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Foraminiferal Distribution in Recent Sediments of Jizan Shelf, Red Sea, Saudi Arabia

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ABSTRACT. Thirty-four bottom sediments samples from Jizan shelf have been analysed for benthic foraminifera where hyaline, porcelaneous and agglutinated foraminifera have been recorded. In contrast with the north-eastern parts of the Red Sea, hyaline foraminifera dominate over porcelaneous foraminifera in about 68% of the samples. The relative abundance of hyaline foraminifera over porcelaneous ones is attributed to the periodic influx of fresh water and mixing of terrigenous sediments with the in situ carbonates.

The total number of foraminifera is highly variable and the sediments generally poor in foraminifera compared to those of the central and northern part of the Red Sea. Such a depletion is due to the mixed nature of the sediments and is independent on their mean-grain size. However, hyaline foraminifera shows a general negative relationship with the mean grain size of the sediments; agglutinated foraminifera shows preference to sandy or silty sediments.

The faunal assemblage identified do not show a clear relationship with depth. However, hyaline foraminifera reveals a positive correlation with organic carbon, while porcelaneous foraminifera shows a positive correlation with carbonate contents. This may explain the maximum distribution of both the hyaline and porcelaneous foraminifera in the northern and central part of the study area, respectively. Also, it confirms the opinion that the hyaline foraminifera uses an organic nucleating surface for calcite growth, and dominates environment with somewhat lower concentration of calcium carbonate than those required by porcelaneous foraminifera.

Introduction

Numerous studies on the distribution of Recent benthonic foraminifera have been carried out at various places. Their results indicate that the distributions are control-

led by a number of parameters, i.e. temperature, salinity, substrate, nutrients, etc. Except for the information on the beach sediments of Farasan Islands, and on littoral sediments of Al Lith-Al Qunfidah coast, Southeastern Red Sea (Bahafzallah 1984, Abou Ouf *et al.* 1988), nothing is known on the microfaunal compositions of shelf sediments of southeastern Red Sea. Therefore, an attempt is made to study the foraminiferal distribution in Jizan shelf sediments. It is also intended to establish correlations between the observed patterns and measured ecological factors. From such correlation, it is hoped to identify the major environmental controls on foraminiferal distribution both geographically and bathymetrically.

Methods

The bottom sediment samples were collected on board Ibn Majed using a grab sampler along eight profiles extending seaward from as close to shore as possible (Fig. 1). It was originally planned to collect samples at 34 stations representing different depths. The grain size analysis of these sediment samples were obtained from another work already prepared by the author to study the sedimentology and mineralogy of the same area.

Organic carbon was determined by a simple oxidation method following the technique of El Wakeel and Riley (1957). A calcimeter was used to determine the total carbonate.

The foraminiferal assemblages in the > 63 um fraction were studied. The most common genera in each sample were identified and their abundance was determined by a count of 400 specimens.

Results

Sediments Characteristics

Sediments are greyish and generally muddy with mean grain-size varying from 1.5 (muddy sand) to 8.9 ϕ (silty clay) (Fig. 2).

Total Carbonate

The detailed carbonate distribution shown in Fig. 4 sheds more details on sedimentary processes in the Jizan shelf. Carbonate content increases gradually from < 25% in the southern most part to about 40% in the northern part, and reflects the waning influence of terrigenous sediment supply northward. This inference is in conformity with sediment texture variations (Fig. 2). The carbonate distribution in area away from significant terrigenous sediment influxes reflects a significant bathymetric control (Fig. 3).

The low $CaCO_3$ content in the southernmost part reflects massive terrigenous sediment influx to the Red Sea from the Jizan intermittent streams.

Organic Carbon

The organic carbon concentration in the Jizan shelf sediments is generally high,

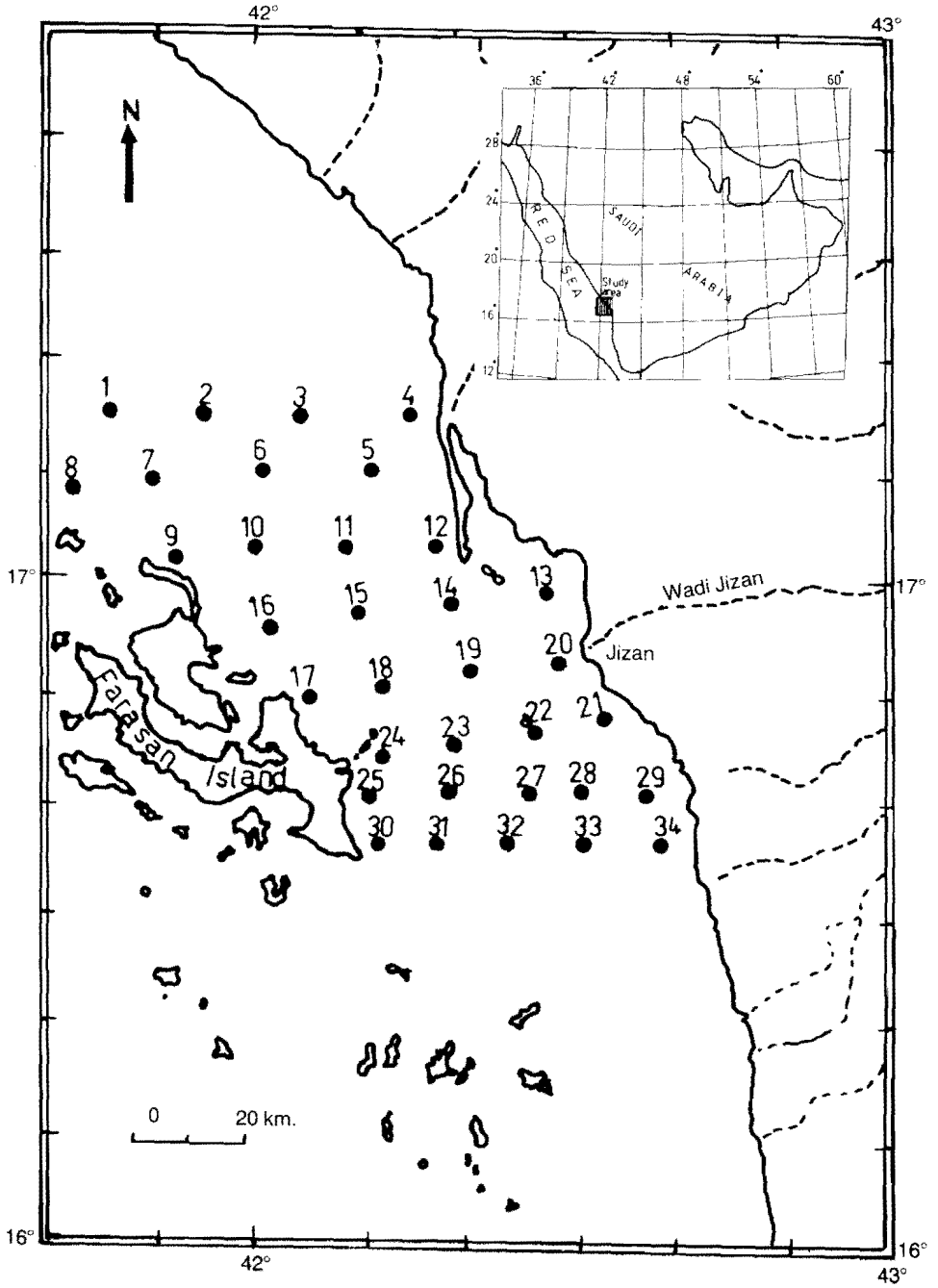

FIG. 1. Location map and sampling locations.

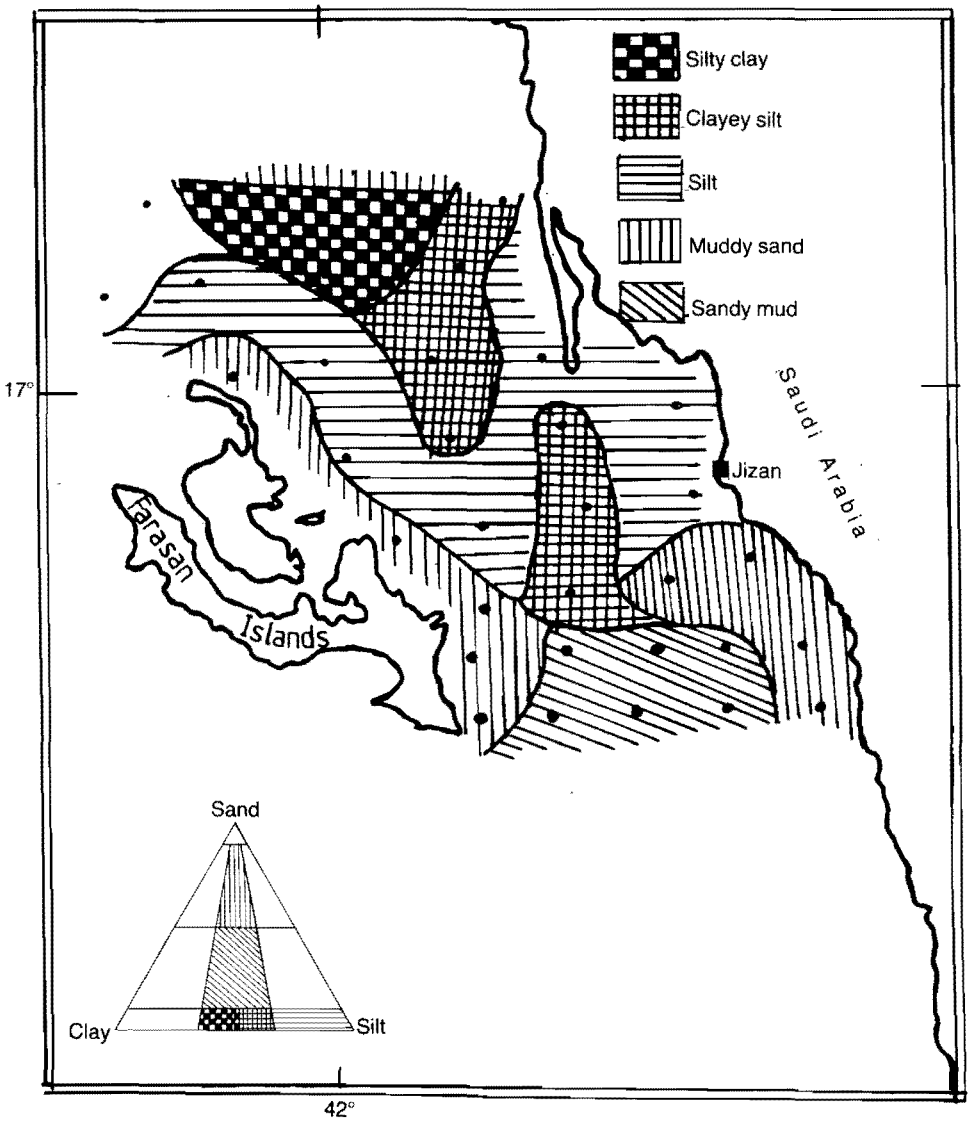

FIG. 2. Sediments distribution map.

