75	61	3151
15	RO-Mix-b1	2950	85	15	2	8	5	2	2	43	56	3168
16	RO-Mix-b2	3188	115	32	7	3	10	7	0	40	63	3465
17	RO-Mix-b3	2992	143	80	7	2	2	2	3	35	55	3320
18	RO-Mix-c	1198	48	28	0	2	0	3	0	7	33	1319
	Ave Mix	2897	88	37	4	4	3	5	1	35	56	3129
	Percentage	92,6	2,8	1,2	0,1	0,1	0,1	0,2	0	1,1	1,8	100
19	RO-Rhi-a1	2873	160	75	0	10	2	18	2	78	40	3258
20	RO-Rhi-a2	1110	132	52	0	0	0	10	0	222	33	1558
21	RO-Rhi-a3	1213	117	52	0	2	2	5	0	208	18	1616
22	RO-Rhi-b1	2972	115	28	2	7	0	8	15	40	58	3244
23	RO-Rhi-b2	1653	78	42	2	7	0	10	0	238	53	2083
24	RO-Rhi-b3	1532	113	62	0	7	0	8	2	283	16	2022
25	RO-Rhi-c	3745	57	30	3	10	2	8	0	32	68	3954
	Ave Rhi	2157	110	49	1	6	1	10	3	157	41	2534
	Percentage	85,1	4,4	1,9	0	0,2	0	0.4	0,1	6,2	1,6	100
Average		2539	94	37	4	5	4	6	4	60	51	2803
Percentage		90,6	3,3	1,3	0,1	0,2	0,1	0,2	0,1	2,1	1,8	100

Ne: Nematodes Co: Copepods Na: Nauplii Po: Polychaetes Ol: Oligochaetes
Ki: Kinorhynchs Ac: Acari Os: Ostracods Fo: Foraminifera Ot: Others

Density in Mud-1 was significantly higher than in Mud-2 ($P<0,05$), but not significantly different than in stations Mud-4 and Mud-3 ($P>0,05$) (fig. 3, A). In Avicennia site, density in Avi-a1 was significant higher than Avi-a3 ($P<0,05$). In addition, density in station Avi-b1 also was significant higher than station Avi-b2 and Avi-b3 (P<0,05). In subtidal station Avi-c, density was significantly lower than all other stations (P<0,05) (fig. 3, B). Between stations in Mixed site, there was no significant difference between intertidal stations, but subtidal station Mix-c was also significant lower than other intertidal stations (P<0,05) (fig. 3, C). In Rhizophora site, density of meiobenthos in station Rhi-a1 significant higher than station Rhi-a2 and Rhi-a3 (P<0,05), station Rhi-b1 was generally higher than stations Rhi-b2 and Rhi-b3 but no significant difference (P>0,05), one exception that meiobenthic density in the station Rhi-c was significantly higher than in the station Rhi-a2 and Rhi-a3 (P<0,05) (fig. 3, D).

