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The salinity effect and sedimentary types for the fauna distribution during the Holocene in Southern Iraq

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Abstract - In the present study, abundance and distribution of fauna in the sub surface sediments of the eight stations, Abo Flos, Ras Al-Besha, Khor Al-Umaya, Khor Shitana, Umm Qaser, Khor Al-Zubair, Kutaiban and Al-Faw were investigated. The stations selected for the present study were located at the southern region of Mesopotamia plain in Iraq. A reconnaissance survey in the study area showed the distribution of many marine species in the coastal areas (Khor Shitana, Umm Qaser, Khor Al-Zubair and Al-Faw). They were affected by the marine water areas with few effects of tidal flat and current waves. The affinities of the studied species are coming from the Indian Ocean towards the Red sea and the Arabian Gulf. The salinity and texture of sediment are the main factors that control the ecology and distribution of recent fauna. The soil texture for eight stations are sandy silt, clayey silt, silt, sandy silt and mud respectively.

Keywords: Salinity, Sedimentary, Fauna, Holocene and Mesopotamia.

Introduction

The Holocene sediments cover the major part of the Mesopotamia plain. They form the upper sequence (about 15-20 m) of the Quaternary sediments of the Mesopotamia Basin. The Holocene sequence is characterized by an alternation of fluvial, deltaic, lacustrine and estuarine/marine units. At present day, they are represented on the surface by almost similar modern sedimentary environments (Yacoub, 2011). The Mesopotamia plain is mostly covered by Quaternary sediments where the texture of the sediments are consist largely of silt and clay with little amount of sand fraction (Buringh, 1960).

The present paper aimed to study the distribution of fauna including Mollusca, Foraminifera and Ostracoda in the selected stations at southern part of Mesopotamia during the Holocene period and the effect of salinity and types of sediments on it.

Materials and Methods

Eight samples were collected from eight stations, Abo-Flos, Ras Al-Besha, Khor Al-Umaya, Khor Shitana, Umm Qaser, Khor Zubair, Kutaiban and Al-Faw. The samples were collected by a team of researchers from Marine Science Center during Basrah Pearl Trip in 20-29/6/2012 and one of these sample was collected from Kutaiban station by using a grab sampler (Fig. 1). In the laboratory, the weight of each sample was about 50 g and the grain size distribution was obtained by wet sieving using a sieve of 230 mesh to separate the sand from silt and clay fraction. Then, the silt and clay percentage were measured by a Pipet method after that examination under light microscope. The samples were washed on 230 mesh sieve to remove (silt and clay) particles.

The remnant which included sand and fauna were collected and dried, then picking the fauna using stereo-microscope. The identification was carried out with the aid of Moore (1961), with Howe (1962), Jain (1978), Malz (1982), Witte (1993a, b), Loeblich and Tappan (1988) has been followed for foraminifera, Keen and Coan (1974) for Gastropoda and Moore (1969) for Pelecypoda.

Figure 1. A map showing the location of sampling stations.

Results and Discussion

Salinity and Texture of Sediments:

Salinity is one of the most important ecological factors that affect of the fauna population, especially in coastal areas. The prescribed Salinity range was:

a. 0.5 - 5 ‰ (oligohaline): Fresh water.
b. 5 - 18 ‰ (mesohaline): Brackish water.
c. 18 - 30 ‰ (polyhaline): Brackish water.
d. 30 - 40 ‰ (euhaline): Marine water.

The sediments of the study area are of Holocene age. From the present study, it was found that the Kutaiban and Abo-Flos stations have the fresh water because it is a part of Shatt Al-Arab. They are characterized essentially by sandy silt and clay silt, respectively according to the texture classification of Folk (1974) (Fig. 2, Table. 1, Fig. 3, Table. 2 and Fig.4).

Tigris and Euphrates Rivers joined each other after leaving the marshes at Al-Qurna, forming Shatt Al-Arab (River), which flows in rather smoothly meandered channel. It was also fed from Hor Al-Hammar through the Garmat Ali channel (the outlet), just north of Basrah (Yacoub, 2011).

Ras Al-Beshais characterized the essentially by silt and it was brackish water also (Fig. 2, Table. 1, Fig. 3, Table. 2 and Fig. 4). Ras Al-Besha site represents a meeting place between the fresh water and marine water of Arabian Gulf (Al-Badran *et al.*, 2002). The Shatt Al-Arab is affected by the input of Karun River; this is clearly visible at their conflux north of Al-Sibah, where abrupt increase in the amount of suspended mud in the water of Shatt Al-Arab downstream of Al-Sibah occurs. It is worthful to mention that the water level of Shatt Al-Arab was influenced by the tidal action of the head of the Arabian Gulf, especially downstream of Basrah (Yacoub, 2011). Umm Qaser, Khor Al-Zubair and Al-Faw stations represents a marine water, while the grain size was silt, sandy silt and mud respectively (Fig. 2, Table. 1, Fig. 3, Table. 2 and Fig. 4). The tidal flat was characterized by the fine textured sediments, usually silt and clay, and occasionally sand. The sand was abundant at Khor Al-Zubair coast, due to influence of the reworked sediments of the Dibdibba formation.

The tidal flat is the coastal muddy shore of the head of the Arabian Gulf, occupying the intertidal zone between the high and low tides, which ranged between 1 - 1.5 m. The active tidal zone has an average width of 1 - 2 Km, extends along the coast from Al-Faw to Umm Qaser. The active tidal flat have wet muddy surface entrenched by narrow rills (Yacoub, 2011). Khor Al-Zubair area was affected from its formation until today by many changes of its water quality and sediments etc. by the influence of many factors such as factors that related to erosion, sedimentation, recent tectonic activities and sea level change (Kassler, 1973 and Al-Mussawy, 1991). In the last stage (1000 year ago to 1983), when the Shatt Al-Basrah cannel was opened and it is connected with Al-Massab Al-A'am project, the Euphrates run changed its waterway, that made Khor Al-Zubair to be considered as longitudinal Beach Lake extend on marine tongue shape land ward (Al-Mussawy, 1991).

Khor Shitana was characterized essentially by sand and its marine water (Fig. 2, Table 1, Fig. 3, Table 2 and Fig. 4). Khor Al-Umaya is the marine environment and it is characterized essentially by sandy mud (Fig. 2, Table. 1, Fig. 3, Table 2 and Fig. 4).

