Recent Foraminifers from Oman Coast

Abdul Razak Siddiq Al-Sayigh¹, Moza Muhanna Al Jahdhami¹ and Ahmed Mohamed Muftah²

1. Department of Earth Sciences, College of Science, Sultan Qaboos University, Muscat 132, Sultanate of Oman

2. Department of Earth Sciences, Faculty of Science, University of Benghazi, Benghazi 9480, Libya

Abstract: This study presents the first documentation work on recent benthic foraminifers of Oman coasts, especially of the northern part of Sultanate at Sawadi and the southern part at Janoof Tidal Creek near Taqah-Salalah beach. Eleven samples were collected from both localities. Twenty-nine species of benthonic Foraminifera belonging to 20 genera are retrieved, identified and illustrated herein. The study areas show the interaction in land and sea. Lagoons with normal marine hypersaline inhabited with sea grass and Mangrove-swamps. Mainly calcareous porcellaneous and hyaline walled foraminifers are abundant. Environmentally, the Janoof Tidal Creek shows better condition than Sawadi Tidal Creek as reflected by the more diverse and high abundance of foraminiferal taxa at the former locality. Both water bodies are free of toxic-heavy elements as evidenced by the lack of any abnormal foraminiferal test.

Key words: Mangrove, foraminifera, tidal creek, sawadi, muscat.

1. Introduction

The Sultanate of Oman located at the eastern extremity of the Arabian Peninsula covering an area of 309,500 km² enclosed between latitudes 16.40° N and 26.20° N and longitudes 51.50° E and 59.40° E. Oman is flanked by the United Arab Emirates and Ruba' Al Khali of Saudi Arabia to the west, Yemen to the south, the straits of Hormuz (Iran) to the north and the Oman Sea to the east (Fig. 1a). This study aimed to document the retrieved foraminiferal taxa from Oman coast, in particular Sawadi and Janoof areas, and to monitor the pollution in these two near shore areas.

2. Material and Methods

The samples were collected from two areas (Fig. 1 and Table 1); (1) eight samples (RS1 to RS8) were collected on July 4, 2009 from Sawadi area, which is located in Al Batinah region 85 km far from Muscat at the northeastern part of Sultanate Oman (23°76'12.70" N and 57°79'28.92" E); (2) three samples (JNF1 to JNF3) were collected from the Janoof tidal creek, which is located in Janoof area 1,100 km from Muscat,

near Taqah-Salalah coast at the southern part of Sultanate Oman (17°03'70.90" N and 54°37' 46.85" E).

Sawadi tidal creek and Janoof Tidal Creek sediments are largely deposited by action of low water current circulation, since they were restricted by sand bar in inner lagoon. The offshore bars are usually subjected to waves which leading to the formation of highly agitated area.

The bulk sediments of the collected samples consist of sands.

The Sawadi Tidal Creek sands are of medium to very fine sizes and well sorted grains (Fig. 2). Meanwhile, the Janoof Tidal Creek sands are of fine grain size (Fig. 2). However, the granules and very coarse grains (gastropods, bryozoans and bivalves shells or their debris) are mainly linked to beach and foreshore areas. The distribution of these sediment types were found to be related to the water depth as well as to the geographic location. Since the beach and the shallower parts of the area were exposed to agitated force by waves, where coarse and medium sand were found in significant size to the fine fraction. The various size fractions percentages of the collected sediments from the Sawadi Tidal Creek (Figs. 2b and 2c) as well as the Janoof Tidal Creek (Fig. 2d) were

Corresponding author: Ahmed Mohamed Muftah, assistant professor, Ph.D., research field: paleontology, historical geology and environment. E-mail: a_muftah@yahoo.com.

Fig. 1 (a) Location map of Sultanate of Oman shows the two studied localities; (b) Satellite image of the Sawadi tidal creek; (c) General view shows the sampled Mangroves at Sawadi Beach; and (d) Satellite image shows Janoof tidal creek near Taqah beach.

Table 1 Samples against each locality with brief remarks.