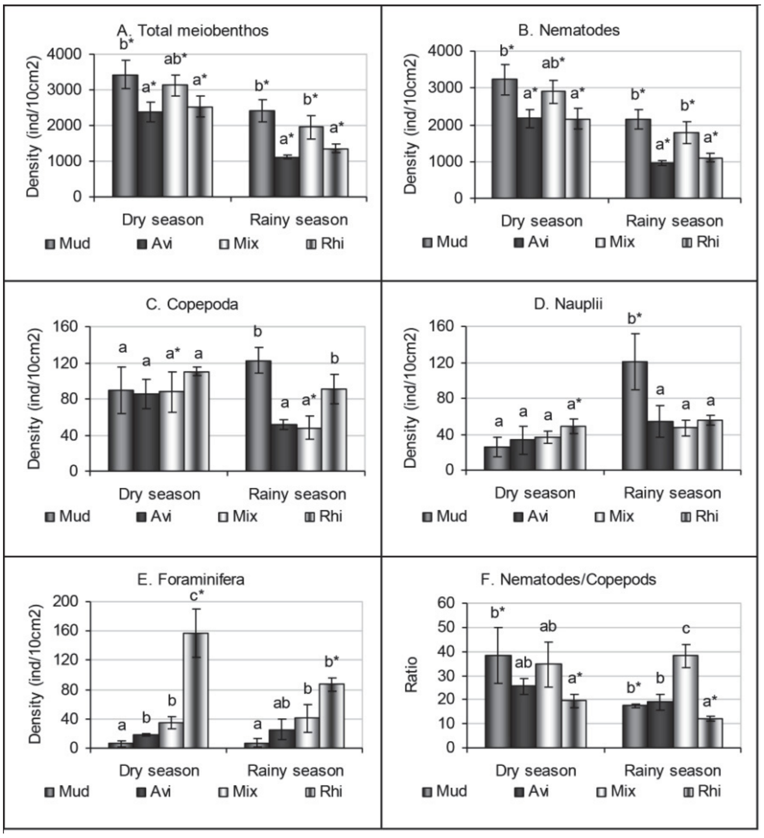

Fig. 2. Densities (mean ± sd) of meiobenthos (A), major benthic groups (B, C, D, E) and ratio Nematodes/Copepods (F) in dry and rainy seasons

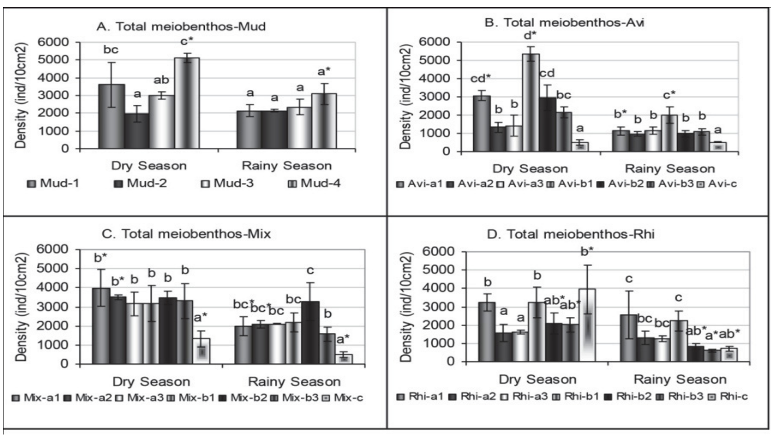

Fig. 3. Densities (mean ± sd) of total meiobenthos in the Mud (A), Avi (B), Mix (C) Rhi (D) at different stations in dry and rainy seasons

Meiobenthic density in the rainy season reduced so much to average 1630 ind/10 cm^2, reduced 42 % of 2803 ind/10 cm^2 in dry season. Density reduction with the highest percentage was 53 % of average density in dry season in Avicennia site. Result remained only average 1118 ind/10 cm2 in Avicennia site in rainy season. Assessment of meiobenthos in 4 sites in the rainy season showed densities in Mudflat and Mixed sites was significant higher than in Rhizophora and Avicennia sites (P<0,05) (fig. 2, A). Between stations in Mudflat site, meiobenthic density had no significant difference. In Avicennia site, Avi-b1 was significantly higher than all other stations, in the meantime the subtidal station Avi-c was significant lower than all others (P<0,05) (fig. 3, B). In Mixed site, between intertidal stations, Mix-b2 was significant higher than Mix-b3, and other intertidal stations were not significant difference. Change between intertidal and subtidal stations was significant (P<0,05) (fig. 3, C). In Rhizophora area, densities in Rhi-a1 and Rhi-b1 were significantly higher than in Rhi-b2 and Rhi-b3 (P<0,05), but not significant in Rhi-a2 and Rhi-a3 (P>0,05) (fig. 3, D).

Change of meiobenthic density in dry season and rainy season was significant difference among all sites. Densities of meiobenthos in dry season was significantly higher than in rainy season (P<0,05) (fig. 3, A). In Mudflat site, significant difference was in Mud-4 (P<0,05) (fig. 3, A). In other sites, significant differences were at stations Avi-a1 and Avi-b1 in Avicennia site, stations Mix-a1, Mix-a2 and Mix-c in Mixed site, stations Rhi-b2, Rhi-b3 and Rhi-c in Rhizophora site (P<0,05) (fig. 3, B; 3, C; 3, D).

