MEIOFAUNA OF THE MAFLA AREA

Unversity of Florida, Marine Laboratory

Co-Principal Investigators:
Michael R. Crezee
Frank J. Maturo

ABSTRACT

Analysis of the quantitative samples has been completed and the data forwarded to the data management group. These data show the meiofauna to be extremely abundant, and the results of correlation analyses and other examination of the data show that meiofauna can be a particularly important group to characterize sediment types and particular stations.

B

INTRODUCTION

Nematodes, copepods , crustacean larvae, polychaete larvae (less than six veligers) , kinorhynchs, priapulids, tardigrads, coelentera.ten, and halacarid mites were counted at these levels without any further identification attempted. Ostracods were deleted from consideration when it was found that extraction methods were not efficient for them.. They were too uncommon to justify attempts to recover them. Gastrotrichs were identified to the genus level, except that a difficult group of genera are included in "Mesodasys". So that at least one group could be examined in more detail, turbellarians were separated to species where possible. Unfortunately, this is not possible with juveniles, which form a sizeable percentage of the population, nor can the species be named without the reference work with the live samples. However, species codes have been assigned for the approximately 200 species encountered, and Data Management has been supplied a list assigning each of these species codes to a family. In order to make the data interpretation most meaningful to later studies, however, for analysis the turbellarians have been grouped into taxonomic units which vary from generic to ordinal level. Each grouping used is a taxonomic unit to which even juveniles, badly damaged animals and usually pieces can unhesitatingly be assigned by an experienced person.

METHODS AND MATERIALS

For processing of many of the samples from the first sample period methods common to previous meiofauna studies were employed, It was quickly realized that such methods were not designed for the handling of large numbers of samples in very limited time. Furthermore, these methods did not allow strictly comparable treatment of samples of different sediment types. Coarse sand and mud could not be treated in the same manner in actual practice. Therefore, a new separation technique was developed by modifications of older techniques and was standardizedso that comparable treatment could be given to all sediment types. A fuller description of this technique will shortly be submitted to Limnology and Oceanography. Development of an adequate means of separatiori was essential, and it greatly facilitated work with the third set of samples and also the second sample period, when it was still being developed. This problem with methods created two major difficulties in the program, however. 1) Experimentation with a variety of possible improvements, together with the very time consuming assessment of the extraction efficiency of each technique, consumed large amounts of time. We could ill-afford this, for even with the new technique allowing faster and more efficient treatment of samples, the time necessary for the work had been under-guessed (for there had been no figures from any comparable studies on which to base time estimates). 2) Figures for the first sample period are undoubtedly too low because methods which were then state-of-the-art were not so efficient as the new methods.

In spite of these problems, however, and in spite of the limited amount of data analysis possible without the project continuation upon which funds for data analysis and interpretation were dependent, the data nonetheless, indicate the Crest promise of meiofauna in developing a robust characterization of sediment types or of particular stations.

RESULTS AND DISCUSSION

In almost every sediment type nematodes are the most abundant metazoan. In only a very few samples were copepods more common. Averaged over the entire MAFLA region and all seasons, there are 330,775 nematodes/m^2 or 29.3/cm^2. Yearly average densities ranged from 37/10 cm^2 at station 2543 up to 1,189/10 cm^2 at 2207. (1/10 cm^2 = 1,000/m^2). Stations 2209 and 2419 also support over one million nematodes per m^2 throughout the year, and other of the shallower stations of Transects I, II, III and IV have similar densities in many samples. Tables 1, 2 and 3 present average densities of nematodes during sampling periods I, II and III, respectively.

These densities are comparable to the 157 to 593 nematodes/10 cm^2 reported by Tietjen (1971) for sandy stations between 50 and 100 m water depth off the North Carolina coast. The shallow stations are also quite comparable to the range of 328-1767/10 cm^2 found by McIntyre and Murison (1973) on the coast of Scotland at only 6-7 m water depth. The mud stations are also near the 328/10 cm^2 found at 20 m in Buzzard's Bay, Massachusetts (Wieser, 1961), but less than the yearly average of 876/10 cm^2 in a silty sediment under 80 m of North Sea Water (Warwick and Buchanan, 1971), Finally, de Bovee and Soyer (1974) report nematode densities of 3-8x10^3/10 cm^2 for Banyuls-sur-Mer on the French Mediterranean coast. These latter values are an order of magnitude higher than those reported by anyone else.

