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# Climatic and environmental changes during the late Holocene at Harier area, North of Basrah Governorate, Southern Iraq

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**Abstract -** The present article includes a Palynomorphs analysis of the recent sediments of Harier area in the north of Basrah Governorate. Thirty six samples were analyzed; Pollen diagrams were drawn depending on the percentage of some pollen, spores that indicate environmental and climatic changes. Five pollen zones were recorded which represent the climate of Late Holocene period. This study revealed new results of environmental and climatic changes during the late Holocene period in the marshes areas of southern Iraq, especially the study area. About 30 species and 14 Genera of pollen, 6 species of spores, 8 forms of fungi and Dinoflagellate were recorded.

**التغيرات المناخية والبيئية خلال الهولوسين المتأخر لمنطقة حرير شمال محافظة البصرة، جنوب العراق**

صبا قاسم كلخان[1] و عباس حميد محمد[2] و بثينة سلمان الجبوري[3]
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**المستخلص -** تضمنت هذه الدراسة التحليل البالينولوجي للترسبات الحديثة لمنطقة حرير الواقعة شمال محافظة البصرة في جنوب العراق، حيث تم تحليل 36 عينة رسوبية و رسم المخطط البالينولوجي لها أعتماداً على النسب المئوية لبعض الانواع من حبوب الطلع والابواغ ذات الدلائل البيئية والمناخية، أذ حددت خمسة أنطقة بيئية مثلت التغيرات المناخية خلال فترة الهولوسين المتأخر. كذلك سجل (30) نوعا تعود الى (14) جنساً من حبوب الطلع، و(6) أجناس من الابواغ فضلاً عن (8) أشكال من الفطريات ومن قديرية الأسواط.

**الكلمات المفتاحية:** حبوب الطلع، جراثيم، حرير، هولوسين المتأخر ، العراق

## Introduction

The studied area and the Marshes of southern Iraq are of special interest due to the climatic changes of the Mesopotamia at the 10000Y, that is called the Holocene period. Many studies indicate that the Holocene period was an icy period, while there were non-icy areas of the earth, like that of the Arab regions especially Iraq, as they suffered from important climate changes as well as the presence of sediments of this period are widely distributed in Iraq and the rest of the world (Al-Ali, 2007).

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The study of pollen and spores of the area is the best way to know the historical time of the climatic changes during that period, Pollen diagrams indicated the changes in climate through geological column. Anderson *et al.* (1985) studied the Temperature and drought at the Late Quaternary period in California. On the other hand the studies of climatic changes in the Middle east include the study of plants in Syria, Jordan and North of Iraq.

Weinstein (1976); Bottema and Berkuda (1979), Beehler (2006) observed the change of salinity rates in the fresh waters of the Bay Sea in America and its role in the distribution of some plants and the nature of their growth.

As for Iraq, Al-Jibeuri (1997) studied the climatic changes and the plants in the Delta of southern part of Mesopotamia at the Late Pleistocene and Holocene period. Recently, Al-Tawash *et al.* (2013) studied the environmental and climatic changes and their impact on civilizational development during the late Holocene in Babylon. Also, Al-Nuaimi and Ali (2014) presented a palynological and mineralogical study of gypsum soils in Iraq. And from the observation of climate patterns and previous studies, it was possible to identify climatic changes during the late Holocene epoch by relying on some types of pollen and spores that were recorded during the current study of the area. Five ecological zones have been identified, which represented the Late Holocene period from 4,200 years BCE to the present day.

**Methodology & Study Area**

It is located in Harier area in the North of Basrah Governorate between Al-Mushab and Al-Salal Rivers (Fig. 1). Two locations were chosen as bellow:

1-The first locality coordinate at (30˚35′52″ N), (47˚42′35″ E).

2-The second locality coordinate at (30˚35′45″ N), (47˚42′16″E).

