First recording of gastropods and pelecypods molluscs from southern Iraq; evidence of Holocene sea level fluctuation

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Abstract

The current study focused on the diagnosis of species related to gastropoda and pelecypoda classes, mostly in the planktonic larval stage, to be used as evidence of marine transgression in mid-Holocene. Of these, twenty of them have been recognized for the first time in Iraq. Three bio-facies were distinguished using these species as well as statistical grain size parameters. They are; the first bio-facies (B1) reflects the marine transgression that occurred in the middle of the Holocene, while the second bio-facies (B2) shows the marine regression. The third bio-facies (B3) indicates the sea level fluctuation at the end of the Holocene.

Keywords: Microfossils, Mollusca larvae, Marine transgression, Mid-Holocene period, Southern Iraq.

Introduction

Southern Iraq is a part of Mesopotamia plain zone where subsidence is postulated to have been significant in recent geological time. The Tigris and Euphrates rivers flow along the length of the topographic low of the Mesopotamian lowlands and, with the Karun River, they combine to form the extensive Shatt-al-Arab estuary, marsh area and deltaic system at the head of the Arabian Gulf (1). The Southern Mesopotamia Plain has been influenced by marine inundation during early to mid Holocene that confirmed from the presence of Holocene marine sediments (2).

The marine transgression reached the northern Arabian Gulf area between 9000 and 8000 cal yr BP (1,3), forming an extensive marine estuary in the location of the present delta area (4). The modern delta has since filled the estuary (4). As of 9000 cal yr BP onward, and especially after 6000-5500 cal yr BP, sea-level datum slowed globally (4,5). In the northern Arabian Gulf, sea level reached its present height at 6000 cal yr BP, was probably 2.5m upper between 6000 and 5000 cal yr BP or longer, inundating the low-lying areas of lower Mesopotamia [1], and after that was comparatively steady close to current levels [6]. [7] related Lower Mesopotamia Ahwar evolution mainly to sea-level fluctuation. [8]distinguished group of the marine fossils in southern Ahwar of what prove existence the marine influence during the Holocene period in southern Iraq. [3] indicated the occurrence of pyrite within the ancient organic-rich sediments during the study of the Holocene deltaic successions of Lower Mesopotamia as a sign of the domination of anoxic conditions resulted from the marine influence during Mid-Holocene sea-level rising. [2] mentioned a marine transgression has reached as far as Amara City, on the eastern side and Nasiriyah City, on the western side, about 200 Km north of the present day northern shoreline of the Arabian Gulf.

Materials and Methods

One core was taken at depth 20 m from a borehole in the Basrah city, on April 2012 (Fig.1). The core was split and subsampled based on visual changes. Grain size distribution was made using a Malvern Mastersizer 2000 in the Department of Geology, College of Science, University of Basrah.

The subsamples were subjected to particle size analysis, calculation of textural parameters such as graphic mean (MZ), inclusive standard deviation (σI), inclusive graphic skewness (SKI), and kurtosis (KG) based on [9], (Table.1). In addition to the percentages of sand, silt, and clay were calculated for each sample that were plotted on triangular graphfor classification of the sediments into textural class [10], (Table.1). For microfossils analysis, about fifty grams of sediment was disaggregated with distilled water, left for twenty four hour, afterward sieved with a 63µm sieve. The residual of the sieve was preserved in the beaker and dried in the oven. The microfossil population, including gastropods and pelecypods were extracted from the residue, hand-picked under a binocular microscope and mounted on microfossil slides for generic and species identification (Table.2),(Plate 1and 2). The gastropodal classification depended on [11]. Additional taxonomic references used to identify gastropoda such as [12,13,14,15,16,17,18,19,20], while the pelecypods was classified according to [21], more taxonomic references used to recognize them comprise [22,23,24,25,26,27].

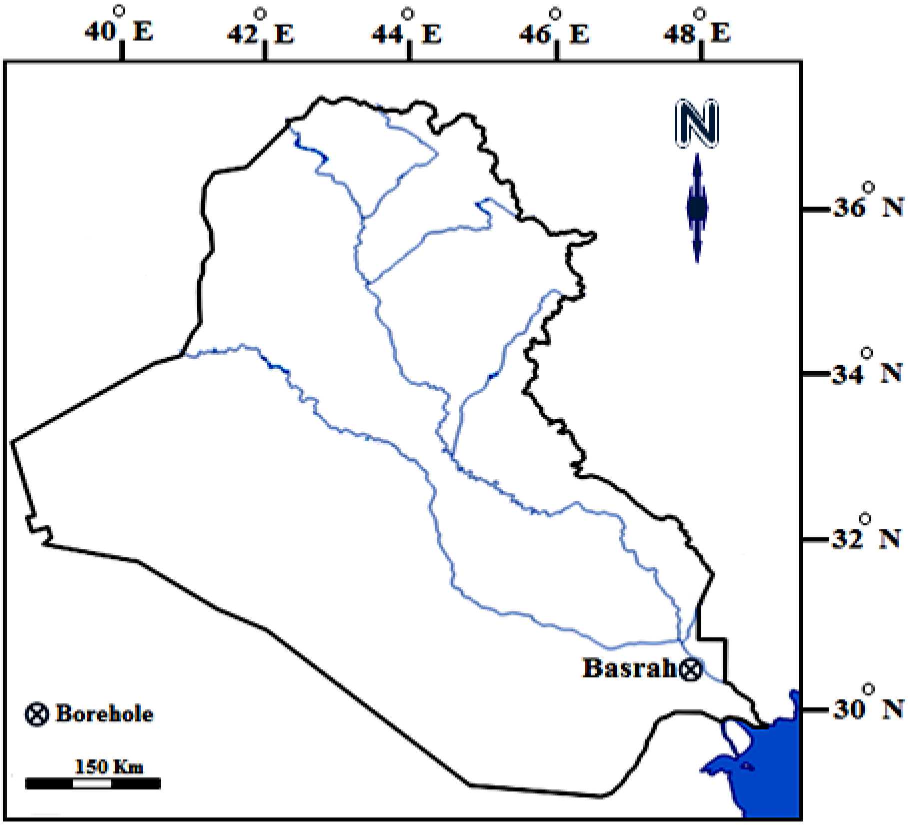

Figure (1) Map showing the borehole location in study area.

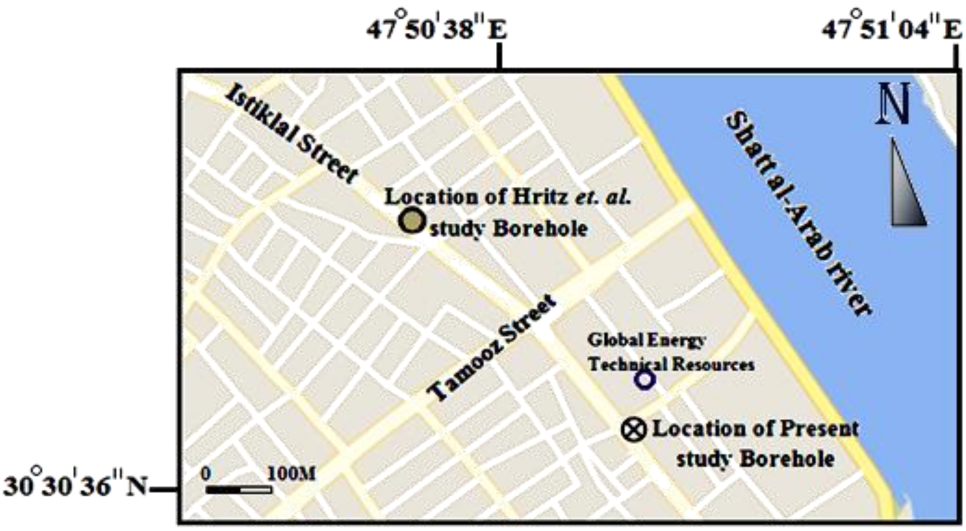

Figure (2) The distance between locations depended on [56] study and the present study.

Table (1) Statistical size parameters with the percentage of sand, silt and clay in the borehole samples of the study area.

Sample No.	Sample depth(m)	Sediment texture	Mean (Mz)	Sorting (σ_I)	Skewness (SK_I)	Kurtosis (K_G)	Sand %	Silt %	Clay %
1	3	Sandy silt	4.62	1.70	0.10	1.86	38.40	61.38	0.22
2	4	Sandy silt	4.61	1.69	0.11	1.85	38.20	61.59	0.21
3	5	Sandy silt	4.60	1.67	0.13	1.94	37.90	61.19	0.91
4	6	Silt	5.96	1.64	-0.02	0.76	1.40	98.40	0.20
5	7	Silt	5.87	1.63	-0.02	0.75	1.90	97.83	0.27
6	8	Silt	5.49	0.79	1.03	0.94	2.20	97.60	0.20
7	9	Silt	5.75	0.84	1.01	0.90	2.29	97.48	0.23
8	10	Silt	5.94	1.17	-0.01	0.61	2.20	97.60	0.20
9	11	Silt	5.95	1.16	-0.01	0.61	2.60	97.08	0.32
10	12	Silt	5.40	0.89	-0.19	0.80	8.01	91.72	0.27
11	13	Silt	5.42	0.81	-0.12	0.80	6.60	93.12	0.28
12	14	Silt	5.45	0.66	0.05	0.74	1.40	98.30	0.30
13	15	Silt	5.49	0.64	0.05	0.73	1.21	98.50	0.29
14	16	Silt	5.54	0.64	0.06	0.71	0.60	99.10	0.30
15	17	Silt	5.17	0.67	0.06	0.70	0.89	98.81	0.30
16	18	Silt	5.48	0.69	0.05	0.73	1.20	98.51	0.29

17	19	Silt	5.50	0.68	0.06	0.74	0.99	98.71	0.30
18	20	Silt	5.53	0.70	0.05	0.75	0.80	98.90	0.30

Results

Sedimentary record and biofacies index

Grain size distribution clarify that the sediments can be categorized into silt and sandy silt based on (10) in which the silt is the predominant portion of the sediments in the studied core where it formed 80%. The statistical parameters obtained from granulometric analysis showed the graphic mean distribution for the sediments range from 4.61 to 5.96Ø and it is indicative of coarse silt to medium silt. According to the standard deviation ranges of 0.64 to 1.70 Ø, the sediments are moderately well sorted to poorly sorted. While the skewness values of the sediments are ranged from -0.19 to 1.26Ø, reflecting coarse skewed to strongly fine skewed and the kurtosis range is between 0.61 and 1.86 Ø, where the sediments vary from very platykurtic to very leptokurtic (Table.1). The microfossils content brought to the identification of 20 species 11 species of gastropoda and 9 species of pelecypoda shells (Table.2, Fig.3, Plate 1 and 2). It is worth mentioning that all these species are recording for the first time in Iraq.

On the basis of the fossils contents in the sediments, in addition to the physical properties and grain size statistical parameters of the sediments, three biofacies have been identified from the bottom to top of studied borehole (Fig.3).

1- Biofacies1 (B1) (depth of 20-11m):

It can be distinguished to subbiofacies as:

Subbiofacies1A (B1A) (depth of 20-16m):

Deposits of this subfacies are from silt medium size (5.17-5.53Ø) and value of the sorting (0.675-0.70Ø) which means moderately well sorted. While the value of skewness (0.06-0.05Ø) reflecting nature of near symmetrical deposits, as for the value of kurtosis (0.70-0.75Ø) has shown that platykurtic sediments.

In relation to the fossils contents of this subbiofacies, it have been appeared at the depth of 20 meter with the species *Crassostrea bilineata* followed by *Ostrea edulis* and *Dacrydium sp*. after this depth. All these species belong to the Pelecypoda and all of them represented a pediveliger in their various stages between prodissoconch I(PdI) and prodissoconch II (PdII), and that is meaning they were in the role of planktonic larvae. These three species refering to the marine environment [25,28,29], with the presence of the latter two species in deep water [23,30].

And with the beginning of the depth 18meter, species of class Gastropoda appeared represented by *Atlanta keraudrenii* (which is a kind of Holoplanktonic molluscs) and *Eatoniella sp*.1. Both species exist in the marine environment [14,19]. Other species of class Pelecypoda including: *Kellia symmetros* and *Ostrea edulis* in planktonic larvae phase (PdI and PdII) and little of them exhibiting an early dissoconch (Dc) stage (juvenile), in addition to the species *Abra nitida*. All previous mentioned species are present in a marine environment that reaches deep water [27,30,31]. After this depth, the number of above mentioned species has decreased.

Table (2) Systematic list for the studied species. (Gastropoda)

Class	**Subclass**	**Super-order**	**Order**	**Sub-order**	**Super-family**	**Family**	**Sub-family**	**Genus**	**Species**
Gastropoda	Prosobr-anchia	Archaeog-astropoda	Vetigastr-opoda	–	Trochoidea	Trochidae	Trochacl-idinae	*Trochaclis*	*versiliensis* (Warén,arrozza &Rocchini in Warén, 1992)
Gastropoda	Prosobr-anchia	–	Mesogast-ropoda	–	–	Eatoniell-idae	–	*Eatoniella*	*sp*.1
Gastropoda	Prosobr-anchia	–	Mesogastr-opoda	–	–	Eatoniell-idae	–	*Eatoniella*	*sp*.2
Gastropoda	Prosobr-anchia	–	Caenogast-ropoda	–	Truncatell-oidea	Adeorbidae	Teinosto-matinae	*Teinostoma*	*sp*.
Gastropoda	Prosobr-anchia	–	Mesogast-ropoda	–	Cerithioi-dea	Cerithiidae	Cerithiin-ae	*Bittium*	*scabrum* (Olivi, 1792)
Gastropoda	Prosobr-anchia	–	Mesogast-ropoda	Heter-opoda	–	Atlantidae	–	*Atlanta*	*keraudrenii* (Lesueur,1817)
Gastropoda	Prosobr-anchia	–	Neogastr-opoda	–	Rissoelloi-dea	Rissoellidae	–	*Rissoella*	*globularis* (Forbes & Hanley, 1852)
Gastropoda	Heterob-ranchia	–	Allogastr-opoda	–	Pyramidell-oidea	Pyramidelli-dae	Pyramide-llinae	*Bacteridiella*	*sp*
Gastropoda	Heterob-ranchia	–	Allogastr-opoda	–	Pyramidell-oidea	Pyramidelli-dae	Odostomii-nae	*Odostomia*	*hendersoni* (Bartsch, 1909)
Gastropoda	Heterob-ranchia	–	Allogastr-opoda	–	Pyramidell-oidea	Pyramidelli-dae	Odostomii-nae	*Cingulina*	*spina* (Crosse & Fischer, 1864)
Gastropoda	Heterob-ranchia	–	Allogastr-opoda	–	Pyramidell-oidea	Ebalidae	–	*Ebala*	*trigonostoma* (de Folin,1869)