Although the highest nematode densities occur in the shallower stations of the southern four transects and the lowest values in the muds of Transects

V and VI , few other patterns are evident from an examination of the data. The figures in Table 4 represent the difference between highest and lowest seasonal densities divided by the yearly mean density for the station. Roman numerals in italics indicate the sampling period during which highest densities were found. The range is greater than the mean at several stations, but there is also a great amount of variation between replicates. The few other reports of seasonal collections of subtidal nematodes differ. De Bovee and Soyer (1974) found a summer maximum in nematode densities on the French coast, but Warwick and Buchanan (1971) found that month to month variation was no greeter than the variation between sets of replicates at their North Sea station. In the MAFLA program the highest average nematode densities were during sample period I at 61% of the station, during period II at 27% and III at only 12% of stations. Thus, the indication is that summer is a time of maximum numbers. However, some stations rather clearly show no seasonality (2208, 2317, 2425, 2531 and 2642, for example). In any case the variation is not as patterned as to allow prediction.

Furthermore, the report of Warwock and Buchanan (1971) was rather compelling in discounting seasonality, for they considered community and population structure. They followed monthly population fluctuations of the 10 commonest species and examined the population structure of the five most dominant species. The relative ranking of the species was highly congruent from month to month, showing that no single species was increasing disproportionately. Morover, they concluded that at least the majority of nematodes breed throughout. the year with complete asynchrony in reproductive cycles, for they found that juveniles always formed over half the population and that gravid females were always present. This would be expected to even out numbers and lead one not to expect any marked seasonality.

The ten commonest nematode species formed 45.5%-59.3% at this North Sea station. At summer in Buzzard's Bay, Wieser (1961) lists nematode speciesabundances for a comparable station (also ca.30% silt-clay). Here, too, the first ten species form 48.1% of the population, and their relative rankings are as reported for the North Sea. One species and two further genera within these ten species were common to the two distant locations.

Copepod average densities for sampling periods I, II and III are presented in Tables 5, 6 and 7, respectively. Ratios of range of densities over season to annual mean density are presented together with season of highest density in Table 8. As for the nematodes, the highest values appear in the shallow stations of the southern four transects. The variability from season to season is high with the ratio of range:mean averaging 1.0. This is even higher than for nematodes where the average value for this ratio is 0.8. Maximum densities occurred in winter at only 10% of the stations, and the maxima for other stations were evenly divided between summer and fall sampling periods.

Although on the average, the ratio of range:mean was higher for copepods than for nematodes, the copepod ratio was higher at only 58% of the stations and therefore not notably different from the 50% expected with variations unrelated. Seasonal grand mean densities for periods I, II and III are 57.6, 64.5 and 52.9/10 cm^2, respectively, and vary only 10% about the mean.

Although no patterns are clear from looking at the data displayed in map-like fashion according to depth in Tables 1-8, correlation analyses performed by the data management group show significant relation between abundances of different taxonomic groupings and grain size of sediments. The correlations between each group and sediment mean grain size are listed in Table 9. All correlations were significant at $\alpha<0.00001$ level. The very high correlations within several of the groupings would strongly indicate the promise of meiofauna in characterizing sediments. Previous studies have indicated the importance of sediments to meiofauna (review by Gray 1974), but never before so decisively. Unfortunately, these correlations appear suspiciously high and consistent and the level of significance too high to be true for every case. The 0.99 and 0.98 correlations within the turbellarians go counter to negative correlations between some of these groups, as apparent in observations as in Table 10 and discussed below.

Although the correlation values are so high as to warrant double-checking, they are certainly correct in attributing a high predictive potential to meiofauna. Several tables show distribution patterns of selected groups of meiofaunal animals which show possibilities of characterizing stations either by simple presence-absence data or by combining to form a simple ratio.

On Transect I the nematodes and copepods show a high variability between seasons. Total numbers and ratios between copepod and nematode total numbers vary greatly. Looking at turbellarians, however, there are clear trends consistent between seasons. *Carcharodorhynchus* is the dominant kalyptorhynch at the two shallowest stations (21.01 and 2102), then declines in abundance to be completely replaced by eukalyptorhynchs in the deeper stations. This change is not related to depth, but rather to sediment type. The sandier stations of Transects V and VI can be pj.eked out by looking at the distribution of Carcharodorhynchus (see Table 10). (There are several species of the genus involved.) The correlation analyses also show that these two kalyptorhynch turbellarian groups are highly faithful indicators of sediment type and that their absence from a sediment type where they should occur would be strong evidence of a toxin or of some disturbance.