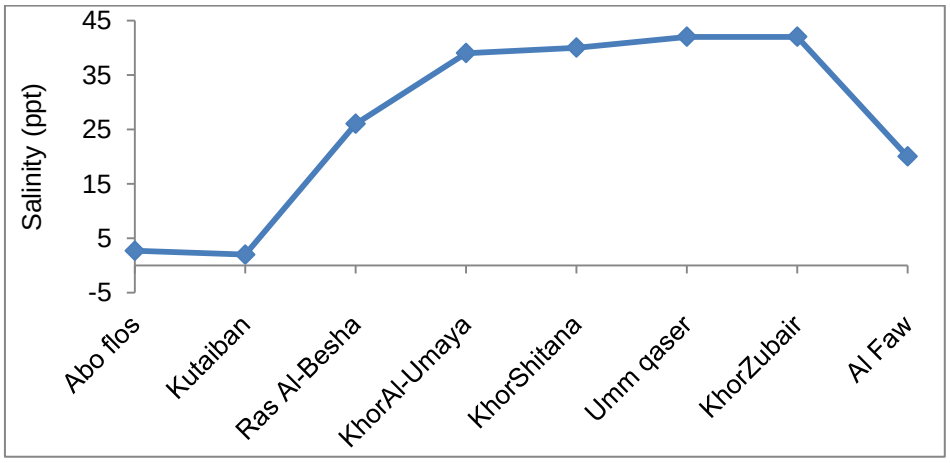

Figure 2. Concentrations of salinity (ppt) of stations.

Table 1. Salinity of stations.

Sample No.	Station Name	Salinity (ppt)
1	Abo flos	2.7
2	Kutaiban	2
3	Ras Al-Besha	26
4	KhorAl-Umaya	39
5	KhorShitana	40
6	Umm qaser	42
7	KhorZubair	42
8	Al Faw	20

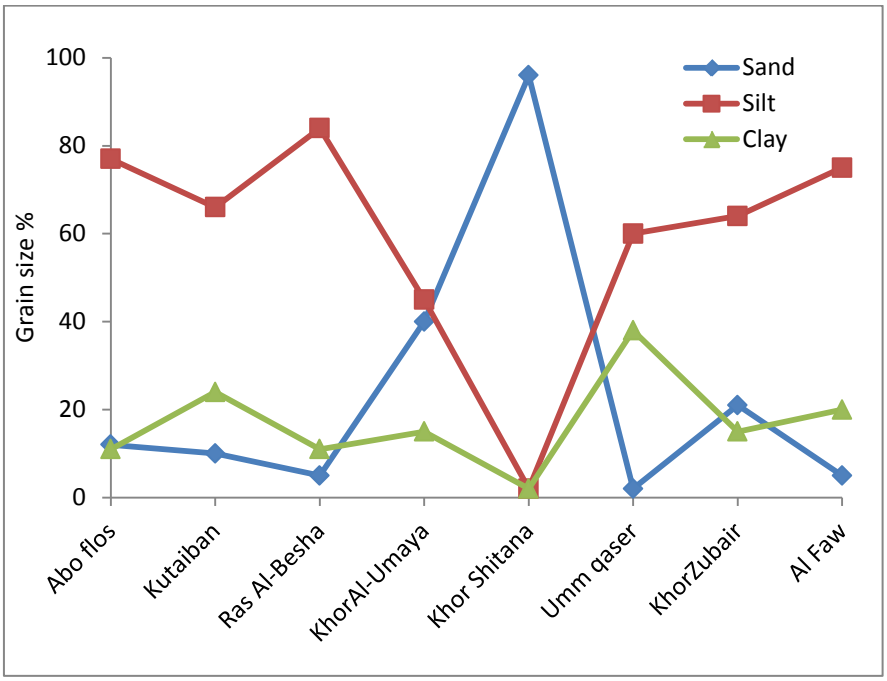

Figure 3. Grain size analysis of stations.

Table 2. Grain size analysis of stations.

Sample No.	Station Name	Sand %	Silt %	Clay %
1	Abo flos	12	77	11
2	Kutaiban	10	66	24
3	Ras Al-Besha	5	84	11
4	KhorAl-Umaya	40	45	15
5	KhorShitana	96	2	2
6	Umm qaser	2	60	38
7	KhorZubair	21	64	15
8	Al Faw	5	75	20

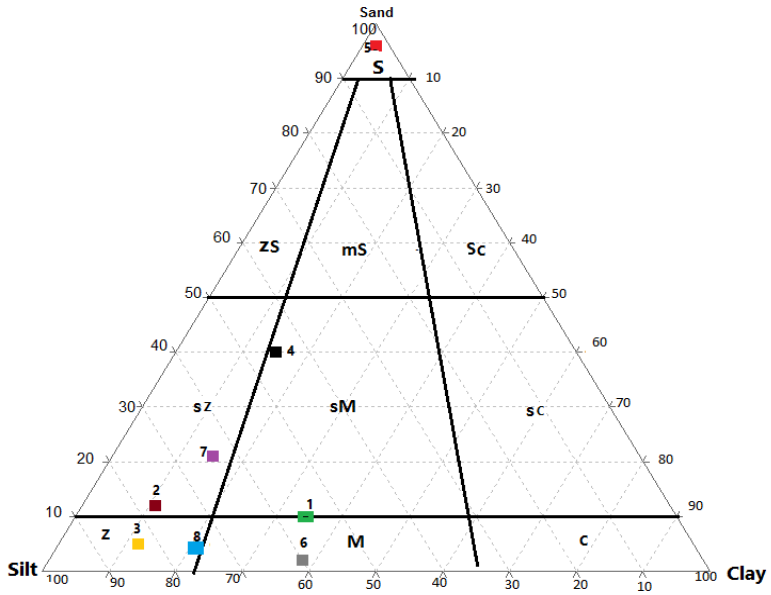

Figure 4. Grain Size classification by using the triangle of Folk (1974).
Symbol Index: C-clay, Z-silt, M-mud, S-sand, sC-sandy clay, sM-sandy mud, sZ-sandy silt, cS-clayey sand, mS-muddy sand and zS-silty sand.

Fauna Distribution:

Several types of Mollusca, Foraminifera and Ostracoda were recognized in the sampled stations. Their abundance and distribution are variable. These are:

1. Mollusca: Mollusca are a clade of organisms that all have soft bodies which typically have a "head" and a "foot" region. Often their bodies are covered by a hard exoskeleton, as in the shells of snails and clams or the plates of chitins. Most mollusca are marine, living at all levels from the intertidal zone to the abyssal zone. Some groups were live in fresh water and others have adapted to live on land. The Mollusca represents the high percent from the other groups, depending on Moore (1969). These are:
   A. Pelecypoda: Pelecypoda means ‘two’ and as the name suggests these mollusca possess two valve. They are also known as Pelecypoda meaning ‘hatchet-footed’. The Pelecypoda recorded many species. They are:
      1. *Angulus* sp. is a marine species (Pl. 1, Fig. 1). This species was found in Umm Qaser station.
      2. *Barbatia foliate* (Forsskål in Niebuhr, 1775) is a marine species (Pl. 1, Figs. 2, 2a). This species was found in Umm Qaser station.
      3. *Brachyodontes variabilis* (Krauss, 1848) is a marine species and it is widely available in Mangroves environment (Pl. 1, Figs. 3, 3a). This species was found in Khor Shitana station and it was recorded in Arabian Gulf at Jazirat-Hecham coast, Umm Qaser by Ahmed (1973).
      4. *Carditella pallid* (Smith, 1881) is a marine species (Pl. 1, Figs. 4, 4a). This species was found in Khor Shitana and Khor Al-Zubair stations.
      5. *Corbula taitensis* (Lamarck, 1818) is a marine species (Pl. 1, Figs. 5, 5a, 5b). This species was found in Khor Shitana and Khor Al-Zubair stations.