ranging between 1.5% and 6.9% with an average value of 3.6% (Fig. 5). However, the organic carbon content in the northern part of the study area is more abundant than in the southern part. The distribution of organic carbon in the sediments shows a negative correlation with grain size. Also, a negative correlation is revealed between organic carbon and carbonate contents of the shelf sediments.

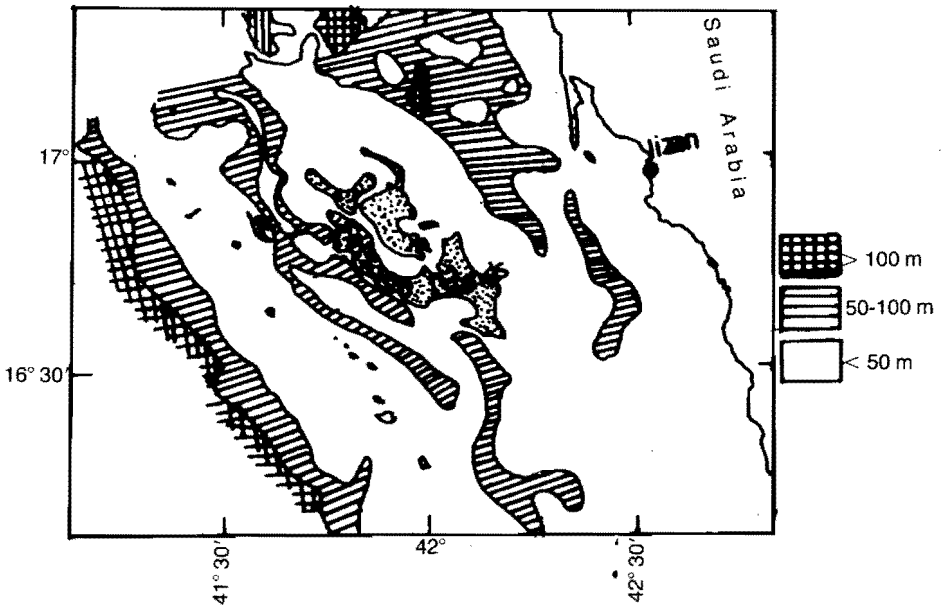

FIG. 3. Bathymetric map of the study area.

Faunal Composition

Figures 6 and 7 shows the faunal distribution of these sediments. Generally, their assemblage is dominated by hyaline calcareous foraminifera ranging between 44.0% and 64.0%, with an average of 55.5% and porcelaneous calcareous foraminifera with between 25.0% to 69.9%. Agglutinants are present with only 2.1% to 15.7%.

Discussion

Foraminifera in the studied sediments include hyaline, porcelaneous, and agglutinated species. Hyaline foraminifera dominate over porcelaneous ones (Fig. 5, 6 & 7). This distribution trend is in contrast with that noticed in the Jeddah Bay (Bahafzallah 1979), in beaches of Farasan Islands (Bahafzallah 1984), and in the beach sands of Jeddah, central Red Sea coast (Bahafzallah and El Askary 1981) where porcelaneous foraminifera overwhelm the hyaline ones. It is also in contrast with the faunal assemblage in the Arabian Gulf (Wagner and Togt 1973; Murray 1973 and Abou Ouf 1982). However the present results agree with the study of Abou Ouf *et al.* (1988) on the littoral sediments of Al Lith-Al Qunfidah coast, Red Sea.

This 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 (Murray 1973).

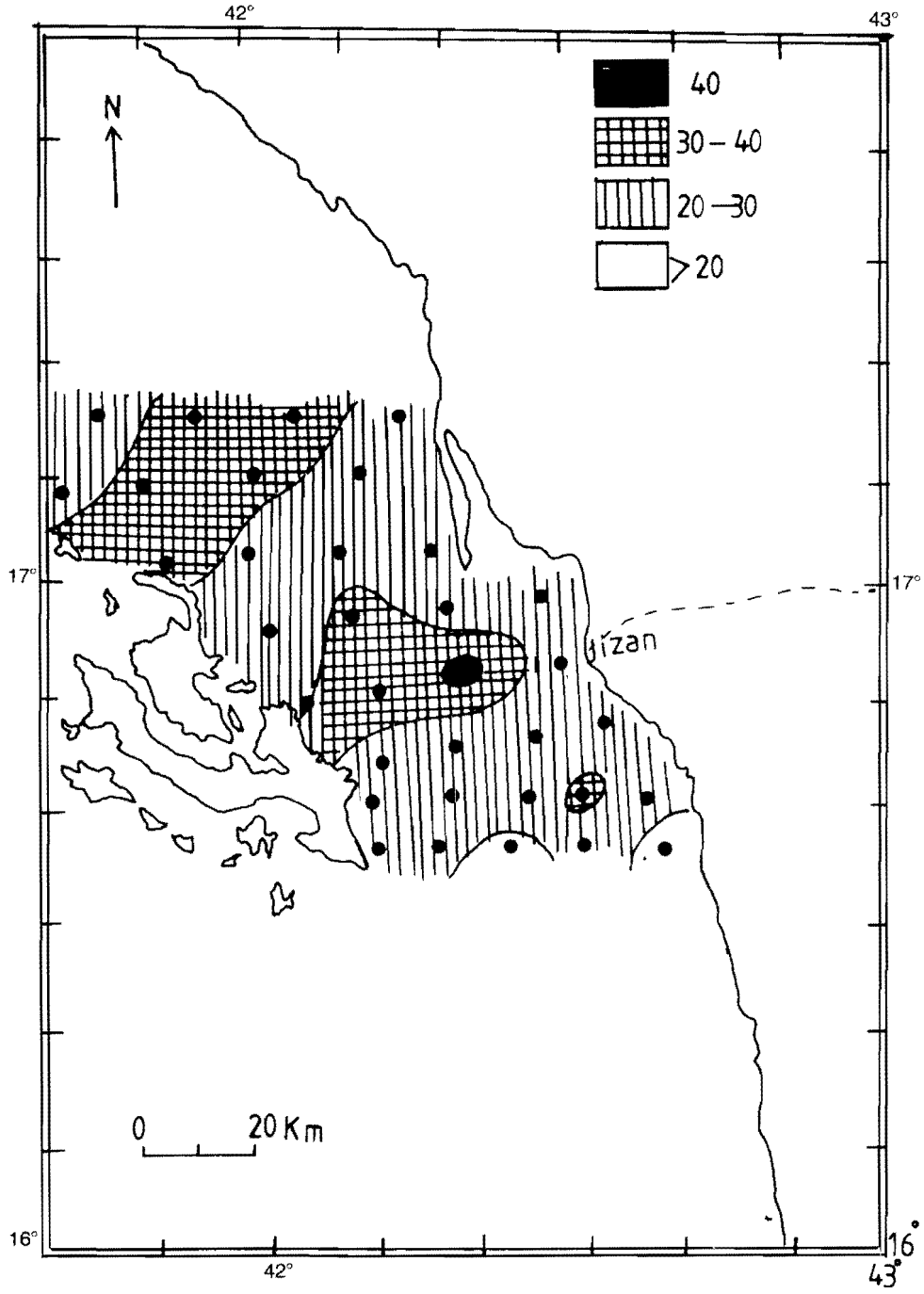

FIG. 4. Distribution of total carbonate in the Jizan shelf sediments.

