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Benthic Foraminifera from Littoral Sediments of Al Lith-Al Qunfidhah Coast, Southeastern Red Sea

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Fifty five surface sediment samples from the nearshore area between Al Lith and Al Qunfidhah, southeastern Red Sea have been analysed for benthic Foraminifera. In contrast with the northeastern parts of the Red Sea, rotaliids dominate the fauna of this region. However, in sediments rich in carbonate, miliolids are abundant. Textularids are very rare. Rotaliids are mostly associated with fine sediments, while miliolids are shared between coarse and fine sediments. The relative dominance of Rotaliina over Miliolina is attributed to the periodic influx of fresh water and mixing of terrigenous sediments with the *in situ* carbonates. The observed dominance of Miliolina over Rotaliina in certain sediments along the coast indicates typical character of subtropical carbonates and no hypersaline conditions in those places.

Few foraminiferal studies[1-3] have been conducted in the northeastern part of the Red Sea. Except for the information on littoral sediments of Farasan islands in the southern Red Sea[4], nothing is known on the microfaunal compositions of the southeastern Red Sea, particularly in the nearshore region. Therefore, an attempt is made to study the foraminiferal composition in the nearshore sediments along Al Lith-Al Qunfidhah coast and to compare the distribution with that of the northeastern Red Sea.

Materials and Methods

The study area covers about a 170 km stretch of the nearshore environment, on the west coast of Saudi Arabia (Fig. 1). Unlike the other parts of the coastline in the eastern Red Sea, the Al Lith-Al Qunfidhah coast (Fig. 1) is shaped by prominent deltas built up by the wadis (streams). These wadi channels traverse 10-30 km wide coastal plain landward of the beaches. The nearshore zone is characterized by shallow banks and coral reef deposits. The coastal sediments are a mixture of calcareous and terrigenous fractions. Al Lith forms an approximate climatic northern boundary of the area that is influenced by monsoon rains[5].

Along 11 transects, 55 sediment samples were collected from the beach, intertidal and subtidal areas (Fig. 1) during January and February 1986. The transects were so selected that alternate transect is located in front of a major wadi. In each transect, 1 sediment sample from the foreshore beach and 2 each from the intertidal (I1 and I2) and subtidal (S1 and S2) regions were collected. The sample interval in the intertidal and subtidal zones varied from 15 to 25 m depending on the extent and depth of water in the area. Sediments were obtained by a small Van Veen grab from the subtidal regions below 1.5 m. Samples were scraped off the surface from the beach and intertidal areas.

Mean grain-size analysis[6] of a portion of the desaltified sediments was carried out using 1/2 ϕ interval sieves. Total carbonate (TC) content of the sedi-

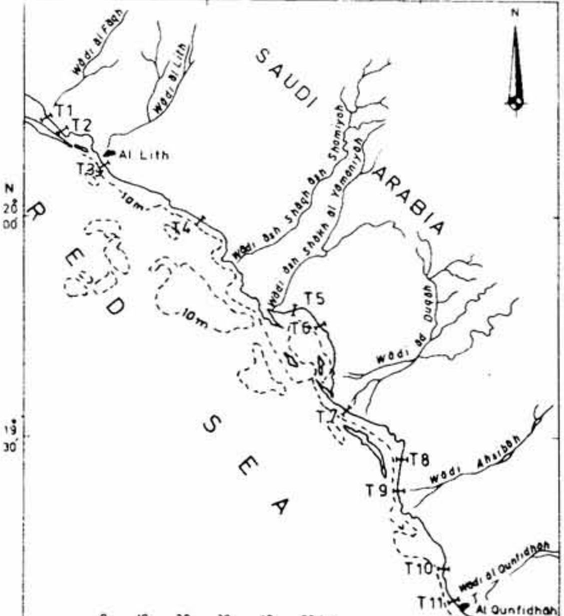

Fig. 1—Location of transects in the study area (depth contour—10 m)

ments was determined by gasometric method using calcimeter.

For the Foraminifera, a representative portion of the sample was initially washed through a 63 μm mesh sieve and the sand fraction was then air-dried. Foraminifera were concentrated from the sediments by standard flotation technique using carbon tetrachloride. In the representative splits of each sample, Foraminifera were identified, counted and numerical percentages calculated. Species diversity was measured using Fisher[7] α index.