Other genera, also easily recognized with even limited training, are not so highly correlated with sediment type but are reliably found at certain stations. Acanthodasys (Table 11) and Diplodasys (Table 12) are two such examples. Acanthodasys is most common in coarse sands of Transects III and IV, but it also very reliably occurs at stations 264o and 2642, the two stations in Transect VI with the lowest silt-clay contents. Diplodasys as well is characteristic of a few stations with sediment of lower silt-clay contents.

Priapulids are easily recognized with minimal experience and occur sporadically throughout the area. All of these larvae (only a very few adults were found) appear to be Tubilucus coralicola, the only known meiofaunal priapulid. The table reinforces the correlation giving only 0.23 relation to sediment type, but this preference seems to be for sediments of intermediate clay content.

Kinorhynchs (Table 14) occurred in almost all samples. They may be of special value because some of the genera are abundant in muds and remain in high densities in most of Transect VI. The high numbers at station 2209 could be explained if sediment from Tampa Bay and rich in organics are deposited here, for kinorhynchs are presumed to be non-selective deposit feeders. Because of this type of feeding and their presence in fair number throughout the MAFLA area, the kinorhynchs could prove especially valuable indicators of pollutants, such as heavy metals, which accumulate in sediments.

SUMMARY

The results of this study, so far as analysis has been possible, shows an abundant nematode and copepod fauna, with densities comparable with the few values previously reported. Presumably, the nematodes will be quite diverse, with the most abundant ten species making up about 50% of the assemblage. Perhaps one-third as many species of copepods would be expected. The next most abundant groups are the Turbellaria and Gastrotricha, although Kinorhynchia may be more common in muds. We have found about 200 species of turbellarians in the MAFLA area. Although samples have been a little too small to adequately sample the turbellarian assemblage for diversity measures, characteristic groups have been found. Furthermore, grouping of species into more easily recognized taxonomic units has proven valuable. Gastrotrich genera and some of the "minor" taxonomic groups also offer promise of helping to characterize sediments with several "cross referencing" indicator groups allowing a sensitive biological indicator of environmental conditions.

(On this basis we would especially point to station 2420 as being consistently different from expectation).

Table 1. Sampling Period I, June 1975

Average number of nematodes per 10 cm^2

Depth	Transects VI	V	Iv	III	II	I
10 m			1205			862
			650			
			1253	338	1205	858
20 m	345		353			
	397		140	548		
30 m	611		354		460	
	432				1610	
	616	132		525		
	348	100	210	x		476
40 m		57		x	196	
		67				
50 m						348
60 m	187	47				
70 m	67	40				
80 m			219			
90 m						78
100+m	101	227				
		113	114	152	179	173

Table 2. Sampling Period II, September 1975

Average number of nematodes per 10 cm^2

Depth	Transects VI	V	IV	III	II	I
10 m			498			1164
			42			
			535	449	1542	1562
20 m	526		173			
	321		95	505		
30 m	442		188		360	
	264				1135	
	140	207		310		
	376	82	188	721	410	553
40 m		116			103	
		69				
50 m		81				305
60 m	155	47				
70 m	51	39				
80 m			151			
90 m						85
100+m	39	6 8				
		57	182	133	127	169

Table 3. Sampling Period III, January 1976

Average number of nematodes per 10 cm²

Depth	Transects VI	V	IV	III	II	I
10 m			1424			406
			263			
			353	696	821	355
20 m	474		131			
	204		64	560		
30 m	322		206		374	
	157				676	
	572	62		130		
	307	53	181	116	658	?05
40 m		52		579-	48	
		54				
50 m		131				69
60 m	139	104				
70m	18	32				
80 m			112			
90 m						55
100+m	16	121				
		126	26	50	76	72

Table 4. Nematodes
(range of average number per 10 cm² over seasons)
÷ (annual average density per 10 cm²)
Sampling season of highest density in italics **(*I*, *II*, or *III*)**

Depth	Transects VI	V	Iv	III	II	I
10 m			.9 *III*			.9 **II**
			1.91			
			1.3*I*	.7 *III*	.6 *II*	1.311
20 m	.4 *II*		1.0*I*			
	.6 *I*		.8 *I*	.1 **III**		
30 m	.6 *I*		.7 **I**		.2 **I**	
	1.0*I*				.8 **I**	
	1.1*I*	1.1*II*		1.21		
	.2 **II**	.6 *I*	.1 **I**			1.2*II*
40 m		.8 **II**			1.3*I*	
		.2 II				
50 m						1.2*I*-
60 m	.31′	.9 *III*				
70 m	1.1*I*	.21				
80 m			.6 **I**			
90 m						
100+m	1.6*I*	1.11				.4 *II*
		.7 *III*	1.5*II*	.91	.8 *I*	.71′

