

Environmental Applications of Marine Foraminifera and Ostracoda Assemblage in Faw Town, South of Iraq

Badria Ali Hussain ^{1*} ali.b.h.1989.sa@gmail.comAbbas Hameed Mohammed ¹ doctorabbas71@yahoo.co.in¹ Department of Geology, College of Science, University of Basrah, Basrah, Iraq.

* Correspondence author.

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Abstract

In this paper, we present surface and subsurface sample from (50) cm by using grab instrument to (21) m by diver variations of ostracoda and foraminifera assemblage from (15) samples (5) shallow whereas (10) subsurface along Arabian Gulf at Al-Faw (Kaser Al- Muge) in the Basrah city south of Iraq, Surface and subsurface sediments variation in ostracoda and foraminifera assemblage. Totally (15) sample were sorted under the binocular microscope (24) species of the Ostracoda taxa belonging to (21) genera, (4) subfamilies, (17) families, (8) super families and (4) suborders and 51 species of the foraminifera taxa belonging to (19) genera, have been identified. With increasing depth of the depositional environments, the prevalent genera in ostracoda are Cyprideis, Tanella, Actinocythereis, and Neocytheromorpha, while the prevalent foraminiferal taxa are Ammonia, Elphidium, Quinqueloculina, and Spiroloculina. In all studied samples the predominant genera of the surface sample belonging to tidal and marine environments which characterized by low saline water and mud flat condition, while the other genus indicate marine environment which characterized by high saline conditions, in addition, to that environments are affected by sea level changes. Ostracoda and foraminifera along Al-Faw beach were studied by sampling surface and subsurface sediments from the marine shelf and upper slope to understand recent ostracoda and foraminifera assemblages and Systematics. Grain size analysis and organic matter were also determined.

Keywords:

Ostracoda and foraminifera assemblage, Al Faw beach, Kaser Al-muge, Grain size and organic matter, South of Iraq.

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1. Introduction

(Kaser Al-Muge) Al-Faw beach in southern Iraq is one of the most important study areas, comprising geographical units and forming a complex ecological system. Therefore, paleontological and sedimentological studies are important for determining sedimentary environments based on specific types of invertebrate fossils (ostracods and foraminifera). Ostracoda and foraminifera have received great importance in determining environments in different geological ages, including the modern era. Ostracoda and foraminifera have a long geological range, as they were found in sediments ranging in age from the Upper Cambrian to the Recent era (Al- Meshlab and Mohammed, 2012; Al-Shawi et al., 2019; Al-Ali et al., 2020). Ostracoda and foraminifera are found in almost all mixed aquatic environments (marine, brackish,

fresh) and are characterized by their large numbers; a few of them live on the surface of the water, and others spread throughout the water column. A large number of their species are benthic, and their spread is affected by salinity, temperature, substrate texture, and depth. Ostracoda and foraminifera are of great importance in stratigraphic comparison and identification of the ancient environment and ancient geography. In addition to being an important tool for oil exploration, they have also been utilized in research on environmental contamination (Al-Hilli, 1977). Irrigation-related man-made marine environments had a significant impact on the floodplain sediments of southern Iraq during the late Holocene, and irrigation water carried reworked sands and silts, resulting in widespread

contamination (Al Meshlab and Mohammed, 2012). The sediment region is made up of sand, silt, and clay, with the silt content being the most prevalent and the sand grain size being extremely small. At a depth of between 16 and 17 m, there is a distinctive thin layer of silty clay that is dark gray in color, which is characterized by the absence of fossils. This layer, which was represented by a pyritization, may represent the upper part of the Al-Hammar Formation (Sabah, 2010).

2. Study Area

The reason for selecting the Al-Faw (Kaser Al-Muge) region and the goal of the study is because the ecological study of the ostracoda and foraminifera fauna from that area has not yet been conducted. The purpose of the study is to determine the distribution of the ostracoda and foraminifera assemblage, attempt to match their distribution with the observed environment, and assess the ecology of the widespread and abundant ostracoda and foraminifera taxa. The necessary equipment for collecting the samples, such as a motor launch, mud grab, and water sampler, is also included in the choice of location and purpose of the study. The study area is investigated in southern Iraq, Al- Faw (Kaser Al-Muge). Figs. (1,2 and 3) and Table (1) were prepared using UTM GIS (Universal Transverse Mercator). The systematics of recent ostracoda and foraminifera depend on the sediment sample. This work includes many stations in Basrah city, Al- Faw (Kaser Al-Muge). Five surface samples by grab at 50 cm, and ten subsurface samples (down-sampled sediment) were collected by a diver at 21m. The study area lies south of Mesopotamia (Tectonically). It is one of the important areas for geological studies, which represents the largest body of water in Iraq.

Table 1: Location of the study area (TP 01 to TP 06) in the (Al- Faw-Kaser Al-Muge)

Name (Tern Point)	X (Longitude)	Y (Latitude)
TP 01	253379.8024	3308055.293
TP 02	251364.341	3310736.183
TP 03	240570.6423	3319262.927
TP 04	233964.1125	3323563.385
TP 05	222545.9978	3326135.924
TP 06	206223.3991	3327520.188

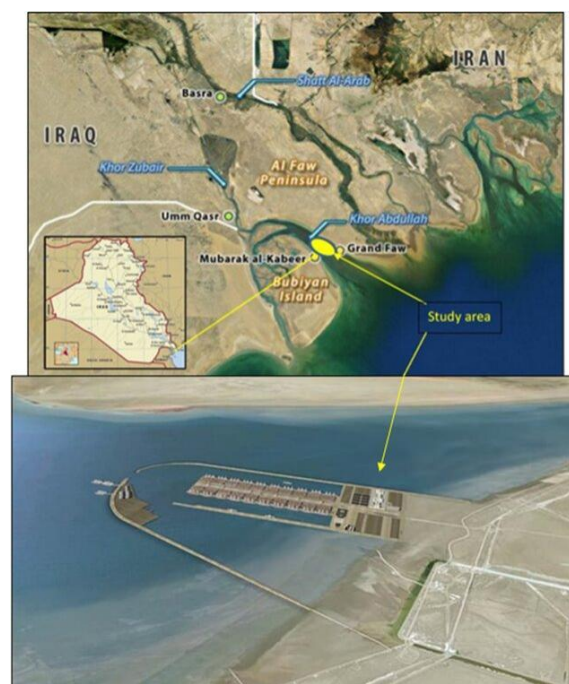


Fig. 1: Satellite image of the study area in southern Iraq, Basrah, Al-Faw beach. Eastern breakwater, western breakwater, and inner basin.

3. Materials and Methods

Total Fifteen sediment samples collected for two different location surface and subsurface in June, 2024 the coastal and marine environments of the study area along the A-Faw coastal in Basrah (Kaser Al-Muge), southern Iraq. The surface sediments sample by the author herself taking necessary precautions, making use of samples collected at depth (50) cm Peterm grap (Betjeman, 1969), and the down-sample or subsurface by the diver is collected sediment samples in depth (21) m. Extreme care was taken to retrieve the sediment samples from sites that are not presently affected by modern-day tidal processes. All the sediment samples collected from the study area were brought to the laboratory and recorded, including details such as colour. The composition of the sediment and related substances included shell fragments of gastropoda, pelecypoda, wood pieces, coal fragments, etc. Prior to analyzing a sample, its location, depth, and surroundings were also recorded. We took 50 grams from each of the samples after cutting and weighing them on the balance. The sample was air-dried after being well cleaned. To break up the flocculated clay particles and dissolve any tiny salt that might have been trapped between the finer grains, a (0.025) sodium hexametaphosphate solution was typically utilized

(Shepared and Moore, 1955; Barnes, 1959; Jayraju, 1993). To extract ostracoda, the fossil specimens were cleaned using an ASTM (230) mesh sieve (0.063 mm opening) to remove the smaller particles (silt and clay mud) for viewing under the stereo binocular microscope. The residue, which contained sand and fossils, was placed in a ceramic eyelid and dried in an oven between (50°) C and (60°) C. Under a binocular microscope, benthic ostracoda and foraminifera specimens were chosen and separated from the residue using a (0.001) mm winder and Newton sable hairbrush. The ostracoda and foraminifera were carefully distributed, and in this way, they were indexed on a single (24) chamber cardboard microfaunal slide. To make a slide, the typical species chosen from the slide are maintained in a slide with several chambers. Every species is identified and selected from these using a binocular microscope, and at the (TP 01, TP 02, TP 03, TP 04, TP 05, and TP 06) levels, the genus and species were processed for ostracoda and foraminifera research (Fig. 3 and Table 1). Offshore shallow water sediments are often composite materials made up of particles ranging in size from sand to clay in various combinations. The moisture content of each sample was first removed by thoroughly drying it in a hot air oven to determine the proportions of sand, silt, and clay. Following that, the samples were disseminated overnight with a 0.025 N sodium hexametaphosphate solution for disaggregation in the right amounts. The material was then disaggregated and rinsed through a phosphor bronze wire mesh with a (230) ASTM sieve mesh (opening = 0.063) until clear water came through, making sure the washings were less than (1000) cc. The weight of the substance coarser than (1/16) mm, i.e., sand, and the fine material (silt and clay) were determined by weighing the dried material that was retained on the sieve; the washings were analyzed by the pipette method in accordance with the procedure adopted by (Krumbein and Pettijohn, 1938). The suspension passing through the sieve was collected in a 1-liter graduated measuring jar. If the suspension collected in the jar, after complete washing, is less than (1000) cc, the already prepared sodium hexametaphosphate solution was added to make it up to (1000) cc. The suspension in the measuring jar was well agitated using a stirring device to have a uniform distribution of the particles in the suspension. As soon as the agitation stopped, the

time was noted. Exactly after (2) hours and (3) minutes, a (20-cc) pipette was used to draw the sample out of the area using consistent suction after being gradually introduced into the solution to a depth of 10 cm. After being pipetted out, the sample was placed in a (50) cc beaker and dried in an oven. Measures were taken to avoid boiling and splitting. The residue's weight was determined after it was completely dry. The weights of sand, silt, and clay were transformed into weight percentages and displayed on a trilinear diagram. The species were identified and organized in accordance with the categorization proposed by (Moore and Pitrat, 1961; Harthman and Puri, 1974; Loeblich and Tappan, 1988). All species have been kept in the Paleontology Laboratory of the College of Science, Department of Geology, Basrah University.

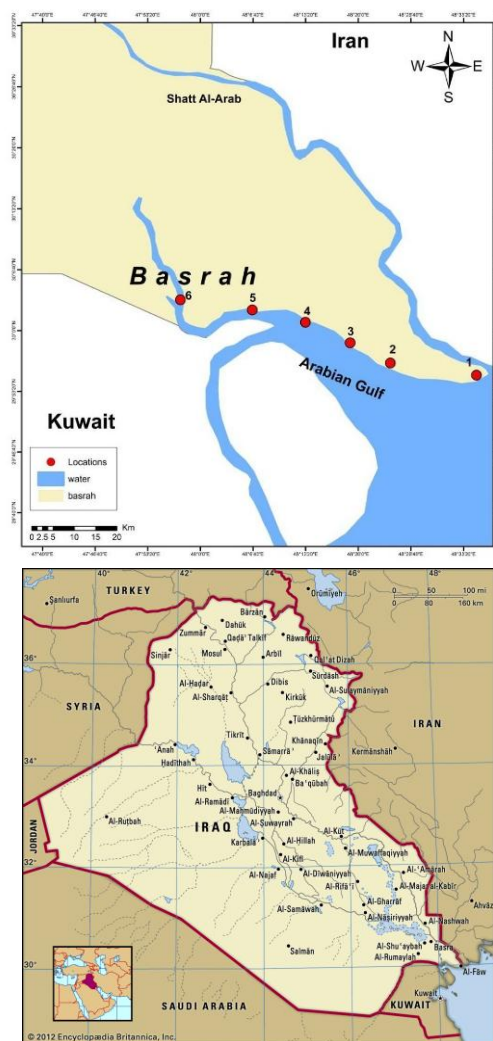


Fig. 2: Location of the study area in southern Iraq, Basrah, Al-Faw beach, the six sites (TP 01 to TP 06)

4. Results

1. Grain size analysis

Sand -Silt- Clay Ratio estimation:

The sediments were characterized in the current investigation using (Trefethen's, 1950) textural terminology. Using (Folk, 1974), the triangular diagram (Fig. 5) shows the percentage distribution of sand, silt, and clay fractions in surface and subsurface sediment samples. The percentage sediment texture is shown below for each region in the coastal and marine environments, as classified by the plot sediments. The percentages of clay, silt, and sand in the

sediment components of Al- Faw beach are listed in Table 2. The results clearly indicate that the sediments are mainly composed of silt in the regions. We also note the presence of a difference in the percentages of sediment components of clay and sand. The sand percentage was low in areas, ranging at Al-Faw beach (eastern Kaser Al-Muge) between 8 and 39, with the highest value recorded at a depth at sample station (5) and the lowest value at a depth at station (9). In western Kaser Al-Muge, its clay ranged between 14 and 25 percent, with the highest value recorded at a depth of station (4) and the lowest value recorded at station (12).

Table 2: Results of volumetric analysis using the pipette method according to (Folk, 1974) and percentages of sediment components of clay, silt, and sand in (Kaser Al-Muge)

No.	Sample name	Sand%	Silt%	Clay%	Particle Size Distribution Classification
1	1	20	61	19	slightly clayey sandy silt
2	2	25	56	19	Slightly clayey sandy silt
3	3	23	59	18	slightly clayey sandy silt
4	4	12	63	25	slightly sandy clayey silt
5	5	39	44	17	slightly clayey sandy silt
6	15	13	66	21	slightly sandy clayey silt
7	6	21	62	17	slightly clayey sandy silt
8	7	18	67	15	slightly sandy, slightly clayey silt
9	8	8	70	22	slightly sandy clayey silt
10	12	14	62	24	slightly sandy clayey silt
11	10	14	65	21	slightly sandy clayey silt
12	11	25	61	14	slightly clayey sandy silt
13	13	11	64	25	slightly sandy clayey silt
14	14	16	62	22	slightly sandy clayey silt
15	9	17	68	15	slightly sandy, slightly clayey silt

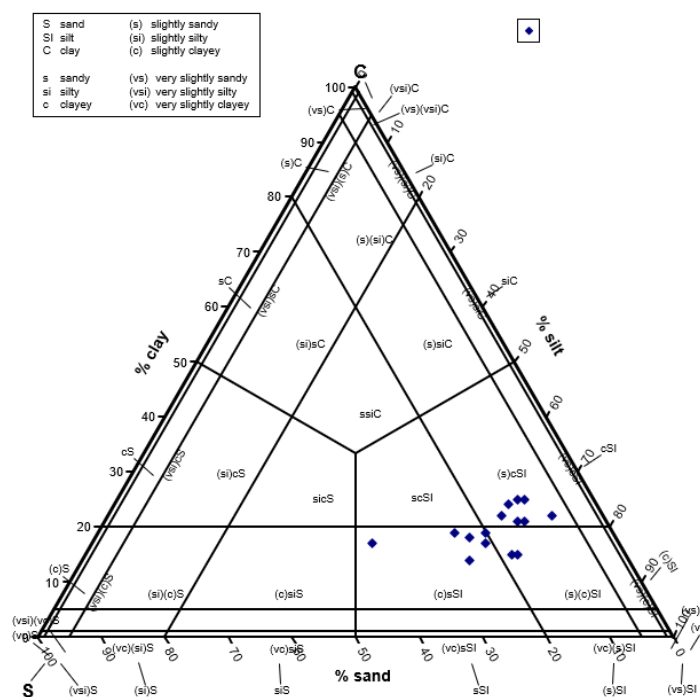


Fig. 3: Grain size analysis in the study area according to (Folk, 1974).

2. Organic Matter

The term organic matter refers to the decomposable matter accumulated in a sediment through organic activity and excludes shells and other hard skeletal parts originating from organisms. Most organic matter in coastal sediments is derived from benthic material which has been trapped between finer particles of the inorganic sediments. The organic matter in the sediment was determined by ignition (Davies, 1974). The recorded values are tabulated below. The OM values in the study area ranged from 1.42 to 1.60 in the surface sample, while in the deeper sample they ranged from 1.56 to 3.21. The only way to directly ascertain organic matter is by using a strong hydrogen peroxide solution to oxidize the sediment organic matter and measuring the resulting loss as an indicator of organic matter. The organic material, though, is often determined by its organic carbon concentration. Dry combustion, wet combustion, and titrimetric techniques may be used to estimate this with high accuracy. The dry combustion techniques are excessively expensive and don't differentiate between various kinds of carbon, like coal, charcoal, graphite, etc. The wet combustion techniques are excessively labor-intensive (Kumar, 1988).

Table 3: Percentage of Organic matter (OM)

Surface	Deep
1.45	2.68
1.60	2.78
1.53	3.01
1.52	2.08
1.42	2.67
	1.89
	2.32
	3.21
	1.56
	2.38

3. Identification of Ostracoda and Foraminifera

The ostracoda identified in the present study are under Suborder Podocopina according to (Moore and Pitrat, 1961; Harthman and Puri, 1974). The benthic ostracoda are most dominant group is suborder Podocopina, represented by (24) species belonging to (21) genera. The variation of ostracoda assemblages with depth showed the abundant presence of *Cypridis*, *Tanella*, *Actinocythereis*, and *Neocytheromorpha*, with different (TP 01, TP 02, and TP 03) indicating high

saline conditions. Nevertheless, in the sample, the presence of *Cypridis* and *Tanella* suggests a marine environment characterized by mud flats and low salinity. Four benthic Ostracoda species, *Cypridis torosa*, *Tanella gracilis*, *Actinocythereis scutiger*, and *Neocytheromorpha* sp. cf. *N. indoarabic*, were found in all the samples. The benthic Ostracoda have been abundant in four samples, and these are:

TP 01: *Cypridis*, *Tanella*, *Actinocythereis*, *Neocytheromorpha*, *Parakrithe* and *Candona neglecta*.

TP 02: *Cypridis*, *Tanella*, *Actinocythereis* and *Neocytheromorpha*, *Xestoleberis variegata* and *Miocypridis* sp.1.

TP 03: *Cypridis*, *Tanella*, *Actinocythereis* and *Neocytheromorpha*, *Keijia demissa* and *Kalingella*.

TP 04: *Cypridis*, *Tanella*, *Actinocythereis* and *Neocytheromorpha*, *ALocopocyt-hera reticulata* and *Neocyprides* sp.

TP 05: *Cypridis*, *Tanella*, *Actinocythereis* and *Neocytheromorpha*, *Calliostoma coppingeri* and *Lankacythere coralloide*.