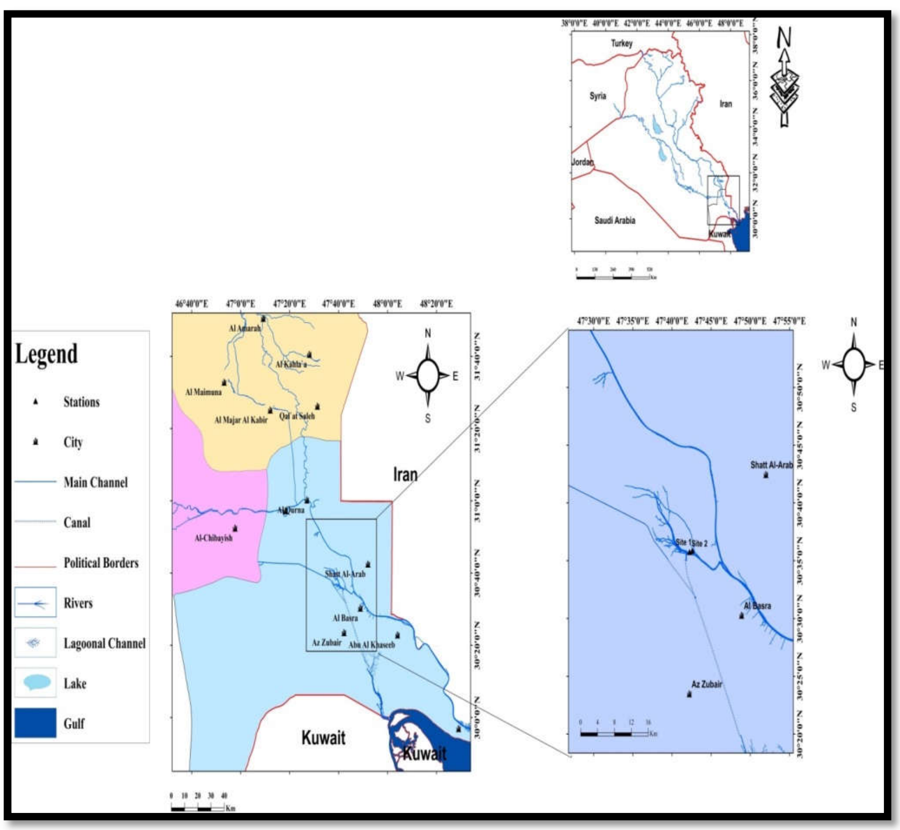


Figure 1. Location of the study Area at Harier, Basrah.

The sediments of the study area and the rest of the marsh consist of mud and silt and are soft-very soft, light gray to black in color. Organic and inorganic, and thus have a positive effect on increasing their biological diversity. Climatically the study area is located within the dry to semi-arid range, as it is characterized by a hot-dry climate in summer and cold in winter with a temperature rate of about 24°C annually. July is the month with the highest temperature at a rate ranging between (34-36)°C, corresponding to January in winter with an average of 12°C was considered as the coldest month. The monsoon rains prevail during the winter and spring seasons with relatively little precipitation. These arid climatic conditions still prevail in the present-day setting of the southern part of Mesopotamian plain (Aqrawi, 2001). And this is what characterizes the climate of the alluvial plain, including the study area.

Poclain excavation machine was used at the first location about 340cm deep. 17 samples were collected at each 20cm depth. Hand drilling was used at the second location and a core sediment of 380cm was obtained and cutting it into about 20cm for each sample. The laboratory work was to collect the pollen, spores, and fungi, Foraminiferal tests lining and Dinoflagellates.

The methods of Traverse (1988) and Barss and Williams (1973) were used to collect the palynomorphs as in the diagram bellow (Fig. 2):

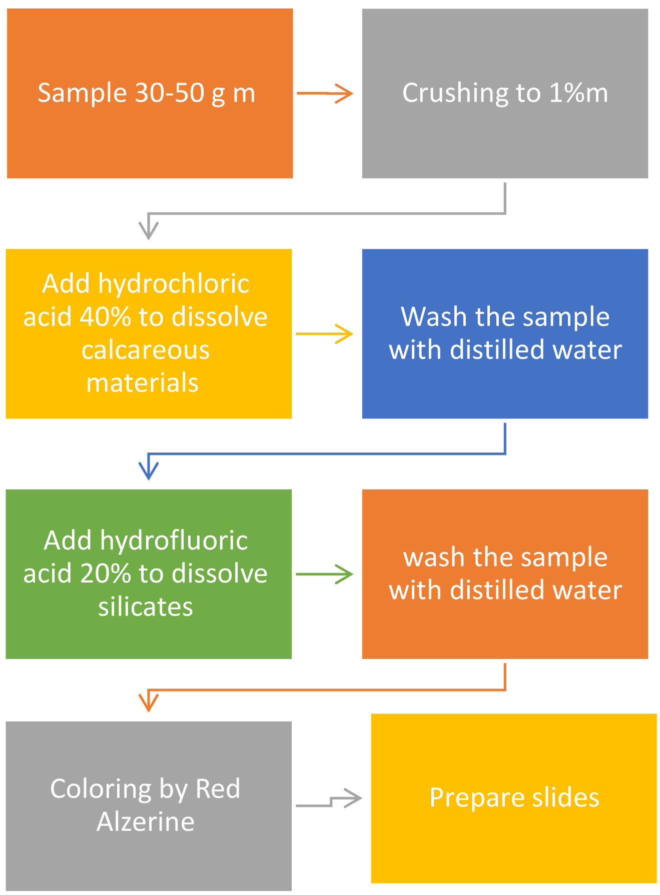


Figure 2. The diagram of preparation and separation to palynomorphs at the studied area (Traverse, 1988 and Barss and Williams, 1973).