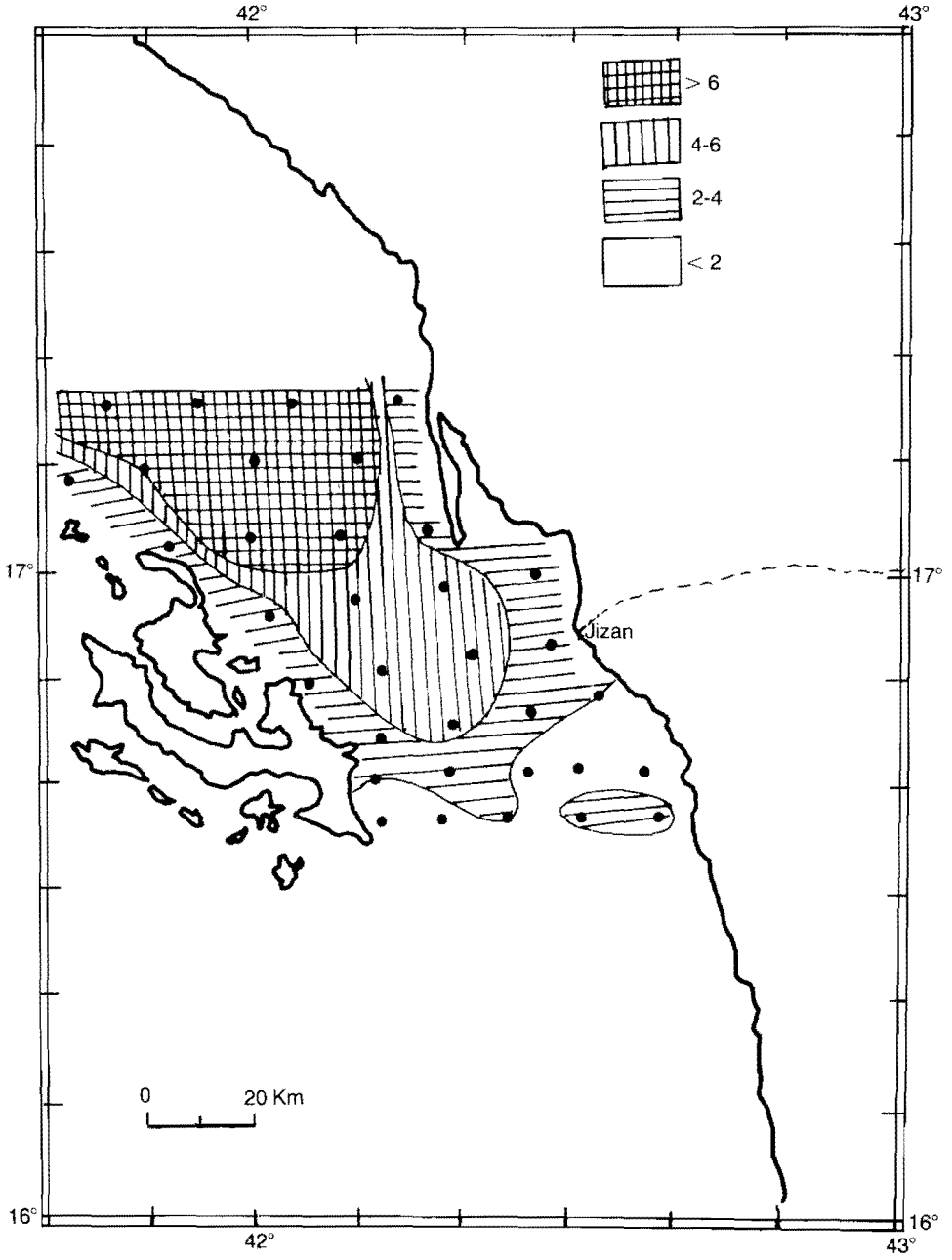

FIG. 5. Distribution of organic carbon in the Jizan shelf sediments.

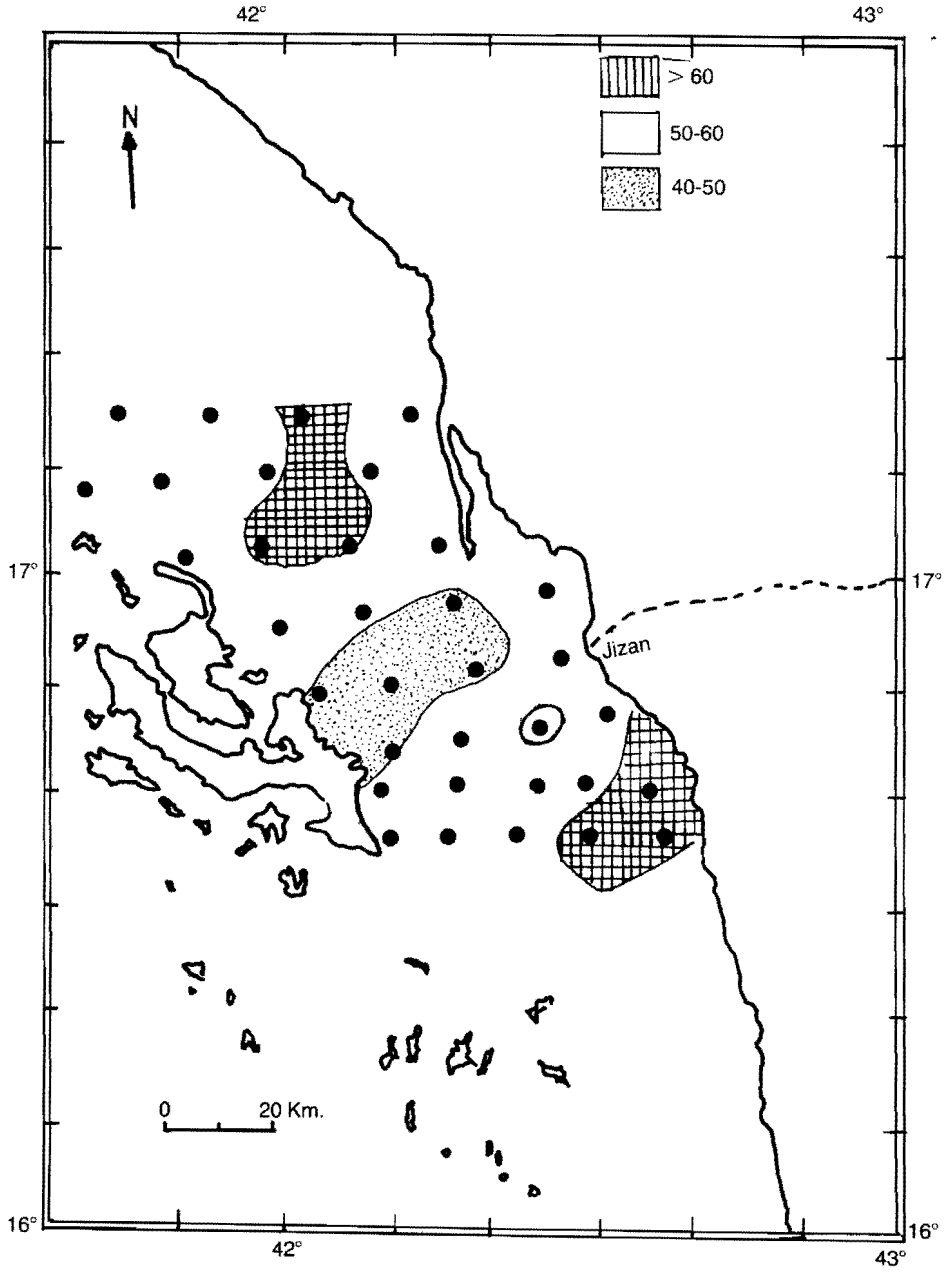

FIG. 6. Distribution of hyaline foraminifera in the Jizan shelf sediments.