6. *Crassostrea iridescens* (Hanley, 1854) is a marine species (Pl. 1, Figs. 6, 6a, 6b, 6c). This species was found in Khor Shitana and Umm Qaser stations.
7. *Kellia* sp. is a marine species (Pl. 1, Fig. 7, Pl. 2, Fig. 7a). This species was found in Khor Al-Umaya station.

Plate 1. Pelecypoda species.
(1) *Angulus* sp., external view, 32x.
(2) *Barbatia foliate* (Forsskål in Niebuhr 1775), external view, 40x.
(2a) *Barbatia foliate* (Forsskål in Niebuhr, 1775), internal view, 40x.
(3) *Brachyodontes variabilis* (Krauss, 1848), external view, 12x.
(3a) *Brachyodonte svariabilis* (Krauss, 1848), internal view, 12x.
(4) *Carditella pallid* (Smith, 1881), external view, 80x.
(4a) *Carditella pallid* (Smith, 1881), internal view, 80x.
(5) *Corbula taitensis* (Lamarck, 1818), Bivalve, external view, 60x.
(5a) *Corbulata itensis* (Lamarck, 1818), external view, 60x.
(5b) *Corbulata itensis* (Lamarck, 1818), internal view, 60x.
(6*)* *Crassostrea iridescens* (Hanley, 1854), external view, 60x.
(6a) *Crassostrea iridescens* (Hanley, 1854), internal view, 60x.
(6b) *Crassostrea iridescens* (Hanley, 1854), external view, 32x.
(6c) *Crassostrea iridescens* (Hanley, 1854), internal view, 32x.
(7) *Kellia* sp. external view, 40x.

8. *Mactra dissimilis* (Reeve, 1854) is a marine species environment (Pl. 2, Figs. 8, 8a). This species was found in Khor Shitana and Al-Faw stations and it was recorded in Arabian Gulf at Jazirat-Hecham coast, Umm Qaser by Ahmed (1973).
9. *Ostrea* sp1, sp2. is a marine species. (Pl. 2 , Figs. 9, 9a, 9b). This sp1 was found in Umm Qaser station and sp2 was found in Khor Shitana station.
10. *Theora mesopotamica* (Annandale, 1918) is a species of saltwater and brackish water clam (Pl. 2, Figs. 10, 10a). This species was found in Shitana and Umm Qaser stations. This species was known from the northwestern end of the Arabian Gulf and from sub fossil remains in brackish deposits in the lower Tigris-Euphrates basin of Iraq.
11. *Timoclea* sp. is a marine species (Pl. 2, Figs. 11, 11a). This species was found in Khor Al-Zubair and Khor Al-Umaya stations.
12. *Unio tigridis* (Bourginat, 1852) is a species of freshwater and marine environment (Pl. 2, Figs. 12, 12a). They were reported to be abundant in fluviatile channels, marsh channels sub-environment and lacustrine environment (Yacoub *et al*., 1981). They are suspension feeders and shallow burrowers in freshwater sediments (Murray, 1985). This species was found in Khor Shitana station.

B. Scaphopoda: Scaphopoda means 'boat-footed'. This class includes marine Mollusca that are usually buried in sand. It recorded only two species.

1. *Dentalium octangulatum* (Donovan, 1803) is a marine species (Pl. 2, Fig. 13). This species was found in Umm Qaser and Khor Al-Zubair stations.
2. *Cadulus euloides* (Melvill and Standen, 1901) is marine species (Pl. 2, Fig. 14). This species found in Khor Shitana and Khor Al-Zubair stations.

C. Gastopoda: This word is a combination of two Greek words: 'Gastir which means 'stomach' and podi which means 'foot'. This study recorded many species. They are:

1. *Bellamya bengalensis* (Lamarck, 1822) is a marine, brackish, fresh, terrestrial species (Pl. 3, Figs. 1, 1a, 1b). This species was found in Khor Shitana and Umm Qaser stations.
2. *Bittium* sp. is a marine species (Pl. 3, Fig. 2). This species was found in Umm Qaser station.
3. *Cerithium pfeifferi* (Dunker, 1882) is a marine species (Pl. 3, Figs. 3, 3a). This species was found in Khor Shitana, Katiban, Abo Flous, Umm Qaser and Ras Al-Besha stations.
4. *Ethminolia degregorii* (Caramagna, 1888) is a marine species (Pl. 3, Figs. 4, 4a). This species was found in Khor Al-Zubair and Umm Qaser stations
5. *Gibbula* sp. is a marine species (Pl. 3, Figs. 5, 5a). This species was found in Katiban and Abo Flous stations.
6. *Gyraulus intermixtus* (Mousson, 1874) is a species of air-breathing freshwater snails in aquatic environment (Pl. 3, Figs. 6, 6a). This species was found in Katiban station.
7. *Lymnaea tenera* euphratica (Mousson, 1874) is a freshwater species (Pl. 3, Figs. 7, 7a). This species was found in rivers and estuaries with muddy intertidal zones such as the Shatt al-Arab river in Iraq. This is a brackish river with a comparatively high temperature during summer and moderately low temperature during winter. It was influenced by the semidiurnal tide of the Arabian Gulf. This species has also been found in

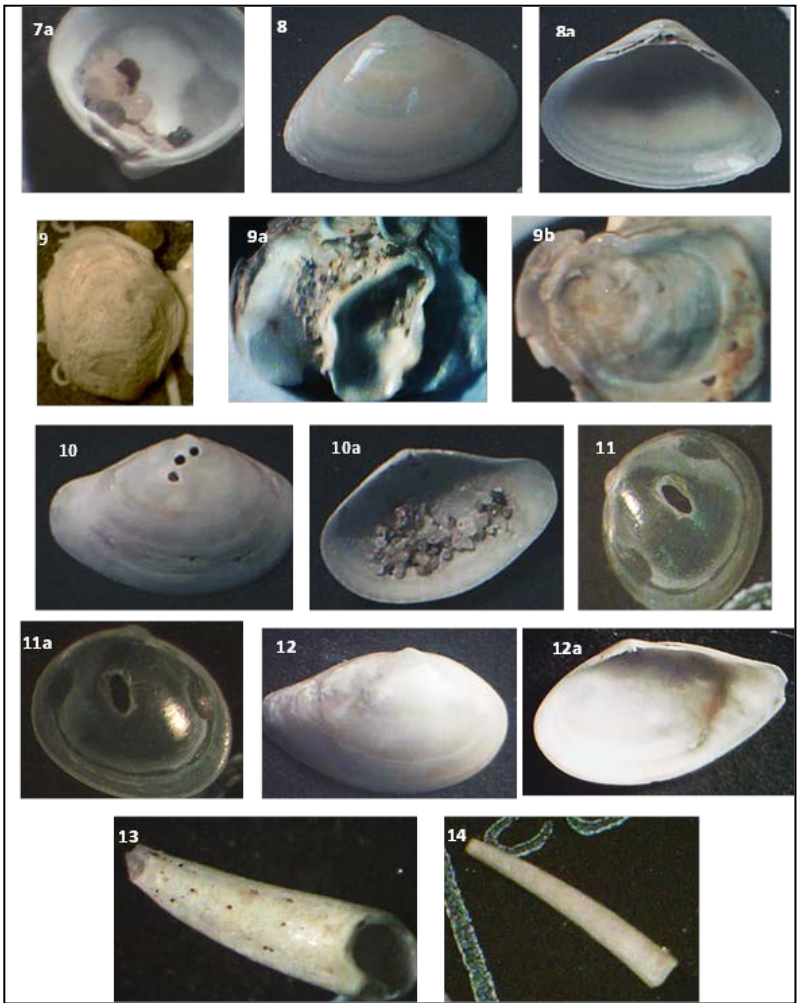

Plate 2. Pelecypoda and Scaphopoda species.
(7a) *Kellia* sp., internal view, 40x.
(8) *Mactra dissimilis* (Reeve, 1854), external view, 12x.
(8a) *Mactra dissimilis* (Reeve, 1854), internal view, 12x.
(9) *Ostrea* sp1., external view, 32x.
(9a) *Ostrea* sp2., external view, 12x.
(9b) *Ostrea* sp2., internal view, 12x.
(10) *Theora mesopotamica* (Annandale, 1918), external view, 12x.
(10a) *Theora mesopotamica* (Annandale, 1918), internal view, 12x.
(11) *Timoclea* sp., external view, 60x.
(11a) *Timoclea* sp., internal view, 60x.
(12) *Unio tigridis* (Bourginat, 1852), external view, 18x.
(12a) *Unio tigridis* (Bourginat, 1852), internal view, 18x.
(13) *Dentalium octangulatum* (Donovan, 1803), 32x.
(14) *Caduluse uloides* (Melvill and Standen, 1901), 32x.

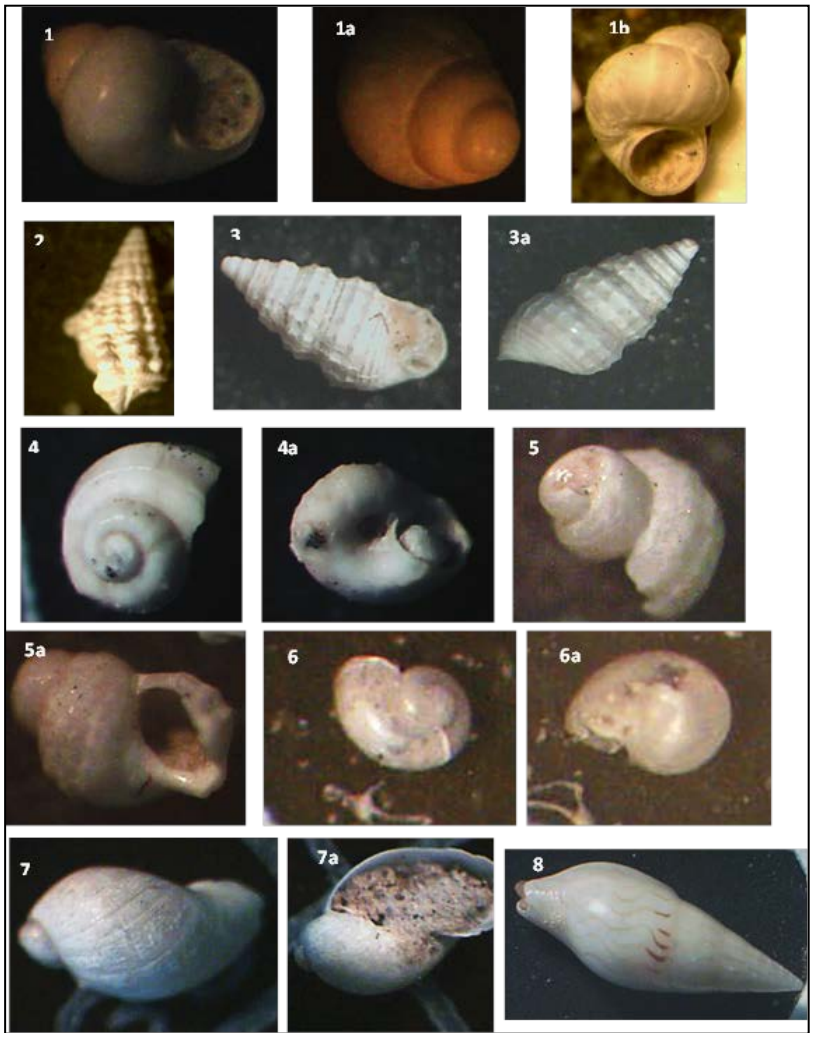

Plate 3. Gastropoda species.
(1, 1a, 1b) *Bellamya bengalensis* (Lamarck, 1822), 40x.
(2) *ittium* sp., 32x.
(3) *Cerithium pfeifferi* (Dunker, 1882), 32x.
(3a) *Cerithium pfeifferi* (Dunker, 1882), 32x.
(4) *Ethminolia degregorii* (Caramagna, 1888), 100x.
(4a) *Ethminolia degregorii* (Caramagna, 1888), 100x.
(5) *Gibbula* sp., 100x.
(5a) *Gibbula* sp., 100x.
(6) *Gyraulus intermixtus* (Mousson, 1874), 100x.
(6a) *Gyraulus intermixtus* (Mousson, 1874), 100x.
(7) *Lymnaea tenera* euphratica (Mousson, 1874), 80x.
(7a) *Lymnaea tenera* euphratica (Mousson, 1874), 80x.
(8) *Mitrella blanda* (Sowerby, 1844), 12x.

ditches, pools, canals and rice paddies (Machattie, 1936; Mills *et al.*, 1936; Ali and Salman, 1986). Machattie (1936) described this species as 'common' along the banks of the lower Euphrates River, Iraq. Mills *et al.* (1936) described this species as being by far the most prevalent gastropod in all parts of central and Southern Iraq. However, there is a lack of recent literature to confirm if this species is still common. This species was found in Abo Flos station.

