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A QUANTITATIVE STUDY OF THE SAND BEACH MEIOFAUNA IN TUNISIA — PRELIMINARY REPORT

By

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ABSTRACT

A quantitative study of the sand beach meiofauna was conducted at Raouad Beach during December, 1970. The abundance of the meiofauna ranged from 49 to 285 specimens per 10 cm^2 in the wave-wash zone and 5 to 22 per 10 cm^2 in the 40 cm water table. Differences in extraction efficiency using magnesium chloride and ethyl alcohol are presented and the significance discussed.

RESUME

Une étude quantitative sur la méiofaune de la plage sablonneuse de Raouad a été effectuée durant le mois de décembre 1970. L'abondance de cette méiofaune varie entre 49 et 285 spécimens par 10 cm^2 dans la zone de ressac et entre 5 à 25 spécimens par 10 cm^2 dans la zone recouverte par 40 cm d'eau. Les différences entre les méthodes d'extraction au chlorure de magnésium et à l'alcool éthylique sont présentées et discutées.

This is a preliminary report on a study of the population dynamics and zoogeography of the meiofauna of sand beaches of Lebanon, Tunisia and Morocco. The studies in Tunisia are in cooperation with the Institut national scientifique et technique d'océanographie et de pêche and their assistance is gratefully acknowledged. Financial support for the study is provided through the Foreign Currency Program of the Smithsonian Institution and the American University of Beirut. The Mediterranean Marine Sorting Center provided invaluable assistance during this study. The support and assistance of these institutions and organizations are also gratefully acknowledged. The assistance of Dr. John Gray, Wellcome Marine Laboratory, Robin Hood's Bay, England and Dr. Willis Hayes, Department of Biology, American University of Beirut for the statistical analyses is acknowledged.

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Meiofaunal studies in the Mediterranean have been reviewed by Delamare Deboutteville (1960), Pérès (1968), Bacescu (1969), McIntyre (1969) and Hulings (1972). Little is known of the numerical density and zoogeography of the sand beach meiofauna in the Mediterranean, especially the coast of North Africa. Most of the studies that have been conducted (France, Italy and northern Adriatic) have been faunistic and qualitative rather than quantitative. Delamare Deboutteville (1953a, b) conducted faunistic surveys of selected sand beaches of Tunisia and Algeria. The beaches were sampled only once and qualitatively rather than quantitatively.

Recently detailed studies of the meiofauna of the sand beaches of Tunisia have resulted in the finding of new important taxa. Westheide and Bunke (1970) described the first marine species of the Aelosomatidae (Oligochaeta), *Aeolosoma maritimum,* and a new genus of an aberrant Archiannelida, *Apharyngtus punicus,* was described by Westheide (1971) from sand beaches in the Gulf of Tunis. Westheide (1970) studied the organization, biology and ecology of the interstitial polychaete, *Hesionides gohari* Hartmann-Schröder, from Tunisian beaches.

A study of population dynamics and zoogeography along the coast of North Africa has been initiated concentrating primarily on Tunisia and Morocco. Studies in Lebanon are also being conducted along the same lines. The sampling program is based on intensive quantitative sampling, statistically designed, and conducted two times a year, once during the dry season (summer) and once during the rainy season (winter). All beaches being studied are open marine. This report is on a winter sampling in Tunisia and is intended only as a preliminary report in the sense that the various taxa have not been considered at the species level and the various environmental parameters have not been sufficiently documented.

DESCRIPTION OF SAMPLING AREA

Raouad Beach is on the western side of the Gulf of Tunis and fully exposed to the open Gulf. The beach is about 23 km long without interruption by rock outcrops and is oriented in an approximate north-south direction. At the northern end of the beach, the Medjerda River empties into the Gulf of Tunis. At the southern end and to the west is Lake Sebka Er Riana which during the summer (dry season) is a salt flat and during the winter (rainy season) is filled with water. It appears that the combination of flow of the Medjerda River and the filling of Lake Sebka Er Riana during the winter has little widespread effect on reducing salinity in the Gulf of Tunis.

The Gulf of Tunis is, for all practical purposes, tideless. The controlling factor as far as the beaches are concerned, is wind waves which can drastically alter the profile of the beaches in a short period of time. Usually, however, the profile is rather gentle being less than 5°. The sand is fine grained and well sorted (see Table 1).