Table (2) Systematic list for the studied species. (Pelecypoda)

Class	Subclass	Super-order	Order	Sub-order	Super-family	Family	Sub-family	Genus	Species
Pelecypoda	Pteriom-orphia	–	Mytiloi-da	–	Mytiloi-dea	Mytilid-ae	Modiolinae	*Dacrydium*	*sp*.
Pelecypoda	Pteriom-orphia	–	Limoida	–	Limoi-dea	Limid-ae	–	*Limatula*	*subauriculata* (Montagu, 1808)
Pelecypoda	Pteriom-orphia	–	Ostreoi-da	Ostreina	Ostreoi-dea	Ostreid-ae	Ostreinae	*Ostrea*	*edulis* (Linnaeus,1758)
Pelecypoda	Pteriom-orphia	–	Ostreoi-da	Ostreina	Ostreoi-dea	Ostreid-ae	Ostreinae	*Ostrea*	*lurida* (Carpenter 1864)
Pelecypoda	Pteriom-orphia	–	Ostreoi-da	Ostreina	Ostreoi-dea	Ostreid-ae	Crassostr-einae	*Crassostrea*	*bilineata* (Röding, 1798)
Pelecypoda	Hetero-donta	–	Veneroi-da	–	Galeom-matoidea	Kelliid-ae	Kelliinae	*Kellia*	*symmetros* (Jeffreys,1876)
Pelecypoda	Hetero-donta	–	Veneroi-da	–	Mactroi-dea	Mactri-dae	Mactrinae	*Mactra*	*achatina* (Holten, 1802)
Pelecypoda	Hetero-donta	–	Veneroi-da	–	Tellinoi-dea	Semeli-dae	–	*Abra*	*nitida* (Müller, 1776)
Pelecypoda	Hetero-donta	–	Myoida	Pholadi-na	Pholado-idea	Pholadi-dae	Pholadinae	*Barnea*	*Candida* (Linnaeus, 1758)

