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Meiobenthos in Nha Trang Bay of the South China Sea (Vietnam)

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Abstract – The distribution of the taxonomical composition and the density of meiobenthos depending on the sediment type has been studied in bottom sediments of Nha Trang Bay. The maximal population density and the taxonomical diversity were observed in the silted coarse and heterogeneous sand (1031.4±419.7 ind. 10 cm^{-2}), whereas the minimal level of density and diversity (588.1±152.5 ind. 10 cm^{-2}) was in the coarse and heterogeneous sand with shell debris and corals. The correlation between the median diameter of sediment particles and population density of meiobenthos has been revealed ($r=0.82$, $p<0.05$). In bottom sediments of Nha Trang Bay, twenty six taxonomic groups of meiobenthos were observed. Nematodes dominated in all sediment types. Representatives of four orders, twenty eight families and ninety seven genera of marine nematodes were identified. The vertical distribution of meiobenthos in different sediment types was considered. A sediment column (10 cm height) was sectioned by five 2 cm portions. In the last layer (8-10 cm) the most number of meiobenthic groups was found in sandy sediments. In the lower layers of silt sediments, only nematodes were found.

Key words – Density of meiobenthos, sediment type, nematodes, horizontal and vertical distribution

1. Introduction

There have been some studies, conducted in South China Sea, which deal with the composition and distribution of subtidal and tidal assemblages of macrobenthos (Crosse and Fischer 1863; Dawydoff 1952; Gurjanova and Chang Hiu Phuong 1972; Lukin *et al.* 1988). However, attention has not been given to research on the meiofauna in benthic communities, even though, as it is known, the meiobenthos is an important component of marine ecosystems (McIntayr 1969; Heip *et al.* 1985; Higgins and Thiel 1988; Galtsova 1991; Riemann and Helmke 2002). There only a few studies on the meiobenthos in South China Sea, which are mainly dealing with the taxonomy of separate groups – foraminiferans (Waller 1960; Stshedrina 1972) and ostracods (Chavtur 1989).

Recently, numerous papers of Vietnamese authors have appeared dealing with studies of composition and distribution of free-living marine nematodes in Ha Long Bay and in the coastal zone of central Vietnam (Nguyen Vu Thanh *et al.* 2002; Nguyen Vu Thanh and Nguyen Dinh Tu 2003), but research work on meiobenthos in Nha Trang Bay has not been performed yet. The study of the groups of higher taxonomical order will lead us to new insights on the importance of these groups in their ecosystems.

The aim of this work is to study the taxonomic composition and the horizontal and vertical distribution of the density of meiobenthos in various sediment types.

2. Materials and Methods

Meiobenthos samples from Nha Trang Bay were collected in October 2003 (stations 1-20), and some samples were taken near the islands, on reefs, in bottom sediments between corals (stations 15-20) (Fig. 1). Samples were collected by a SCUBA diver using a 10 cm^2 tube (four samples on every station). In order to investigate the vertical distribution of animals in sediments, a tube of three cm diameter was used (two samples were taken). A sediment column of 10 cm in height was sectioned by

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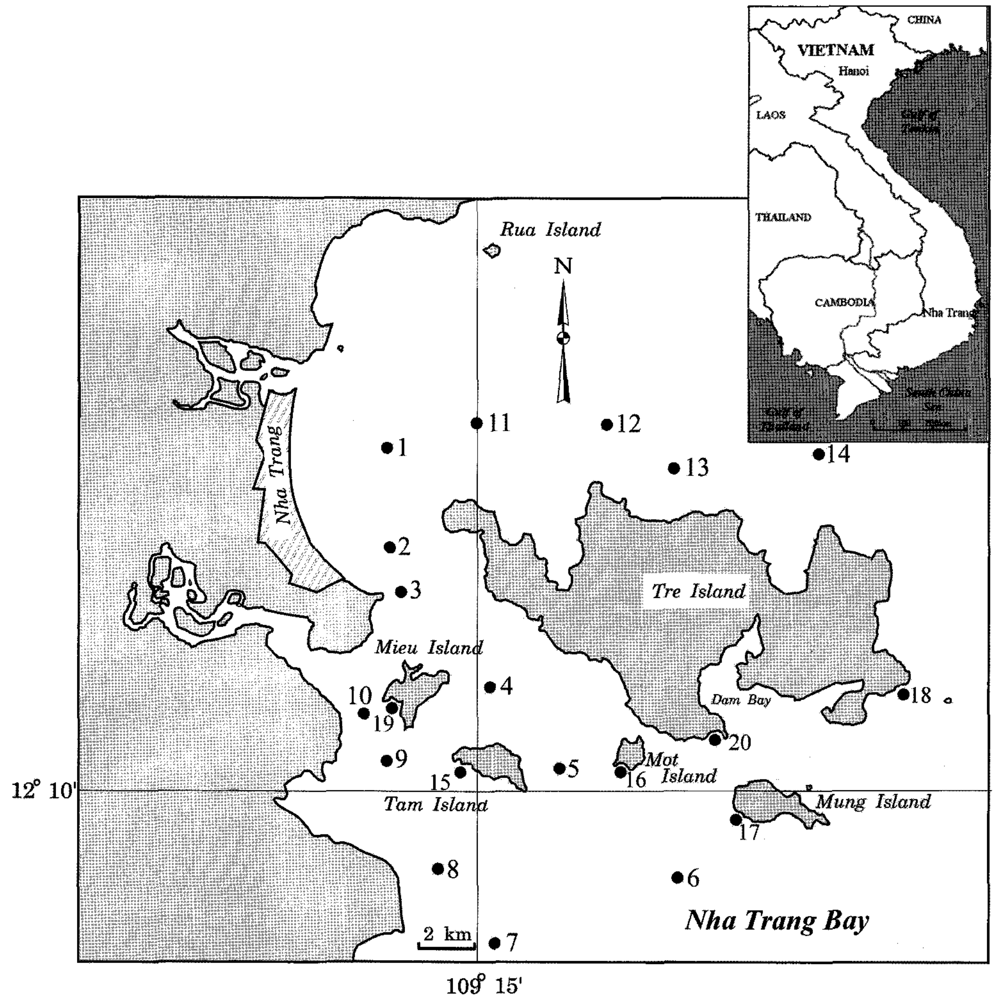