8. *Mitrella blanda* (Sowerby, 1844) is a marine species (Pl. 3, Fig. 8, Pl. 4, Fig. 8a). This species was found in Khor Shitana station.
9. *Melanopsis nodosa* (Ferussac, 1823) (Pl. 4, Figs. 9, 9a). The nodular morphology is more common in freshwater environments and the smother form appears to be more abundant in estuarine waters, and it was described as abundant in lacustrine environments (Yacoub *et al.*, 1981). This species was found in Abo Flos station with nodes.
10. *Melanoides tuberculata* (Muller, 1774) is a freshwater species snail first described in Asia (Pl. 4, Fig. 10). This species was described as abundant in lacustrine environments (Yacoub *et. al.*, 1981). This species was found in Abo flos station.
11. *Monilea chiliarches* (Melvill, 1910) is a marine species (Pl. 4, Fig. 11). This species was found in Khor Al-Zubair, Umm Qaser and Khor Al-Umaya station
12. *Odostomia serenei* (Saurin, 1959) is a marine species (Pl. 4, Fig. 12). This species was found in Khor Shitana station.
13. *Oscilla jocosca* (Melvill, 1904) is a marine species (Pl. 4, Fig. 13). This species was found in Khor Shitana and Umm Qaser stations.
14. *Pyramidellidae* gen. sp. is a marine species (Pl. 4, Fig. 14). This species was found in Khor Shitana and Khor Al-Zubair stations.
15. *Scaliola* sp. is a marine species (Pl. 4, Fig. 15). This species was found in Khor Shitana station.
16. *Theodoxus jordani* (Sowerby, 1836) is freshwater species (Pl. 4, Figs. 16, 16a). This species was found in Katiban, Abo flos stations.
17. *Tornatina persiana* (Smith, 1872) is a marine species (Pl. 4, Figs. 17, 17a). This species was found in Al-Faw and Umm Qaser stations.
18. *Turbonilla umbrina* (Melivill, 1910) is a marine species (Pl. 4, Fig. 18). This species was found in Khor Shitana and Khor Al-Umaya stations.

2. Foraminfera: Foraminfera are single-celled protists with shells. Their shells are also referred to as tests because in some forms the protoplasm that covers the exterior of the shell. Modern foraminifera are primarily marine organisms but the living individuals have been found in brackish and freshwater. The generally accepted classification of the foraminifera was based on that of Loeblich and Tappan (1988). This study records many species these are:
    1. *Adelosina* sp. is a marine species (Pl. 5, Figs. 1, 1a). This species was found in the Khor Al-Zubair and Khor Al-Umaya stations.
    2. *Ammonia beccarii* (Linne, 1758) is a brackish, marine and hypersaline (Salinity in these salinas was ranged between 7 to 92 ‰) (Pl. 5, Figs. 2, 2a). This species may reflect the brackish estuarine conditions of very shallow environments such as lagoon and intertidal flats (Murray, 1991). This species was found in Khor Shitana, Katiban, Umm Qaser and Khor Al-Zubair stations.
    3. *Ammonia tepida* (Cushman, 1926) is a marine species (Pl. 5, Figs. 3, 3a).

This species was found in the Khor Al-Zubair station.

4. *Cibicidoides bradyi* (Trauth, 1918) is a marine species (Pl. 5, Figs. 4, 4a). This species was found in Khor Al-Zubair and Umm Qaser stations.
5. *Cibicides pseudoungerianus* (Cushman, 1931) is a marine species (Pl. 5, Fig. 5). This species was found in Umm Qaser station.
6. *Eilohedra rotunda* (Husezima and Maruhasi, 1944) is a marine species (Pl. 5, Fig. 6). This species was found in Umm Qaser.
7. *Elphidium advenum* (Cushman, 1922) is a marine species (Pl. 5, Fig. 7). This species was found in Umm Qaser and Ras Al-Besha stations.
8. *Elphidium craticulatum* (Fichtel and Moll, 1798) is a marine species (Pl. 5, Fig. 8). This species was found in Umm Qaser station.
9. *Elphidium lessonii* (d'Orbigny, 1839) is a marine species (Pl. 5, Fig. 9). This species was found in Umm Qaser and Ras Al-Besha stations.
10. *Elphidium macellum* (Fichtel and Moll, 1808) is a marine species (Pl. 5, Figs. 10, 10a). This species was found in Khor Al-Zubair station.
11. *Elphidium* sp. is a marine species (Pl. 5, Fig. 11). This species was found in Katiban, Khor Al-Zubair, Umm Qaser and Al-Faw stations.
12. *Pseudotriloculina elongate* (d'Orbigny, 1839) is a marine species (Pl. 5, Fig. 12). This species was found in Umm Qaser station.
13. *Quinqueloculina akneriana* (d'Orbigny, 1846) is a marine species (Pl. 5, Fig. 13). This species was found in Umm Qaser station.
14. *Quinqueloculina angulta* (Williamson, 1858) is a marine species (Pl. 5, Fig. 14). This species was found in Khor Al-Zubair and Umm Qaser stations.
15. *Quinqueloculina arctica* (Cushman, 1933) is a marine species (Pl. 6, Figs. 15, 15a). This species was found in Khor Al-Zubair and Khor Al-Umaya stations.
16. *Quinqueloculina peregrine* (d'Orbigny, 1846) is a marine species (Pl. 6, Figs. 16, 16a). This species was found in Khor Al-Zubair and Khor Al-Umaya stations.
17. *Quinqueloculina poeyana* (d'Orbigny, 1838) is a marine species (Pl. 6, Figs. 17, 17a). This species was found in Umm Qaser station.
18. *Quinqueloculina stelligera* (Schlumberger, 1893) is a marine species (Pl. 6, Figs. 18, 18a). This species was found in Khor Al-Zubair station.
19. *Rotalinoides compressiuscula* (Brady, 1884) is a marine species (Pl. 6, Figs. 19, 19a). This species was found in Khor Shitana and Khor Al-Umaya stations.
20. *Spiroloculina Laevigata* (Cushman and Todd, 1944) is a marine species (Pl. 6, Fig. 20). This species was found in Khor Shitana, Umm Qaser and Khor Al-Zubair stations.
21. *Spiroloculina rotundata* (Williamson, 1858) is a marine species (Pl. 6, Fig. 21). This species was found in Khor Shitana, Khor Al-Zubair and Umm Qaser stations.
22. *Triloculina baldai* (Bermudez and Seiglie, 1963) is a marine species (Pl. 6, Fig. 22). This species was found in Khor Shitana station.
23. *Triloculina oblonga* (Montagu, 1803) is a marine species (Pl. 6, Fig. 23). This species was found in Khor Al-Zubair and Umm Qaser stations.
24. *Triloculina quadrilateralis* (d'Orbigny, 1839) is a marine species (Pl. 6, Figs. 24, 24a). This species was found in Shitana station.
25. *Triloculina* sp. is a marine species (Pl. 6, Figs. 25, 25a). This species was found in Khor Al-Zubair station.