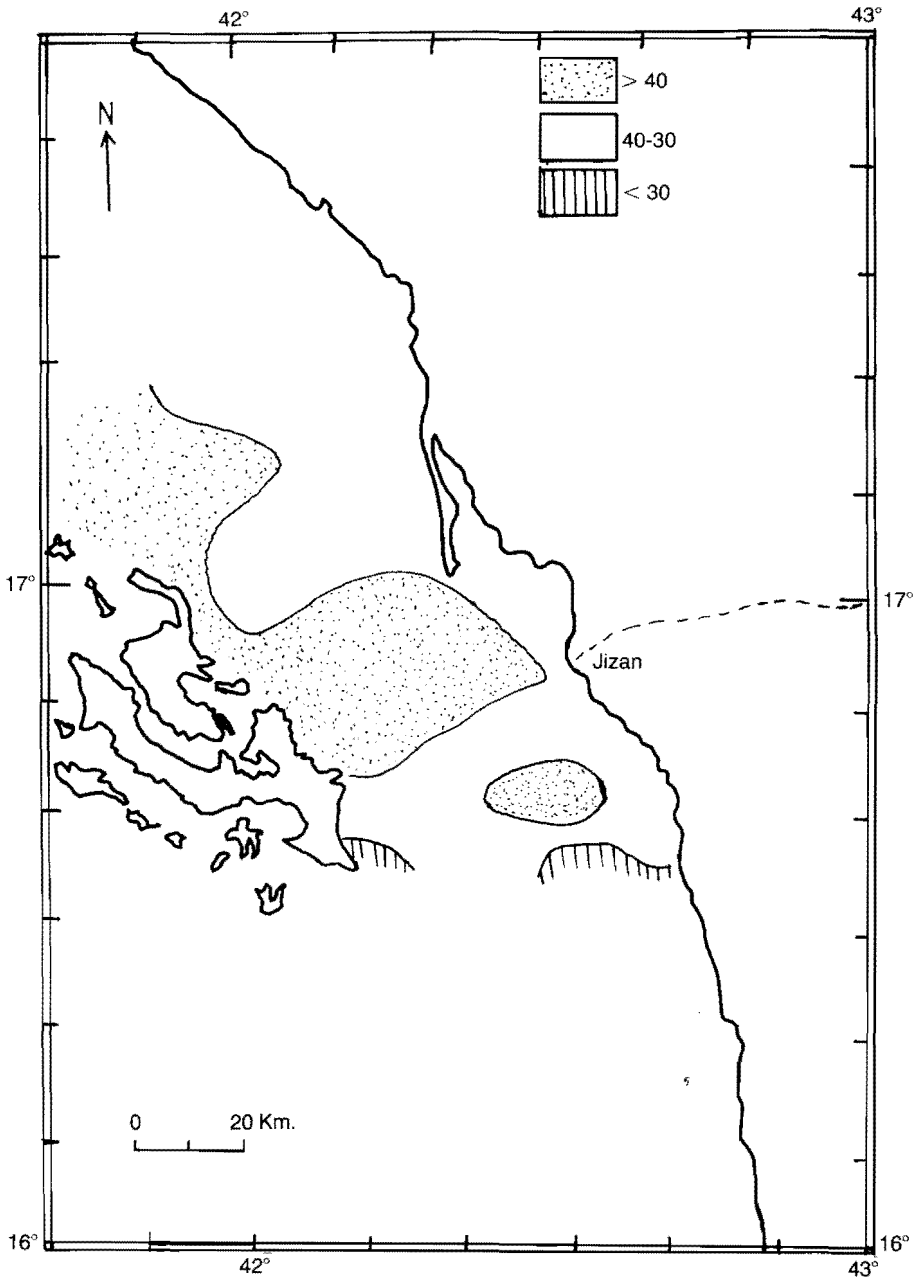

FIG. 7. Distribution of porcelaneous foraminifera in the Jizan shelf sediments.

The total foraminiferal number (TFN) of these sediments is highly variable, and some samples are almost devoid of foraminifera, in others TFN as large as 170g of dry sediment has been recorded. In general, sediments in this area 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 sediment of central and northern parts of the eastern Red Sea are composed virtually of pure carbonates (Durgaprasada Rao and Behairy 1986). As indicated by the total carbonate contents of sediments, there is a considerable dilution of the locally produced carbonates by the terrigenous sediments 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. The total number of foraminifera is independent of the mean grain-size of the sediments. However, there is a general negative relationship between hyaline foraminifera abundance and the mean grain size of the sediments (Fig. 8a). Also, agglutinating foraminifera shows preference to sandy or silty bottom (Fig. 8a).

The hyaline foraminifera is dominated by Ammonia convex, Ammonia beccari, *Elphidium* spp. and *Nonion* spp. Among the porcelaneous foraminifera, Quinqueloculina, Spiroloculina, Triloculina are abundant. *Clavulina* spp. are the characteristic species of the agglutinated foraminifera.