Fig. 1. A schematic map of sampling stations in Nha Trang Bay (South China Sea, Vietnam).

Table 1. Granulometric composition of bottom sediments (%) in Nha Trahg Bay

Station	Sediment particle size, mm									Type of bottom sediments
	>10	7-10	5-7	3-5	2-3	1-2	0.5-1	0.25-0.5	<0.25	
						Nha Trang Bay				
1, 11-14	-	-	-	-	10.6-29.0	44.9-61.1	9.9-19.3	4.0-12.4	2.3-17.9	I
10			0.1	0.1	12.1	48.1	0.2	3.3	35.7	II
7-9	-	-	0-0.4	0-0.2	0-0.8	0.1-3.1	0.5-7.1	8.6-26.8	68.9-90.2	III
2-6	-	0.68	-	0.39	0.08-0.58	0.03-0.13	0.41-1.26	0.13-10.24	87.04-99.39	IV
						Reefs				
19	0.9	0.44-	0.15	0.53	1.67	5.3	12.28	36.75	41.98	V
15 - 18					12.72-27.94	14.53-23.14	7.32-16.87	16.21-30.95	14.13-32.56	VI
20					10.97	17.78	2.45	9.33	60.17	VII

Note: I–coarse-grained sand; II–silted coarse and heterogeneous sand; III–silted fine-grained sand; IV–silt of different structure; V–silted pebble, heterogeneous sand and shell debris; VI–slightly silted coarse and heterogeneous sand with shell debris and corals; VII–heavily silted heterogeneous sand.

five 2 cm levels and each part of each sample was examined separately. In total, ninety two meiobenthos samples were collected and treated. The samples were washed through 1 mm and 63 µm sieves and fixed by 4% formalin and stained with "Rose Bengal". All animals were taken into account, except for foraminifers.

During the sampling period the temperature of bottom water varied from 26°C to 29°C, and salinity – from 29 to 32 PSU. The depth of stations varied from 11 to 39 m, on reefs it was from 6 to 10 m. Bottom sediments were classified according to the traditional nomenclature (Parsons *et al.* 1982). In total, seven sediment types were detected (Table 1).

3. Results

Horizontal distribution and taxonomic composition of meiobenthos in the bay

The density of meiobenthos is distributed non-uniformly in the Bay (Fig. 2). The highest density of meiobenthos (1406.7±455.6 ind. 10 cm^{-2}) was registered in silted coarse and heterogeneous sand (sediment type II, station 10, depth 11 m) (Fig. 3). In the northern part of the Bay with coarse sand (sediment type I, stations 1, 11–14) the depth varied from 15 to 32 m, and the meiobenthos density was 1098.9±359.3 ind. 10 cm^{-2} (Fig. 3). In the southern part of the Bay with the silted fine sand (sediment type III, station 7–9), with a depth range from 13 to 22 m, the meiobenthos density was 1031.4±419.7 ind. 10 cm^{-2} (Fig. 3). In the central part of the Bay, sediments consist of silt of different structure (sediment type IV, station 2–6) in which the depth ranged from 19 to 39 m, the density of meiobenthos was the lowest –545.3±235.9 ind. 10 cm^{-2} (Fig. 3).

Negative correlation between the density of meiofauna on different sediment types and the vertical depth was only slightly expressed (Pearson's correlation coefficient is -0.34, p=0.05).

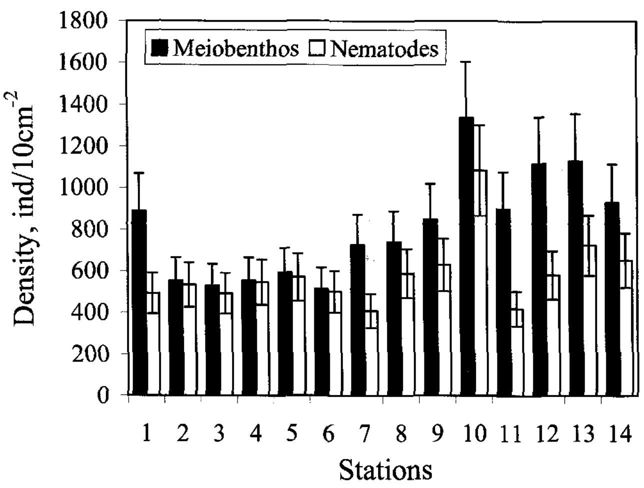


Fig. 2. Abundance of meiobenthos and nematodes at stations in the bay.