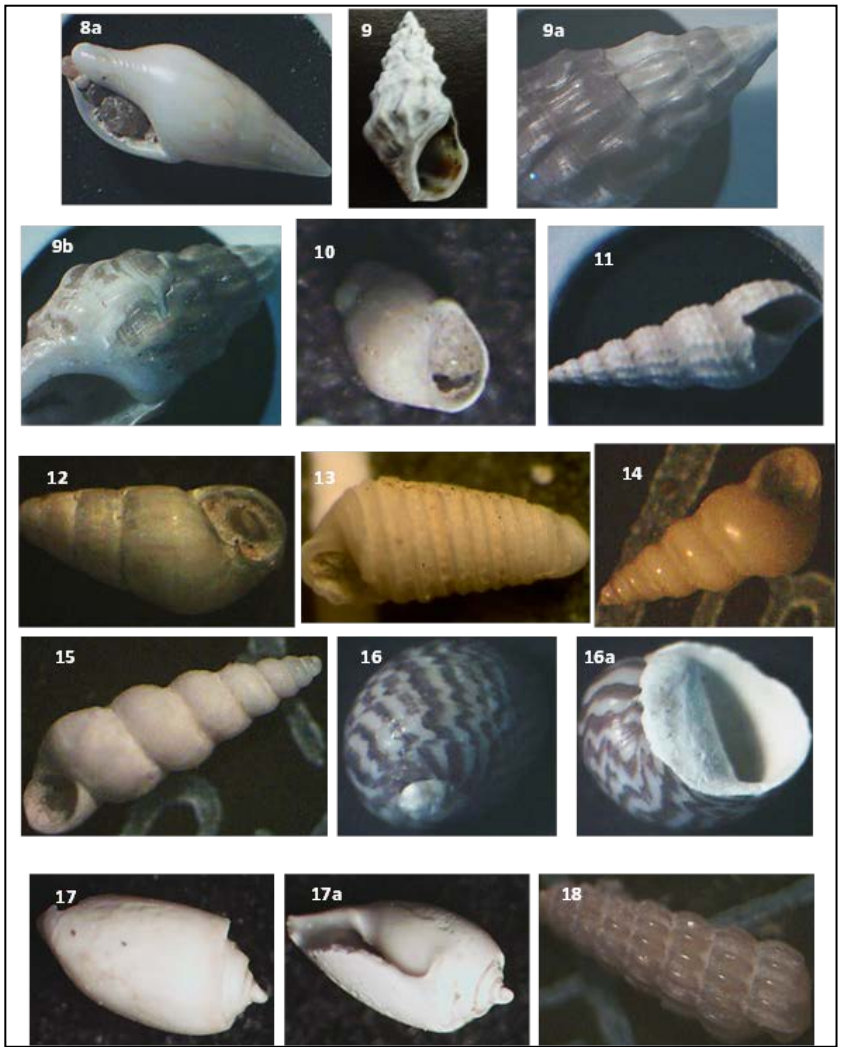

Plate 4. Foraminfera species.

(8a) *Mitrella blanda* (Sowerby, 1844), 12x.
(9) *Melanopsis nodosa* (Ferussac, 1823), 10x.
(9a) *Melanopsis nodosa* (Ferussac, 1823), 12x.
(9b) *Melanopsis nodosa*-Ferussac, 1823, 12x.
(10) *Melanoides tuberculata* (Muller, 1774), 100x.
(11) *Monilea chiliarches* (Melvill, 1910), 18x.
(12) *Odostomia Serenei* (Saurin, 1959), 60x.
(13) *Oscilla jocosca* (Melvill, 1904), 32x.
(14) *Pyramidellidae* gen. sp., 100x.
(15) *Scaliola* sp., 80x.
(16) *Theodoxus jordani* (Sowerby, 1836), 100x.
(17) *Tornatina persiana* (Smith, 1872), 80x.
(18) *Turbonilla umbrina* (Melivill, 1910), 50x.

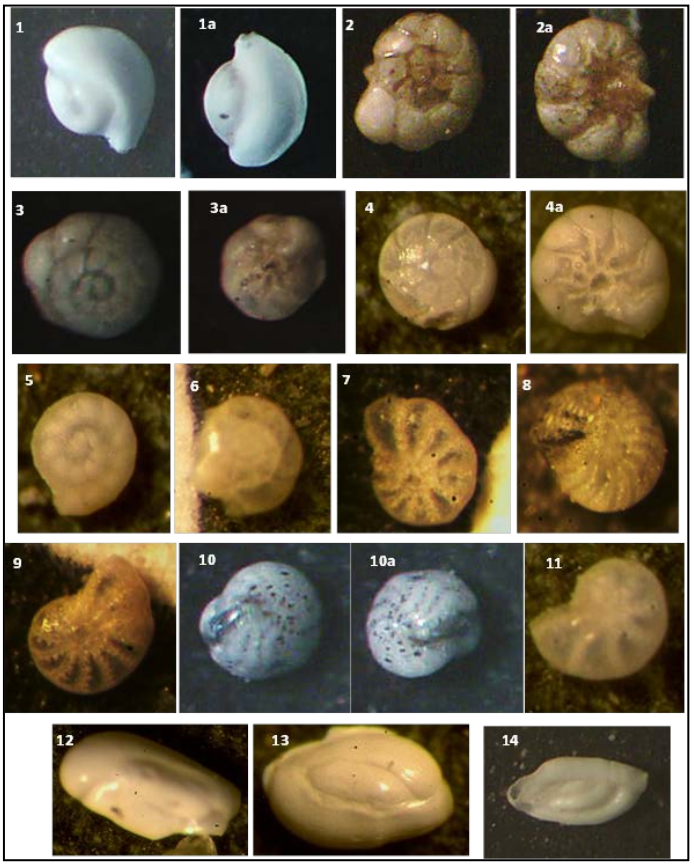

Plate 5. Foraminfera species.

(1) *Adelosina* sp., side view, 100x.
(1a) *Adelosina* sp., apertural view, 100x.
(2) *Ammonia beccarii* (Linne, 1758), side view, 100x.
(2a) *Ammonia beccarii* (Linne, 1758), apertural view, 100x.
(3) *Ammonia tepida* (Cushman, 1926), external view, 100x.
(3a) *Ammonia tepida* (Cushman, 1926), apertural view, 100x.
(4) *Cibicidoides bradyi* (Trauth, 1918), side view, 32x.
(4a) *Cibicidoides bradyi* (Trauth, 1918), apertural view, 32x.
(5) *Cibicides pseudoungerianus* (Cushman, 1931), side view, 32x.
(6) *Eilohedra rotunda* (Husezima and Maruhasi, 1944), side view, 32x.
(7) *Elphidium advenum* (Cushman, 1922), side view, 32x.
(8) *Elphidium craticulatum* (Fichtel and Moll, 1798), side view, 32x.
(9) *Elphidium lessonii* (d'Orbigny, 1839), side view, 32x.
(10) *Elphidium macellum* (Fichtel and Moll, 1808), side view, 32x.
(10a) *Elphidium macellum* (Fichtel and Moll, 1808), apertural view, 32x.
(11) *Elphidium* sp., external view, side view, 32x.
(12) *Pseudotriloculina elongate* (d'Orbigny, 1839), side view, 32x.
(13) *Quinqueloculina akneriana* (d'Orbigny, 1846), side view, 32x.
(14) *Quinqueloculina angulta* (Williamson, 1858), side view, 32x.