Sample No.	Remarks
RS1	Mid-channel (slightly Sandy)
RS2	Tidal bank, branched channel
RS3	Tidal bank
RS4	Top 0-3cm surface mud Mangroves
RS5	Mangroves area reduced bank (H ₂ S smell)
RS6	Mangroves 3
RS7	Distance canal 2, Inner Khor region, mid-Canal pool 0-5cm mud
RS8	Distance canal 1, mid-Canal area 3
JNF1	Entrance of Khor
JNF2	Tidal bank
JNF3	Tidal bank

analyzed to understand the depositional mechanism and the distribution of foraminiferal assemblages.

3. Taxonomical Notes

3.1 Foraminiferal

Foraminifers (the tool used in this study) are unicellular microfaunas moving by means of granuloreticulose pseudopodia. (0.1-1.00 mm). They are widely distributed in space and time in almost all

marine environments [1]. Foraminifers are restricted to marine and brackish waters, and benthic forms are particularly abundant in shallow coastal seas, therefore, they are very useful in the ecological and environmental studies, as well as detecting the pollution risk in the coastal water bodies [2]. Pollution of marine environment by the heavy metals had been studied by several workers including Alve [3]. Furthermore, the impact of the concentration of specific heavy metal/metals on foraminiferal test has been discussed by Yanko. et al. [4]. The study of Muftah [5] is an example of the polluted coast as indicated by the presence of some abnormal foraminiferal tests from Libyan coast. However, several studies have been published in relation to Mangrove swamps and nearshore environments [6, 7, 10]. Foraminifers with coiled tests are abundant in the region with mangrove forest muddy and clayey beds, meanwhile, further offshore, uniserial, biserial or triserial tests exists with more abundant and diversity [6].

The collected samples from both localities are tried for their foraminiferal contents (Table 1). Among

Fig. 2 Histogram of the average grain sizes distribution of the various textural classes.

29 species of benthic foraminifers identified in the material collected, only *Ammonia*, *Elphidium*, *Quinqueloculina*, *Triloculina* *Parrellina* and *Cibicides* were ever numerically dominant although several other genera were abundant (e.g., *Amphistegina*, *Pseudotriloculina*, *Borelis*, *Troculina*, *Siphonaperta*, *Adelosina*, *Nonion*, *Rosalina* and *Textularia*).

Twenty-nine species of benthic foraminifers belonging to 15 genera are listed alphabetically in Table 2 by family sensu as illustrated in Figs. 3 and 4 [8].

3.2 Foraminiferal Analysis

3.2.1 Foraminiferal Distribution of Sawadi Tidal Creek

Eight sediment samples were collected from Sawadi Tidal Creek. They show the highest frequency of total foraminiferal test from the sediments around Mangroves and inner khor region in Sawadi. However, the low frequency of foraminiferal tests was found in the entrance of the khor and in tidal bank areas. Foraminiferal tests of the inner part of Khor were

smaller than those of near shore area. However, some tests were found broken with sediments from the entrance of the Khor. More than 13 different foraminiferal species belonging to eight genera were identified in this area. The genera distributed as follows: *Elphidium* (40%), *Pseudotriloculina* (20%), *Ammonia* (18%), *Nonion* (11%), *Quinqueloculina* (4%), *Siphonaperta* (3%), *Adelosina* (2%), and *Textularia* (2%). *Elphidium* constituted the highest percentage of the reported taxa in this area, followed by *Pseudotriloculina*, *Ammonia* and *Nonion*. While *Quinqueloculina*, *Siphonaperta*, *Adelosina* and *Textularia* constituted less than 10%.

3.2.2 Foraminiferal Distribution of Janoof Tidal Creek

Three sediments samples were collected from Janoof Tidal Creek. They are very rich in foraminifers. The highest frequency of total foraminiferal tests was recognized in the sediments of the inner Khor region. However, the low frequency of foraminiferal tests was found in sandy channels near coast area. Foraminiferal

Table 2 The classification and distributional summary of the reported foraminifers at both localities.

Family	Species and (Figure No.)	Materials		Spatial distribution
		Janoof	Sawadi	
Alveolinidae	<i>Borelis schlumbergeri</i> (Fig. 3a)	14 (2-3)		Southern Oman, Janoof and Salalah coasts
	<i>Ammonia beccarii</i> (Fig. 3b)	53 (1-3)	32(4,5,7)	Southern Oman, Salalah and Northern Oman, Batinah coasts
Ammoniidae	<i>Ammonia convexa</i> (Fig. 3c)	78 (1-3)	23(4,5,8)	Southern Oman, Salalah and Northern Oman Batinah coasts
	<i>Ammonia topida</i> (Fig. 3d)		15(3,5)	Northern Oman, Batinah coasts
Amphisteginidae	<i>Amphistegina radiata</i> (Fig. 3e)	57 (1-3)		Southern Oman, Janoof and Salalah coasts
	<i>Amphistegina papillosa</i> (Fig. 3f)	44 (1-3)		Southern Oman, Janoof and Salalah coasts
Cibicididae	<i>Cibicides mabahethi</i> (Fig. 3g)	63 (1-3)		Southern Oman, Janoof and Salalah coasts
Discorbidae	<i>Trochulina</i> sp. (Fig. 3h)	21 (2-3)		Southern Oman, Janoof and Salalah coasts
	<i>Elphidium advenum</i> (Fig. 3i)	61 (1-3)	36(5,6,8)	Southern Oman, Salalah Coast and Northern Oman, Batinah coast
	<i>Elphidium limbatum</i> (Fig. 3j)	31 (2-3)		Southern Oman, Salalah Coast
Elphidiidae	<i>Elphidium williamsoni</i> (Fig. 3k)	74 (1-3)	53(4,5,7,8)	Southern Oman, Salalah Coast and Northern Oman, Batinah coast
	<i>Elphidium</i> spp.	80 (1-3)	43(6,8)	Southern Oman, Salalah Coast and Northern Oman, Batinah coast
	<i>Parrellina</i> cf. <i>P. milletti</i> (Fig. 3l)	18 (1-3)		Northern Oman, Batinah Coast
	<i>Triloculina affinis</i> (Figs. 4a,b)	92 (1-3)		Southern Oman, Janoof and Salalah coasts
	<i>Triloculina</i> cf. <i>T. serrulata</i> (Fig. 4c)	26 (2-3)		Southern Oman, Janoof and Salalah coasts
	<i>Triloculina</i> cf. <i>T. trigonula</i> (Fig. 4d)	78 (1-3)		Southern Oman, Janoof and Salalah coasts
	<i>Quinqueloculina</i> cf. <i>Q. multimarginata</i> (Fig. 4e)	37 (1-3)		Southern Oman, Janoof and Salalah coasts
	<i>Quinqueloculina parvula</i> (Fig. 4f)	29 (1-3)		Southern Oman, Janoof and Salalah coasts
	<i>Quinqueloculina patagonica</i> (Fig. 4g)	29 (2-3)		Southern Oman, Janoof and Salalah coasts
	<i>Quinqueloculina poeyana</i> (Fig. 4h)		24(5,6,8)	Northern Oman, Sawadi, Batinah coast
Hauerinidae	<i>Quinqueloculina ungeriana</i> (Fig. 4i)	5 (3)		Southern Oman, Janoof and Salalah coasts
	<i>Pseudotriloculina subgranulata</i> (Fig. 4j)		69(5,8)	Northern Oman, Sawadi, Batinah coast
	<i>Siphonaperta pittensis</i> (Fig. 4k)		11(2,7)	Northern Oman, Sawadi, Batinah coast
	<i>Adelosina</i> sp. (Figs. 4l and 4m)		10(4,6,8)	Northern Oman, Sawadi, Batinah coast
Spiroloculinidae				
Nonionidae	<i>Nonion</i> sp. (Fig. 4n)	45 (1-3)	41(6,8)	Southern Oman, Janoof and Northern Oman, Batinah coasts
Rosalinidae	<i>Rosalina bradyi</i> (Fig. 4o)	22 (2-3)		Southern Oman, Janoof and Salalah coasts
Textulariidae	<i>Textularia agglutinans</i> (Fig. 4p)	16 (1-3)	8(5,8)	Southern Oman, Janoof and Northern Oman, Sawadi, Batinah coasts

