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Recent benthic foraminifera in the saline pool and its surrounding areas at ras shukier and Gulf of Suez, Egypt

Mohamed Abd El Wahab Mohamed[1] , Hashem Abbas Madkour[1] & A. El-Taher[2,3*]

[1]National Institute of Oceanography & Fisheries, Red Sea Branch, Egypt.

[2*]Physics Department Faculty of Science, Al-Azher University, Assiut Branch, Egypt

[3]Physics Department, Faculty of Science, Qassium University, Buraydah, 51452, Saudi Arabia

[E-Mail : atef_eltaher@hotmail.com]

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Fifty two species belonging to twenty one benthic foraminiferal genera have been recorded from seventeen samples collected from three localities; 12 samples from saline pool and its surrounding Sabkha at Ras Shukeir area and 5 samples from the Gulf of Suez. Their taxonomy, ecology and the main factors controlling their distribution are discussed. The frequency of fauna in Gulf of Suez, evaporatic sabkha and saline pool are (59.27%), (32.78%) and (7.95%) respectively, which reflect abnormal salinity and temperature. All identified species were previously recorded from Red Sea and Mediterranean Sea.

[Key words: Recent Benthic Foraminifera, Saline pool, Sabkha, Marine sediments, Ras Shukeir, Gulf of Suez, Egypt]

Introduction

Recent Sabkhas are generally characterized by unconsolidated carbonate and/or siliciclastic sediments, diagenetic evaporite minerals, aeolian deposits, variable associations of sedimentary structures and foraminifera. Egypt is characterized by coastal Sabkhas which are situated along the Gulf of Suez and Red Sea coasts. The recognition of the supratidal Sabkha with its unique association of sediments, and depositional environments is perhaps the most significant development in sedimentology during the last 30 years[(1-6)]. There are no detailed studies dealing with foraminiferal regime in saline pool and evaporitic environment, although they represent one of the least understood environments in our area. Present study is an attempt to study the benthic foraminifera in the saline pool and its surrounding Sabhka at Ras Shukeir area, in addition to opposite part in the Gulf of Suez and also to make a comparison between them to delineate the facies, ecology and finally discuss the main factors controlling their distribution. Previous studies on the recent benthic foraminifera along the Red Sea coast are summarized by the work of several authors[(7-21)].

Materials and Methods

Twelve surface samples have been collected from saline pool and adjacent Sabkha in addition to five surface bottom samples from Gulf of Suez (Fig. 1).

The loose sediments were analyzed mechanically by sieves arranged at 1 Φ interval. The faunal investigation has been carried out on three fractions of

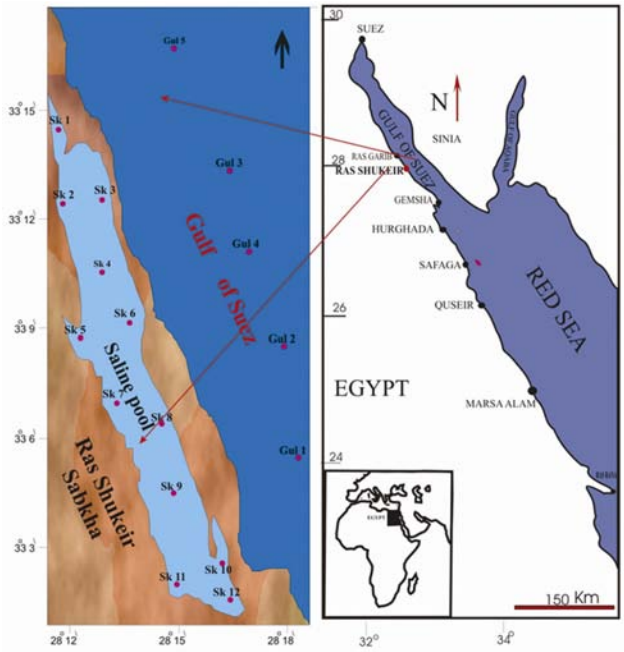

Fig. 1— Location map of the investigated area and studied samples.