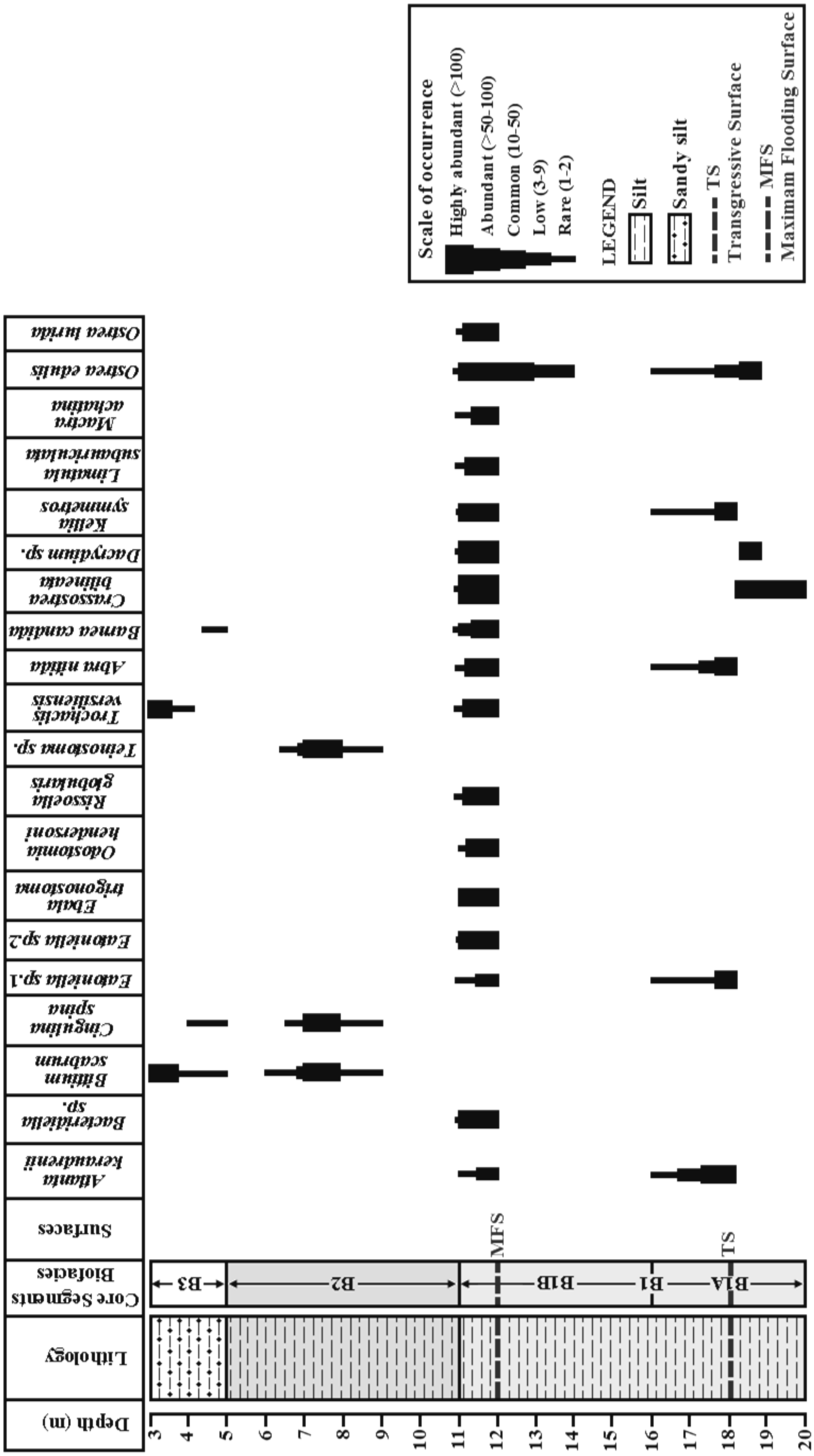

Figure (3) Borehole profile showing the lithology, biofacies and the dynamics of molluscan occurrence.

Subbiofacies1B (B1B) (depth of 16-11m) :

The nature of sediments of this subbiofacies is similar to the previous one in terms of silt medium size (5.4-5.54Ø) with varying sorting values from moderately well sorted to moderately sorted (0.64-0.89Ø). Skewness values range from coarse to near symmetrical skewed (-0.19 -0.06Ø) with continued existence of the kurtosis values within platykurtic (0.70-0.80Ø).

These subbiofacies were characterized by the complete disappearance of all species of both gastropods and pelecypods at depth 16 meter and this situation continued until reaching a depth of 14 meter where the species *Ostrea edulis* reappeared in low numbers, but it is still within the planktonic larvae stage (pediveliger: PdI and PdII) and the number of this species has increased with a depth of 13 meter.

At the depth of 12 meter, the previous species in subbiofacies1A (B1A) for both gastropods and pelecypods appeared here but in very great numbers, with recording of new species of Gastropoda class appeared in this biofacies which were represented by *Eatoniella sp*.2, *Ebala trigonostoma*, *Bacteridiella species* appeared larval shell (protoconch), *Odostomia hendersoni*, *Rissoella globularis* and *Trochaclis versiliensis*. All these species reflect the marine environment and can be found in deep depths [12,14,15,18,20].

The new species recorded of Pelecypoda class have included: *Barnea candida*, *Limatula subauriculata*, *Mactra achatina* and *Ostrea lurida*. They are differing in terms of the environmental parameters. These species are found in lower intertidal and subtidal zone of estuary and saltwater lagoon such as *Ostrea lurida* [32] and other species exceed their existence in the intertidal range to deeper waters over 60 meter and may reach 2000 meter [26,28,33].

2- Biofacies2 (B2) (depth of 11-5m):

Deposits of this biofacies are medium size silt (5.49-5.96Ø). The sorting values varied between moderately sorted (0.79Ø) and poorly sorted (1.64Ø). While Skewness values (-0.02-1.03Ø) reflecting the nature of deposits between near symmetrical and very fine skewed. The kurtosis values differed between very platykurtic and mesokurtic (0.61-0.94Ø).

This biofacies is starting from the depth 11 meter where the crushed shells begin to vanish and disappearance completely upon reaching a depth of 10 meter. The fossils remnants were returned with the depth of 9 meters to distinguish three benthonic species of gastropods which are: *Bittium scabrum*, *Cingulina spina* and *Teinostoma sp*. All of marine environment[17,18,34].

With the decrease in depth, the numbers of these species become less. Only of broken shells that belonging to species *Bittium scabrum* can be distinguished at the depth of 6 meter.

3-Biofacies3 (B3) (depth of 5-3m)

This biofacies was categorized as sandy silt deposits with a coarse silt size (4.6-4.62Ø). Sediments are poorly sorted(1.67-4.70Ø), with fine skewness (0.10-0.13Ø) and very leptokurtic deposits (1.85-1.94Ø).

Fractured shells appeared at the depth 5 meter from both Gastropoda and Pelecypoda classes, the shells were in a small quantity then increased with a depth of 4 meter. Both species appeared at a depth of 3 meter, the first is *Bittium scabrum*, who appeared earlier in Biofacies2, and the second *Trochaclis versiliensis* recorded its appearance for the first time here. The latter species lives in a marine environment with great depths(200-1000m [15].

What draws attention in this biofacies is the presence of ooids in facies end.

Discussion

The combination of the fossils content and the textural statistical parameters (mean, standard deviation, skewness and kurtosis) of the current study revealed existence of three biofacies.

Each biofacies reflects different environmental conditions of diversity and flourishing of fauna. Compare the nature of three biofacies among themselves in order to know which one them has been affected by marine transgression that occurred in Holocene.

The facies (B1) is divided into two subfacies because of the appearance of different species of fossils in the facies although they all representing marine environment. The occurrence of fossils differed with the facies depths. Where the Pelecypoda class species appeared at the bottom of the subfacies (B1A) and with decreasing depth appeared the Gastropoda class species in participation with Pelecypoda class new species, and the species of both classes were in pelagic life stage. But these subbiofacies has been affected particularly at the depth of 18 meters with the open sea situation and the proof of this is the presence of *Atlanta keraudrenii* species.

From observing the nature of silt deposits it can be realized that subbiofacies reflects a nearshore marine environment, where the impact of wave energy and tide with the overlapping of river influence, but in spite of that major contribution of the marine source remains. It was confirmed by the nature of sorting where moderately well sorted [35] as well as skewness is near symmetrical for deposits[36], in addition to the platykurtic deposits [37].

As the number of fossils decreased significantly at the end of the subbiofacies (B1A) and their complete disappearance at 16 meters depth, the beginning was to determine the subfacies (B1B). The sediments showed that the conditions of the sedimentary environment for subfacies (B1B) is similar to subfacies (B1A) in terms of the marine action presence.

This is illustrated by the statistical parameters of the subfacies sediments, with the increase of environmental energy clearly by roughening the silt at the top of the subfacies.

The fossils are completely disappeared between the depths 16 and 14 meter followed by rare occurrence of one species of pelecypods (are larval stage).The number of this species increased as it reaches 13 meter. This is followed by appearance various species with very large number for each species of gastropods and pelecypoda classes at depth 12 meters, and that is mean arriving of the marine waters to its greatest depth and ultimately, the enormous abundance of marine species of pelecypods class in the pelagic life stage, as the species at this stage have the ability to move in marine waters by currents [38]. When by checking the places where these species are located (Table.3), it is found that most of them are far away from the Arabian Gulf and the coast of Iraq, as it did not register the presence of these species as mature forms in the current study or studies that dealt with the coast of Iraq (latest newest reference).That is confirms the thought that these species come in exceptional circumstances of the sea currents during the marine transgression. The nature of the study area is consistent with that reported by[39], and therefore the possibility of planktonic (pelagic) larvae in the area due to contact with seawater.

Table (3) Locations of the studied species in the world

Fossil Class	Fossil Species	Locales of Species availability in the world
Gastropoda	*Atlanta keraudrenii* (Lesueur,1817)	The eastern Mediterranean Sea [19] and Gulf of Aden [40]
	Bacteridiella sp.	Indonesia; Hong Kong waters and East Atlantic [41]
	Bittium scabrum (Olivi, 1792)	Malta; Italy; Turkey; Mauritania; Spain; Tunisia; Greece; Romania; United States of America; Lebanon; Croatia and France [42]
	Cingulina spina (Crosse & Fischer, 1864)	Tropical Indo-West Pacific; Central and East Indian Ocean; Indo-Arabia and Arabian Gulf [43]
	*Eatoniella sp.*1 and *Eatoniella sp* .2	Antarctic and sub-Antarctic [14]; Argentinean [44]; New Zealand [45]; Scotia Sea, South Pacific Ocean and South Atlantic Ocean [46]; South Africa and Southeastern Australia [47]
	Ebala trigonostoma (de Folin, 1869)	North Atlantic Ocean (European and Portuguese waters) [18] and Southwestern Spanish Mediterranean [48]
	Odostomia hendersoni (Bartsch, 1909)	North West Atlantic Ocean and United States of America : Massachusetts, North Carolina [12]
	Rissoella globularis (Forbes & Hanley, 1852)	Ireland, North Atlantic Ocean (Azores, European waters and North East Atlantic) and United Kingdom (North and West Coast of Scotland) [18]

	Teinostoma sp.	Red Sea [49] and Southwestern United States of America; North Venezuela; West Brazil; off Morocco; coast; South Africa and Sydney in Australia [43]
	Trochaclis versiliensis (Warén, Carrozza & Rocchini in Warén, 1992)	The western Mediterranean and adjacent Atlantic in 200-1000m [15]

(cont…..)