The sites on the beach selected for detailed study were chosen following a preliminary survey during the Summer of 1970. In conducting the preliminary survey, samples were taken with various diameter coring tubes and evaluated following the method of Gray (1972). It was found that the 4.4 cm diameter core yielded the most representative sample.

MATERIALS AND METHODS

Raouad Beach was sampled during a 10 day period (19 to 28 December 1970). Two sites on Raouad were sampled, one at the south end near a bunker and the other, about 1 km to the north. At each site, two specific areas of the beach were sampled, one in the wave-wash or splash zone at a point where the surface of the sand was saturated with water 90 to 95 percent of the time; the other, landward to the beach where the water table was at a depth of 40 cm. In the latter case, the sand was excavated to where the surface of the sand at 40 cm was saturated to the same degree as in the wave-wash zone.

At each specific site, a 0.25 m^2 frame divided into 16 equal squares was placed for sampling. Six samples were taken within the frame, the squares to be sampled being determined by random numbers (each square was numbered 1 through 16). Within each square, a coring tube 4.4 cm in diameter was used to collect cores 10 cm deep. Each core was divided into 0 to 5 cm and 5 to 10 cm and studied separately. Temperature measurements, using an ordinary bulb thermometer were made; water samples for salinity determinations and approximately 100 g of sand for grain size analysis were taken from the middle or as close to the middle as possible of the 0.25 m^2 frame.

In the laboratory, the meiofauna was extracted by using two separate techniques. The first extraction was with isotonic $MgCl_2$ (ca 75 g/L of seawater). Extraction was carried out in the containers (475 ml) in which the cores were placed. To each container, 275 ml of isotonic $MgCl_2$ was added and left for about 30 min. During this period, the sample was stirred two to three times. The supernatant was poured through a 62-μ net. Three washes with seawater followed and the concentrate was placed

TABLE 1

Salinity, temperature and grain size data for RN and RB.

	Salinity (‰)	Temp (°C)	Mz (Phi)	σ I
RN (WWZ; 0-5; 19 Dec)	—	—	2.28	.47
RN (WWZ; 5-10; 19 Dec)			2.40	.38
RB (WWZ; 0-5; 22 Dec)	—	18.0	2.83	.22
RB (WWZ; 5-10; 22 Dec)			2.38	.46
RN (WWZ; 0-5; 24 Dec)	—	18.5	2.50	.33
RN (WWZ; 5-10; 24 Dec)			2.40	.38
RN (WT; 0-5; 24 Dec)	—	17.0	2.32	.24
RN (WT; 5-10; 24 Dec)			2.20	.52
RB (WWZ; 0-5; 24 Dec)	—	18.5	2.18	.24
RB (WWZ; 5-10; 24 Dec)			2.10	.38
RB (WT; 0-5; 24 Dec)	—	—	2.02	.45
RB (WT; 0-5; 24 Dec)			2.00	.46
RN (WWZ; 0-5; 28 Dec)	37.6	15.0	2.42	.42
RN (WWZ; 5-10; 28 Dec)			2.15	.43
RN (WT; 0-5; 28 Dec)	31.8	14.0	—	—
RN (WT; 0-5; 28 Dec)			—	—
RB (WWZ; 0-5; 28 Dec)	37.4	15.8	2.13	.34
RB (WWZ; 5-10; 28 Dec)			2.30	.46
RB (WT; 0-5; 28 Dec)	37.2	—	—	—
RB (WT; 5-10; 28 Dec)			—	—

in Petri dishes for study and enumeration. Following the $MgCl_2$ extraction, a second extraction, using 10 percent ethyl alcohol was made. The alcohol was added to the sample, stirred vigorously and left for one minute. The supernatant was then poured through a 62-μ net as were three washes with seawater. The concentrate was placed in a separate Petri dish for study and enumeration. Following extraction by $MgCl_2$ and ethyl alcohol, spot checks were made to determine extraction efficiency. Without exception, the two extractions proved to be almost 100 percent efficient for all taxa.