Results and Discussion

The sediments in the study area are mostly clastic in nature and are mixed with *in situ* carbonates in various proportions. TC content of the sediments varies between 1 and 80%. Sediments from the mouth regions of the wadis and about 85% of sediments in between the wadis have carbonate values < 10%. Exceptionally sediments off wadi Al Dugh (Fig. 1) contain TC content of more than 50% (maximum 80%). The rest of the sediments in between the wadis have carbonate contents ranging from 23-33%.

Texturally the beach sediments are sands with the mean grain size varying from 0.9 ϕ (coarse sand) to 2.65 ϕ (fine sand), whereas the sediments of intertidal and subtidal areas have almost similar mean size values ranging from 1.8 ϕ (medium sand) to 5.3 ϕ (medium silt). However, the primary mode of intertidal sediments shifts between 2 and 3 ϕ. Subtidal sediments have a primary mode between 3 and 4 ϕ. Intertidal and subtidal sediments are relatively finer than the beach material (Fig. 2). According to the classification of Folk[8], the beach sediments are sandy and slightly gravelly sand, whereas the intertidal and subtidal sediments are sands, muddy sands and slightly gravelly muddy sand and sandy muds. Sediment texture does not show any recognizable latitudinal distributional trend in the study area (Fig. 2). Further, the littoral sediments opposite the wadis and in between the wadis have more or less the same grain size characteristics.

Total foraminiferal number (TFN) of the nearshore sediments is highly variable (Fig. 2). While some samples are almost devoid of Foraminifera, in others TFN as large as 160.g^{-1} of dry sediment has been recorded. In general, sediments in this region are strikingly poor in Foraminifera compared to the central and northern parts of the Red Sea. Such a depletion is due to the mixed nature of the sediments. The sediments of central and northern parts of the eastern Red Sea are composed virtually of pure carbonates[9]. As indicated by the TC contents of sediments, there is a considerable dilution of the