**Results**

Palynological studies have evolved from the phenotypic point of view using modern techniques such as DNA technology in diagnosing genera and types of spores and pollen grains such as Whittal *et al.* (2004); Lacoul & Freedman (2006) and Uchimura *et al.* (2006).

As for this study, the microscopic studies of the palynomorphs slides recorded many genera and species of pollen, spores, fungi, Foraminiferal tests lining besides a few Dinoflagellates. The classification of Jansonius & Hills (1976); Moore & Webb (1978); Hoorn (1994) were used and for the plant families the studies of Barnet (1989); Hoorn (1994); Al-Jibeuri (1997); Jassim (2001); Al-Rawi *et al.* (2005) and Al-Saadi (2009) were followed. The fungi classification was according to Jarzen & Elsik (1986); Al-Jibeuri (1997).

1-Group Pollenites (Potonie, 1931):

Division Monocolpatae (Iverson et Troels-Smith 1950)

- *Clavamonocolptes sp*. (Gonzales Gazman, 1967) (Pl. 1, Fig. 1)
- *Nypa sp.* (Pl. 1, Fig. 2)

  *Palmae pollenites* (Potonie 1951, Stuttgart) ex Potonie 1958 bbt

  *Palmae pollenites tranguillus* (pot.) pot .1951`
- *pollenites tranguillus* (Potonie, 1934). (Pl. 1, Fig. 3)
- *Pritcharida pacifica* (Seeman & Wend land, 1962) (Pl. 1, Fig. 4)
- *Psilamono colpites maximus* (Van-Der Hammen et Gareia. De Mutis 1965) (Pl. 1, Fig. 5)
- *Psilamono colpites nanus* (Pl. 1, Fig. 6)

Division Monoporatae (Iversen et Troels-Smith, 1950):

  *Graminites* Cookson 1947 ex Potpnie 1960

  *Graminidites media* (Cookson) ex Pot
- *Monoporaites* (*Graminidites*) *media* (Cookson) (Pl. 1, Fig. 7)
- *Cyperaceapllis sp.* (Krunsch, 1970) (Pl. 1, Fig. 8)

Division Dicolporatae (Iversen et Troels-smith, 1950)

- *Umbelliferoipollis sp* (Venkatachala & Kar, 1969) (Pl. 1, Fig. 9)

Division Tricolpatae (Iversen et Troels-Smith, 1950)

  *Aceripollenites* (Nagy, 1969)
- *Aceripollenites reticulatus* (Nagy, 1970) (Pl. 1, Fig. 10)
- *Convolucea convolvulus* (Pl. 1, Fig. 11)
- *Crototricolpites sp.*(Leidelmeyer, 1966) (Pl. 1, Fig. 12)

  *Salixipollenites* (Srivastava, 1966)

  *Salixipollenites discoloripites* (Wodeh) Sriv, 1966
- *Salix discoloripites* (Wedchous, 1933) (Pl. 1, Fig. 13)

Division Triporatae (Iversen et Troels-Smith, 1950)

  *Betulaepollenites* (Potonie, 1934 ex Potonie, 1960)

  *Betulaepollenites microexcelsus* (Pot.) Pot. 1960
- *Betulaepollenites microexcelsus* (Pot.) Pot. 1934 (Pl. 1, Fig. 14)

  *Corsinipollenites* (Nakoman, 1965)
- *Corsinipollenites oculusnoctis* (Thiergart, 1940) & (Nakoman, 1965) (Pl. 1, Fig. 15)

  *Psilatriporites* (Van der Hmmen, 1956 ex Hoorn, 1993)
- *Psilatriporites sarmientoni* (Hoorn, 1993) (Pl. 2, Fig. 1)

  *Proteacidites* (Cookson) (Couper, 1953)

- *Proteacidites c.f triangulates* (Lorente, 1989) (Pl. 2 Fig. 2)

Division Tricolportae (Iversen et. Troels-Smith, 1950)

- *Artemisiaepollenites* (Nagy, 1969) (Pl. 2, Fig. 3)
  *Bombacacidities* (Couper, 1960)
- *Bombacacidities baculatus* (Muller *et al.*, 1987) (Pl. 2, