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The Community Structure and Spatial Distribution of Meiobenthos in the Kanghwa Tidal Flat, West Coast of Korea

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Abstract: The community structure of meiobenthos was studied in tidal flats of Kanghwado in November, 1997. Nematodes were the most dominant group among 18 total meiofaunal groups at most stations except for at lower tidal flats where the most abundant groups were harpacticoid copepods. Meiobenthos were the most abundant in the upper 1 cm and their density decreased depending on the depth from the surface. The highest density of the meiobenthos was 6,094 inds. 10 cm^{-2} at the upper tidal flat, while the lowest was 1,524 ind. 10 cm^{-2} at the lower tidal flat. The density was higher in general at the upper tidal flats, but decreased at the stations toward lower tidal flat at all transect lines. At all transect lines, nematodes decreased as stations were along toward lower tidal flat whereas harpacticoids increased. The values of N/C (nematodes/benthic harpacticoids) ratio were higher at the upper tidal flats than the lower tidal flats at all transect lines.

1. Introduction

Coastal wetland associated with tidal flat is one of the ecosystems of high productivity (Costanza 1997; Lee 1998; KORDI 1998). Meiobenthos, the sediment inhabited animal groups sieved with mesh aperture between 1 mm and 32㎛, are very important in these ecosystems because of their extremely high density and diversity (Shirayama 1993; Shirayama and Kim 1998). From the 1 m2 of sediment in shallow water ecosystems 106~107 individuals of meiobenthos have been collected (Mc- Intyre 1969). Thus, total energy usage of the animal groups is five times higher than that of macrobenthos (Gerlach 1971) and ATP amounts in total body of meio- benthos and microorganisms are almost alike (Yingst 1978). During the last decade, meiobenthos have been examined as an indicator to assess environmental condition of marine benthic ecosystem because comparatively short generation time cause rapid response of the populations to variable environments (Sandulli & De Nicola 1990). Among the meiobenthos groups, nematodes are more resistant to environmental change than harpacticoid copepods that are sensitive to oxygen starvation, and some nematode species even prefer anoxic condition (Heip et al. 1985). From these opposite ecological characteristics of two animal groups, N/C (nematodes/benthic harpacticoids) ratio has often been used as an environmental indicator (Raffaelli 1981, 1987; Raffaelli and Mason 1981; Warwick 1981; Amjad and Gray 1983; Lamshead 1984; Shiells and Anderson 1985; Itaoka and Tamai 1993).

Kanghwado is an island with an area of about 410 km^2, located in the mouth of Han and Yeseong rivers. One of the biggest tidal flat

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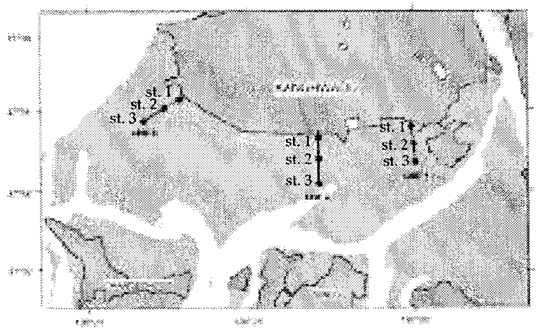

Fig. 1. Location map showing 3 transect lines in Kanghwa tidal flat.

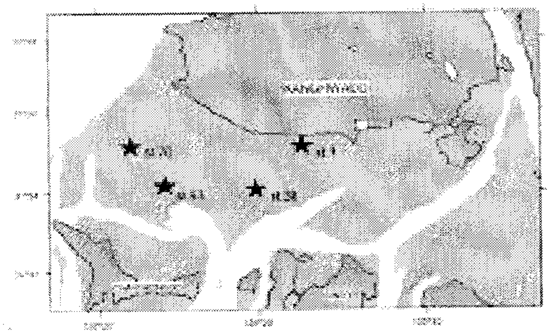

Fig. 2. The sampling stations of meiofauna with different sediment types in Kanghwa tidal flat.

(about 90 km²) lies in the southern part of the island and registered to both World Wildlife Fund and AWB. However, little is known about meiobenthos in the tidal flat. We collected data about horizontal and vertical distribution of the meiobenthos from three basic transect lines in the tidal flat and discussed the relationship of sedimentary characteristics and value of N/C ratio.

2. Materials and Methods

Community structure, and horizontal and vertical distribution of meiobenthos were analyzed from the samples collected on 15-19 November, 1997. Three transect lines in southern tidal flat of Kanghwado were determined, and sample collection was made at three stations of each

Table 1. The number and percentage of meiobenthos at each station in Kanghwa tidal flat. (Unit: /10cm²)

Kanghwado	Line 1						Line 2						Line 3						Total	
/stations	St. 1		St. 2		St. 3		St. 1		St. 2		St. 3		St. 1		St. 2		St. 3			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Nematodes	1706	77.4	1125	65.3	274	18.0	4374	71.8	2204	57.3	241	15.5	3553	80.2	2142	66.6	1502	55.3	17121	62.7
Harpacticoids	47	2.1	100	5.8	879	57.7	304	5.0	605	15.7	1019	65.6	174	3.9	153	4.8	210	7.7	3491	12.8
Sarcomastigophorans	177	8.0	111	6.4	46	3.0	470	7.7	307	8.0	38	2.4	405	9.1	503	15.6	187	6.9	2244	8.2
Nauplius	85	3.9	53	3.1	193	12.7	576	9.5	398	10.3	129	8.3	89	2.0	34	1.1	72	2.7	1629	6.0
Ciliophorans	112	5.1	87	5.1	26	1.7	142	2.3	104	2.7	25	1.6	82	1.9	120	3.7	135	5.0	833	3.1
Bivalves	1	0.0	66	3.8	11	0.7	11	0.2	27	0.7	14	0.9	29	0.7	128	4.0	454	16.7	741	2.7
Sipunculids			88	5.1			114	1.9	19	0.5	9	0.6	11	0.2			18	0.7	259	0.9
Turbellarians	7	0.3	15	0.9	14	0.9	43	0.7	21	0.5	7	0.5	21	0.5	46	1.4	40	1.5	214	0.8
Polychaetes	2	0.1	14	0.8	16	1.0	8	0.1	20	0.5	20	1.3	14	0.3	18	0.6	32	1.2	144	0.5
Nemertines	13	0.6	16	0.9	15	1.0	24	0.4	16	0.4	1	0.1	9	0.2	22	0.7	14	0.5	130	0.5
Cnidarians	11	0.5	19	1.1	9	0.6	5	0.1	31	0.8	8	0.5	8	0.2	17	0.5	21	0.5	129	0.5
Ostracods					7	0.5			55	1.4			2	0.0			4	0.1	68	0.2
Gnathostomulids	7	0.3	5	0.3	6	0.4			8	0.2	9	0.6			10	0.3			45	0.2
Holothurians	19	0.9											2	0.0			4	0.1	25	0.1
Copepods	5	0.2	1	0.1	4	0.3					11	0.7							21	0.1
Gastropods	4	0.2			7	0.5	1	0.0	4	0.1	5	0.3							21	0.1
Amphipods											1	0.1					5	0.2	6	0.0
Cumaceans															1	0.0	1	0.0	2	0.0
Tunicates							1	0.0					1	0.0					2	0.0
Others	7	0.3	22	1.3	17	1.1	21	0.3	28	0.7	17	1.1	28	0.6	24	0.7	17	0.6	181	0.7
Total	2203	100	1722	100	1524	100	6094	100	3847	100	1554	100	4428	100	3218	100	2716	100	27306	100

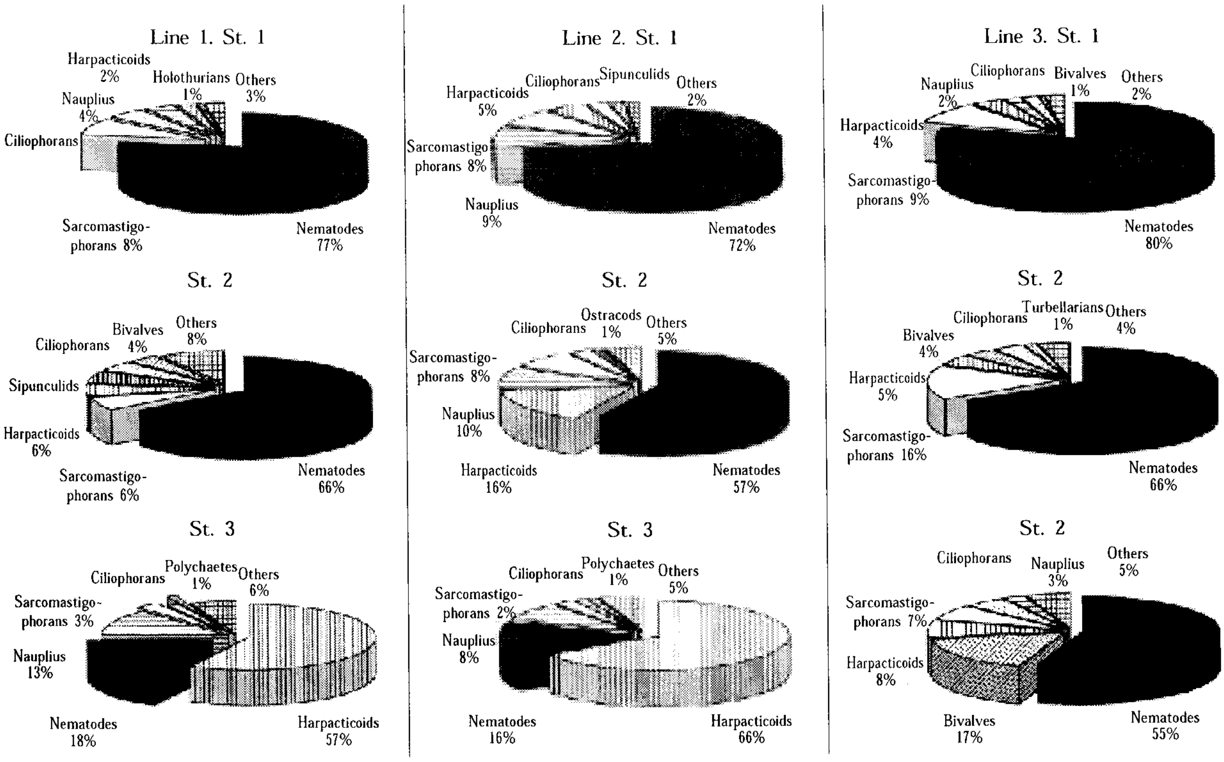

Fig. 3. The percentage of major meiofaunal groups at each station in Kanghwa tidal flat.

lines (Fig. 1). In all transect lines, Stn. 1 was located in the most landward tidal flat, approximately 100 m from the flood line. Stn. 2 in all three lines was located on 1 km far from the flood line, while each Stn. 3 in line 1, 2 and 3 was located 1.8 km, 2.4 km and 2.0 km, respectively. Additional samples were also collected from four different stations where sedimentary characteristics were unlike (Fig. 2).

Sediment samples were collected using acrylic cores (diameter 3.4 cm) and sliced 1 cm in depth from the surface to 10 cm (0~1 cm, 1~2 cm, 2~3 cm, 3~4 cm, 4~5 cm, 5~6 cm, 6~7 cm, 7~8 cm, 8~9 cm, 9~10 cm), then fixed with 5% neutralized formalin mixed with Rose Bengal. The samples were size fractioned with variable mesh aperture sieves (1 mm, 500μm, 250 μm, 125μm, 63μm and 37μm), then animals were identified and counted under a stereomicroscope. Because more than 90% of the meiobenthos were found within upper 5 cm, horizontal abundance of meiobenthos presented in this paper was evaluated from the data gained from only upper 5 cm sediment.

When copepods except for benthic harpacticoid copepods were found in samples, we mention them in this paper as opepods whereas later as arpacticoids .

3. Results and Discussion

Community Structure

Total 18 meiofaunal groups were found in the study area (Table 1). Nematodes were dominant at both Stn. 1 and 2 in transect line 1 (77.4%, 66.0% of total in individuals), while at Stn. 3 benthic harpacticoids were most abundant (57.7% of total in individuals) (Fig. 3). Sarcomastigophorans, ciliophorans, crustacean larvae (nauplius stage), harpacticoids, sipunculids and bivalves were subdominant groups that occupied 2.0 - 8.0% in individuals at Stn. 2 and 3. At Stn. 3, nematodes and nauplius larvae were subdominant (18.0% and 12.7%). At Stn.

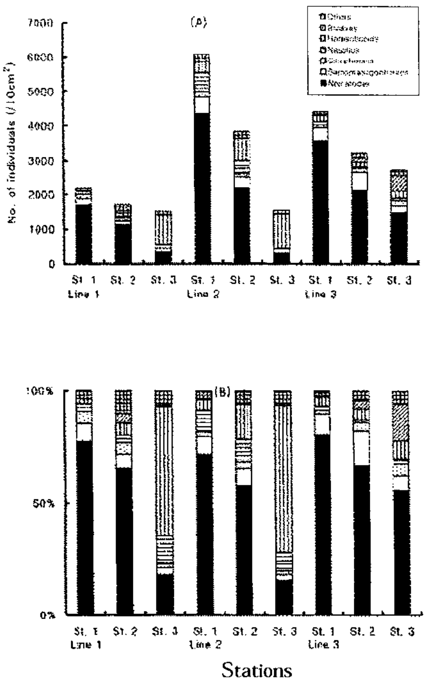

Fig. 4. (A) The number of individuals of meiobenthos at each station.
(B) The cumulative percentage composition