III. 2. 2. Nematodes

In the dry season, result showed nematode percentage was 90,6 %, decreased in comparison with 87,2 % in the rainy season. The highest percentage of nematodes was remained in Mudflat site with 94,3 %. However, the lowest percentage was not in Avicennia site, but in Rhizophora site. On the other hand, to compare with nematodes in the rainy season, nematode density increased 35 %, reached average 2539 ind/10 cm^2, mainly in Avicennia and Mudflat sites. Density of nematodes in Mudflat site was significantly higher than in Avicennia and Rhizophora sites (P<0,05). Density in Mixed site was higher than in Rhizophora, Avicennia sites and lower than in Mudflat site, however it did not varied significantly among sites (P>0,05) (fig. 2, B).

Within stations, there was not significant difference of nematode density between stations in Mudflat site (P>0,05) (fig. 2, E). In Avicennia site, density in Avi-a1 was significantly higher than in Avi-a2 and Avi-a3. In the opposite bank of the creek, Avi-b1 was also significantly higher than Avi-b2 and Avi-b3 (P<0,05). Density in subtidal station Avi-c was significantly lower than all intertidal stations (P<0,05) (fig. 4, B). In Mixed site, there was not significantly different between intertidal stations (P>0,05) (fig. 4, C). However in subtidal station Mix-c, density was significantly lower than other intertidal stations (P<0,05). Comparison of density in Rhizophora site, density in stations Rhi-a1, Rhi-b1, Rhi-c was significantly higher than in station Rhi-a2, Rhi-a3. Density in stations Rhi-b2, Rhi-b3 was lower than in station Rhi-b1, but the difference was not significant (P>0,05) (fig. 4, D).

Nematode density was also investigated in the rainy season. Result showed that nematode percentage reduced in comparison with the dry season and equivalent with the rainy season, was 87,2 % of the total meiobenthos. But percentages in different site forests were changed. Percentage was the highest in Mixed site and lowest in Rhizophora site. Nematode density reduced drastically about 44 % to compare with the dry season. Average nematode density was only 1421 ind/10 cm2 in the rainy season. Between 4 sites, densities in Mudflat and Mixed sites were significantly higher than in Rhizophora and Avicennia sites (P<0,05) (fig. 2, B). In Mudflat site, there was no significant different between stations (P>0,05) (fig. 4, A). In Avicennia site, nematode density in Avi-b1 was significantly higher than all others (P<0,05), Avi-c was significantly lower than almost of them except Avi-a2. Between stations in Mixed site, subtidal station Mix-c was significantly lower than all other stations, Mix-b2 was not significantly different from Mix-a1, Mix-a2, Mix-a3, Mix-b1 (P>0,05), but significantly different from station Mix-b3 (P<0,05) (fig. 4, C). In Rhizophora site, Rhi-a1 and Rhi-b1 were significantly higher than Rhi-b2, Rhi-b3 and Rhi-c (P<0,05), but not significantly different from Rhi-a2 and Rhi-a3 (P>0,05) (fig. 4, D).

Between the dry season and the rainy season in, difference of nematode density was significant in all 4 sites (P<0,05) (fig. 2, B). In Mudflat site, difference between 2 seasons was significant at station Mud-4. In Avicennia site, significant difference between 2 seasons was at stations Avi-a1 and Avi-b1. In Mixed site, difference was significant at Mix-a2, Mix-b1 and Mix-c. In Rhizophora site, difference between dry and rainy seasons was significant at stations Rhi-b3 and Rhi-c (P<0,05) (fig. 4, A; 4, B; 4 C; 4, D).