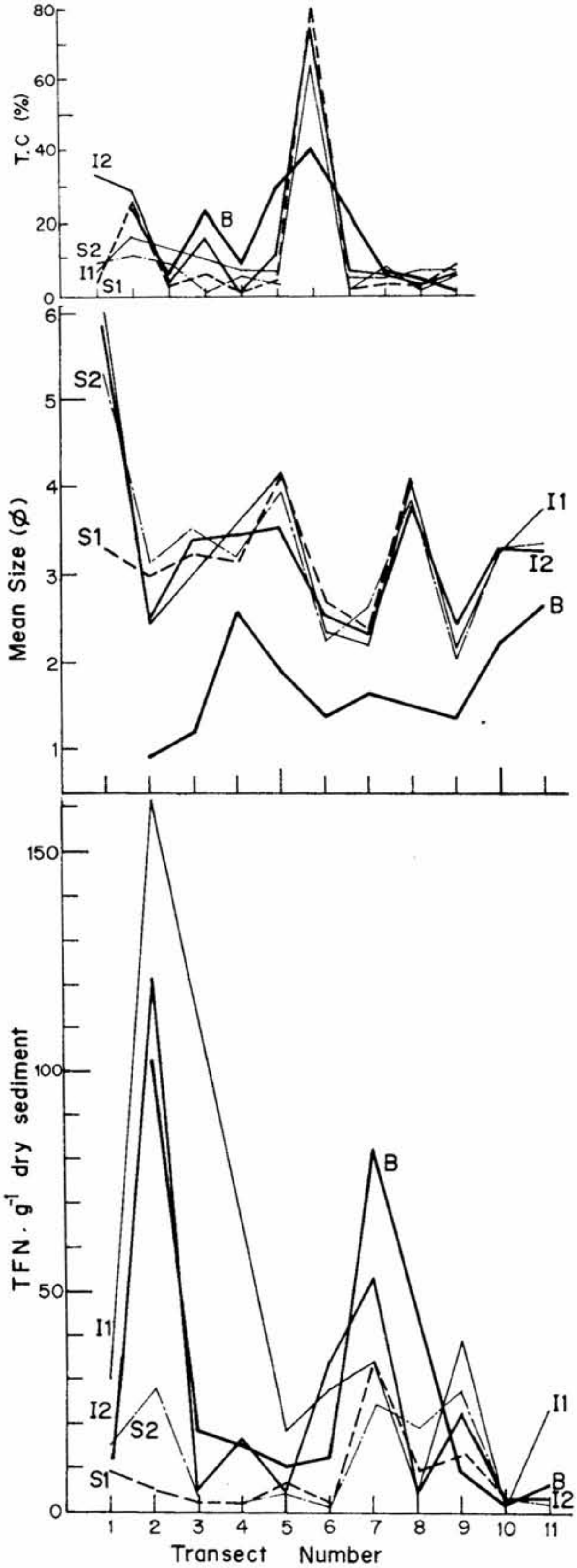

Fig. 2—Latitudinal (N – S) distribution patterns of TFN.g^{-1}, mean size and TC of sediments from beach (B), intertidal (I1, I2) and subtidal (S1, S2) areas

locally produced carbonates by the terrigenous sediment contributed by the wadis. Such a mixing in various proportions lower the foraminiferal population in the sediments and cause variations in the concentration from place to place. TFN shows no discernible variation among the sub-environments (Fig. 2) and is independent of the mean grain-size of the sediments. However, among the suborders there is a general negative relationship between Rotaliina abundance and the mean grain size of the sediments (Fig. 3). The abundant Rotaliina species, *Ammonia beccarii* and *Calcarina calcar* occur mostly in the fine sediments of the intertidal and subtidal zones. In the Miliolina, *Peneroplis-Sorites* assemblage is related to the coarse-grained sediments, which to a large extent are concentrated in the beaches, while *Triloculina* and *Quinqueloculina* are associated with the intertidal and subtidal fine sediments.

The Fisher index[7] values ranging from < 1 to 3 (Fig. 4) are significantly lower than those (5-10) which characterize the shallow subtropical waters of the central Red Sea.

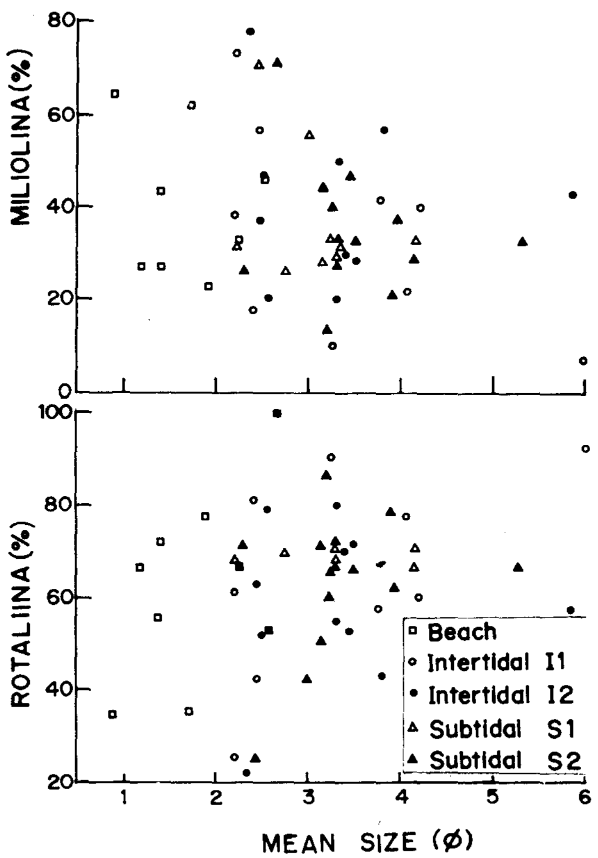

Fig. 3—Variations of Rotaliina and Miliolina contents with the phi mean size of the sediments [Note independent distribution of Miliolina with the mean size. General positive correlation between Rotaliina and phi mean size of the sediments is notable in beach (r= 0.52), I1 (r= 0.46) and S1 (r= 0.45)