I	*61%*
II	*27%*
III	*12%*

Table 5. Copepods, Sampling Period I, June 1975

Average number per 10 cm^2

Depth	VI	V	Transects IV	III	II	I
10 m			137			5
			101			
			78	348	80	131
20m	9		19			
	11		23	106		
30 m	14		53		23	
	45				57	
	52	34		75		
	56	97	84			146
40 m		99			49	
		68				
50 m			28			61
60 m	36	31				
70 m	36	39				
80 m						
90 m						18
100+m	2 4	32				
		8	8	15	9	15

Table 6. Copepods, Sampling Period IX, September 1975

Average number per 10 cm^2

Depth	VI	V	Transects Iv	111	II	I
10 m			763			45
			72			
			212	234	228	111
20 m	2		114			
	1		5 7	84		
30 m	3		75		74	
	16				192	
	33	58		66		
	10	85	98	32	52	50
40 m		85			54	
		84				
50 m		30				28
60 m	37	28				
70 m	42	38				
80 m			52			
90 m						35
100+m	12	4				
		2	15	10	8	19

Table 7. Copepods, Sampling Period III, January 1976

Average number per 10 cm^2

Depth	VI	V	IV	III	II	I
			Transects			
10 m			52			22
			96			
			147	684	108	20
20m	16		58			
	3		8	78		
30 m	12		19		46	
	48				174	
	42	15		100		
	45	26	42	53	48	8
40 m		39		46	23	
		29				
50 m		24				26
60 m	22	24				
70 m	20	20				
80 m			17			
90 m						19
100+m	12	2				
		6	6	10	7	12

Table 8. Copepods, seasonal highs and variation (range of season means) ÷ (annual mean)

Depth	VI	V	IV	III	II	I
			Transects			
10 m			.9 *II*			**1.7*II***
			.3 *I*			
			.9 *II*	1.1*III*	1.1*II*	1.3*I*
20 m	1.6*III*		1.5*II*			
	2.0*I*		1.7*II*	.3 ***I***		
30 m	1.1*I*		1.1*II*		1.1*II*	
	.9 ***III***				1.0*II*	
	.4 *I*	1.2*II*		.4 *III*		
	1.2*I*	1.0*I*	.7 II			4.1*I*
40 m		.8 *I*			.7 *II*	
		.9 *II*				
50 m						.9 *I*
60 m	.5 ***II***	.2 ***I***				
70 m	.7 ***II***	,6 ***I***				
80 m			1.1*II*			
90 m						.7 *II*
100+m	.8 *I*	2.3*I*				
		1.2*I*	.9 *II*	.4 *I*	.2-	.5 ***II***

I 44%
II 46%
III 10%

P

Table 9.

Correlations between meiofaunal taxonomic groupings and sediment mean grain size. Level of significance is $\alpha < 0.00001$ for all correlations.

Taxonomic group	Correlation
Nematoda	0.23
Copepoda	0.24
crustacean larvae	0.22
polychaete larvae	0.20
Kinorhynchia	0.20
Priapulida	0.23
Tardigrada	0.26
all above groups combined	0.99
all Gastrotricha	0.98
Acanthodasys	0.26
Diplodasys	0.23
Mesodasys group	0.20
Tetranchyroderma	0.26
Urodasys	0.20
other gastrotrichs	0.26
all Turbellaria	0.99
Acoela	0.24
Macrostomida	0.26
Retronecitdae	0.25
Proseriata	0.96
Prolecithophora	0.95
Typhloplanoida	0.99
Dalyellioida	0.99
Eukalyptorhynchia	0.99
Karkinorhynchidae	0.99
Carcharodorhynchus	0.98
other Schizorhynchidae	0.99

B

B

Table 10. Ratio Carcharodorhynchus: Eukalyptorhynchia (Turbellaria)
Average values over seasons II and III
(indicates pattern not consistent between seasons)

Depth	Transects VI	V	IV	III	11	I
10 m			2			>10
			→ .2			
			4	.05	13	2
20 m	o		.4			
	*		1	.3		
30m	.2		.2			
	.5	.3		.1		
	.3	0	.7	0	.5	~
40 m		0			0	
		0				
50 m		.1				0
60m	O	.1				
70 m	O	0				
80 m			0			
90 m						0
100+m	*	0				
		0	0	0	0	0

* both groups absent from all samples
+ arrow indicates station 2420, which does not conform to expected patterns

B

D

Table 11. Seasonal presence of <u>Acanthodasys</u>

Numeral 1, 2 or 3 indicates presence at station in period I, 11 or III.