Hyaline, porcelaneous and agglutinated fauna do not show a clear relationship with depth (Fig. 8b). Hyaline and agglutinated foraminifera exhibit a decrease in their concentration with total carbonate increase (Fig, 9a). In contrast, porcelaneous foraminifera increase in concentration with total carbonate increase. Also, hyaline and porcelaneous foraminifera show a positive correlation with organic matter (Fig. 9b). Agglutinated foraminifera, on the other hand, decrease with increasing organic matter. These observations of the studied fauna can be explained on the basis of Greiner's View (1974) presenting evidence that the availability of calcium carbonate controls the distribution of shell types. Agglutinated Foraminifera, which have the least demand for carbonate as shell or wall material, are most abundant under hyposaline conditions and below the calcite compensation depth (CCD); porcelaneous foraminifera are largely confined to hypersaline conditions, and hyaline foraminifera are found everywhere.

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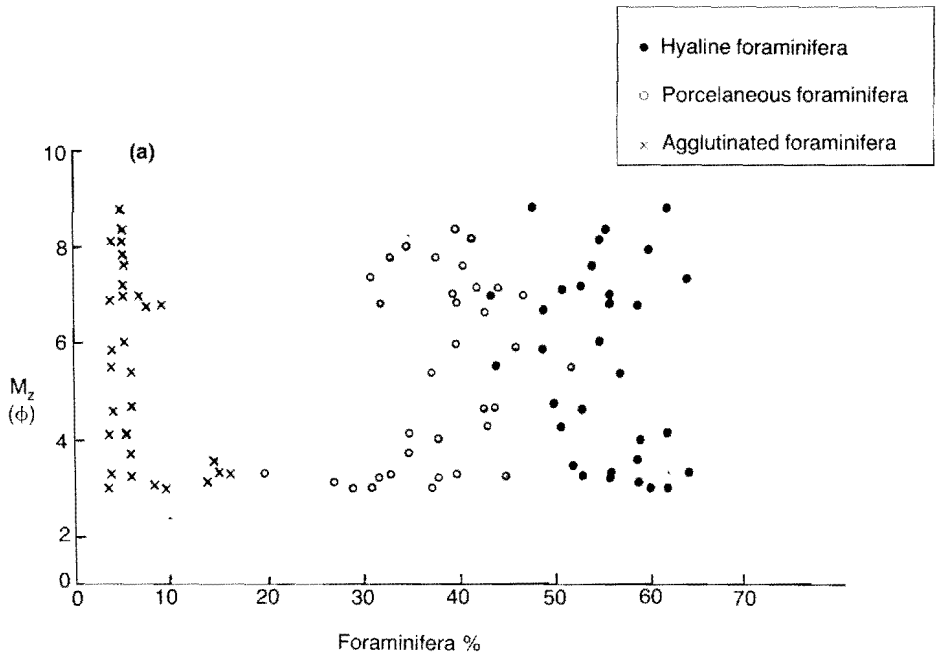
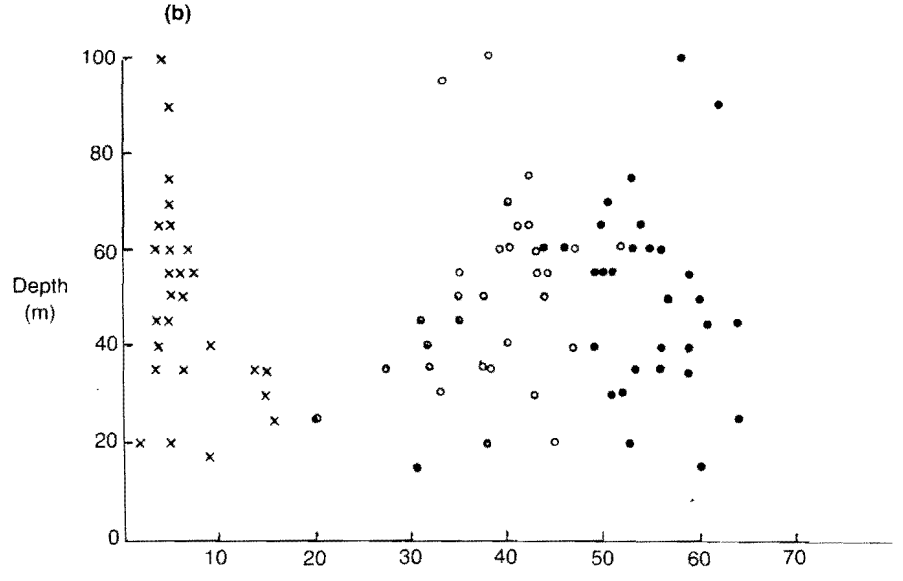


FIG. 8a. Variation of the identified fauna contents in the Jizan shelf with the phi mean size of the sediments.



8b. Variation of the identified fauna contents in the Jizan shelf sediments with depth.