TP 06: *Cypridis*, *Tanella*, *Actinocythereis* and *Neocytheromorpha*, *Dohukia fossulata* and *Heterocypris giesbrechtii*

The foraminiferal assemblage that identified in the present study can be grouped into four suborders (Loeblich and Tappan, 1988): Textulariina, Milioliina, Rotaliina and Lagenina (Table 2). The most dominant group of foraminifera is Milioliina, represented by (6) genera and (23) species, whereas the other groups are: Textulariina and Lagenina appear few and rare. In the present study, only two species, *Ammonia* and *Elphidium* species, are abundant and have occurred since the early Holocene period for Rotaliina. *Quinqueloculina*, *Triloculina*, and *Spiroloculina* also occur in abundance for Milioliina.

The sediment sample variation of foraminifera with depth revealed the abundant presence of *Ammonia beccarii*, *Elphidium*, and *Quinqueloculina seminulum*, with fluctuations (TP 01, TP 02, and TP 03) indicating high salinity. However, in the specimen, the presence of *Ammonia* and *Elphidium* suggested a marine environment with low salinity and mudflat conditions. The four benthic foraminiferal species are *Ammonia beccarii*, *Ammonia tepida*,

Elphidium advenum, and *Elphidium crispum*, were found in all the samples. The benthic Foraminifera have been abundant in four samples, and these are:

TP 01: *Ammonia beccarii*, *Elphidium craticulatum*, *Quinqueloculina seminulum*, *Spiroloculina communis* and *Triloculina trigonula*.

TP 02: *Ammonia beccarii*, *Elphidium spl*, *Quinqueloculina seminulum*, *Quinqueloculina seminulum*, *Spiroloculina communis* and *Triloculina trigonula*.

TP 03: *Ammonia beccarii*, *Elphidium advenum*, *Elphidium sp. Nonionoides elongatum*, *Quinqueloculina seminulum* *Spiroloculina communis* and *Triloculina trigonula*.

TP 04: *Ammonia beccarii*, *Elphidium hispidulum* and *Elphidium sp.*, *Spiroloculina communis* and *Triloculina trigonula*.

TP 05: *Ammonia beccarii*, *Elphidium hispidulum* and *Elphidium excavatum*, *Spiroloculina communis* and *Triloculina trigonula*.

TP 06: *Ammonia beccarii*, *Elphidium hispidulum* and *Elphidium excavatum*, *Spiroloculina communis* and *Triloculina trigonula*)

However, the foraminiferal assemblages do not exhibit high diversity. The agglutinated group is few fauna. The dominant groups are Miliolida and Rotaliina.

Studies of Foraminifera from the surface and subsurface sediments collected off (Kaser Al-Muge) in Faw Town have led to the recognition of benthonic species, (12) subfamilies, and (9) superfamilies. Out of the total (51) species, (17) species fall under suborder Rotiliinae; (5) species under suborder Textulariina; (28) species under suborder Millioliinae; and the remaining (1) species under suborder Laginiae.

Table 4: Foraminifera species that are found in the study area, according to Loeblich and Tappan 1988.

Suborder	Superfamily	Family	Subfamily	Genus	Species
Rotaliina	Rotallacea	Rotalidae	Rotaliinae	<i>Ammonia</i>	<i>Ammonia beccarii</i>
	Rotalioidea	Ammoniidae	Ammoniinae	<i>Ammonia</i>	<i>Ammonia tepida</i>
	Rotalioidea	Ammoniidae	Ammoniinae	<i>Ammonia</i>	<i>Ammonia dentata</i>
	Rotalioidea	Elphidiidae	Elphidiinae	<i>Elphidium</i>	<i>Elphidium advenum</i>
	Rotalioidea	Elphidiidae	Elphidiinae	<i>Elphidium</i>	<i>Elphidium incertum</i>
	Rotalioidea	Elphidiidae	Elphidiinae	<i>Elphidium</i>	<i>Elphidium crispum</i>
	Rotalioidea	Elphidiidae	Elphidiinae	<i>Elphidium</i>	<i>Elphidium excavatum</i>
	Rotalioidea	Elphidiidae	Elphidiinae	<i>Elphidium</i>	<i>Elphidium lessonii</i>
	Rotalioidea	Elphidiidae	Elphidiinae	<i>Elphidium</i>	<i>Elphidium selseyense</i>
	Rotalioidea	Elphidiidae	Elphidiinae	<i>Elphidium</i>	<i>Elphidium discoidale</i>
	Rotalioidea	Elphidiidae	Elphidiinae	<i>Elphidium</i>	<i>Elphidium gerthi</i>
	Rotalioidea	Elphidiidae	Elphidiinae	<i>Elphidium</i>	<i>Elphidium poeyanum</i>
	Rotalioidea	Elphidiidae	Elphidiinae	<i>Elphidium</i>	<i>Elphidium macellum</i>
	Calcarinoidea	Calcarinidae	Pararotaliinae	<i>Pararotalia</i>	<i>Pararotalia nipponica</i>
	Calcarinoidea	Calcarinidae	Pararotaliinae	<i>Pararotalia</i>	<i>Pararotalia calcar</i>
	Bolivinitoidea	Bolivinitidae	Bolivinitinae	<i>Brizalina</i>	<i>Brizalina striatula</i>
	Rotalioidea	Rotalioidea	Notorotaliidae	<i>Parrellina</i>	<i>Parrellina hispidula</i>
	Nonionioidea	Nonionidae	Nonioninae	<i>Nonionoides</i>	<i>Nonion elongatum</i>
	Nonionioidea	Nonionidae	Nonioninae	<i>Nonion</i>	<i>Nonion fabric</i>
	Nonionioidea	Nonionidae	Nonioninae	<i>Nonionella</i>	<i>Nonionella stella</i>
	Nonionacea	Nonionidae	Nonioninae	<i>Florilus</i>	<i>Florilus grateloupi</i>
	Planorbuloidea	Cibicides	Cibicidinae	<i>Cibicides</i>	<i>Cibicides refulgens</i>
	Textulariina	Textulariidae	Textulariinae	<i>Textularia</i>	<i>Textularia sagittula</i>
	Textulariina	Textulariidae	Textulariinae	<i>Textularia</i>	<i>Textularia earlandi</i>
	Textulariina	Textulariidae	Textulariinae	<i>Textularia</i>	<i>Textularia agglutinans</i>
	Textulariina	Textulariidae	Textulariinae	<i>Textularia</i>	<i>Textularia candelana</i>
	Textulariina	Textulariidae	Textulariinae	<i>Textularia</i>	<i>Textularia aura</i>
	Ammodiscina	Ammodiscoidea	Ammodiscinae	<i>Ammodiscus</i>	<i>Ammodiscus incertus</i>
	Miliolina	Milioloidea	Spiroloculinidae	<i>Spiroloculina</i>	<i>Spiroloculina communis</i>
	Miliolina	Milioloidea	Spiroloculinidae	<i>Spiroloculina</i>	<i>Spiroloculina laevigata</i>
	Miliolina	Milioloidea	Spiroloculinidae	<i>Spiroloculina</i>	<i>Spiroloculina nitida</i>
	Miliolina	Milioloidea	Spiroloculinidae	<i>Spiroloculina</i>	<i>Spiroloculina sp.</i>
	Miliolina	Milioloidea	Spiroloculinidae	<i>Spiroloculina</i>	<i>Spiroloculina depressa</i>
	Miliolina	Soritoidea	Peneroplidae	<i>Spirolina</i>	<i>Spiroculina acicularis</i>
	Miliolina	Milioloidea	Miliolidae	<i>Rupertianella</i>	<i>Rupertianella rupertiana</i>
	Miliolina	Milioloidea	Hauerinidae	Miliolinellinae	<i>Triloculina</i>
	Miliolina	Milioloidea	Hauerinidae	Tubinellinae	<i>Articulina</i>
	Miliolina	Milioloidea	Hauerinidae	Hauerininae	<i>Quinqueloculina</i>
		Hauerinidae			<i>Quinqueloculi-na sp</i>
	Miliolina	Milioloidea	Hauerinidae	Hauerininae	<i>Quinqueloculina</i>
	Miliolina	Milioloidea	Hauerinidae	Hauerininae	<i>Quinqueloculi-na lamareckiana</i>
	Miliolina	Milioloidea	Hauerinidae	Hauerininae	<i>Quinqueloculina</i>
	Miliolina	Milioloidea	Hauerinidae	Hauerininae	<i>Quinqueloculi-na oblonga</i>
	Miliolina	Milioloidea	Hauerinidae	Hauerininae	<i>Quinqueloculi-na polygona</i>
	Miliolina	Milioloidea	Hauerinidae	Hauerininae	<i>Quinqueloculi-na reticulata</i>
	Miliolina	Milioloidea	Hauerinidae	Hauerininae	<i>Quinqueloculi-na stalkeri</i>
	Miliolina	Milioloidea	Hauerinidae	Hauerininae	<i>Quinqueloculi-na seminulum</i>
					<i>Quinqueloculi-na rameswarensis</i>
					<i>Quinqueloculi-na tenagos</i>
	Miliolina	Soritoidea	Soritidae	<i>Sorites</i>	<i>Sorites marginalis</i>
	Miliolina	Milioloidea	Hauerinidae	Miliolinellinae	<i>Pyrgo</i>
Allogromioidea		Allogromiidae	Argillotubinae	<i>Micatuba</i>	<i>Micatuba</i>
	Nodosariacea	Lagenidae		<i>Lagena</i>	<i>Lagena setigera</i>