*Corresponding author: Dr. Atef El-Taher

sediments (1.0, 0.5, and 0.250 mm). These fractions were examined by a binocular microscope and the minimum of grains counted were 300 grains and this number of grains is sufficient for statistical reliability[22]. Also, some physical parameters of water e.g. (water salinity, hydrogen ion and specific conductivity) were measured in situ using Hydrolab instrument (Surveyor-4).

The foraminiferal species in each sample were identified based on the classification of foraminifera by[23]. For illustration, the foraminiferal taxa are photographed by using the Scanning Electron Microscope (JSM-5400LV) of Assiut University, (plates 1 - 2).

The saline pool and its surrounding Sabhka are a part of the south-western coastal area of the Gulf of

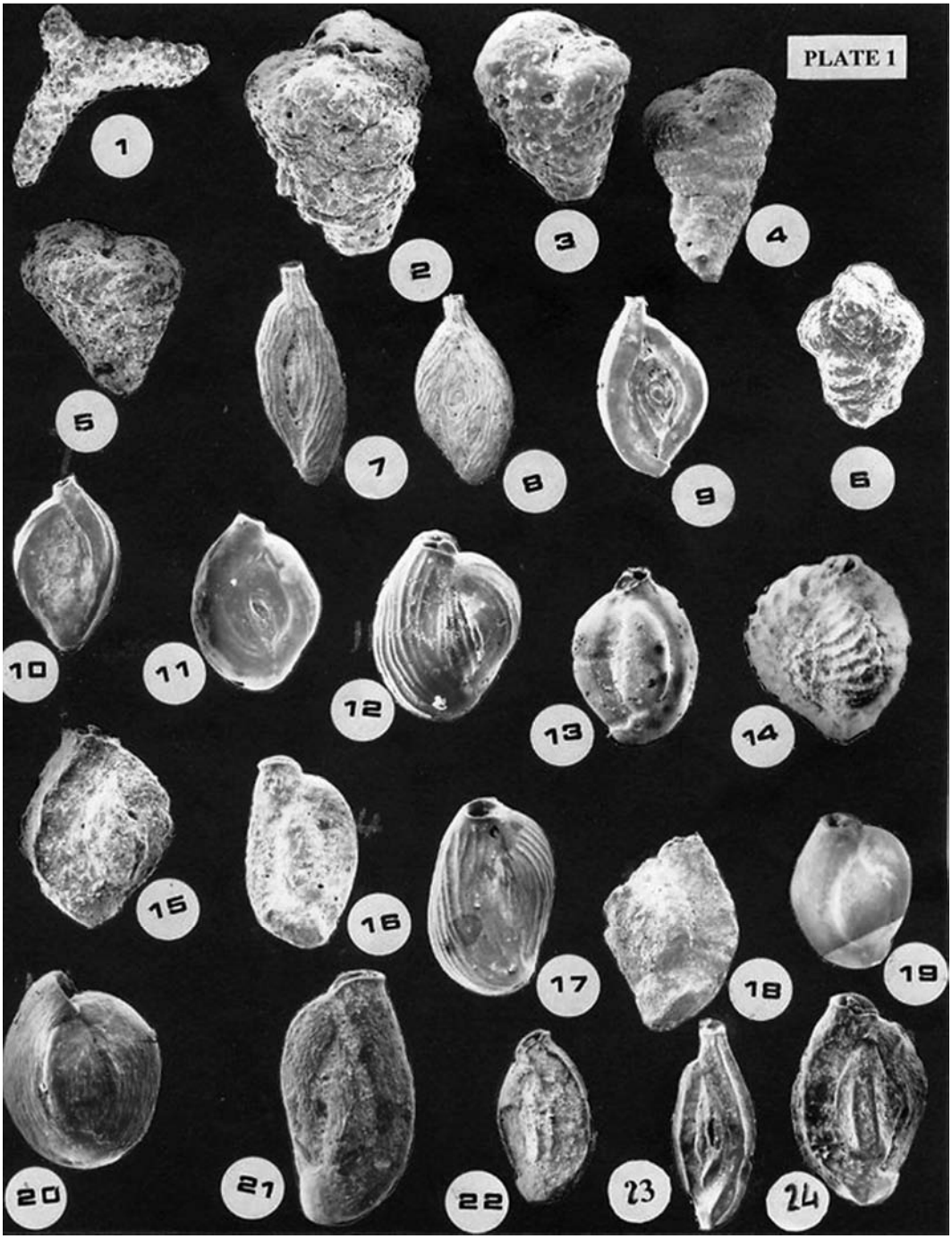

Plate I

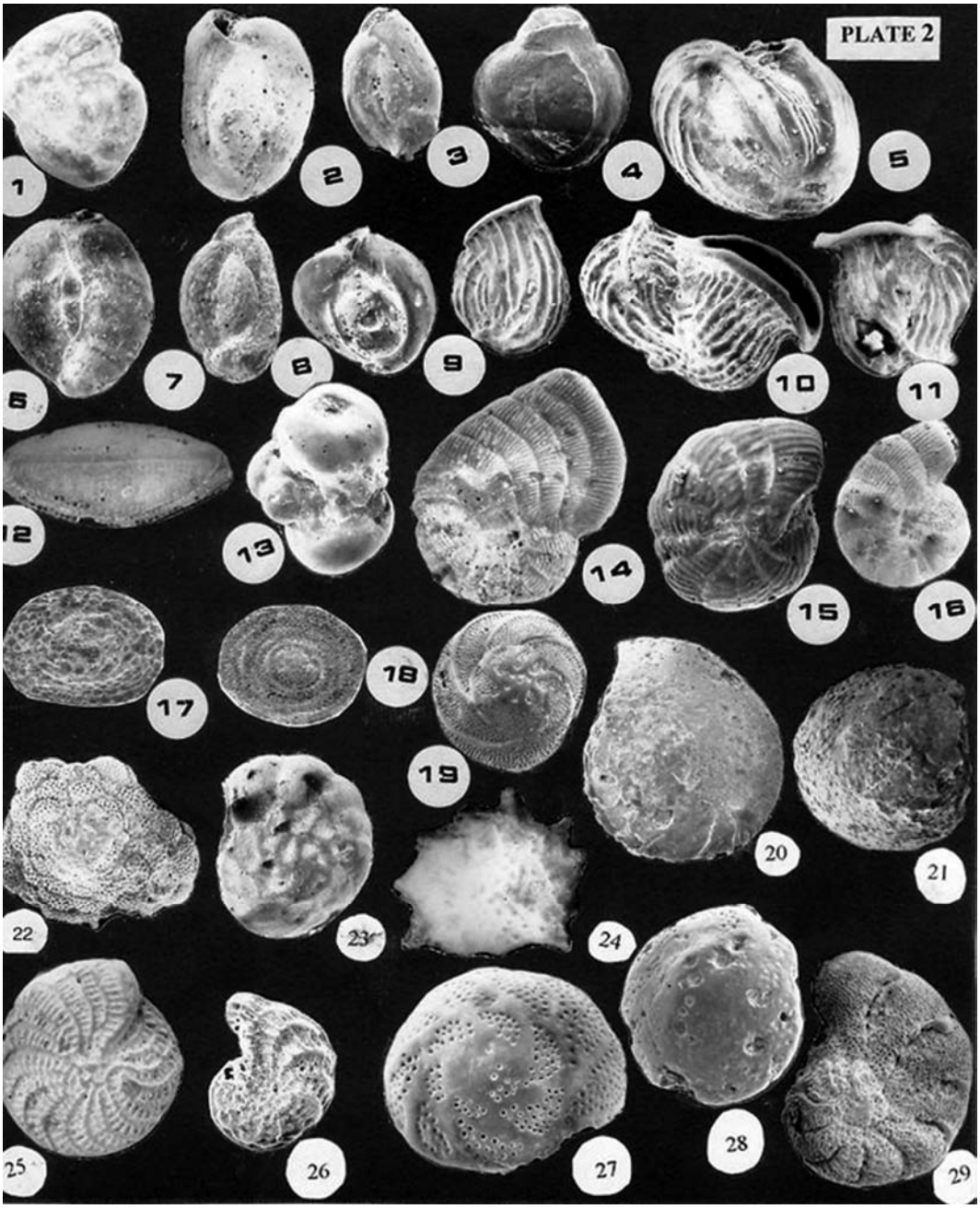

Plate II

Suez which is depressed gradually from the shores of the Gulf of Suez with gentle slope toward the mountainous region in the western side of the Eastern Desert. This area lies along the Gulf of Suez coast (about 3 km west of Ras Shukier and 32 km south of Ras Gharib city (Fig. 1). Geographically, the study area is located on a major anticlinal ridge which trends N-S and NW-SE from south of Ras Gharib to Ras Shakier parallel to the Gulf of Suez. This area had been subjected to both extensive sediment deposition and sea-level fluctuations during the marine transgression and regression of the Holocene Epoch. During that time, the northern Red Sea, especially in the Gulf of Suez is believed to have been relatively stable. The Gulf of Suez is considered a hypersaline basin (about 41 - 42‰) as it is within an arid climatic zone bordering a desert region and where evaporation greatly exceeds freshwater influx.

The supratidal zone is considered as a depression dissected by a NW-SE fault system (Pliocene - Recent) forming two grabens which include saline pools and evaporitic sabkha closing the eastern and western fault lines[24].

The pools are a small saline basins (ponds) following a separate small semicircular topographic depressions, within aeolian terrigenous sands, silts and clays with concentrated evaporates and carbonate sands in the upper parts. Each pool is about 200 m long and 150 m wide with maximum depth reaching 1m during the high tide time. These pools are isolated and its connection with the Gulf of Suez is restricted by a gravel and coarse sand beach, (about 180 m wide and up to 3 m high). The evaporitic Sabkha is situated around the saline pools and nearly is flat and interrupted by high relief sand and coastal vegetated dunes. This Sabkha is covered with gypsum and halite crusts that exhibit tepee structures,[14] Quaternary gravelly hills about 8m in thickness surround the Sabkha,[15].

The Gulf of Suez is a more or less closed arm of the Red Sea. It extends for about 300 Km in length with about 50 km wide at its widest point. It is relatively shallow, semi-enclosed basin and its bottom is covered mainly with sand,[25].

Analysis of most ecological parameters controlling the distribution of the foraminifera is based on their occurrences and the measured parameters. According to physical data; the water salinity of the Gulf of Suez varies between 41.32‰ and 42.27‰ with an average 42‰, while the salinity value in saline pool ranges from 53.2‰ to 114.6‰ averaging 98.72 (Table 1). This is attributed to low rainfall, arid climate and high evaporation rate around the saline pool and its surrounding sabkha.

The ion hydrogen (pH) shows that the Gulf of Suez is slightly alkaline, whereas the pH ranges from 7.56 to 8.02 with an average 7.7, while the pH value of saline pool is highly alkaline because the pH fluctuate between 7.05 and 8.53 averaging 8.12. Since the *p*H value in the saline pool is affected greatly by the water temperature and the amount of organic constituents in pool water.

Specific conductivity fluctuate around 61.3 ms/cm in the Gulf of Suez, while it ranges from 41.47 to 84.21 ms/mc, averaging 73.12 ms/mc in saline pool (Table 1). Generally, the ecological data indicate that the Gulf of Suez is warm, slightly alkaline, hypersaline marine environment, while the saline pool is very shallow, slightly warm, highly alkaline, extremely hypersaline and oxidizing environment.

Results and Discussion

It is clear from table (2) and figure (2) that the family Amphisteginidae is the most abundant one (31.48%) in the studied areas. The high proportion of *Amphistegina* supports the assumption that these forms thrive in calm waters[26].

The family Hauerinidae (20.41%) is represented by 5 genera; *Quinqueloculina* (13.93%), *Triloculina* (4.43%), *Articulina* (1.23%), *Hauerina* (0.57%) and *Parrina* (0.25%). Thus, it may be suggested that an abundance of these genera may be taken as a criterion for shallow, sheltered, warm marine environments such as (Gulf of Suez) and also, in very calm warm water body in saline pool.

Another significant feature of the faunal distribution in the present work is the presentation of *Amphistegina* species which has high proportion (31.48%), which may be related to the shallow water and biogenic sand facies of the Gulf of Suez comparing with the off-shore samples from the Red Sea.

Among the most abundant foraminiferal species recorded in the studied area are *Ammonia* (7.87%) and *Elphidium* (8.52%). The high abundance of *Ammonia* supports the fact that the increases in frequency for this species occur under the abnormal environmental conditions such as the high salinity such as saline pool

Table 1— The oceanographic parameters recorded during the field survey.

S. No.	Location	depth	Salinity	pH	Sp.C.
Sk 1	Saline pool and Sabkha	0.30	114.6	8.01	84.21
Sk 2		0.30	53.20	8.33	41.47
Sk 3		0.40	210.0	8.53	78.82
Sk 4		0.35	95.24	8.10	69.50
Sk 5		0.50	105.0	7.50	80.17
Sk 6		0.40	87.58	8.49	64.55
Sk 7		0.30	114.6	8.01	84.21
Sk 8		0.20	53.20	8.33	41.47
Sk 9		0.35	56.08	8.53	78.82
Sk 10		0.45	95.24	7.05	69.50
Sk 11		0.30	112.28	8.07	80.17
Sk 12		0.40	87.58	8.49	64.49
	average		98.72	8.12	73.12
Gul l	Gulf of Suez	33.0	42.04	8.02	6.28
Gul 2		25.0	41.32	7.66	6.32
Gul 3		23.0	42.15	7.56	6.30
Gul 4		27.0	42.17	7.70	6.33
Gul 5		26.0	42.27	7.73	6.34
	average		42.00	7.70	61.30

Depth in meter; Salinity in ‰; PH = Ion of hydrogen; Sp.C. = conductivity in ms/mc;
Sk = Sabakhah, Gul = Gulf of Suez

Table 2— Frequency and distribution of the assemblage's benthic foraminifera at the study areas

G. No.	S. No.	Family	Genus	Species	Sabkha	Saline pool	Gulf of Suez	Total	%
1	1	Rhabdamminidae	*Rhabdammina*	*Rhabdammina abyssorum* Sars	10	2	4	16	1.31
	2			*Textularia aegyptica* Said	4	2	10	16	1.31
	3			*Textularia agglutinans* d'Orbigny	4	1	6	11	0.9
2	4	Textulariidae	*Textularia*	*Textularia candeinana* d'Orbigny	3	0	6	9	0.74
	5			*Textularia foliacea* Heron-Allen & Earland	4	2	10	16	1.31
	6			*Textularia gramen* d'Orbigny	2	0	8	10	0.82
	7			*Spiroloculina angulata* Cushman	1	0	6	7	0.57
	8			*Spiroloculina communis* Cushman & Todd	1	0	4	5	0.41
3	9	Spiroloculinidae	*Spiroloculina*	*Spiroloculina corrugate* Cushman	1	0	2	3	0.25
	10			*Spiroloculina hada* d'Orbigny *i*	1	0	2	3	0.25
	11			*Spiroloculina lucida* Cushman & Todd	1	0	5	6	0.49
	12			*Quinqueloculina angularis* d'Orbigny	3	2	8	13	1.07
	13			*Quinqueloculina crassa* Cushman	1	0	6	7	0.57
	14			*Quinqueloculina laevigata* d'Orbigny	3	0	12	15	1.23
	15			*Quinqueloculina lamarkiana* d'Orbigny	6	1	15	22	1.8
	16			*Quinqueloculina limbata* d'Orbigny	3	0	10	13	1.07
	17			*Quinqueloculina mosharrafi* Said	2	0	8	10	0.82
4	18		*Quinqueloculina*	*Quinqueloculina neostraitula* Thalmann	1	0	6	7	0.57
	19			*Quinqueloculina partschii* d'Orbigny	1	1	5	7	0.57
	20			*Quinqueloculina samoaensis* Cushman	6	2	14	22	1.8
	21			*Quinqueloculina seminulum* Linne'	8	1	16	25	2.05
	22			*Quinqueloculina subpolygona* Parr	2	0	10	12	0.98
	23	Hauerinidae		*Quinqueloculina sp.1*	4	1	6	11	0.9
	24			*Quinqueloculina sp.2*	1	0	5	6	0.49
5	25		*Hauerina*	*Hauerina bradyi* Cushman	1	0	6	7	0.57
6	26		*Miliolinella*	*Miliolinella subrotunda* Montagu	6	2	19	27	2.21
	27			*Triloculina affinis* d'Orbigny	1	0	4	5	0.41
	28			*Triloculina asymmetrica* Said	3	1	8	12	0.98
	29			*Triloculina irregularis* d'Orbigny	4	0	6	10	0.82
7	30		*Triloculina*	*Triloculina quadrata* Collins	0	0	4	4	0.33
	31			*Triloculina rupertiana* Brady	10	2	4	16	1.31
	32			*Triloculina subgranulata* Cushman	1	0	6	7	0.57
8	33		*Articulina*	*Articulina sagra* Cushman	2	0	6	8	0.66
	34			*Articulina pacifica* Cushman	1	1	5	7	0.57
9	35		*Parrina*	*Parrina bradyi* (Millett)	0	0	3	3	0.25
10	36	Alveolinidae	*Borelis*	*Borelis schlumbergeri* Reichel	1	0	5	6	0.49
	37			*Peneroplis pertusus* (Forskal)	3	5	10	18	1.48
11	38	Peneroplidae	*Peneroplis*	*Peneroplis planatus* (Fichtel & Moll)	5	8	20	33	2.7
	39			*Peneroplis proteus* d'Orbigny	2	3	6	11	0.9
12	40	Soritidae	*Sorites*	*Sorite marginalis* (Lamarck)	20	6	32	58	4.75
13	41		*Amphisorus*	*Amphisours hemprichii* Ehrenberg	12	5	24	41	3.36
14	42	Rosalinidae	*Rosalina*	*Rosalina globularis* d'Orbigny	2	0	6	8	0.66
	43			*Amphistegina cumingii* Carpenter	39	12	65	116	9.51
15	44	Amphisteginidae	*Amphistegina*	*Amphistegina lessonii* d'Orbigny	80	6	80	166	13.61
	45			*Amphistegina radiata* (Fichtel & Moll)	30	2	70	102	8.36
16	46	Cymbaloporidae	*Cymbaloprella*	*Cymbaloporella tabellaeformis* Brad	6	0	20	26	2.13
17	47	Rotaliidae	*Ammonia*	*Ammonia beccarii* Linne'	54	12	30	96	7.87
18	48	Calcarinidae	*Calcaeina*	*Calcarina calcar* d'Orbigny	4	0	6	10	0.82
19	49	Elphidiidae	*Elphidium*	*Elphidium advenum* Cushman	12	6	22	40	3.28
	50			*Elphidium crispum* Linne'	16	8	40	64	5.25
20	51	Rosalinidae	*Gavelinopsis*	*Gavelinopsis turbinate* Cushman & Valentine	12	3	22	37	3.03
21	52	Planulinidae	*Planulina*	*Planulina cf. wuellerstorfi* Schwager	0	0	10	10	0.82
			Total		400	97	723	1220	100