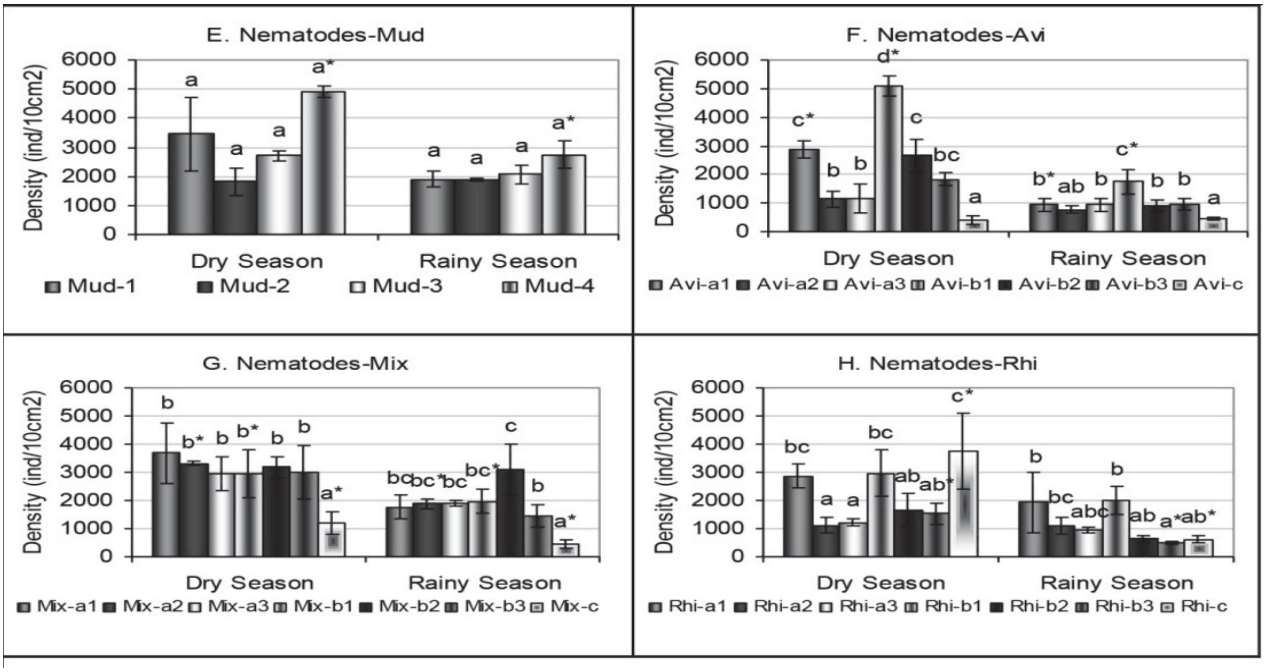

Fig. 4. Densities (mean ± sd) of total meiobenthos in the Mud (A), Avi (B), Mix (C) Rhi (D) and nematodes in the Mud (E), Avi (F), Mix (G), Rhi (H) at different stations in dry and rainy seasons

III. 2. 3. Copepods and nauplii

In the dry season, result in Rachoc Creek showed copepods increased fairly and to be second abundance with average density 94 ind/10 cm^2 and percentage 3,3 % of total meiobenthos. Copepods were the highest density in Rhizophora site (110 ind/10 cm2) and also the highest in percentage (4,4 % of total meiobenthos). Comparison of copepod density between 4 sites, there was not significant difference in dry season (P>0,05) (fig. 2,C).

Nauplii were the 4^{th} abundance with average 1.3% of total meiobenthos. Nauplii density was the highest abundance 49 ind/10 cm^2 (1,9 % of total meiobenthos) in Rhizophora site. However there was not significantly different among different sites (P>0,05) (fig. 2,D).

Copepod density in Rachoc Creek in the rainy season remained in the second abundance, but density reduced to average 73 ind/10 cm^2. However, copepod percentage remained at level 4,5 % of total investigated meiobenthos. Among them, density was the highest in area of the Mudflat site with average 122 ind/10 cm^2. Densities in Mudflat and Rhizophora sites were significantly higher than in Avicennia and Rhizophora sites (P<0,05) (fig. 3, C). In rainy season, nauplii were the third abundant group with 63 ind/10 cm^2, occupied 3,9 % of total meiobenthos. The highest nauplii density was 121 ind/10 cm^2 (5 %) in Mudflat site. In addition, density in Mudflat site was significantly higher than in other sites (P<0,05) (fig. 3, D). Difference of copepod densities between dry and rainy seasons was significant in Mixed site only (P<0,05) (fig. 3, C). On the other hand, nauplii density had a significant difference in Mudflat site (P<0,05) (fig. 3, D).

III. 2. 4. Other less abundant groups

Some other groups as polychaetes, oligochaetes, acari and ostracods had a less abundance usually less than 1 % of total meiobenthos, but also showed their variations in different types of mangrove. In general, polychaete density reduced from Mudflat site to Rhizophora site in dry season. Difference between Rhizophora site and other sites was significant (P<0,05). In rainy season, oligochaete density changed a little, exception in Rhizophora site, density was significant higher than in dry season (P<0,05). However there was no significant difference among 4 sites in rainy season (P>0,05) (fig. 5, A).