Plates of foraminifera species

Species of Foraminifera

Plate 1

1. *Ammonia beccarii*, 40 x
2. *Ammonia tepida*, 40 x
3. *Ammonia dentata*, 40 x
4. *Elphidium advenum*, 40 x
5. *Elphidium incertum*, 40 x
6. *Elphidium crispum*, 40 x

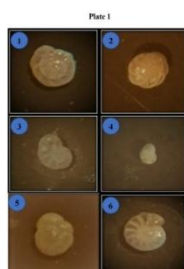


Plate 2

1. *Elphidium excavatum*, 40 x
2. *Elphidium lessonii*, 40 x
3. *Elphidium selseyense*, 40 x
4. *Elphidium discoidale*, 40 x
5. *Elphidium gerthi*, 40 x
6. *Elphidium poeyanum*, 40 x

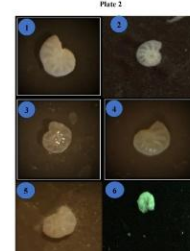


Plate 3

1. *Elphidium macellum*, 40 x
2. *Pararotalia nipponica*, 40 x
3. *Pararotalia calcar*, 40 x
4. *Brizalina striatula*, 40 x
5. *Parrellina hispidula*, 40 x
6. *Nonion elongatum*, 40 x

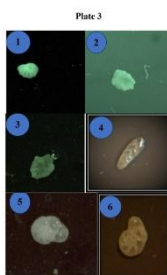


Plate 7

1. *Articulina funalis*, 40 x
2. *Quinqueloculina* sp., 40 x
3. *Quinqueloculina agglutinans*, 40 x
4. *Quinqueloculina lamarkiana*, 40 x
5. *Quinqueloculina oblonga*, 40 x
6. *Quinqueloculina polygona*, 40 x

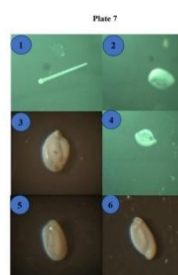


Plate 4

1. *Nonion fabric*, 40 x
2. *Nonionella stella*, 40 x
3. *Florilus grateloup*, 40 x
4. *Cibicides refulgens*, 40 x
5. *Textularia sagittula*, 40 x
6. *Textularia earlandi*, 40 x

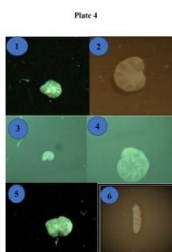


Plate 8

1. *Quinqueloculina reticulata*, 40 x
2. *Quinqueloculina stalkeri*, 40 x
3. *Quinqueloculina seminulum*, 40 x
4. *Quinqueloculina rameswarensis*, 40 x
5. *Quinqueloculina tenagos*, 40 x
6. *Sorites marginalis*, 40 x



Plate 5

1. *Textularia agglutinans*, 40 x
2. *Textularia candelana*, 40 x
3. *Textularia avara*, 40 x
4. *Ammodiscus incertus*, 40 x
5. *Spiroloculina communis*, 40 x
6. *Spiroloculina laevigata*, 40 x



Plate 9

1. *Pyrgo elongata*, 40 x
2. *Micatuba* sp., 40 x
3. *Lagena setigera*, 40 x

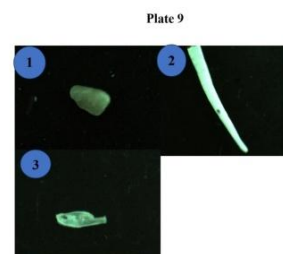


Plate 6

1. *Spiroloculina nitida*, 40 x
2. *Spiroloculina* sp., 40 x
3. *Spiroloculina depressa*, 40 x
4. *Spiroloculina acicularis*, 40 x
5. *Rupertianella rupertiana*, 40 x
6. *Triloculina trigonula*, 40 x

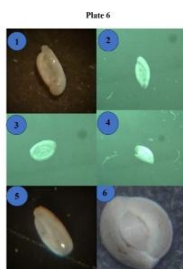


Table 5: Classification of ostracoda species in the study area according to (Moore and Pitrat, 1961; Howe, 1962; Harthman and Puri, 1974

Sub order	Super family	Family	Subfamily	Genus	Species
Podocopina		Cytherideae	Cytheracea	<i>Cyprideis</i>	<i>Cyprideis</i> sp.
		Cytherideae	Cytheracea	<i>Cyprideis</i>	<i>Cyprideis torosa</i>
	Cytheracea	Cytherideidae		<i>Miocyprideis</i>	<i>Miocyprideis</i> sp.1
		Cytherideidae		<i>Neocyprides</i>	<i>Neocyprides</i> sp.
		Cytherace	Cytherideinae	<i>Cytherelloidea</i>	<i>Cytherelloidea</i> sp.
	Cytheracea	Krithidae		<i>Parakrithe</i>	<i>Parakrithe</i>
	Cytheroidea	Xestoleberididae		<i>Xestoleberis</i>	<i>Xestoleberis variegata</i>
		Cytherellidae		<i>Cytherelloidea</i>	<i>Cytherelloidea praecipua</i>
			Pterygocyterinae	<i>ALocopocyt-here</i>	<i>ALocopocyt-here reticulata</i>
		Candonidae	Candoninae	<i>Candona</i>	<i>Candona neglecta</i>
		Schizocytheridae		<i>Neomonoceratina</i>	<i>Neomonoceratina iniqua</i>
		Schizocytheridae		<i>Neomonoceratina</i>	<i>Neomonoceratina porocostata</i>
		Leptocytheridae		<i>Tanella</i>	<i>Tanella gracilis</i>
	Cypridacea	Cyprididae	Cypridinae	<i>Heterocypris</i>	<i>Heterocypris giesbrechtii</i>
	Bairdioidea	Bairdiidae		<i>Bairdoppilata</i>	<i>Bairdoppilata alcyonicola</i>
		Bairdiidae	Bairdiinae	<i>Bairdia</i>	<i>Bairdoppilata carinata</i>
	Bairdiace	Pectocytherida		<i>Keijia</i>	<i>Keijia Demiss</i>
		Trachyleberididae		<i>Actinocythereis</i>	<i>Actinocythereis scutiger</i>
		Trachyleberidida		<i>Carinocytherei</i>	<i>Carinocythereis hamat</i>
		Trachyleberidida		<i>Asymmetricyther</i>	<i>Asymmetricythere reticulata</i> sp
				<i>Lankacyther</i>	<i>Lankacythere coralloide</i>
			Arculacythereina	<i>Neocytheromorph</i>	<i>Neocytheromorpha</i> sp. cf. <i>N. indoarabic</i>
		Unertai		<i>Kalingell</i>	<i>Kalingell</i>
		Leptocytherida		<i>Dohuki</i>	<i>Dohukia fossulat</i>

Plates of ostracoda species

Species of Ostracoda

Plate 10

1. *Cyprideis* sp., 40 x
2. *Cyprideis torosa*, 40 x
3. *Miocyprideis* sp., 40 x
4. *Neocyprides*, 40 x
5. *Cytherelloidea* sp., 40 x
6. *Parakrithe* sp., 40 x

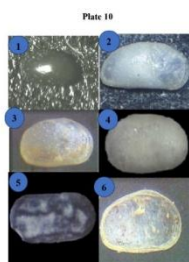


Plate 12

1. *Tanella gracilis*, 40 x
2. *Heterocypris giesbrechtii*, 40 x
3. *Bairdoppilata alcyonicola*, 40 x
4. *Bairdoppilata carinata*, 40 x
5. *Keijia Demiss*, 40 x
6. *Actinocythereis scutiger*, 40 x

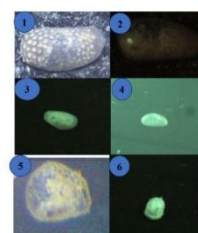
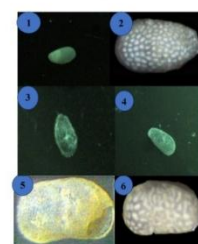


Plate 13

1. *Carinocythereis hamata*, 40 x
2. *Asymmetricythere reticulata* sp., 40 x
3. *Lankacythere coralloides*, 40 x
4. *Neocytheromorpha indoarabica*, 40 x
5. *Kalingella*, 40 x
6. *Dohukia fossulata*, 40 x



5. Discussion

The most important characteristic of ostracoda and foraminifera is their sensitivity to environmental change. Our knowledge of modern species indicates that many species have well-defined ecological ranges, and therefore changes in fossils assemblage through reflect changing environmental conditions, which can be reconstructed if the ecological tolerances of the

species are known (Haslett, 2002). The variations in salinity determine the composition and diversity of the ostracoda, and there are well-defined assemblages, each dominated by just four species: Cyprideis, Tanella, Actinocythereis and Neocytheromorpha (Boomer and Eisenhauer, 2002). There are some species that prefer muddy substrate, and some that prefer sandy substrate. In some environments, ostracod assemblages are dominated by a single taxon. The study was characterized by a high abundance of ostracod communities, which showed great diversity and were widespread, indicating that the organisms are sensitive to environmental changes (Hemidawi, 2020). The presence of certain ostracod communities in a particular region reflects the type of environment in which these communities and their significant environment impact have lived in the size, shape, and ornamentation of ostracod shells. So, the study of ostracod taxonomy gives clues to the environments (Alkaabi, 2001). Ostracod communities are environmentally controlled by factors such as temperature, water depth, sediment nature, volumetric gradient, and nutrient availability that reflect the direct impact of the environment. The high abundance of ostracoda in the study area, which showed largely varied sizes and shapes that indicates the original environment of ostracoda, which was not transferred from another region. The important species in the study are Cypridis, Tanella, Actinocythereis and Neocytheromorpha, which have been shown the availability of this species in marine and brackish environments (Morkhoven, 1962 and 1963). The presence of Cypridis, Tanella, Actinocythereis, and Neocytheromorpha in all the samples suggests their wide range of tolerance to the observed environmental parameters (Mohammed, 2006). The genera Cypridis, Tanella, Actinocythereis, and Neocytheromorpha, and especially the species Tanella gracilis, are widely distributed in the Indo-Pacific and Atlantic, including the Caribbean and also in my study area. The wide geographic distribution of this cosmopolitan species in primary through passive transport by ships (Zhao and Whatley, 1989; Witte, 1993), and this species has been found to occur very widely throughout the Faw Coastal. In the present study, an attempt was made to identify the same in all the sediment samples taken off Faw Coastal (Kasar Al-Muge) due to the fact that the abundance of ostracoda in