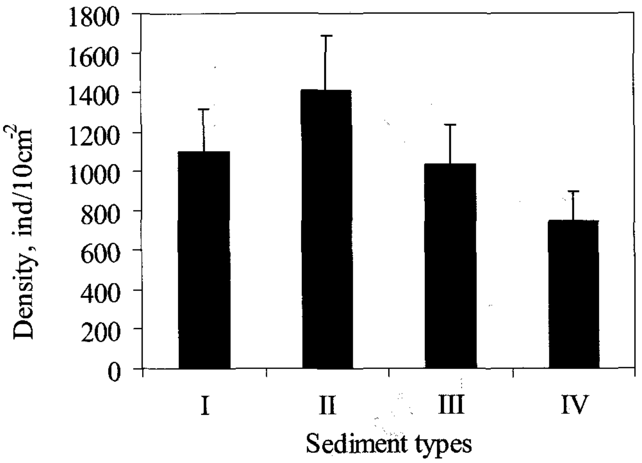


Fig. 3. Abundance of meiobenthos at different sediment types in the bay.

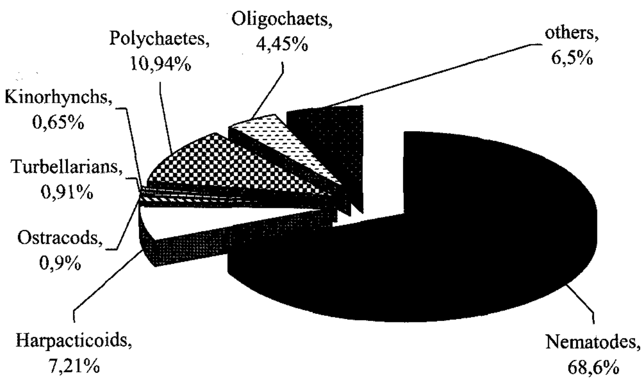


Fig. 4. The percentage of major meiobenthic groups at stations in the bay. "Others" included such groups: Nemertines, Bivalves, Gastropods, Isopodes, Holothurians, Sipunculids, Amphipods, Caprellids, Cumaceans, Pantopods.

Taxonomical composition of meiobenthos was presented by twenty three groups at higher taxonomic levels (class, order). Marine nematodes were the dominant group, accounting for 68.6% of total meiofauna (Fig. 4). Representatives of three orders, twenty three families and ninety one genera were identified (Table 3).

The high taxonomic diversity of meiobenthos was found in coarse sand (sediment type I – II), where twenty one groups of animals were found. Nematodes dominated in eumeiobenthos, and harpacticoids occupied the second place. Polychaetes dominated in temporary meiobenthos (Fig. 5). In sediment type III, seven meiobenthos groups were found. In eumeiobenthos, nematodes dominated whereas in temporary meiobenthos, polychaetes and oligochaetes did. In sediment type IV, the taxonomic composition was

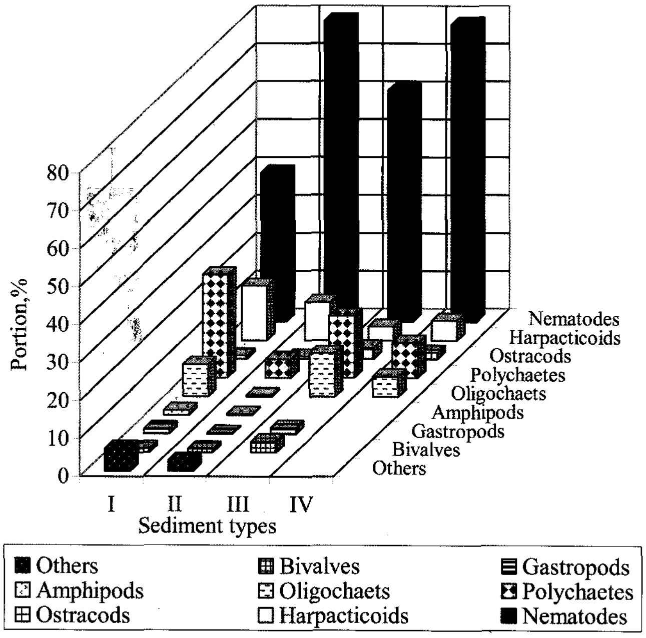


Fig. 5. The proportions (%) of meiobenthic groups at different sediment types in the bay. Others groups: Turbellarians, Halacaroids, Sipunculids, Kinorhynchs, Cumaceans, Nemertines, Pantopods, Isopods, Holothurians.