1 and 2 in transect line 2, nematodes were also dominant, then harpacticoids, nauplius larvae and sarcomastigophorans were subdominant, while harpacticoids were dominant, and nematodes, nauplius larvae and sarcomastigophorans were subdominant at Stn. 3, thus the tendency was alike as the line 1. Since the sediment granule size was the smallest at Stn. 3 in both of the transect lines, these results agree well with the general rule that nematodes and harpactoicoids or sarcomastigophorans are dominant and subdominant (Shirayama 1993; Shirayama and Kim 1998; Kim *et al.* 1998a, 1998b) in the sediment with fine grain size and relative abundance in harpacticoids increases where the sediment becomes coarser (Kim and Shirayama 1996). The line 3 showed different results of above two lines: Nematodes were dominant at all three stations, occupying 80.2%, 66.6%, 55.3% of total in abundance, and subdominant groups were sarcomastigophorans at the Stn. 1 and 2, while bivalves were subdominant (16.7%) at Stn. 3. Harpacticoids occupied small portion as 3.9%, 4.8%, 7.7%, respectively. The high abundance of bivalves at Stn. 3 probably indicates that the area may provide an appropriate habitat for the animal to settle down.

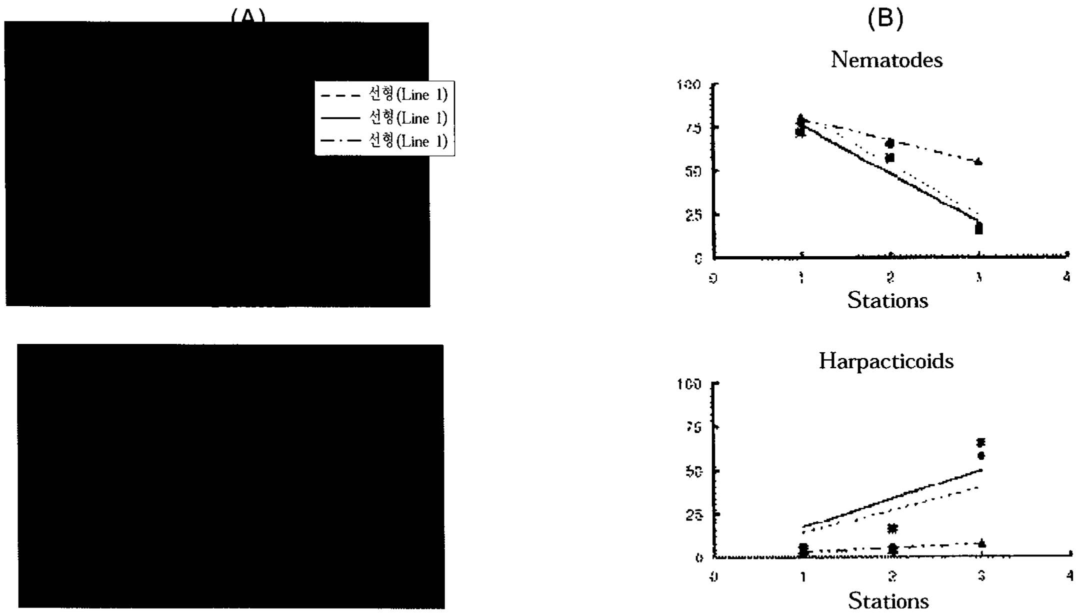

Fig. 5. (A) The number of nematodes decreased toward lower tidal flat where as that of harpacticoids increased at the lower tidal flats of all transect lines.

Table 2. The number of individuals of meiobenthos at each study line in Kanghwa tidal flat.

(Unit: /10cm²)