During the study and enumeration of the organisms, each specimen was recorded by taxon usually a higher level since determination of the species has not been initiated. Special attention was given to the « soft fauna », i.e., those forms that cannot be adequately preserved for systematic study, especially Turbellaria and Gastrotricha. The specimens belonging to the « soft fauna » were photographed live and squash preparations of some of the Turbellaria were made for later study. Following study and enumeration of each sample, it was preserved in buffered 5 percent formalin. Chlorinity was determined by the standard Knudsen silver nitrate titration and converted to salinity. The procedure given in Hulings and Gray (1971) was followed for analysis of the sand. The graphic mean, M_z (Folk, 1968) and the inclusive graphic standard deviation, σ I (Folk, 1968) were determined. Temperature, salinity and sand analysis data are shown in Table 1. The following designations are used for the various sampling sites : RN = Raouad North; RB = Raouad Bunker; WWZ = wave-wash zone; WT = water table at 40 cm.

RESULTS

As shown by Gray and Rieger (1971), extraction of meiofauna by $MgCl_2$ alone is not sufficient to yield the total fauna. They found that $MgCl_2$ yielded 58.53 percent of the fauna and ethyl alcohol the remaining 41.47 percent. Significant differences were found among the various taxa by Gray and Rieger. The results of the two extractions in this study (Table 2) are essentially the same as found by Gray and Rieger.

It should be noted that the ethyl treatment has a detrimental effect on certain taxa, especially certain Turbellaria to the extent that the body wall becomes very distorted. For other taxa, the response to the two extractions is extremely variable. Some survive the $MgCl_2$ treatment but are killed by the ethyl alcohol, while others are not killed by the ethyl alcohol. Within the Nematoda, one finds an example of the above. The Harpac-

TABLE 2

Extraction efficiency for selected taxa

	Mg Cl_2		Ethyl Alcohol	
	Number	Percent	Number	Percent
Total Fauna	4140	57	3138	43
Nematoda	2670	48	2913	52
Turbellaria	476	78	137	22
Gastrotricha	23	72	9	28
Tardigrada	11	39	17	61
Harpacticoida	587	98	10	2
Archiannelida	274	96	11	4
Polychaeta	36	97	1	3
Cyclopoida	48	68	25	32
Halacaridae	1	14	6	86
Oligochaeta	14	61	9	39

TABLE 3

Mean of total fauna, number per 10 cm², mean and percent in 0 to 5 and 5 to 10 cm intervals for RN and RB

	Total*	No/10 cm^2	0-5 cm		5-10 cm	
			Mean	% of total	Mean	% of total
			RN (WWZ)			
19 Dec 70	198	130	100	51	98	49
24 Dec 70	144	95	99	69	45	31
28 Dec 70	433	285	250	58	183	42
			RB (WWZ)			
22 Dec 70	183	120	72	39	111	61
24 Dec 70	163	107	43	26	121	74
28 Dec 70	75	49	28	37	47	63
			RN (WT)			
24 Dec 70	13	9	5	38	8	62
28 Dec 70	8	5	5	63	3	37
			RB (WT)			
24 Dec 70	19	13	11	58	8	42
28 Dec 70	33	22	18	55	15	45

* Mean number per 4.4 cm diameter, 10 cm deep core for six combined samples.

ticoida are often killed by the $MgCl_2$ whereas neither $MgCl_2$ or ethyl alcohol seems to have a significant effect on the Cyclopoida and Tardigrada in terms of live *vs.* dead. The Archiannelida are, in most cases killed by the ethyl alcohol and fragment very easily.

The faunal results are shown in Tables 3 and 4. Table 3 shows the total fauna (mean of six 10 cm cores); the number per 10 cm^2; the mean and percent occurring in the 0 to 5 and 5 to 10 cm intervals. The data for the wave-wash zone at RB reveals that the mean of fauna was considerably different during the period of sampling (ranging from 144 to 433) although the results for vertical distribution were fairly consistent in that most of the fauna was only slightly more abundant in the 0 to 5 cm interval than in the 5 to 10 cm interval. The wave-wash zone at RB also revealed a significant fluctuation in total fauna during the sampling period and the vertical distribution was the reverse of that at RN in that more of the meiofauna occurred in the 5 to 10 cm interval than in the 0 to 5 interval.