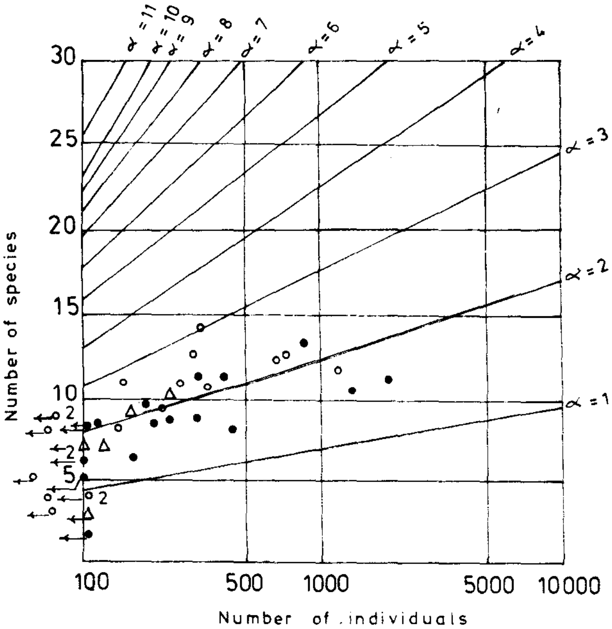

Fig. 4—Fisher α diversity indices for beach (Δ), intertidal (●) and subtidal (○) sediments

Foraminiferal fauna in the modern nearshore sediments include textulariids, miliolids and rotaliids. However, textulariids are absent in > 80% of the samples and are only rare in the remaining samples. It is only in the beach sample near wadi Al Lith the textulariids occur in a maximum concentration (5.6%). Rotaliids dominate over the miliolids in about 85% of the samples (Table 1). This distribution trend is in contrast with that noticed in the Jeddah Bay[1], off Farasan Islands[4], and in the beach sands of Jeddah, central Red Sea coast[2], where miliolids overwhelm the rotaliids. It is also in contrast with the faunal assemblage observed in the Arabian Gulf[10,11], where miliolids are the dominant element of the benthic Foraminifera. However, present results agree with the findings of Yusuf[3], who has recorded more rotaliids in the shelf sediments of Jeddah-Yanbu coast.

In some of the sediments containing high TC, Miliolina dominates the Rotaliina and exhibits an increase in their concentration with the increasing TC contents (Fig. 5).

The high Rotaliina-low Miliolina foraminiferal assemblage that characterizes the Al Lith-Al Qunfidhah coast stands in contrast to the Miliolina-dominant assemblage believed hitherto to prevail in the eastern Red Sea. The anomalous distribution is considered to be due to the oscillations in the ecological parameters caused by the influx of fresh water and mixing in various proportions of the terrigenous material with the *in situ* carbonates. In places, where the clastic sediment dilution is minimal, the miliolids dominate indicating the typical character of shallow water tropical or subtropical carbonate sediments[7]. But there is no evidence to relate the abundance of Miliolina here to hypersaline conditions, as in Farasan Islands[4].

The foraminiferal assemblage consists of 22 species; some are low in frequency but are found in abundances of 1% or more in atleast one sample. Agglutinated *Clavulina* spp are the characteristic

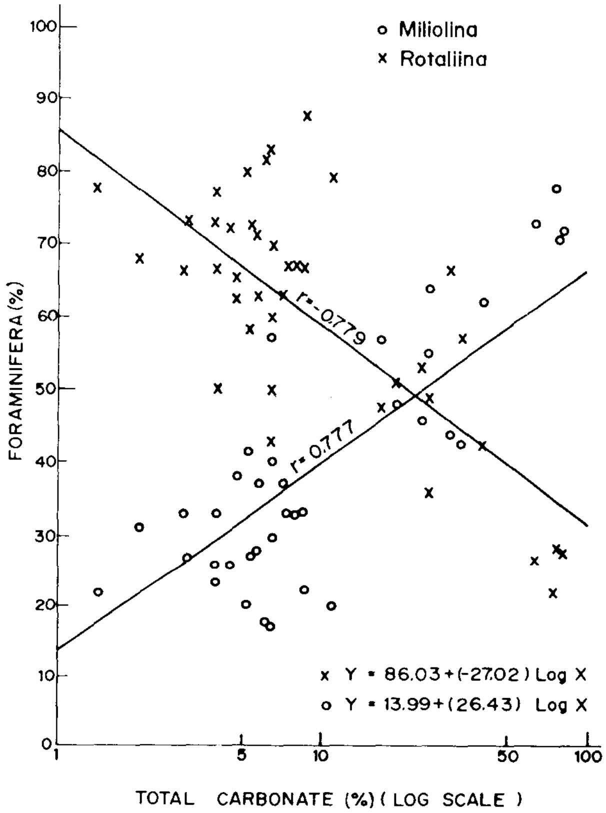

Fig. 5—Correlation between total carbonate content and Miliolina and Rotaliina concentrations in the littoral sediments