Oligochaete densities in dry season changed among 4 sites but these were not significantly different (P>0.05). The same result was in rainy season. Comparison between 2 seasons, there was also no significant difference about density of oligochaetes (P>0,05) (fig. 5, B).

Ostracods in dry season showed densities in Mudflat and Avicennia sites were significantly higher than in Mixed site (P<0,05). But in rainy season, ostracod density reduced in all sites and there was no significant difference (P>0,05). Comparison in 2 seasons, ostracod densities in Mudflat, Avicennia and Rhizophora sites in dry season were significantly higher than in same sites in rainy season (P<0,05). In Mixed site change between 2 seasons was not significant (P>0,05) (fig. 5, D).

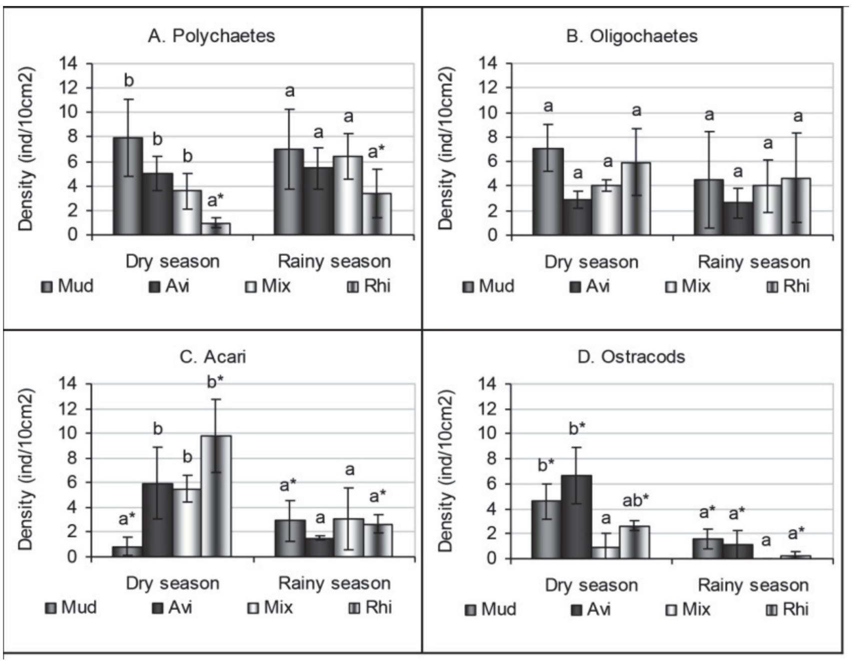

Fig. 5. Densities (mean ± sd) of less abundant groups oligochaetes (A), Polichaetes (B), Acari (C) and Ostracods (D) in dry and rainy seasons

III. 3. Correlation with abiotic factors

The Table 2 showed a significant positive correlation between total meiobenthos, nematodes, copepods with water temperature (T°C) (P<0,05; P<0,01)). N/C ratio had a positive correlation with temperature also (P<0,05). On the other hand, total meiobenthos and nematode density were significant positive correlation with pH (P<0,05). In addition, polychaetes had significant positive correlation with oxygen in water (DO) (P<0,01). The abundances of meiobenthos and major meiobenthic groups were not significant correlation with salinity (NaCl) and turbidity (Tu). Other meiobenthic groups as nauplii, foraminifera, oligochaetes did not showed a significant correlation with temperature, oxygen in water, pH, salinity, and turbidity in this study.