The data for the 40 cm water table at both sites reveal a very low number of specimens compared to the wave-wash zone and a difference in the vertical distribution between the two sites. It is interesting to note that the vertical distribution at the wave-wash zone and at the water table is the reverse at both RN and RB.

Table 4 shows the distribution of the taxa by sample in the 0 to 5 and 5 to 10 cm intervals. At RN, the dominant taxa, in order of decreasing abundance, were Nematoda, Turbellaria, Archiannelida, and Harpacticoida. The occurrence of the Archiannelida, however, was not consistent (note the large numbers obtained 19 Dec. 70). Fluctuations also occurred in other groups (Nematoda, Turbellaria and Harpacticoida). At RB, the Nematoda, followed by the Turbellaria, Harpacticoida, and Archiannelida were the dominant taxa. It is important, however, to note the fluctuations from one sampling date to another.

The meiofauna at the 40 cm water table at RN was dominated by the Nematoda and Harpacticoida with the other taxa almost equally distributed. At RB, Nematoda again were the dominate faunal element followed, as before, by the Harpacticoida and Oligochaeta. But again, note must be taken of the fluctuations from one sampling data to the next.

Considering the occurrence of individual taxa, the Mystacocarida and Tardigrada were found at RB in both the wave-wash zone and at the 40 cm water table but not at RN. Their abundance, however, was very small at RB.

TABLE 4

Number of specimens per taxon in the 0 to 5 and 5 to 10 cm intervals for RN and RB

RN (WWZ; 19 Dec 70)

Taxon	1		2		3		4		5		6		Total	Mean	Mean %
	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10			
Nematoda	88	76	52	41	62	32	81	48	66	92	108	81	827	137.8	69.5
Harpacticoida	6	7	6	3	4	2	4	0	3	4	4	4	47	7.8	3.9
Cyclopoida	0	0	0	0	0	1	1	0	1	1	1	0	5	0.8	0.4
Turbellaria	5	14	9	5	5	7	10	5	9	5	9	9	92	15.3	7.7
Gastrotricha	1	0	0	0	0	0	0	1	0	0	0	0	2	0.3	0.2
Archiannelida	22	7	8	13	10	22	11	32	8	42	4	34	213	35.5	17.9
Others	0	0	2	0	0	0	0	0	2	0	0	0	4	0.7	0.3
Total	122	104	77	62	81	64	107	86	89	144	126	128	1190	198.3	

TABLE 4 (Continued)

RN (WWZ; 24 Dec. 70)

	1		2		3		4		5		6		Total	Mean	Mean %
	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10			
Nematoda	73	40	81	22	69	42	72	28	62	33	58	31	611	101.8	70.0
Harpacticoida	11	8	9	4	8	7	6	4	9	9	11	10	96	16.0	11.0
Cyclopoida	0	0	2	0	1	2	0	0	0	1	0	0	6	1.0	0.7
Turbellaria	23	10	18	5	30	3	18	3	11	6	11	7	145	24.1	16.6
Gastrotricha	1	0	1	0	0	0	1	0	0	0	1	0	4	0.7	0.5
Archiannelida	0	0	0	0	1	0	0	0	0	1	1	0	3	0.5	0.3
Polychaeta	0	0	2	0	2	0	2	0	0	0	0	0	6	1.0	0.7
Others	0	0	0	0	0	1	0	0	1	0	0	0	2	0.3	0.2
Total	108	58	113	31	111	55	99	35	83	50	82	48	873	145.5	

TABLE 4 (Continued)

RN (WWZ; 28 Dec. 70)

	1		2		3		4		5		6		Total	Mean	Mean %
	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10			
Nematoda	234	216	184	95	304	189	131	95	282	207	244	175	2356	392.7	90.6
Harpacticoida	5	3	2	4	2	5	2	7	0	5	0	2	37	6.2	1.4
Cyclopoida	1	0	0	0	1	0	1	0	4	0	0	2	9	1.5	0.3
Turbellaria	20	9	28	11	12	7	10	10	8	17	7	14	153	25.5	5.8
Gastrotricha	0	1	3	1	2	1	1	1	0	0	1	0	11	1.8	0.4
Archiannelida	3	1	2	0	2	7	1	1	1	3	0	2	23	3.8	0.9
Polychaeta	0	0	0	0	0	0	0	0	0	1	0	0	1	0.2	0.04
Halacaridae	0	1	1	0	0	1	0	2	1	0	0	0	6	1.0	0.2
Others	0	0	0	1	0	0	0	1	0	1	0	0	3	0.5	0.1
Total	263	231	220	112	323	210	146	117	296	234	252	195	2599	433.2	