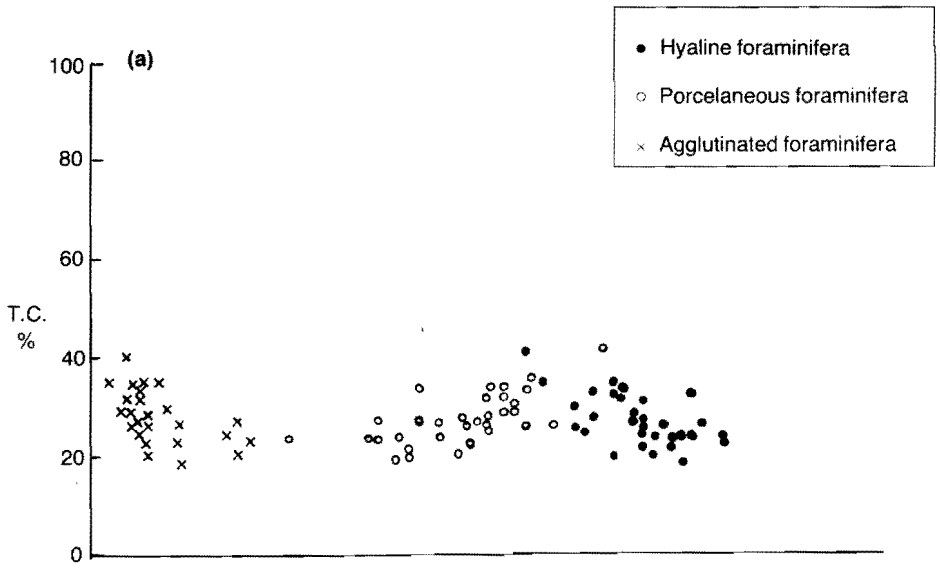
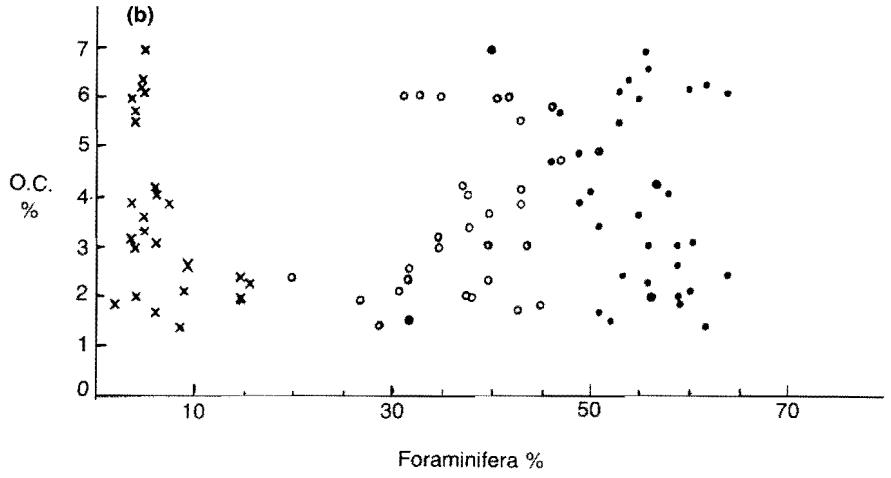


FIG. 9a. Correlation between total carbonate content and identified fauna in the study area.



9b. Correlation between organic carbonate and identified fauna in the study area.

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توزيع المنخربات (الفورامنيفيرا) في الرواسب الحديثة للرصيف القاري أمام منطقة جيزان بالبحر الأحمر - المملكة العربية السعودية

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المستخلص . لقد حللت ٣٤ عينة من رسوبيات قاع الرصيف القاري أمام منطقة جيزان حيث احتوت هذه الرواسب على منخربات (فورامنيفيرا) قاعية خزفية وزجاجية ومجمعة . ولعله من الملفت للنظر أن تكون المنخربات (الفورامنيفيرا) الزجاجية هي الأكثر شيوعًا من المنخربات (الفورامنيفيرا) الخزفية في هذه المنطقة وذلك على النقيض من الأجزاء الشمالية الشرقية من البحر الأحمر . ولقد أعزى الأزدياد النسبي للمنخربات (الفورامنيفيرا) الزجاجية على المنخربات (الفورامنيفيرا) الخزفية إلى انصباب المياه العذبة واختلاط الرواسب القارية برواسب الكربونات القابعة في مكانها .

إن العدد الكلي للمنخربات (للفورامنيفيرا) يتغير تغيرًا كبيرًا من عينة إلى أخرى في هذه الرواسب ولكن هذه الرواسب فقيرة عمومًا في المنخربات (الفورامنيفيرا) مقارنة بتلك التي في رواسب الجزء الأوسط والشمالي من البحر الأحمر . ومثل هذا النضوب إنما يرجع أساسًا إلى الطبيعة المختلطة للرواسب وليس إلى متوسط حجوم حبيباتها . ومع أن المنخربات (الفورامنيفيرا) الزجاجية تعرض علاقة عكسية مع متوسط الحجوم في هذه الرواسب إلا أن المنخربات (الفورامنيفيرا) المجمعة تعرض تفضيلاً للرواسب الرملية والغرينية .

إن صحبة المنخربات (الفورامنيفيرا) ككل في هذه الرواسب لا تبين علاقة واضحة مع العمق . إلا أن المنخربات (الفورامنيفيرا) الزجاجية تبين علاقة طردية مع المحتوى العضوي ، أما المنخربات (الفورامنيفيرا) الخزفية فتبين علاقة طردية مع محتوى الكربونات . إن هذا قد يشرح الزيادة القصوى لكل من المنخربات (الفورامنيفيرا) الزجاجية والخزفية في الجزء الأوسط والشمالي من منطقة الدراسة على الترتيب . وأن هذا قد يعزز الرأي القائل بأن المنخربات (الفورامنيفيرا) الزجاجية تستخدم سطح نواة لمادة عضوية كما ينمو عليه الكالسيت ، كما أنها تسود في البيئات التي لها تركيز منخفض إلى حد ما من كربونات الكالسيوم عن تلك التي تتطلبها المنخربات (الفورامنيفيرا) الخزفية .