Line 1	Sediment depth (cm)						
	0-1	1-2	2-3	3-4	4-5	Total	%
St. 1							
Nematodes	1026	545	102	24	9	1706	77.4
Sarcomastigophorans	156	18	3			177	8.0
Ciliophorans	94	15	2		1	112	5.1
Nauplius	76	9				85	3.9
Harpacticoids	40	6	1			47	2.1
Holothurians	19					19	0.9
Nemertines	10	3				13	0.6
Cnidarians	9	1		1		11	0.5
Gnathostomulids	5	2				7	0.3
Turbellarians	6		1			7	0.3
Copepods	5					5	0.2
Gastropods	4					4	0.2
Polychaetes	2					2	0.1
Bivalves	1					1	0.0
Others	5	2				7	0.3
Total	1458	601	109	25	10	2203	100.0
St. 2							
Nematodes	718	283	93	24	7	1125	65.3
Sarcomastigophorans	79	29	3			111	6.4
Harpacticoids	60	34	5	1		100	5.8
Sipunculids	35	32	16	4	1	88	5.1
Ciliophorans	53	30	3		1	87	5.1
Bivalves	34	22	7	3		66	3.8
Nauplius	34	19				53	3.1
Cnidarians	5	10	2	1	1	19	1.1
Nemertines	4	5	4	3		16	0.9
Turbellarians	7	5	1		2	15	0.9
Polychaetes	1	3	4	4	2	14	0.8
Gnathostomulids			2	3		5	0.3
Copepods		1				1	0.1
Others	10	4	4	3	1	22	1.3
Total	1040	477	144	46	15	1722	100.0
St. 3							
Harpacticoids	676	174	25	4		879	57.7
Nematodes	67	101	71	29	6	274	18.0
Nauplius	145	37	9	2		193	12.7
Sarcomastigophorans	31	12	3			46	3.0
Ciliophorans	12	7	4	1	2	26	1.7
Polychaetes	3	2	6	3	2	16	1.0
Nemertines	4	3	5	1	2	15	1.0
Turbellarians	7	4	2	1		14	0.9
Bivalves	5	1	3	2		11	0.7
Cnidarians	6	2	1			9	0.6
Gastropods	1	3	3			7	0.5
Ostracods	4	3				7	0.5
Gnathostomulids		3	3			6	0.4
Copepods	4					4	0.3
Others	5	1	7	2	2	17	1.1
Total	970	353	142	45	14	1524	100.0

Line 2	Sediment depth (cm)						
	0-1	1-2	2-3	3-4	4-5	Total	%
St. 1							
Nematodes	1766	2095	394	89	30	4374	71.8
Nauplius	566	9	1			576	9.5
Sarcomastigophorans	410	45	14		1	470	7.7
Harpacticoids	295	6	2		1	304	5.0
Ciliophorans	117	17	2	6		142	2.3
Sipunculids	44	46	21	1	2	114	1.9
Turbellarians	40	3				43	0.7
Nemertines	22	2				24	0.4
Bivalves	9	1	1			11	0.2
Polychaetes	3	1	4			8	0.1
Cnidarians	3	2				5	0.1
Gastropods	1					1	0.0
Tunicates			1			1	0.0
Others	12	7	1	1		21	0.3
Total	3288	2234	441	97	34	6094	100.0
St. 2							
Nematodes	753	1050	304	84	13	2204	57.3
Harpacticoids	522	78	5			605	15.7
Nauplius	309	77	12			398	10.3
Sarcomastigophorans	167	110	24	6		307	8.0
Ciliophorans	31	43	17	10	3	104	2.7
Ostracods	36	17	2			55	1.4
Cnidarians	14	9	5	3		31	0.8
Bivalves	11	7	5	3	1	27	0.7
Turbellarians	9	9	2	1		21	0.5
Polychaetes	7	3	5	2	3	20	0.5
Sipunculids	4	8	4	3		19	0.5
Nemertines	6	4	4	2		16	0.4
Gnathostomulids				7	1	8	0.2
Gastropods		3	1			4	0.1
Others	8	3	8	8	1	28	0.7
Total	1877	1421	398	129	22	3847	100.0
St. 3							
Harpacticoids	709	289	21			1019	65.6
Nematodes	58	54	69	54	6	241	15.5
Nauplius	80	45	4			129	8.3
Sarcomastigophorans	22	7	5	4		38	2.4
Ciliophorans	8	4	2	10	1	25	1.6
Polychaetes	2	5	5	5	3	20	1.3
Bivalves	3	6	4	1		14	0.9
Copepods	9	2				11	0.7
Gnathostomulids			6	3		9	0.6
Sipunculids	5	3	1			9	0.6
Cnidarians	1	2	2	2	1	8	0.5
Turbellarians	4	3				7	0.5
Gastropods			4	1		5	0.3
Amphipods		1				1	0.1
Nemertines	1					1	0.1
Others	5	4	3	3	2	17	1.1
Total	907	425	126	83	13	1554	100.0