TABLE 4 (Continued)

RB (WWZ; 22 Dec. 70)

	1		2		3		4		5		6		Total	Mean	Mean %
	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10			
Nematoda	49	82	77	114	59	78	59	115	47	96	60	82	918	153.0	83.8
Harpacticoida	9	3	6	5	6	9	9	7	3	7	2	4	70	11.7	6.4
Cyclopoida	1	1	0	0	0	1	0	0	0	0	0	0	3	0.5	0.3
Turbellaria	11	4	7	5	4	5	1	10	3	6	3	8	67	11.2	6.1
Gastrotricha	1	1	0	2	0	0	1	0	0	1	1	0	7	1.2	0.6
Archiannelida	1	0	0	0	0	0	0	0	1	0	1	0	3	0.5	0.3
Polychaeta	2	0	0	2	0	1	1	0	1	0	2	1	10	1.7	0.9
Tardigrada	2	1	0	4	0	1	0	3	0	3	0	0	14	2.3	1.3
Others	0	1	0	0	0	1	1	0	1	0	0	0	4	0.7	0.4
Total	76	93	90	132	69	96	72	135	56	113	69	95	1096	182.7	

TABLE 4 (Continued)

RB (WWZ; 24 Dec. 70)

	1		2		3		4		4		6		Total	Mean	Mean %
	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10			
Nematoda	19	64	20	58	37	73	27	61	24	91	17	90	581	96.8	59.2
Harpacticoida	11	39	3	44	5	44	13	17	8	31	7	29	251	41.8	25.6
Cyclopoida	2	0	1	1	1	2	4	2	2	1	1	2	19	3.2	1.9
Turbellaria	4	14	4	8	14	12	15	7	8	2	2	7	97	16.2	9.9
Gastrotricha	0	0	1	0	0	0	1	0	0	0	0	2	4	0.7	0.4
Archiannelida	0	0	0	0	0	1	1	3	0	2	0	1	8	1.3	0.8
Polychaeta	0	2	0	0	0	1	0	4	0	1	0	2	10	1.7	1.0
Tardigrada	0	1	0	1	0	0	0	1	2	1	1	1	8	1.3	0.8
Others	1	1	0	0	0	0	0	0	0	0	1	0	3	0.5	0.3
Total	37	121	29	112	57	133	61	95	44	129	29	134	981	163.5	

TABLE 4 (Continued)

RB (WWZ; 28 Dec. 70)

	1		2		3		4		5		6		Total	Mean	Mean %
	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10			
Nematoda	27	32	14	19	13	14	15	38	15	42	17	18	264	44.0	58.3
Harpacticoida	7	6	5	18	2	9	2	15	4	10	1	0	79	13.2	17.4
Cyclopoida	1	0	0	0	2	0	1	1	0	1	0	0	6	1.1	1.3
Mystacocarida	0	1	0	1	0	0	0	0	0	0	0	0	2	0.3	0.4
Turbellaria	7	3	5	14	7	5	3	2	2	3	5	3	59	9.8	13.0
Gastrotricha	1	1	0	1	0	0	0	0	0	0	0	0	3	0.5	0.7
Archiannelida	9	2	0	6	1	4	0	1	1	5	0	3	32	5.3	7.1
Polychaeta	0	1	0	2	0	0	0	1	0	0	0	0	4	0.7	0.9
Tardigrada	0	0	0	0	0	0	0	0	0	0	0	1	1	0.2	0.2
Halacaridae	0	0	0	1	0	0	0	0	0	0	0	0	1	0.2	0.2
Others	0	0	1	0	1	0	0	0	0	0	0	0	2	0.3	0.4
Total	52	46	25	62	26	32	21	58	22	61	23	25	453	75.5	

TABLE 4 (Continued)

RN (WT; 24 Dec. 70)