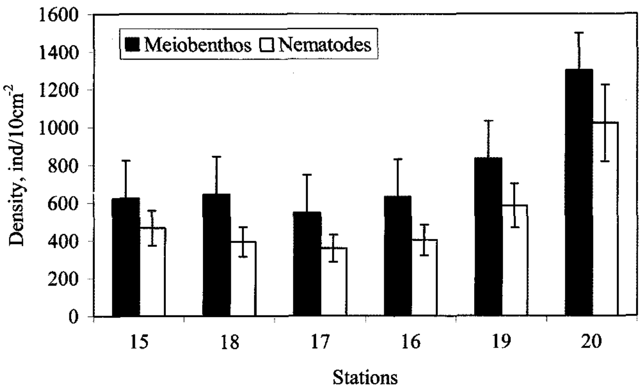


Fig. 6. Abundance of meiobenthos and nematodes at reefs stations.

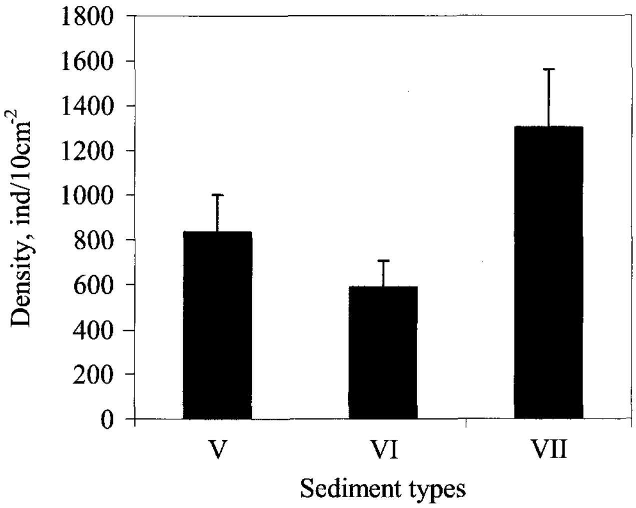


Fig. 7. Abundance of meiobenthos at different sediment types on the reefs.

poor and included only nematodes (Fig. 5).

Thus, one can conclude that, in general, the higher density and taxonomic diversity of meiobenthos in the Bay was marked in coarse sands.

Horizontal distribution and taxonomic composition of meiobenthos at the reefs

The density of meiobenthos was uneven near the islands, in the bottom sediments of coral reefs and in the Bay itself (Fig. 6). Sediments on Mieu Island reef (station 19) consist of silted pebble, heterogeneous sand and shell debris (sediment type V). Mieu Island is the closest to the coast. Its reef is in a depressed state as waste discharge and a small river affect the area. Bottom water salinity near the reef was the lowest, and made less than 29 PSU. The density of meiobenthos was 833.1±227.4 ind. 10 cm^{-2} (Fig. 7). Sediments of reefs at Tam, Mot, and Mung Islands and to the east of Tre Island (stations 15–18) consist of slightly silted coarse and heterogeneous sand with shell debris and corals (sediment type VI). These reefs are fairly in order. The density of meiobenthos (588.1±152.5 ind. 10 cm^{-2}) was lower than on Mieu Island reef (Fig. 7). On a reef located south of Tre Island (station 20), sediments are heavily silted heterogeneous sand (VII sediment type). The reef is depressed, and the majority of the corals are dead. The reef is greatly affected by a lobster culture farm, located behind the nearest cape. The meiobenthos density here was the highest – 1299.8±538.4 ind. 10 cm^{-2} (Fig. 7).

Twenty six taxonomic groups of meiobenthos were found in bottom sediments of coral reefs (Table 2). As in the Bay, nematodes dominated in meiobenthos (Fig. 8). There, representatives of three orders, twenty families and forty seven genera of marine nematodes were identified (Table 3). Taxonomic composition of Mieu Island reef included sixteen meiobenthos groups, where nematodes dominated and harpacticoids and polychaetes occupied the second place (Fig. 9). Taxonomic composition of the reefs near four islands – Tam Island, Mot Island, Mung Island and to the east of Tre Island – was presented by the

Table 2. Taxonomic composition and population density (ind. 10 cm^{-2}) of meiobenthos in bottom sediments of Nha Trang Bay and its reefs

Taxa	Bay	Reefs
	Nm_N	Nm_N
Nematodes	636.3±288	537.1±55.6
Harpacticoids	57.7±8.6	138.5±49.3
Ostracods	9.38±4.0	12.5±1.3
Turbellarians	9.7±4.9	10.0±1.1
Halacaroids	6.2±2.3	5.2±1.5
Kinorhynchs	6.9±3.2	10.3±4.0
Gastrotrichs	-	22.2±1.2
Polychaåts	148.8±15.5	104.7±38.9
Oligochaets	64.8±23.1	44.3±9.1
Nemertines	8.3±5.8	9.7±1.8
Bivalves	12.5±6.4	15.9±1.8
Gastropods	13.3±6.9	8.3±2.1
Isopods	10.4±2.8	2.7±1.6
Holothurians	7.9±3.8	7.6±3.2
Sipunculids	13.3±4.9	4.8±1.8
Amphipods	8.3±3.7	8.8±2.6
Caprellids	6.3±1.8	4.2±2.0
Insects	-	9.3±2.3
Cumaceans	6.2±1.8	2.6±0.9
Chironomids	-	1.2±0.8
Total meiobenthos	1034.6±450.0	944.3±303.7

Note: N–population density, ind. 10 cm^{-2}; m_N – standard deviation. Representatives of Ophiuroids, Hydrozoids, Priapulids, Pantopods, Tanaidaceans and Tardigrads taxonomic groups were not included into the Table, since they were met as isolated instances.