Line 3	Sediment depth (cm)						
	0-1	1-2	2-3	3-4	4-5	Total	%
St. 1							
Nematodes	1447	1225	580	251	50	3553	80.2
Sarcomastigophorans	229	142	27	6	1	405	9.1
Harpacticoids	152	15	6	1		174	3.9
Nauplius	85	4				89	2.0
Ciliophorans	49	23	5	3	2	82	1.9
Bivalves	13	4	4	4	4	29	0.7
Turbellarians	14	2	1	2	2	21	0.5
Polychaetes	1	2	2	4	5	14	0.3
Sipunculids	4	5	2			11	0.2
Nemertines	3	3		2	1	9	0.2
Cnidarians	3	5				8	0.2
Holothurians		2				2	0.0
Ostracods	2					2	0.0
Tunicates			1			1	0.0
Others	6	4	4	7	7	28	0.6
Total	2008	1436	632	280	72	4428	100.0
St. 2							
Nematodes	808	702	474	133	25	2142	66.6
Sarcomastigophorans	249	221	33			503	15.6
Harpacticoids	128	21	4			153	4.8
Bivalves	73	38	8	7	2	128	4.0
Ciliophorans	54	34	20	9	3	120	3.7
Turbellarians	26	14	3	1	2	46	1.4
Nauplius	27	5	2			34	1.1
Nemertines	7	5	2	5	3	22	0.7
Polychaetes	1	2	6	5	4	18	0.6
Cnidarians	5	4	6	2		17	0.5
Gnathostomulids		3	6	1		10	0.3
Cumaceans	1					1	0.0
Others	13	5	2	4		24	0.7
Total	1392	1054	566	167	39	3218	100.0
St. 3							
Nematodes	894	406	99	91	12	1502	55.3
Bivalves	428	14	8	4		454	16.7
Harpacticoids	190	16	4			210	7.7
Sarcomastigophorans	142	34	11			187	6.9
Ciliophorans	94	10	7	22	2	135	5.0
Nauplius	57	14		1		72	2.7
Turbellarians	29	2	3	6		40	1.5
Polychaetes	7	8	5	8	4	32	1.2
Cnidarians	6	1	5	8	1	21	0.8
Sipunculids	7	3	6	2		18	0.7
Nemertines	4	3	2	4	1	14	0.5
Amphipods	5					5	0.2
Holothurians		3	1			4	0.1
Ostracods	4					4	0.1
Cumaceans	1					1	0.0
Others	4	5	5	2	1	17	0.6
Total	1872	519	156	148	21	2716	100.0

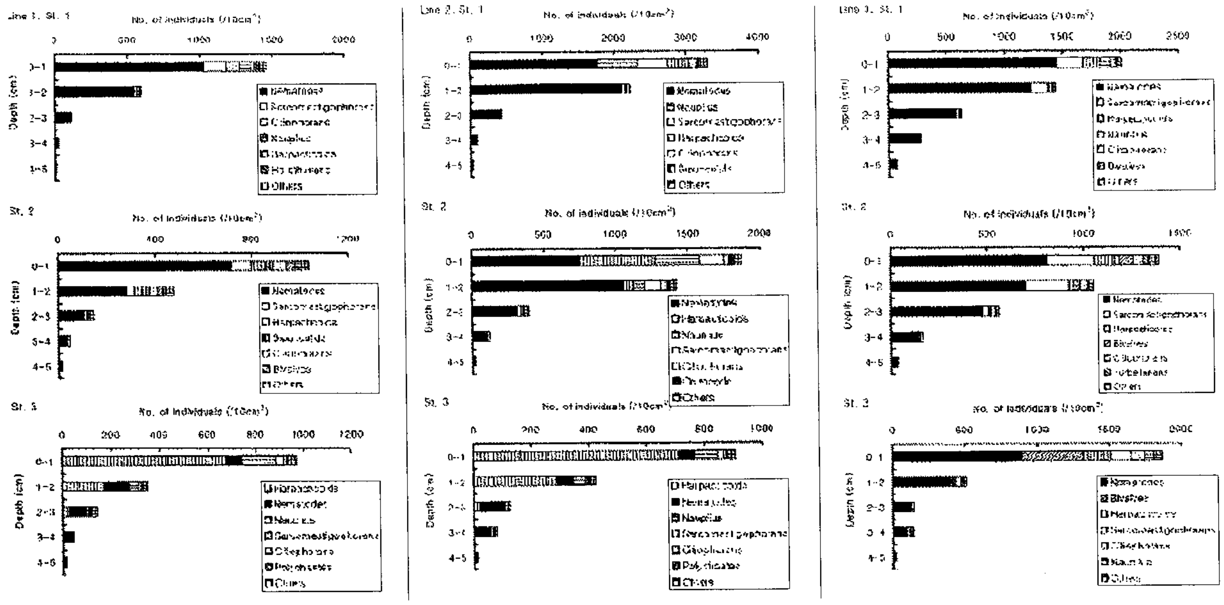

Fig. 6. The vertical distribution of meiobenthos at each station in Kanghwa tidal flat.