the sediments is reflected by the organic content and substrate characteristics. The primary origin of the organic matter found in the sediments. This is a kind of vegetation that flourishes either on land, in the surface waters of the sea, or in both. The majority of the organic matter in marine water sediments comes from terrigenous plant material, whereas the main source of organic matter for the ocean as a whole is the benthic photosynthetic organisms. In both instances, the amount of organic material in sediments is determined by the rate at which organic material is deposited and by an ample supply of organic material. The table above demonstrates that the organic matter is steadily rising and that it has the greatest average values (1. 423. 21) in both the surface and subsurface. The table shows that the amount of organic material increases with the particle size of the sediment, which explains why finer sediments absorb organic material (Kunenen, 1950). The categorization of the sediments and heavy minerals is also briefly discussed, along with how they help in understanding the provenance and depositional environment.

The majority of the sediment is unconsolidated and contains varying amounts of sand, silt, clay, shell pieces from gastropods, pelecypods, echinoids, wood chips, pieces, laterite fragments, coal chips, and foraminifera.

Foraminifera are microscopic, singled celled organisms that build themselves a shell (or test) and live both in the surface layers of the sediment and in the water column (planktonic) (Phleger, 1960); (Murray, 1980); (Maziqa, 2023) and (Shareef, 2023).

Foraminifera in surface and subsurface (down samples) differ in both size and species types of the species from those observed deep in (Kaser Al-Muge) (Faw Town). Foraminifera from deep depths (TP 01, TP 02, TP 03, TP 04, TP 05 and TP 06) are larger in size, while in shallow depths the foraminifera size is small. Different foraminiferal species exhibit responses to changes in salinity; for example, Ammonia beccarii has been reported from very low-salinity surface to higher-salinity marine environments (Hameed and Achuthyan, 2011). (Phleger and Parkar, 1951) report Ammonia beccarii living at salinity between 44‰ and 46‰. Certain forms of foraminifera, especially agglutinated foraminiferal genera, like Textularia agglutinans, and calcareous genera like Elphidium, are much more tolerant of low salinity

conditions (Hameed and Achuthyan, 2011). Miliolid species that are found in the present study occur in marine water in all samples (TP 01 to TP 06). Many species such as *Quinqueloculina seminulum*, *Sproloculina communis* and *Triloculina laevigata* are found in all samples (TP 01 to TP 06).

The generic composition of agglutinated foraminifera such as *Reophax* and *Ammobaculites* does not exhibit any variation in the palaeoecological conditions. Their occurrence indicates a hyposaline to normal marine depositional environment, ranging in intertidal marine settings (Hameed and Achuthyan, 2011). They are assigned to the foraminiferal assemblage generally associated with the marginal marine environment. The above-mentioned genera also indicate the type of substrate that existed, reflecting the muddy layers. The generic composition further reflects the tropical waters. Thus, the agglutinated foraminifera characterize the studied sediments from the hypo- saline to normal marine water regime assignable to the tropical marginal marine environment of deposition. The calcareous group shows high diversity as compared to the other. (Murray, 1971).

In the present study, the calcareous foraminifera form the most dominant percentage of the fauna studied. Among these, the genus *Elphidium* has the maximum number of species. The genus *Elphidium* is the most common shallow-water marine foraminifera occurring throughout the world. It occurs in almost all shallow-water marine environments, from the supratidal region to the shelf, encompassing tropical, subtropical, and temperate environments. *Elphidium* has two principal forms. In the studied assemblage, keeled and nonkeeled forms were observed. According to Murray (1973), keeled forms occur mostly in the inner shelf with salinity 35.50‰, while the nonkeeled forms occur in hyposaline to hypersaline tidal marshes, lagoons, and nearshore environments. Bathymetrically, both the forms and the species exhibit a depth range of (0 to 50) m. Frerichs (1970) has noted the depth range of *Elphidium crispum* between (77) and (225) m in the Andaman Sea and Bay of Bengal. The species presented in this study are typical of al-Faw beach species commonly found along the eastern breakwater, western breakwater, and inner basin, pointing towards a relatively more stable environment. The occurrence of these tests

in this area is due to transportation by waves and tidal currents, and for benthic foraminiferal production, oxygen was always available at the sediment-water interface.

The high percentage of *Rotaliina* and *Miliolina* indicates that the studied sites were very close to the mouth of the estuary. The absence of *Miliammina fusca*, another characteristic foraminifer, and the high percentage of calcareous and porcelaneous species from the six sites indicate that the sites were very near the mouth of the estuary and rule out their position far inland from the mouth. (Kumar, 1988).

The case studies show that foraminifera can be used to interpret environmental change, whether natural or anthropogenic, over time scales ranging from a few years or decades to thousands of years. Natural environmental changes are linked to the climate/ocean system. Because many modern forms were already present in the Holocene, it is possible to make detailed environmental reconstructions that far back in time. Foraminifera are good indicators of changes in salinity, temperature, availability of dissolved oxygen (Haslett, 2002), food supply, eutrophication, and changes in sea level. They can be used to document the effects of various types of pollution (organic, hydrocarbons, heavy metals). In contemporary polluted environments, pre-pollution conditions can be reconstructed from the foraminiferal assemblages preserved in the pre-pollution sedimentary record. Where pollution is diminishing, they can be used to monitor recovery, including recolonisation of previously defaunated substrates, or recolonization by the more sensitive species in areas where the impact did not kill off the entire Foraminiferal fauna (Haslett, 2002)

6. Conclusion

Integration of benthic ostracoda assemblage (21) genera age from the (15) samples (surface and down surface) allows drawing the following conclusions:

Fifteen sediment samples were analyzed for ostracoda assemblage variations, and the study yielded a total of (24) species belonging to (21) genera. The present study reveals that the Al-Faw coast is in the city of Basrah, south of Iraq. Sea level fluctuated locally, and the rise and fall of sea level have been much smaller since the middle current estuaries and tidal zones date from the Holocene, and they overlie the older accumulation

in the subsidence zones. Species were documented in the study area for the first time, along with one new species and one new variety: *Heterocypris giesbrechtii*.