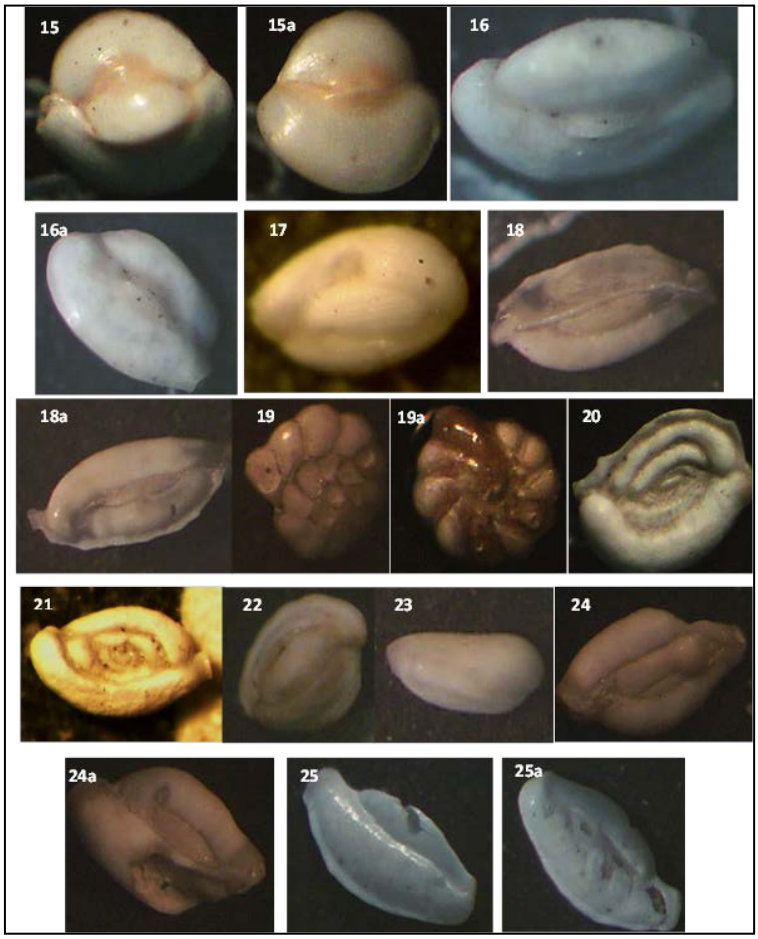

Plate 6. Foraminfera species.

(15) *Quinqueloculina arctica* (Cushman, 1933), side view, 100x.
(15a) *Quinqueloculina arctica* (Cushman, 1933), apertural view, 100x.
(16) *Quinqueloculina peregrine* (d'Orbigny, 1846), side view, 100x.
(16a) *Quinqueloculina peregrine* (d'Orbigny, 1846), apertural view, 100x.
(17) *Quinqueloculina poeyana* (d'Orbigny, 1838), side view, 32x.
(18) *Quinqueloculina stelligera* (Schlumberger, 1893), side view, 100x.
(18a) *Quinqueloculina stelligera* (Schlumberger, 1893), apertural view, 100x.
(19) *Rotalinoides compressiuscula* (Brady, 1848), side view, 80x.
(19a) *Rotalinoides compressiuscula* (Brady, 1848), apertural view, 80x.
(20) *Spiroloculina Laevigata* (Cushman and Todd, 1944), side view, 100x.
(21) *Spiroloculina rotundata* (Williamson, 1858), side view, 32x.
(22) *Triloculina baldai* (Bermudez and Seiglie, 1963), side view, 100x.
(23) *Triloculina oblonga* (Montagu, 1803), side view, 100x.
(24) *Triloculina quadrilateralis* (d'Orbigny, 1839), side view, 100x.
(24a) *Triloculina quadrilateralis* (d'Orbigny, 1839), apertural view, 100x.
(25) *Triloculina* sp., side view, 100x.
(25a) *Triloculina* sp., apertural view, 100x.

3. Ostracoda: Ostracoda are one of the most successful crustacean groups with approximately 8,000 living species. Ostracods are generally small and ranging in length from 0.1 to 32 mm (that's smaller than a poppy seed to the size of a meatball). Their bivalve carapace may cause you to mistake them for tiny clams or mussels, thus the common name of "mussel shrimp". It comprises of two parts, hinged carapace encloses the entire body, similar to the branchiopod Conchostraca. However, their appendages distinguish them from the conchostracans. Another feature was that it differentiates the group which shows lack of growth rings on the carapace. Ostracods shed the carapace with each molt, whereas the conchostracans simply add material to the carapace as they grow. The classification used here was based on Moore (1961); Howe (1962); Jain (1978); Malz (1982); Whatley (1988) and Witte (1993a, b). Many species were recorded in the present study. They are:
    1. *Alocopocythere reticulata* (Hartmann, 1964) Bate, 1971 is a marine, brackish and fresh water (Pl. 7, Fig. 1). This species was found in Umm Qaser station.
    2. *Cyprideis torosa* (Jones, 1850) is a Brackish and marine species (Pl. 7, Figs. 2, 2a). It has the ability to live in wide spectrum of salinity (0.3 - 140 ‰) (Holmes, 1992b and Carbonnel, 1983). On the other side, *Cyprideis torosa* was considered to be an extremely productive species (Heip, 1976). This species was found in Katiban, Khor Al-Zubair, Umm Qaser and Khor Al-Umaya stations.
    3. *Cyprideis* var. *torosa* (Jones, 1850) (Pl. 7, Fig. 3). Vesper (1972b, 1975) showed that the nodding was appeared in the range of salinity 1.8 - 14.5 ‰. Finally, Harten (1993) indicated that the nodes were developed in *Cyprideis torosa*. This species was found in Umm Qaser and Ras Al-Besha stations.
    4. *Darwinula stevensoni*-(Brady and Robertson, 1870) Kaufmann, 1900 is a freshwater species (Pl. 7, Fig. 4). This species was found in Umm Qaser and Khor Al-Zubair stations.
    5. *Hemicytheridea* sp. is a marine species (Pl. 7, Figs. 5, 5a). This species was found in Umm Qaser station.
    6. *Loxoconcha certinata* (Bonaduce, Masoli and Pugliese, 1976) is a marine, fresh species (Pl. 7, Fig. 6). This species was found in Umm Qaser station.
    7. *Loxoconcha immodulata* (Stepanaitys, 1958) is a marine, fresh species (Pl. 7, Fig. 7). This species was found in Khor Shitania station.
    8. *Neomonoceratina iniqua* (Brady, 1868) Whatley and Quanhong, 1987 is a marine, brackish and fresh species (Pl. 7, Fig. 8). This species was found in the Umm Qaser and Ras Al-Besha stations.