Horizontal Distribution and Nematodes/ Harpacticoids Ratio

The abundance data of meiobenthos occured in the upper 5 cm depth of sediment was given in Table 2. There are some characteristics in distributional pattern of meiobenthos in the study area. First, in all three transect lines, the abundance of animals decreased at seaward stations. In transect line 1, densities of total animals were 2,203, 1,722 and 1,524 ind. 10 cm^{-2} at each st. 1, 2 and 3, respectively (Fig. 4). In the lines 2 and 3, those of aniamls were 6,094, 3,847 and 1,554 ind. 10cm^{-2}, and 4,428, 3,218 and 2,716 ind. 10 cm^{-2}, respectively. These results indicate that landward tidal flat is more suitable habitat to meiobenthos in general than seaward tidal flat. Organic matters originated from terrestrial environment or saltmarsh may provide more abundant food source to meiobenthos such as bacteria, benthic diatoms and other organic compounds.

Secondly, the abundance was much lower at the stations in line 1 than those in both line 2 and 3. Clay sediment was distributed at stations in line 1, where grain size was smaller than that of stations in line 2 and 3. One reason of the lower abundance in the line 1 may be due to the fact that this clay sediment may prevent oxygen supply into deeper layer enough to provide adequate habitats for animals. Third, nematodes were dominant at Stn. 1 and 2, and the density was higher at Stn. 1 than Stn. 2, while density of harpacticoids was highest at Stn. 3 in both lines 1 and 2. In line 3, nematodes showed lower abundance in seaward station 3, even though they are dominant at all stations. The abundance of harpacticoids was

Table 3. The value of nematodes/harpacticoids ratio at each station.

Kanghwado	Line 1			Line 2			Line 3		
	St. 1	St. 2	St. 3	St. 1	St. 2	St. 3	St. 1	St. 2	St. 3
Nematodes	1706	1125	274	4374	2204	241	3553	2142	1502
Harpacticoids	47	100	879	304	605	1019	174	153	210
N/C ratio	36.3	11.2	0.3	14.4	3.6	0.2	20.4	14	7.2

Table 4. The number of meiobenthos from different sedimet types on the surface layer of each station.

(0-1cm, Unit: /10cm^2)

Line 2 St. 1	Mesh size					
slightly gravelly sandy mud	0.5	0.25	0.125	0.063	0.037	Total
Nematodes		3	121	1298	344	1766
Nauplius			15	542	9	566
Sarcomastigophorans			57	322	31	410
Harpacticoids		17	189	78	11	295
Ciliophorans		2	43	61	11	117
Sipunculids		2	25	17		44
Turbellarians	1		5	34		40
Nemertines			9	11	2	22
Bivalves		3	4	2		9
Cnidarians		1	2			3
Polychaetes		1	2			3
Gastropods			1			1
Others			2	2	8	12
Total	1	29	475	2367	416	3288

St. 38	Mesh size					
gravelly muddy sand	0.5	0.25	0.125	0.063	0.037	Total
Nematodes		12	334	1186	241	1773
Sarcomastigophorans		2	18	35	13	68
Nauplius			1	23	10	34
Harpacticoids		1	12	3		16
Ciliophorans		1	4	5	2	12
Bivalves				9	2	11
Polychaetes	3	2	4	2		11
Ostracods		1	3	2		6
Turbellarians			2	3		5
Cnidarians			1	2	1	4
Nemertines			2	1	1	4
Amphipods	3					3
Gastropods				1		1
Others			3	1	3	7
Total	6	19	384	1273	273	1955

St. 63	Mesh size					
sand	0.5	0.25	0.125	0.063	0.037	Total
Nematodes		1	26	22	37	86
Nauplius				11	63	74
Bivalves		9	27	2		38
Polychaetes	1	3	8	6	3	21
Sarcomastigophorans		1	2	2	13	18
Ciliophorans				6	2	8
Turbellarians			2	2	3	7
Archiannelids		1	1			2
Gastrotrichs			1	1		2
Tardigrades				2		2
Harpacticoids		1				1
Oligochaetes			1			1
Ostracods		1				1
Others				1	2	3
Total	1	17	68	55	123	264