species of the Textulariina suborder. *Textularia* spp are found only in some subtidal sediments. The suborder Miliolina is dominated by *Quinqueloculina* spp, *Triloculina* spp and *Sorites marginalis*. The other species that are common and/or rare are *Cyclogyra planorbis*, *Spiroloculina* spp, *Vertebralina striata*, *Hauerina diversa*, *Parrina bradyi*, *Peneroplis planatus* and *Spirolina acicularis*. Frequency distribution of the species in the sub-environments shows that the beach sands are enriched in *Sorites marginalis* and *Peneroplis* spp, whereas the relatively fine intertidal sediments are dominated by *Quinqueloculina* spp, *Triloculina* spp and *Spirolina arietina*. The characteristic species of the subtidal zone are the same as those that typify the intertidal zone, especially *Triloculina* spp. Among the suborder Rotaliina, *Ammonia beccarii* and *Calcarina calcar* are abundant, *Elphidium crispum* is common and *Elphidium advenum*, *Elphidium discoidale*, *Cibicides* spp, *Cymbaloporella tabellaeformis* and *Cymbaloporella bradyi* are rare. Both *Ammonia beccarii* and *Calcarina calcar* occur in their highest numbers in the intertidal zone. Subtidal sediments are also considerably rich in these species. Contrastingly *Ammonia beccarii* is virtually absent from the beach sands of Jeddah[2] and in the Jeddah Bay[1]. Further, *Elphidium advenum*, the most common species in Jeddah beach sands and Bay sediments, is very rare in Al Lith-Al Qunfidhah nearshore sediments.

Considerable differences exist in the benthic Foraminifera distribution pattern in the nearshore sediments of the northeastern, central and southeastern Red Sea. The nature of the deposits and the terrigenous sediment input by the wadis in the southeastern Red Sea are major controlling factors in the distribution of total Foraminifera and the relative abundances of the suborders.

Table 1—Numerical Percentages of Textulariina (T), Miliolina (M) and Rotaliina (R) in the Beach (B), Intertidal (I1, I2) and Subtidal (S1, S2) Sediments

Transect No.	B			I1			I2			S1			S2		
	T	M	R	T	M	R	T	M	R	T	M	R	T	M	R
1	—	—	—	0	7.7	92.3	0	42.9	57.1	0	29.4	70.6	0	33.3	66.7
2	1.5	64.0	34.5	0	57.3	42.7	0.4	47.0	52.6	1.6	55.8	42.6	3.6	44.6	51.8
3	5.6	27.8	66.6	—	—	—	0	30.0	70.0	0	33.3	66.7	0	33.3	66.7
4	0	46.7	53.3	—	—	—	0	46.9	53.1	0	28.6	71.4	0	13.3	86.7
5	0	22.2	77.8	0	40.0	60.0	0	28.6	71.4	0	33.3	66.7		37.5	62.5
6	0	43.5	56.5	0	18.2	81.8	0	20.6	79.4	3.4	26.8	69.8	1.4	26.8	71.8
7	2.1	62.5	35.4	1.2	73.2	25.6	0	78.1	21.9	1.9	71.5	26.6	2.9	72.1	25.0
8	—	—	—	0	22.2	77.8	0	57.1	42.9	0	29.4	70.6	0	21.1	78.9
9	0	27.8	72.2	0	38.5	61.5	0	37.0	63.0	0	32.0	68.0	0	27.8	72.2
10	0	33.3	66.7	0	10.0	90.0	0	50.0	50.0	0	31.8	68.2	0	33.3	66.7
11	0	0	100	0	41.7	58.3	0	20.0	80.0	0	33.3	66.7	0	40.0	60.0

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