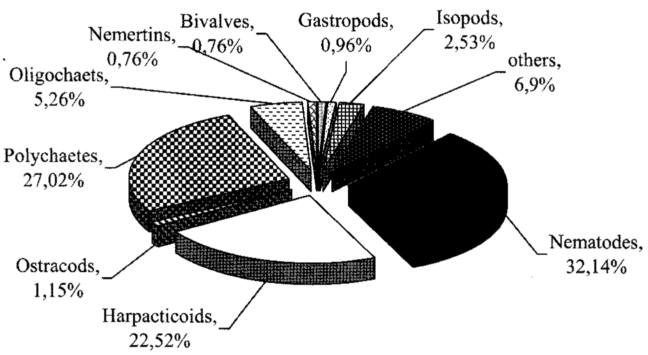


Fig. 8. The percentage of major meiobenthic groups at reefs stations. "Others" included such groups: Turbellarians, Halacaroids, Kinorhynchs, Gastrotrichs, Holothurias, Sipunculids, Amphipods, Caprellids, Insects, Cumaceans, Pantopods, Cumaceans.

highest number of groups, twenty four. Among them, nematodes were dominant. In temporary meiobenthos, polychaetes, oligochaetes and isopods were dominant groups (Fig. 9). Taxonomic composition of meiobenthos in reef sediments southward of Tre Island was poor and included only five groups, and nematodes dominated (Fig. 9).

Thus, the higher density of meiobenthos was registered in reefs sediments in heavily silted heterogeneous sand, and greatest taxonomic diversity in coarse sands.

Vertical distribution of meiobenthos

The vertical distribution of meiofauna in the sediments was studied on five sediment types (Fig. 10). In sediment type I, the greatest density of nematodes (700 ind. 10 cm^{-2}) was observed in the upper layer (0-2 cm). Then, the number of animals gradually declined with depth and in the 8-10 cm layer the density was 270 ind. 10 cm^{-2}. In the last layer only six taxonomic groups were found: nematodes, polychaetes, oligochaetes, kinorhynchs, bivalves and ostracods (Fig. 10). In sediment types II and III, the distribution of animals was similar. The maximum density of meiobenthos (300 ind. 10 cm^{-2}) was observed in 0-2 cm layer, whereas in the second layer (2-4cm) the meiobenthos density was 150 ind. 10 cm^{-2}. The minimum density (90 ind. 10 cm^{-2}) was registered in 8-10 cm layer, where only polychaetes

Table 3. Taxonomic composition of nematodes in Nha Trang Bay

Taxa	Bay	Reefs	Taxa	Bay	Reefs
I. Order Enoplida			**Family Chromadoridae**		
Suborder Enoplina			30. *Chomadora* sp.	+	-
Family Enoplidae			31. *Dichromadora* sp.	+	-
1. *Enoplus* sp.	+	-	32. *Euchromadora* sp.	+	+
Family Thoracostomopsidae			33. *Graphonema* sp.$_1$	+	+
2. *Enoploides* sp.	+	+	34. *Graphonema* sp.$_2$	-	+
3. *Enoplolaimus* sp.	+	-	35. *Hypodontolaimus* sp.	+	-
4. *Paramesacanthion* sp.	+	-	36. *Panduripharynx* sp.	+	+
5. *Trileptium* sp.	+	+	37. *Parapinnanema* sp.	+	+
Family Anoplostomatidae			38. *Spilophorella* sp.	+	+
6. *Anoplostoma* sp.	-	+	**Family Comesomatidae**		
Family Phanodermatidae			39. *Actarjania* sp.	+	+
7. *Crenopharinx* sp.	+	-	40. *Cervonema* sp.	+	+
Family Anticomidae			41. *Comesoma* sp.	+	+
8. *Anticoma* sp.	+	+	42. *Comesomoides* sp.	+	-
9. *Paracticoma* sp.	+	-	43. *Dorylaimopsis* sp.	+	-
Suborder Ironina			44. *Laimella* sp.	+	+
Family Ironidae			45. *Paracomesoma* sp.	+	-
10. *Syringolaimus* sp.	-	+	46. *Sabatiera* sp.$_1$	+	+
Family Oxistominidae			47. *Sabatiera* sp.$_2$	+	-
11. *Halalaimus* sp.	+	-	48. *Setosabatieria* sp.	+	+
12. *Litinium* sp.	+	-	49. *Vasostoma* sp.	+	-
13. *Oxystomina* sp.$_1$	+	-	**Family Cyatholaimidae**		
14. *Oxystomina* sp.$_2$	+	-	50. *Marylynnia* sp.	+	-
Family Oncholamidae			51. *Minolaimus* sp.	+	-
15. *Adoncholaimus* sp.	+	+	52. *Paracanthonchus* sp.$_1$	+	+
16. *Filoncholaimus* sp.	+	-	53. *Paracanthonchus* sp.$_2$	+	-
17. *Meyersia* sp.	+	-	54. *Pomponema* sp.$_1$	+	+
18. *Viscosia* sp.$_1$	+	+	55. *Pomponema* sp$_2$	+	-
19. *Viscosia* sp.$_2$	+	-	56. *Pomponema* sp$_3$	-	+
Family Enchelidiidae			**Family Selachinematidae**		
20. *Bathyeurystomina* sp.	+	+	57. *Cheironchus* sp.	+	-
21. *Calyptronema* sp.$_1$	+	+	58. *Choanolaimus* sp.	+	-
22. *Calyptronema* sp.$_2$	+	-	59. *Gammanema* sp.	+	-
23. *Eurystomina* sp.	+	+	60. *Halichoanolaimus* sp.	+	+
24. *Ledovitia* sp.	+	-	61. *Latronema* sp.	+	-
25. *Polygastrophora* sp.	+	-	62. *Synonchiella* sp.	+	-
26. *Symplocostoma* sp.	-	+	**Family Desmodoridae**		
Suborder Tripyloidina			63. *Catanema* sp.	+	-
Family Tripyloididae			64. *Chromaspirina* sp.$_1$	+	+
27. *Bathylaimus* sp.	+	+	65. *Chromaspirina* sp.$_2$	+	-
Family Rhabdodemaniidae			**Family Desmodoridae**		
28. *Rhabdodemania* sp.	+	-	66. *Echinodesmodora* sp.	+	+
II. Order Trefusiida			67. *Desmodora* sp.	+	+
Family Trefusiidae			68. *Leptonemella* sp.	+	+
29. *Trefusia* sp.	-	+	69. *Metachromadora* sp.	+	+
III. Order Chromadorida			70. *Parallelocoilas* sp.	+	+
Suborder Chromadorina			71. *Pseudonchus* sp.	+	-