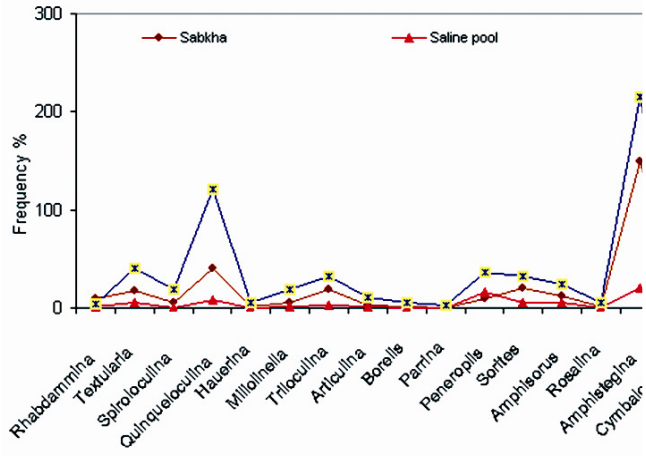

Fig. 2— Relative presentation of foraminifera genera in saline pool and its surrounding sabkhah and Gulf of Suez

and sabkha[27], while the high abundance of *Elphidium* increases in dynamically active environments as in Gulf of Suez[23].

Members of superfamily Soritacea are also a significant part of the fauna (13.19%), they are represent by two genera (*Sorites* and *Peneroplis*). Most abundantly, one of them is *Sorites* (8.11%) and the other one is *Peneroplis* (5.08%), this would also suggest a shallow, sheltered warm marine environment[28].

Other significant component of the faunal distribution of the studied area is the relatively high frequency of *Textularia* species (5.08%). This high frequency could be interpreted accordingly the assumption that in the warmer environments, which are dominated by carbonate precipitation helps in constructing more resistant tests after the death of the organisms. Such a feature may be particularly true for those forms thriving in shallow, warm environments[29].

The frequency of fauna differs from locality to another one, where the high frequency of fauna (59.26%) recorded from the Gulf of Suez samples, while the low proportional fauna (7.95%) is recorded in saline pool, also the Sabkha's samples has frequency of fauna (32.78%) from the identified fauna.

Boltovsky *et al.*,[30] illustrated the hyperhaline water ranges from 40‰ to 75‰. Because of the Gulf of Suez has salinity varying between 41.32‰ and 42.27‰, it is considered as hyperhaline water, while the saline pool has salinity ranges from 53.20‰ to 114.6‰. It is considered as extremely hyperhaline water due to the low rainfall and high evaporation.

Conclusion

Seventeen samples have been collected and studied from two localities at the saline pool and it's surrounding Shabkha at Ras Shukier and from the Gulf of Suez. The most important conclusions of the present study can be summarized as follows.

Fifty two species of benthic foraminifera belong to 21 genera were identified, microphotographed by using the SEM and presented in 2 plates. The geographic distribution and ecology of the benthic foraminiferal species at the studied area has been investigated, and revealed that the study area is generally has a calm energy environment, which dynamically less active than Mediterranean due to the abundance of *Amphistegina, Quinqueloculina, Ammonia,* and *Sorites.* These conditions also favor the preservation of some areanceous shallow forms in the foraminiferal assemblages such as *Textularia.* All recorded species in the studied area are abundant in the northern part of the Red Sea coast, which reflect abnormal salinity (hyperhaline water) and temperature.

Generally, the ecological data indicate that the Gulf of Suez is warm, slightly alkaline, hypersaline marine environment, while the saline pool is very shallow, slightly warm, highly alkaline, extremely hypersaline and oxidizing environment.

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