	1		2		3		4		5		6		Total	Mean	Mean %
	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10			
Nematoda	1	5	4	8	2	6	7	6	0	10	6	7	62	10.3	81.6
Harpacticoida	0	0	0	0	1	0	0	0	0	0	0	0	1	0.2	1.3
Cyclopoida	0	1	2	0	1	0	0	0	1	1	1	0	7	1.2	9.2
Turbellaria	0	1	0	0	0	0	0	1	0	0	0	0	2	0.3	2.6
Oligochaeta	1	0	0	0	0	0	0	0	1	1	0	1	4	0.7	5.3
Total	2	7	6	8	4	6	7	7	2	12	7	8	76	12.7	

RN (WT; 28 Dec. 70)

Nematoda	3	1	1	3	1	2	5	1	2	1	2	2	24	4.0	50.0
Harpacticoida	0	1	0	0	0	0	1	0	6	7	2	1	18	3.0	37.5
Turbellaria	1	0	1	0	0	0	0	1	1	0	1	1	6	1.0	12.5
Total	4	2	2	3	1	2	6	2	9	8	5	4	48	8.0	

TABLE 4 (Continued)

RB (WT; 24 Dec. 70)

	1		2		3		4		5		6		Total	Mean	Mean %
	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10	0-5	5-10			
Nematoda	13	5	4	9	8	6	7	2	7	8	2	3	74	12.3	64.4
Harpacticoida	0	1	0	0	0	0	0	1	1	0	1	0	4	0.7	3.5
Cyclopoida	1	0	1	0	0	0	2	1	0	1	1	0	7	1.2	6.1
Turbellaria	0	2	1	2	0	1	0	1	0	0	0	0	7	1.2	6.1
Oligochaeta	1	1	3	0	1	1	1	0	2	1	2	3	16	2.7	13.9
Polychaeta	0	0	0	1	1	0	1	0	1	0	0	1	5	0.8	4.4
Tardigrada	0	0	0	0	1	0	0	0	0	0	0	0	1	0.2	0.9
Others	0	0	0	0	0	0	0	0	0	0	1	0	1	0.2	0.9
Total	15	9	9	12	11	8	11	5	11	10	7	7	115	19.2	

RB (WT; 28 Dec. 70)

Nematoda	8	2	12	7	5	16	2	7	9	4	—	—	72	14.4	42.9
Harpacticoida	12	7	11	7	3	4	7	7	5	1	—	—	64	12.8	38.1
Turbellaria	1	0	1	1	2	1	0	3	3	1	—	—	13	2.6	7.8
Archiannelida	0	1	2	1	2	0	0	0	1	2	—	—	9	1.8	5.4
Oligochaeta	1	0	1	0	1	0	0	2	1	0	—	—	6	1.2	3.6
Mystacocarida	0	1	0	0	0	0	0	0	0	0	—	—	1	0.2	0.6
Others	0	1	0	1	0	0	0	1	0	0	—	—	3	0.6	1.8
Total	22	12	27	17	13	21	9	20	19	8	—	—	168	33.6	

The results obtained during the December 1970 sampling agree with results obtained during July and August, 1970 in terms of dominant components of the community. Although the data obtained during Summer, 1970 were quantitative, ethyl alcohol extraction of the fauna was not done, thus direct comparisons are meaningless.

DISCUSSION

In attempting to determine absolute numerical density of meiofauna of sand beaches, it is clear from the results obtained here and by Gray and Rieger (1971) that extraction of the fauna is a very critical consideration. Based on preliminary results of a similar sampling program being conducted in Lebanon, it is not only the wave-wash zone fauna, where there is probably a higher percent of the fauna with adhesive structures, that must be extracted by using the $MgCl_2$ and ethyl alcohol techniques but for the meiofauna present in the water table at 40 cm. It, thus, appears that subtidal fauna should be extracted through use of the two extractions in order to obain data approaching the true numerical density.

In comparing the day to day fluctuation in the total population over the sampling period, the fluctuations were relatively small except for the 28 Dec. sampling where at RN there was a 46 percent increase in the total population whereas at RB there was a 41 percent decrease. This comparison is based on maximum number obtained during entire sampling period. A more valid comparison is between days of simultaneous sampling at the two sites; a 33 percent increase at RN and a 46 percent decrease at RB. Yet at any one site, the distribution of the total fauna between the six samples was relatively uniform. Furthermore, the vertical distribution of the fauna was consistent at each site over the three sampling periods.