St. 70	Mesh size					
muddy sand	0.5	0.25	0.125	0.063	0.037	Total
Nematodes		7	373	426	128	934
Sarcomastigophorans			14	23	17	54
Polychaetes	2	6	24	13	6	51
Harpacticoids			32	11	1	44
Ciliophorans			3	21	14	38
Turbellarians		1	3	8	7	19
Ostracods		2	7	6	1	16
Cnidarians		1	3	6	4	14
Bivalves			4	6	2	12
Nemertines			3	5	3	11
Sipunculids			1	3	6	10
Gastropods			5	2	2	9
Nauplius			2	4	3	9
Oligochaetes	2		2			4
Archiannelids	1					1
Others			2	3	8	13
Total	5	17	478	537	202	1239

almost same or slightly higher at seaward stations. Thus, spatial distribution pattern of nematodes and harpacticoids showed opposite trends at most stations (Fig. 5). Table 3 indicated the ratio of abundance of these two animal groups (N/C ratio: nematode/copepod ratio). In line 1, the value at Stn. 1 was three times higher than that at Stn. 2, and about a hundred times higher than Stn. 3. The abundance decreased as the locations moved seaward in the stations in the other two lines. It is suggested that harpacticoids are less resistant to terrestrially originated pollutants, while nematodes tend to endure or even prefer highly polluted environment (Heip *et al.* 1985). Raffaelli and Mason (1981) also mentioned that harpacticoids are very sensitive to the environment of low concentration of dissolved oxygen and organic pollution, which cause lower density of the animals in such condition. Instead, nematodes in general are resistant to rapidly changed environment and some may fit to oxygen deficient condition (Heip 1980; Moore and Bett 1989). Thus, the ratio of abundance in these two animal groups has been utilized as an indicator for process of pollution (Raffaelli 1981, 1987; Raffaelli and Mason 1981; Coull *et al.* 1981; Warwick 1981; Amjad and Gray 1983; Lambshead 1984; Shiells and Anderson 1985; Itaoka and Tamai 1993). Because kinorhynchs may be more sensitive to environmental variation than harpacticoids, distributional data of these animal groups can be used as an environmental indicator (Higgins and Fleeger 1980). N/C ratio in this study was similar to that of Hiroshima Bay, Japan (Itaoka and Tamai 1993). N/C ratio in highly eutrophicated region was high (75 or 64), while much lower in oligotrophic region (8). The N/C ratio will decreasing gradually with decrease of amount of organic compounds and increase of dissolved oxygen. However, other environmental factors can affect the ratio of copepod to nematode abundance, thus this ratio still can be applied restrictively to the case of sand beach.

Vertical Distribution

Meiobenthos in general showed the highest density in the upper 1 cm layer (Fig. 6). This may be associated with food and oxygen supply to subsurface. In coarse sedimentary environment, because of relatively easy penetration of oxygen, high abundance is often observed in deeper than surface layer (Raffaelli 1981, 1987; Raffaelli and Mason 1981; Heip *et al.* 1985). Redox potential discontinuity (RPD) layer of the study area was about 2~3 cm deep and the layer may act as a barrier of high abundance of meiobenthos (Fenchel and Riedl 1970). Gradual decrease of the abundance with depth at Stn. 1 and 2 in the line 3, as compared to drastic decrease in other stations, may reflect that certain depth of the station can be supplied with oxygen, because the grains of the sediment of the station are larger than that of other stations.

In Stn. 1, 2 of the line 2, nematodes were dense in 1~2 cm depth more than in 0~1 cm depth. These results may be due to different feeding types of nematode species: bacterial- or diatom feeders may be distributed in upper layer, while omnivores or carnivores in deeper layer (Coull 1973; Brown and Sibert 1977; Gerlach 1978; Tietjen 1980). Harpacticoids showed extreme preference for surface and few abundance in deeper layers than 2 cm. These animals may less resistant to oxygen deficiency and need the space for comparatively active swimming. Nauplius also showed the same trend, too.

Variation of Abundance in Meiobenthos in Different Sedimentary Faces

Table 4 and Fig. 2 showed density of the animals in the depth of 0~1 cm from the stations of different sementary faces. Average sedimentary grain size was 5.9ψ, 4.64ψ, 4.24ψ and 2.87ψ at Stn. 1 in the line 1, Stn. 38, Stn. 72 and Stn. 63, respectively (KORDI 1998). Total individuals of meiobenthos were 3,288, 1,955, 1,239 and 264 ind. $10cm^{-2}$, thus abundance of the animals was opposite to the grain size. However, in the stations of the line 1 where the sedimentary grain was approximately 7ψ, the average abundance was 1,156 ind. 10 cm^{-2} and in the Stn. 2 and 3 of the line 2 where the grain size was almost same to that of Stn. 1 of the line 2, the abundance was 1,877 ind. 10 cm^{-2} and 907 ind. 10 cm^{-2}, respectively. Sedimentary environment is another important factor to determine distributional pattern of meiobenthos (Warwick and Buchanan 1970). Thus, the abundance of the animals may relate to sediment grain size, but any threshold may exist in smaller grain size. For better understanding of this relationship, more data from various sedimentary faces must be necessary.

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