Pelecypoda	*Abra nitida* (Müller, 1776)	Britain MarLin [31]; North Sea, Skagerrak, Limfjord and Kattegat Norway, south to the Mediterranean [28]
	Barnea candida (Linnaeus, 1758)	India: Andhra Pradesh, Maharashtra, Orissa, West Bengal, Indo-Pacific and Atlantic ocean [50]
	Crassostrea bilineata (Röding, 1798)	Indian and Pacific ocean, Yemen to China [51]
	Dacrydium sp.	Atlantic ocean [25]
	Kellia symmetros (Jeffreys,1876)	North. Atlantic [27]
	Limatula subauriculata (Montagu, 1808)	SE and W Greenland, N and E Iceland, Norway north of Lofoten, and south to the Mediterranean; Northern Kattegat [28]
	Mactra achatina (Holten, 1802)	Tropical Indo-West Pacific , East coast of Africa, Red Sea, Indonesia, the Philippines, Japan, and Australia [52]

	Ostrea edulis (Linnaeus,1758)	South of Norwegian Sea , North , Iberian Peninsula, the Atlantic coast of Morocco and in the Mediterranean and Black Seas [53]. North America, Australasia, Japan and South Africa [54]
	Ostrea lurida (Carpenter 1864)	The west coast of North America and Canada [55]

Thus, the life features of the depths of this facies can be inferred that the sediments of the beginning of borehole where the inmost depth represents tidal environment and in particular the intertidal. At a depth of 18 meters where the deepening of the marine environment is only a guide to the beginning of marine progress, which means that it represents Transgression Surface (TS). Marine transgression at this level can be estimated in the middle Holocene before (7462 Yr BP) by emulation the (TS) depth of the current study with the depth age of 18 meter in [56] (Fig.2), where it is located approximately 493 meter from the current study site. Although the number of fossils found in facies has decreased at a depth of 16 meters, sediments are still composed of silt, this is evidence of a largest deepening of the marine water and proves returning of the fossils appearance at the depth 12 meter with a larger variety and in greater numbers.

These fossils were at different stages of their life but were dominated by planktonic larvae (species of pelecypoda) and from different deep open marine, tidal and estuarine environments. All of these directories indicate that the depth 12 m represents Maximum Flooding Surface (MFS), because of the nature of lifeway and the environmental specifications of fossils at this depth [57] and can estimate its age around late Holocene (4000 Yr BP), according to [58].

Although the silt feature remained in biofacies2 (B2), however, the statistical parameters showed the difference between the extremities and middle of biofacies. In the middle of biofacies, the sediments were moderately sorted, very fine skewed and mesokurtic, while the biofacies were poorly dated, near symmetrical skewed and very platykurtic. The variation of sorting values of the sediments is an evidence of the mixing of sediments from two environments, river and marine, as well as the different skewness values and kurtosis values [59].

At the beginning of the biofacies(B2), the effect of the river environment was clearly manifested by the disappearance of fossils due to rapid mixing between river and marine waters. The river effect was the predominant, and then the re-emergence of the marine influence in the middle of biofacies with the presence of marine species of the gastropoda class. Facies ended with return of the river effect again and the evidence for that is the broken shells could not be distinguished as well as decreased their presence and disappearance at the end of the biofacies. The environmental conditions of this facies reflect an environment similar to the estuarine environment, possibly because the study area near Shatt al-Arab River. This facies may also reflect the nature of marine regression deposits as a result of the increased river water flow.

The quality of sediments in biofacies3 (B3) varied to sandy silt with poorly sorted, fine skewness and very leptokurtic sediment. All these specifications refer to a sedimentary environment where the interaction between river water, tidal currents and waves [60] which led to the entry of sediments in large quantities and thus make the sorting of sediment is poor [61] and very leptokurtic sediment [60].

The fossils reinforced the validity of the above. At a depth of 5 meters appeared shattered shells of gastropoda and pelecypoda classes, the amount of these fragments increased as the depth decreased , which means the presence of high-energy led to break shells. But the emergence of *Trochaclis versiliensis* [15], which is characterized by its presence in the sea depths [15]. In addition to *Bittium scabrum*, which has already appeared in previous facies, has already appeared in the previous facies, indicates the existence of a estuarine environment with increasing marine influence. Presence of ooids in the facies confirms the marine effect because of the ooids formation method [62]. This marine effect appeared in facies may indicate the slight marine transgressive occurrence in the region, which is a result of the sea level fluctuation which may have been terminated nearly (3000 Yr BP) [7].

Conclusions

1- This kind of study is the first in Iraq and, may be in the Middle East, which adopted the microfossils represented by the planktonic larvae of Mollusca.

2- The twenty species of Gastropoda and Pelecypoda classes in the present study are recorded for the first time in Iraq.

3- The presence of species in the larvae stage and absence of their mature forms is evidence of its intrusion from outside the Arabian Gulf region through marine transgressive. The presence of some species in the benthic phase, which has not been recorded in the Gulf region, is also evidence of marine progress.