Table 2

Correlation (r-value) of the abundance of total meiobenthos and meiobenthic groups, and the nematode/copepod ratio (N/C) with some physical variables at the sampling stations

Variable	T (°C)	DO (mg/l)	pH	NaCl (‰)	Tu (mg/l)
Total meiobenthos	0,964**	-0,238	0,833*	0,601	-0,259
Nematodes	0,962**	-0,233	0,827*	0,592	-0,244
Copepods	0,847*	-0,363	0,749	0.638	-0,341
Nauplii	0,625	0,041	0,378	0,206	-0,007
Foraminifera	0,426	0,513	0,256	-0,103	-0,047
Polychaetes	-0,332	0,942**	-0,556	-0,807	0,414
Oligochaetes	0,388	0,636	0,014	-0,370	0,583
N/C ratio	0,892*	0,038	0,733	0,361	-0,020
Values with one star (*) are significant at P<0.05 Values with two stars (**) are significant at P<0,01					

IV. Discussion

Composition and density of total meiobenthos

In a study meiobenthos in Malaysian mangrove, the result of Sasekumar (1994) seemed to be approximate with the result of Chinnadurai & Fernando (2007) when meiobenthic densities were 1109 ind/10 cm^2 in *Avicennia*, 583 ind/10 cm^2 in *Rhizophora*, and lowest 407 ind/10 cm^2 in *Bruguiera* forest. Present study shows the similarity with Vanhove *et al.* (1992). Based on all the samples taken from Rachoc Creek, meiobenthos densities were 1755 ind/10 cm^2 in *Avicennia*, 2543 ind/10 cm^2 in mixed forest of *Avicennia* and *Rhizophora*, 1947 ind/10 cm^2 in *Rhizophora*. It seems that *Rhizophora* in Can Gio mangrove may be more attractive to meiobenthos than *Avicennia*. In addition, the highest densities of meiobenthos in mixed forest of *Avicennia* and *Rhizophora* suggested that mangroves with multi-plant species can create a habitat that more appropriate for development of meiobenthos than mono plant species mangroves.

Abundance of major meiobenthic groups

Normally, nematodes occupied over 80 % of total meiobenthos, sometimes up till 95–99 % Vanhove *et al.,* 1992, Olafsson (1995, 2000); Khalil, 2001; Netto & Gallucci, 2003; Armenteros *et al.,* 2006; Chinnadurai & Fernando, 2007). Nematodes seem to be less important in a study from Australian mangroves with 27–31 % (Alongi, 1987a), and in Cuba mangroves with percentages 35-61% (Lalana-Rueda & Gosselck, 1986). Nematodes are also recorded to be the most abundant taxa in the present study. The average nematode percentages were from 81,1–94,3 %. Among the three types of mangroves in Rachoc Creek, the nematode percentages and densities were generally higher in mud flat site and mixed forest site than *Avicennia* and *Rhizophora* sites. Between the two seasons, Rachoc Creek showed that nematode percentages and densities in dry season were higher than in rainy season. Heavy rains could disturb sediment surface and influence to ratio and density of meiobenthos as well as nematodes. Dry season in Can Gio created a more appropriate environmental condition for nematode development than rainy season. Our result showed that copepods were the second abundance in most study stations. Copeppod percentages showed gradual change from *Rhizophora* sites (6,7 %), to mixed forest *Avicennia* site and *Rhizophora* sites (2,5 %). Among three types of forest, copepod percentages were higher in *Avicennia* and *Rhizophora* sites than in Mixed forest site. The difference was clearer in rainy season. The reason can be from forest structure. Plantation covers and number of tree in *Avicennia* and *Rhizophora* forests are much smaller than mixed forest. These could influence to sediment surface of forest types and subsequently change copepod distribution. Vanhove *et al.* (1992) noted low copepod percentages in silty/muddy sediment suggested this taxon is more related to coarser grain texture. In addition, copepods and epsilonematid nematodes do not withstand high silt fraction. Copepods are report as one of the most sensitive taxon is sensitive for oxygen decrease and usually restricted inoccurrence in oxic condition (Coull & Chandler, 1992).

In present study, nematode and copepod densities possitively correlated with temperature. Nematode density also possitive correlated with pH and polichaetes possitively correlated with dissolved oxygen. Other meiobenthic group had no correlation with abiotic factors. However, Ólafsson (1995) pointed that lack of significant correlations between environmental factors and meiofauna taxa does not mean that these factors were not contributing to the density variations observed. They may indeed control the population densities of the major taxa differently and in different proportion at the various stations. An experiment approach when the factor of interest can be manipulated while fluctuations in all other variables kept to minimum may be more appropriate than simple correlation analyses, in evaluating the importance of community control mechanisms.

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