The variations in the density of the meiofauna at one site from day to day and between sites (RN and RB) especially in the wave-wash zone are unexplainable. It must be pointed out that only very limited environmental data are available. Given the almost identical exposure to the open Gulf of Tunis, essentially the same slope, essentially the same grain size for each site, and a period of relative stability in terms of wave action, it appears that what is reflected are natural fluctuations in the community.

The total faunal data from the wave-wash zone given in Table 4 were treated statiscally using the analysis of variance of Sokal and Rohlf (1969). The data were transformed to $\log_{10}$

TABLE 5

A. Two way analysis of variance of the total wave-wash zone fauna from RB and RN. Analysis based on data from Table 4 after transformation to $\log_{10}$.

Source of variation	Degrees of freedom	Sum of squares	Mean square	*F* ratio
Subgroups	5	1.7825	0.3577	
A - areas RN and RB	1	0.5478	0.5478	81.76
B - time of sampling	2	0.0501	0.0251	3.746
A × B interaction	2	1.1846	0.5923	88.4
Within sample (error)	35	0.2324	0.0067	
Total	45	2.0149		

$F_{.01}\ (1,35) = 7.44$

$F_{.05}\ (2,35) = 3.18$

$F_{.01}\ (2,35) = 5.29$

B. Students « *t* » test on closest sets of data (transformed to $\log_{10}$).

	RN (WWZ; 24 Dec)	*vs*	RB (WWZ; 28 Dec)
$\bar{X}$	2.1597		1.864
S^2_1	0.0019	S^2_2	0.0117

$t = 8.1798$

	RN (WWZ; 28 Dec)	*vs*	RN (WWZ; 19 Dec)
$\bar{X}$	2.6227		2.2932
S^2_1	0.0132	S^2_2	0.0110

$t = 3.9181$

TABLE 5 (Continued)

Nematoda

RN (0-5; 24 Dec) RB (0-5; 24 Dec)	69 24	68 54	9.6	.001
RN (5-10; 24 Dec) RB (5-10; 24 Dec)	33 73	56 213	5.8	.001
RN (0-5; 28 Dec) RB (0-5; 28 Dec)	230 17	4062 27	8.6	.001
RN (5-10; 28 Dec) RB (5-10; 28 Dec)	163 27	2963 137	6.0	.001
RN (0-5; 24 Dec) RN (0-5; 28 Dec)	69 230	68 4062	5.5	.001
RN (5-10; 24 Dec) RN (5-10; 28 Dec)	33 163	56 2963	5.8	.001
RB (0-5; 24 Dec) RB (0-5; 28 Dec)	24 17	54 27	2.0	.05
RB (5-10; 24 Dec) RB (5-10; 28 Dec)	73 27	213 137	1.9	.10

TABLE 5 (Continued)

Fauna other than Nematoda

RN (0-5; 24 Dec) RB (0-5; 24 Dec)	30 19	60 75	2.4	.05
RN (5-10; 24 Dec) RB (5-10; 24 Dec)	14 48	21 115	7.2	.001
RN (0-5; 28 Dec) RB (0-5; 28 Dec)	20 11	109 53	1.7	.10
RN (5-10; 28 Dec) RB (5-10; 28 Dec)	20 20	17 8	.04	.90
RN (0-5; 24 Dec) RN (0-5; 28 Dec)	30 20	60 109	1.9	.10
RN (5-10; 24 Dec) RN (5-10; 28 Dec)	14 20	21 17	2.8	.02
RB (0-5; 24 Dec) RB (0-5; 28 Dec)	19 11	75 53	16.3	.001
RB (5-10; 24 Dec) RB (5-10; 28 Dec)	48 20	5 148	4.2	.001

and the results of the statistical treatment are shown in Table 5. The results of the analysis of variance show that areas RB and RN differ significantly; that there were significant differences in numbers of total fauna with time; and that the area-time interaction between RB and RN was significantly different, i.e., the fauna was significantly different in the areas at different times of sampling.