tests of near coast areas were highly fragmented. In addition, they contain numerous gastropods and ostracods. Twenty-two different foraminiferal species belonging to 11 genera were identified in this area. The genera distributed are as follows: *Elphidium* (25.5%), *Triloculina* (19.5%), *Ammonia* (14%), *Amphistegina* (10.5%), *Quinqueloculina* (10.4%), *Cibicides* (6.5%), *Nonion* (4.6%), *Rosalina* (2.3%), *Trochulina* (2%), *Parrellina* (1.8%), *Textularia* (1.6%) and *Borelis* (1.3%). *Elphidium* and *Triloculina* constituted the highest percentage of the reported taxa

in this area.

This is followed by *Ammonia*, *Amphistegina*, *Quinqueloculina*, *Cibicides* and *Nonion*. However, *Rosalina*, *Trochulina*, *Parrellina*, *Textularia* and *Borelis* constitute less than 10% of the total foraminiferal genera in this area.

The samples from Janoof Tidal Creek showed higher in diversity and abundance of foraminiferal species than from Sawadi Tidal Creek. It may be explained by that Janoof have better seawater exchange than Sawadi. However, high diversity was

Fig. 3 Foraminifera plate: (a) *Borelis schlumbergeri*, X60; (b) *Ammonia beccarii*, ventral view, X60; (c) *Ammonia convexa*, ventral view, X50; (d) *Ammonia tepida*, dorsal view, X75; (e) *Amphistegina radiata*, ventral view, X50; (f) *Amphistegina papillosa*, ventral view, X70; (g) *Cibicides mabahethi*, ventral view, X50; (h) *Trochulina* sp., X200; (i) *Elphidium advenum*, X100; (j) *Elphidium limbatum*, X80; (k) *Elphidium williamsoni*, X50; (l) *Parrellina* cf. *P. milletti*, X100.

related to water exchange of Oxygen and the amount of nutrient in the environment [9]. In general, the majority of foraminifera concentrated at the inner part of Khor (lagoons) where it is away from the currents energy which may affected the characteristics of foraminiferal test such as wall thickness, size and shiny. Obviously, the studied areas represent the interaction of both land and sea water. Lagoons with normal marine hypersaline which have sea grass and Mangroves provide a substrate for epifaunal foraminifera. Certain species were observed in high percentages such as *Elphidium* and *psuedotriloculina* in Sawadi samples. On the other hand, at Janoof Tidal Creek, *Elphidium*, *Triloculina* and *Ammonia* are the

Fig. 4 Foraminifera plate: (a) *Triloculina affinis*, X50; (b) *Triloculina affinis*, X60; (c) *Triloculina* cf. *T. serrulata*, X70; (d) *Triloculina* cf. *T. trigonula*, X50; (e) *Quinqueloculina* cf. *Q. multimarginata*, X50; (f) *Quinqueloculina parvula*, X100; (g) *Quinqueloculina patagonica*, X50; (h) *Quinqueloculina poeyana*, X100; (i) *Quinqueloculina ungeriana*, X50; (j) *Pseudotriloculina subgranulata*, X50; (k) *Siphonaperta pittensis*, X70; (l) *Adelosina* sp., X50; (m) *Adelosina* sp., X60; (n) *Nonion* sp., ventral view, X80; (o) *Rosalina bradyi*, ventral view, X100; (p) *Textularia agglutinans*, X60.

dominant taxa; these measures may be due to the competition to colonize these two particular water depths and the subtropical geographic locations. The increase in diversity and abundance in the Janoof Tidal Creek is linked to the Mangroves setting [10].

4. Conclusions

The foraminifera of Oman coasts exhibit a wide range of depositional environments, from high energy at the entrance of the Khor and in tidal banks to low energy in the Mangroves, lagoons and inner Khor areas.

Twenty-nine recent benthic foraminiferal species are described and illustrated for the first time from

Oman coasts.

The low species diversity and abundance in the samples of the Sawadi Tidal Creek area is due to low water exchange with the sea water in comparison with the Janoof Tidal Creek area.

The absence of the abnormal foraminiferal tests is environmentally positive sign, which indicates that both localities are free of any toxic pollutants.

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