4- Three biofacies were identified depending on microfossils (planktonic larvae) primarily as well as the nature of sediments. They were defined as Biofacies1 (B1), Biofacies2 (B2) and Biofacies3 (B3)

5- Biofacies1 (B1) can be placed within the marine transgression unit that occurred in middle of the Holocene, Biofacis2 (B2) can be considered within the marine regression unit, which is approximately 4000 Yr BP, and The Biofacies3 (B3) may indicates the fluctuation in the sea level at the end of Holocene.

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أول تسجيلات لرخويات البطنقدميات والمحاريات في جنوب العراق؛ دليل على تذبذب مستوى سطح البحر خلال الهولوسين

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المستخلص

ركزت الدراسة الحالية على تشخيص انواع من صنفي البطنقدميات والمحاريات أغلبها في مرحلة اليرقات الطافية لاستخدامها كدليل للتقدم ألبحري الذي حصل في منتصف الهولوسين. حيث تم تشخيص عشرون نوع منها، كلها تظهر لاول مرة في العراق. وقد تم الاعتماد على هذه الانواع بالاضافة الى مساعدة معاملات الحجم الحبيبي الاحصائية لتميز ثلاث سحنات حياتية هي Biofacies1(B1) و(Biofacis2 (B2 و(Biofacies3 (B3. أظهرت السحنة الحياتية الاولى (B1) تأثرها بالتقدم البحري الذي حصل في منتصف الهولوسين، فيما عكست السحنة الحياتية الثانية (B2) رواسب التراجع البحري، أما السحنة الحياتية(B3)الثالثة فقد أشارت الى تذبذب مستوى البحر الذي حصل في نهاية الهولوسين.

الكلمات المفتاحية: المتحجرات الدقيقة، يرقات الرخويات، التقدم البحري، فترة منتصف الهولوسين، جنوب العراق.

EXPLANATION OF PLATES

PLATE 1

1- *Atlanta keraudrenii* (Lesueur,1817) .

2- *Bacteridiella species* (Galli, 2014), Protoconch Shape.

3- *Bittium scabrum* (Olivi, 1792) .

4- *Cingulina spina* (Crosse & Fischer, 1864).

5- *Eatoniella sp*.1 (Dall, 1876).

6- *Eatoniella sp*.2 (Dall, 1876) .

7- *Ebala trigonostoma* (de Folin, 1869).

8- *Odostomia hendersoni* (Bartsch, 1909).

9- *Rissoella globularis* (Forbes & Hanley, 1852).

10- *Teinostoma sp*. (Gofas *et. al*.,2001).

11- *Trochaclis versiliensis* (Warén, Carrozza & Rocchini in Warén, 1992).

PLATE 2

1- *Abra nitida* (Müller, 1776), Left valve.

2- *Barnea candida*(Linnaeus, 1758), Right valve.

3- *Crassostrea bilineata* (Röding, 1798), a. Pediveliger (PdI, PdII) Right valve;

b. Juvenile (PdI; PdII; Dc) Right valve.

4- *Dacrydium sp*., a. Pediveliger (PdI, PdII) Left valve;

b. Juvenile (PdI; PdII; Dc) Left valve.

5- *Kellia symmetros* (Jeffreys,1876), Juvenile (PdI; PdII; Dc) Right valve.

6- *Limatula subauriculata* (Montagu, 1808), Left valve.

7- *Mactra achatina* (Holten, 1802), Right valve.

8- *Ostrea edulis* (Linnaeus,1758), Pediveliger (PdI, PdII) Right valve.

9- *Ostrea lurida* (Carpenter 1864), Juvenile (PdI; PdII; Dc) Left valve.

PLATE 1

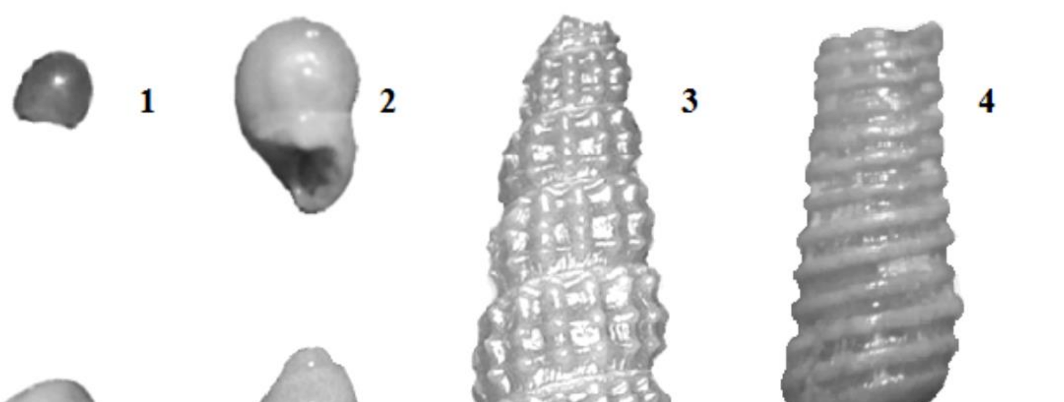

PLATE 2

1

2