Students « t » test was applied to the transformed data to determine which interactions were significant. Only the closest sets of data were analyzed, RN 24 Dec. *vs.* RB 28 Dec. and RN 28 Dec. *vs.* RN 19 Dec. The results of the analysis show that RB had significantly less meiofauna on 28 Dec. than all other areas and at all other times. RN had significantly more meiofauna on 28 Dec. than all other areas times.

There are two primary factors that must be kept in mind in interpreting the above statistical analyses. One is the comparison of areas RN 19 Dec. with RB 22 Dec. The results have demonstrated significant differences at times sampling both areas synoptically. Thus, less significance is given to comparing two areas on two different samplings.

Second, the analysis is based on total fauna at the higher taxon level. No striking differences in the « species » were noted during the study and enumeration of the fauna from the wave-wash zone at RB and RN. It is suspected that then the fauna is treated statiscally at the species level there may, in fact, be considerable similarity between the areas. It is, thus, important to consider the total population at the species level in order to accurately determine community structure and population dynamics.

LITERATURE CITED

BACESCU M. (1969). — Rapport du Comité benthos (1967-1969). *Rapp. P.V. Réun. Comm. int. Expl. scient. Mer. Méd.*, t. 20, n° 2 : 35-75.

DELAMARE DEBOUTTEVILLE C. (1953 a). — La faune des eaux souterraines littorales des plages de Tunisie. *Vie et milieu*, t. 4, n° 2 : 141-170.

DELAMARE DEBOUTTEVILLE C. (1953 b). — La faune des eaux souterraines littorales en Algérie. *Id.*, t. 4, n° 3 : 470-503.

DELAMARE DEBOUTTEVILLE C. (1960). — Biologie des eaux souterraines et continentales. Paris, Hermann : 740 p.

FOLK R.L. (1968). — Petrology of Sedimentary Rocks. Austin, Texas; Hemphills : 159 p.

GRAY J.S. (1972). — Sample Size and Sample Frequency in Relation to the Quantitative Sampling of Sand Meiofauna. In N.C. Hulings, editor, Proceedings of the First Interna ional Conference on Meiofauna.. *Smithson. Contr. Zool.*, n° 76 (In press.).

GRAY J.S. and RIEGER R.M. (1971). — A Quantitative Study of the Meiofauna of an Exposed Sandy Beach, at Robin Hoods's Bay, Yorkshire. *J. Mar. biol. Ass. U.K.*, t. 51 : 1-19.

HULINGS N.C. (1972). — Proceedings of the First International Conference on Meiofauna. *Smi hson. Contr. Zool.*, n° 76. (In press.).

HULINGS N.C. and GRAY J.S. (1971). — A Manual for the Study of Meiofauna. *Id.*, n° 78 : 1-83.

MCINTYRE A.D. (1969). — Ecology of Marine Meiobenthos. *Biol. Rev.*, t. 44 : 245-290.

PERES J.M. (1968). — Rapport du Comité benthos (1964-1966). *Rapp. P.V. Réun. Comm. int. Expl. scient. Mer. Médit.*, t. 19, n° 2 : 39-75.

SOKAL R.R. and ROHLF F.J. (1969). — Biometry. The Principles and Practice of Statistics in Biological Research. San Francisco, W.H. Freeman : 776 p.

WESTHEIDE W. (1970). — Zur Organisation, Biology und Okologie des interstitiellen Polychaeten *Hesionides gohari* Hartmann-Schröder (Hesionidae). *Akad. Wiss. Lit. Math-Naturw. Kl. Mainz, Mikrofauna des Meeresbodens,* 3 : 101-135.

WESTHEIDE W. (1971). — *Apharyngtus punicus* nov. gen. nov. spec., ein aberranter Archiannelide aus dem Mesopsammal der tunesischen Mittelmeerküste. *Akad. Wiss. Lit. Math.-Naturw. Kl., Mainz, Mikrofauna des Meeresbodens,* 6 : 233-249.

WESTHEIDE W. and BUNKE D. (1970). — *Aeolosoma maritimum* nov. spec., die erste Salzwasserart aus der Familie Aeolosomatidae (Annelida : Oligochaeta), *Helgölander wiss. Meeresunters.* 21 : 134-142.