Cypreidis, *Tanella*, *Actinocythereis*, and *Neocytheromorpha* are the most abundant and common species. are low in the study area.

Based on the investigation carried out on the coast of Faw in Basrah city (Kasar Al-Muge) in the study area, it can be concluded that the ostracod assemblage appears to be more suitable and congenial, and further, from the present study it can be inferred that the south coast is more congenial for the production, diversity, and distribution of ostracoda.

The sediments are divided into three categories: somewhat clay sandy silt, somewhat sandy clay, and somewhat sandy slightly clay silt. It is crucial to understand the environment.

The organic material is currently heavily confined in the finer sediment types.

Integration of benthic foraminiferal assemblages from the (15) samples studied allows us to draw the following conclusions:

Fifteen sediment samples were analyzed for foraminiferal assemblage variations, and the study yielded that, out of the total (51) species, (17) species fall under suborder Rotiliinae; (5) species under suborder Textulariinae; (28) species under suborder Millioliinae; and the remaining (1) species under suborder Laginiinae occur in all the fifteen samples since the early Holocene period. The present study reveals that the Al-Faw coast in the city of Basrah, south of Iraq, sea level fluctuated locally and that the rise and fall of sea level have been much smaller since the middle Current estuaries and tidal zones date from the Holocene, and they overlie the older accumulation in the subsidence zones.

Out of the (51) species that have been identified in (18) genera, there are calcareous porous, calcareous porcelaneous, and arenaceous agglutinated. *Lagena setigera*, a new species of *Articulina funalis*, has been discovered, and (30) species have been recorded for the first time in the research area. The species are: *Elphidium gerthi*, *Elphidium poeyanum*, *Pararotalia nipponica*, *Pararotalia calcar*, *Nonion elongatum*, *Nonion fabric*, *Nonionella stella*, *Florilus grateloupi*, *Cibicides refulgens*, *Textularia sagittula*, *Textularia earlandi*, *Textularia candelana*, *Textularia aura*, *Ammodiscus incertus*,

Spiroloculina nitida, *Spiroloculina depressa*, *Spirolina acicularis*, *Rupertianella rupertiana*, *Articulina funalis*, *Quinqueloculina* sp., *Quinqueloculina agglutinans*, *Quinqueloculina oblonga*, *Quinqueloculina reticulata*, *Quinqueloculina stalker*, *Quinqueloculina rameswarensis*, *Quinqueloculina tenagos*, *Sorites marginalis*, *Pyrgo elongata*, *Micatuba*, and *Lagena setigera*.

Ammonia beccarii is the most abundant and common species. Hyaline and agglutinated forms are found to occur in moderate to low abundance in the study area.

Based on the investigation carried out on the coast of Faw in Basrah city in (Kaser Al-Muge) in the study area, it can be concluded that the foraminifera assemblage appears to be more suitable and congenial, and further, from the present study it can be inferred that the south coast is more congenial for the production, diversity, and distribution of foraminifera.

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8. Conflict of Interest

The authors declare that they have no conflict of interest.

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10. Author Contributions:

Badria Ali Hussein: Conceptualization, methodology, sample collection, formal analysis, data curation, investigation, visualization (figures and tables), writing – original draft, and writing – review & editing.

Abbas Hameed Mohammed: Conceptualization, supervision, sample collection, and formal analysis.

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التطبيقات البيئية لتجمعات الفورامينيفرا والأستراكودا البحرية، في مدينة الفاو، جنوبي

العراق

عباس حميد محمد¹

بدرية علي حسين^{*1}

doctorabbas71@yahoo.co.in

ali.b.h.1989.sa@gmail.com

¹ قسم علوم الأرض، كلية العلوم، جامعة البصرة، البصرة، العراق.

* الباحث المراسل.

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الملخص

في الدراسة الحالية، تم أخذ عينات سطحية وتحت سطحية من عمق (50) سم باستخدام أداة الجرافة إلى عمق (21) مترًا بواسطة الغواص لدراسة الاختلافات في مجموعة الأوستراكودا والفورامينيفرا من (15) عينة، (5) منها ضحلة و(10) تحت سطحية على طول الخليج العربي في الفاو (كاسر الأمواج) في مدينة البصرة جنوب العراق لدراسة اختلافات الرواسب السطحية وتحت السطحية في مجموعة الأوستراكودا والفورامينيفرا. تم دراسة (15) عينة تحت المجهر الثنائي. تم تحديد أربعة وعشرون نوعًا من تصنيفات الأوستراكودا تنتمي إلى (21) جنسًا وأيضًا واحد وخمسون نوعًا من أنواع الفورامينيفرا تنتمي إلى (19) جنسًا. توصلت الدراسة الحديثة إلى أن هناك الأوستراكودا مع العمق عن وجود وفير من *Cypreidis* و *Tanella* و *Actinocythereis* و *Neocytheromorpha* كذلك ازدياد في الأنواع العائدة للأجناس التالية من الفورامينيفرا مع ازدياد العمق *Ammonia* و *Elphidium* و *Quingloculina* و *Spiroloculina* في جميع العينات وهي السائدة بينما تتوفر بقية الأجناس والأنواع بنسب متفاوتة في جميع العينات. تشير الأجناس السائدة في العينة السطحية إلى بيئات المد والجزر والمساحات الطينية البحرية ذات الملوحة المنخفضة وحالة الطين المسطح بينما تشير باقي الأجناس الأخرى في العينات بأكملها إلى البيئة البحرية وظروف الملوحة العالية إضافة إلى تأثير التغيرات في مستوى سطح البحر. تم أخذ عينات من الرواسب السطحية وتحت السطحية من الجرف البحري والمنحدر العلوي لفهم تجمعات الأوستراكودا والفورامينيفرا الحديثة وتصنيفها. كما تم إجراء وقياس تحليل حجم الحبيبات والمادة العضوية.

الكلمات المفتاحية:

تجمعات الأوستراكودا والفورامينيفرا، شاطئ الفاو، كاسر الأمواج، حجم الحبيبات والمادة العضوية، جنوب العراق.

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