The distribution of many marine species such as *Angulus* sp., *Barbatia foliate*, *Brachyodontes variabilis*, *Carditella pallida*, *Corbula taitensis*, *Crassostrea iridescens*, *Mactra dissimilis*, *Ostrea* sp., *Timoclea* sp., *Dentalium octangulatum*, *Cadulus euloides*, *Bellamya bengalensis*, *Bittium* sp., *Cerithium pfeifferi*, *Ethminolia degregorii*, *Gibbula* sp., *Mitrella blanda*, *Monilea chiliarches*, *Odostomia Serenei*, *Oscilla jocosca*, *Pyramidellidae* gen. sp., *Scaliola* sp., *Tornatina persiana*, *Turbonilla umbrina*, *Adelosina* sp., *Ammonia tepida*, *Ammonia tepida*, *Cibicidoides bradyi*, *Cibicides pseudoungerianus*, *Eilohedra rotunda*, *Elphidium advenum*, *Elphidium craticulatum*, *Elphidium lessonii*, *Elphidium macellum*, *Elphidium* sp., *Pseudotriloculina elongate*, *Quinquloculina akneriana*, *Quinqueloculina angulta*, *Quinqueloculina arctica*, *Quinqueloculina peregrine*, *Quinqueloculina poeyana*, *Quinqueloculina stelligera*, *Rotalinoides*

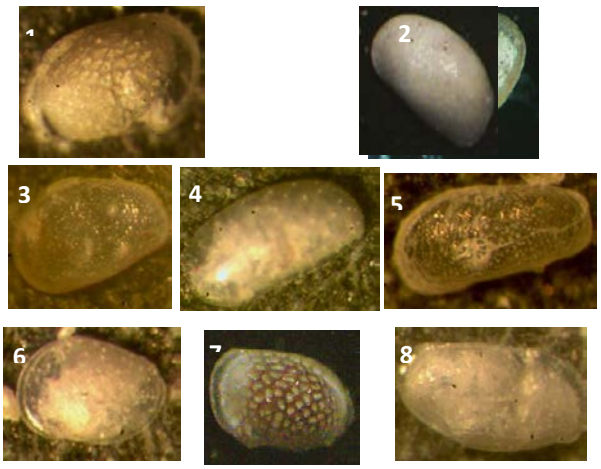

Plate 7.Ostracoda species.

(1) *Alocopocythere reticulata* (Hartmann, 1964) Bate, 1971, external view, 32x.
(2) *Cyprideis torosa* (Jones, 1850), external view, 32x.
(2a) *Cyprideis torosa* (Jones, 1850), internal view, 32x.
(3) *Cyprideis var. torosa* (Jones, 1850), external view, 32x.
(4) *Darwinula stevensoni* (Brady and Robertson, 1870) Kaufmann, 1900, external view, 32x.
(5) *Hemicytheridea* sp., external view, 32x.
(6) *Loxoconcha certinata* (Bonaduce, Masoli and Pugliese, 1976), external view, 32x.
(7) *Loxoconcha immodulata* (Stepanaitys, 1958), external view, 32x.
(8) *Neomonoceratina iniqua* (Brady, 1868) Whatley and Quanhong, 1987, external view, 32x.

compressiuscula, *Spiroloculina Laevigata*, *Spiroloculina rotundata*, *Triloculina baldai*, *Triloculina oblonga*, *Triloculina quadrilateralis*, *Triloculina* sp., *Alocopocythre reticulat* and *Hemicytheridea* sp. are distributed in the coastal areas (Khor Shitana, Umm Qaser, Khor Al-Zubair and Al-Faw). They are affected by marine water areas in addition to tidal flat and current waves. Those species were more abundant in Khor Shitana area because it was considered as a part from Arabian Gulf, which was the part of it and have direct contact with it, perhaps the circular movement of the waves and strong currents in the region and the whole tide flat helped to transfer these marine species in the area. The affinities of these fauna were come from the Indian Ocean towards the Red sea and the Arabian Gulf. The taken subsurface sediment samples in the shallow depth not more than 10 cm seem more affected by marine water. Some of the fresh water species such as *Cyprideis var. torosa* and *Darwinula stevenson* are occured in Umm Qaser and Khor Al-Zubair areas that could be affected by fresh water from the Shatt Al-Basrah at the north.

Conclusion

- The distribution of many marine species in the studied area was lying in the coastal areas. The affinities of the studied fauna are transferred from the Indian Ocean towards the Red sea and the Arabian Gulf with helping of tidal and current waves.

- There are some of fresh water species in Umm Qaser and Khor Al-Zubair areas that was influenced from Shatt Al-Basrah River at the north.
- The texture of studied sediments was sandy silt, clayey silt, silt, sandy silt and mud.
- The grain size factor has affected to the species distribution in study area. The distribution of many Miliolid marine species in Khor Shitana represents sand texture.
- The abundance of Mollusca and Foraminfera species are more than Ostracoda species may be belong to the nature of Ostracoda living that preferred in the clam environment, while the study area was focused in the costal environment with movement from tidal and current waves.

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تأثير الملوحة ونوعية الرواسب على توزيع المجاميع الحياتية خلال العصر الحديث، جنوب العراق

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المستخلص - تم التحري عن وفرة وتوزيع رواسب تحت سطحية تعود إلى ثمان محطات وهي أبو فلوس ورأس البيشة وخور العمية وخور شيطانة وأم قصر وخور الزبير ومنطقة كتيبان والفاو. بين المسح الحقلي لمناطق الدراسة أن توزيع الأنواع البحرية تتواجد في المناطق الساحلية خاصة في محطات خور شيطانة وأم قصر وخور الزبير والفاو وتلك الأنواع قد تأثرت بصورة ثانوية بمسطحات المد وأمواج التيارات. يعود أصل الأنواع الموجودة إلى المحيط الهادي وانتقلت إلى البحر الأحمر والخليج العربي. كما تعد الملوحة والتدرج الحجمي من العوامل الرئيسة في تحديد البيئة لتلك الأنواع الحديثة. التدرج الحجمي لتلك المحطات هو بالتتابع غرين رملي وغرين صلصالي وغرين وغرين رملي وطين.