			Transects			
Depth	VI	V	Iv	III	II	I
10 m			123			123
			12			
			2	123	23	123
’20 m	-		2			
				12		
30m	-		12			
	123					
	-	1		23		
	123	-	12	3	-	3
40 m						
		3				
50 m						
60m	-	1				
70m	-	1				
80 m			2			
90 m						
100+m	-	1				

Table 12. Seasonal presence of <u>Diplodasys</u>

			Transects			
Depth	VI	V	IV	111	I I	I
10 m						
			23			
				123	3	-
20m	-		2			
				12		
30 m	-		123			
	13					
	2	12		23		
	13	12	12	3	-	-
40 m		12			3	
		12				
50 m						
60m	13	123				
70m	-	1				
80 m			123			
90 m						
100+m	-	-				
					3	

Table 13

Priagul d abundance by seasons.

The number separated by periods are total numbers of priapulids (nearly all larvae) at that station during sampling period I, II and III, respectively. A dash (-) means none found (=0), and a cross (x) indicates no sample or no data.

Depth	VI	V	Transects IV	III	II	I
10 m			- 12 -			- - -
			- 1 -			
			- 1 -	- 7 -	- - 1	- 1 -
20 m	- - -		- [illegible]			
	- - -		- - 1	- - 1		
30 m	- - 1		- - 1		- - -	
	1 - -				- - -	
	- - 2	- 20 -		4.1.1		
		[illegible]	[illegible]	x 1 3	- - 3	- - -
40 m		1.1.4		[illegible]	-	
		1 - -				
50 m		[illegible] 4 7				- 13.3
60 m	7.[illegible]	- - -				
70 m	1 [illegible]	- - 1				
80 m			2.6.3			
90 m						- 3.6
100+ m	- -	- - -				
		- - -	- - -	- 1 -	2.3.3	- 8.3

Table 14

Kinorhynchia abundance by seasons.

as for Table 13.

Depth	Transects VI	V	IV	III	11	I
						3.1.2
10 m			6.9.3			
			6.2.58			
			12.31.7	51.35.36	3 - 2	1 - -
20 m	25.14.26		4.12 -			
	17.14.1		6.3.3	13.10.32		
30 m	32.17.21		18.8.2		6.1.6	
	90.20.23				47.26.106	
	66.14.21	4.11.4		12.4.21		
	26. 9.12	16.10.4	16.3.4	X.1.2	- 1.36	12.20.3
40 m		2.8.6		x.x.29	2.1.7	
		2.5.1				
50 m		x.6.2				7.4.3
50 m	21.16.8	8.7.7				
70 m	7.1 -	1 - -				
80 m			23.32.8			
90 m						4,3,1
100+m	14.1.1	15.3.3				
		3.1 -	2.6 -	11.1.3	4.1.1	2.1.3

REFERENCES

Bovee, F. de and J. Soyer. 1974. Cycle annuel quantitatif du meiobenthos des vases terrigenes cotieres distribution verticale. Vie Milieu 24(1B):141-157

Gray, J. S. 1974. Animal-sediment relationships. Oceanogr. rear. Biol.ann. Rev. 12:223-261.

McIntyre, A. D. and D. J. Murison. 1974. The meiofauna of a flatfish nursery ground. J. mar. biol. Ass. U. K. 53:93-118.

Tietjen, J. H. 1971. Ecology and distribution of deep-sea meiobenthos off North Carolina. Deep-Sea Res. 18:941-957.

Warwick, R. M. and J. B. Buchanan. 1971. The meiofauna off the coast of Northumberland. II. Seasonal stability of the nematode population. J. mar. biol. Ass. U.K. 51:355-362.

Wieser, W. 1960. Benthic studies in Buzzards Bay. II. The meiofauna. Limnol. Oceanogr. 5:131-137.

Figure 8A, 8C - Hard Coral Species Diversity and Evenness for BLM 19 and 32/34 Respectively at Station 147.

He' ________ J' --------

Figure 8B, 8D - Hard Coral Number of Individuals and Number of Species/5M Quadrat for BLM 19 and 32/34 Respectively at Station 147.

Individuals/M^2 ____________ No.Species/5M Quadrat --------------