(**Table 3.** Continued)

Taxa	Bay	Reefs	Taxa	Bay	Reefs
72. *Onyx* sp.,$_1$	+	+	92. *Steineria* sp.	+	-
73. *Onyx* sp.,$_2$	+	-	93. *Xyala* sp.	+	-
74. *Spirinia* sp.	+	+	Family Sphaerolaimidae		
Family Microlaimidae			94. *Sphaerolamus* sp.	+	-
75. *Bolbolaimus* sp.	+	-	Family Siphonolaimidae		
76. *Paramicrolaimus* sp.	+	-	95. *Siphonolaimus* sp.	-	+
Family Monoposthidae			Suborder Linchomoeina	-	+
77. *Monoposthia* sp.	+	-	Family Linchomoeidae		
Suborder Leptolaimina			96. *Anticyathus* sp.	+	+
Family Ceramonematidae			97. *Desmolaimus* sp.	+	-
78. *Pselionema* sp.	-	+	98. *Didelta* sp.	-	+
Family Desmoscolecidae			99. *Disconema* sp.	-	+
79. *Desmoscolex* sp.	+	-	100. *Eumorpholaimus* sp.	+	+
80. *Paraudasmoscolex* sp.	+	-	101. *Megadesmolaimus* sp.	+	+
81. *Tricoma* sp.	+	+	102. *Metalinchomoeus* sp.	+	-
IV. Order Monhysterida			103. *Paralinchomoeus* sp.	+	-
Family Xyalidae			104. *Terschillingia* sp.,$_1$	+	-
82. *Cobbia* sp.	+	-	105. *Terschillingia* sp.,$_2$	+	-
83. *Daptonema* sp. $_1$	+	+	Family Axonolaimidae		
84. *Daptonema* sp. $_2$	+	-	106. *Axonolaimus* sp.,$_1$	+	+
85. *Daptonema* sp. $_3$	+	-	107. *Axonolaimus* sp.,$_2$	-	+
86. *Elzalia* sp.	+	-	108. *Odontophora* sp.	-	+
87. *Gonionchus* sp.	+	+	109. *Parodontophora* sp.,$_1$	+	+
88. *Linhystera* sp.	+	-	110. *Parodontophora* sp.,$_2$	-	+
89. *Paramonohystera* sp.	+	-	Family Diplopeltidae		
90. *Pseudosteineria* sp.	+	-	111. *Diplopeltila* sp.	+	-
91. *Theristus* sp.	+	-	112. *Southerniella* sp.	+	-
Total number					
Orders		**4**		**3**	**3**
Families		**28**		**23**	**20**
Genera		**97**		**91**	**47**

and nematodes were found (Fig. 10). In the sediment type IV, the greatest number of animals was found in the upper layer (200 ind. 10 cm^{-2}) and then, the meiobenthos density sharply declined. The minimum meiobenthos density (25 ind. 10 cm^{-2}) was observed in the 8-10 cm layer. In the last two layers, only nematodes were found (Fig. 10). At reefs, the maximum number of animals (780 ind. 10 cm^{-2}) was found in the first three layers of sediment type VI. The minimum density (70 ind. 10 cm^{-2}) was registered in 6-8 cm layer. In 8-10 cm layer, harpacticoids were found together with nematodes and polychaetes.

Thus, the most number of animals was found only in sandy sediments in the 8-10 cm layer, while in the same layer of silt sediments, only nematodes were found.

4. Discussion

Subtidal meiobenthic species assemblages are poorly known in tropical biotopes and few studies give an account of their taxonomic composition and biodiversity (review: Boucher 1997). It is known that one of the key factors affecting distribution of meiofauna is the granulometric composition of sediments. Investigation of meiofaunal density and the taxonomic composition of nematodes in three bottom types in SW lagoon of New Caledonia (SW Pacific) showed that the meiofaunal density was significantly higher in white sand at stations adjacent to the coral reefs than in other biotopes (grey-sand and muddy bottoms).

The meiobenthos density at Nha Trang Bay reefs also

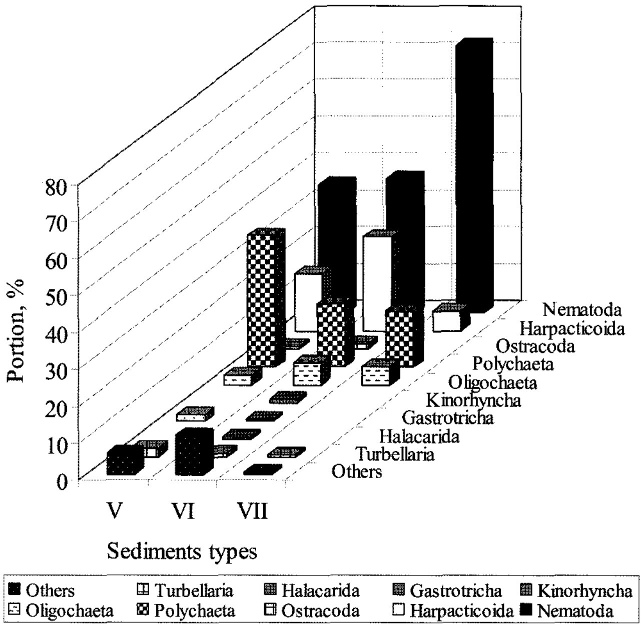


Fig. 9. The proportions (%) of meiobenthic groups from different sediment types on reefs stations. Others: Nemertines, Bivalves, Gastropods, Isopods, Holothurians, Sipunculids, Amphipods, Caprellids, Insects, Cumaceans, Pantopods, Chironomids.

shows an uneven distribution and depends on the sediment type. The correlation analysis revealed the dependence between the median diameter of sediment particles and the density of meiobenthos (Spearman's correlation coefficient was 0.82, $p<0.05$).

A review of existing meiofauna data in tropical areas (Alongi 1989a, b) shows that meiofaunal densities and species diversity are not greater in the tropics (Boucher 1997).

We found that quantitative characteristics of meiobenthos in Nha Trang Bay (944.3±303.7–1034.6±435.8 ind. 10 cm^{-2}) were similar to the data on the other seas: SW lagoon of New Caledonia – 3275±701 ind. 10 cm^{-2} (Boucher 1997); the Yellow Sea – 1524–6094 ind. 10 cm^{-2} (Kim *et al.* 2000), 0.81–1.51 ind. $10^6 cm^{-2}$ (Zhang *et al.* 2001, 2002), the East Sea – 517±185.0–2228.2±527.1 ind. 10 cm^{-2} (Pavlyuk *et al.* 2001). However, taxonomic diversity of meiobenthos in Nha Trang Bay (twenty six groups) was greater than in other areas.

Nematodes dominated in bottom sediments both in Nha Trang Bay itself and at its reefs (Figs. 2, 6). In total, representatives of four orders, twenty eight families and ninety seven genera were found in Nha Trang Bay (Table 3). Nematodes made up to more than 90% of the total

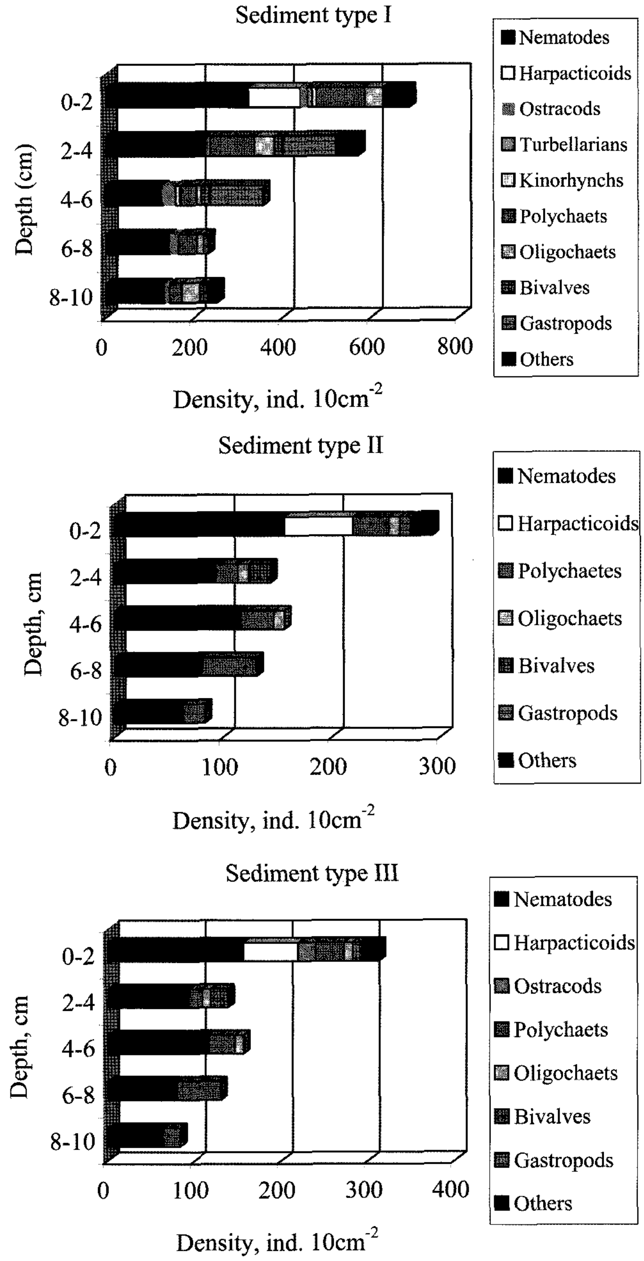
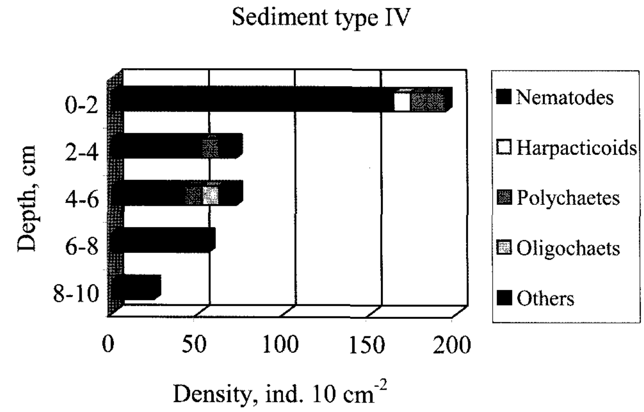
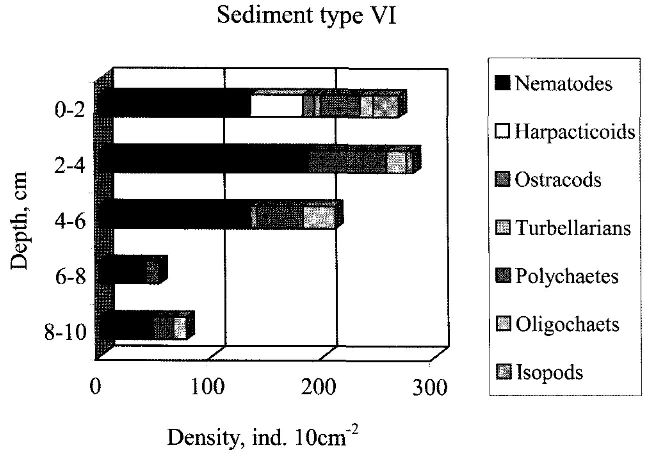


Fig. 10. The vertical distribution of meiobenthos at each type of ground sediments. Others groups: at type I - Holothurians, Sipunculids, Amphipods, Caprellids, Nemertines; at type II, III - Sipunculids, Amphipods; at type IV – Amphipods.

population density of meiobenthos at stations with high number of silt particles in sediments (stations 2-6). Nematodes made 68.6% of the total meiobenthos density in Nha Trang Bay, but at reefs they made only 32.14% (Figs. 4, 8). The highest density of nematodes (1020.8± 354.8–1029±547.1 ind. 10 cm^{-2}) was found in silted sands of sediment types II and VII. Statistically significant positive





(**Fig. 10.** Continued)

correlation was found between the median diameter of sediment particles and population density of nematodes (Spearman's correlation coefficient was 0.63, $p<0.05$). Representatives of *Xyalidae*, *Chromadoridae* and *Enchelidiidae* families dominated in sandy sediments of the Bay and in silt sediments – representatives of *Comesomatidae* and *Desmodoridae* families. In sediments of coral reefs, representatives of *Axonolaimidae* and *Desmodoridae* families dominated.

Vertical distribution of meiobenthos in soft sediments can be affected by various causes: mechanical properties of sediment, oxygen regime, seasonality and other factors (Janssen 1967; Fenchel and Riedl 1970; Skoolmun and Gerlach 1971; Pavlyuk 1984; Galtsova, 1991; Kim *et al.* 2000; Huang *et al.* 2005). In sandy sediments, where high oxygen concentration is a rule and interstitial space extends to a considerable depth, meiofauna can be found deep in the bottom layers of sediments (Renaud-Debyser 1963; Bush 1966). It is quite different in silt sediments, where the main number of animals is in the upper sediment layer. In the central part of Nha Trang Bay, the soft silt sediment layer reaches the depth of several tens of centimeters and there is no mechanical barrier to the penetration of animals into the deep layers of sediments. However, bottom oxygen concentration there makes less that 50% of the saturation (Smurov 2003). Probably, the oxygen deficiency is a limiting factor for the penetration of animals into the depth of sediments in the central part of Nha Trang Bay.

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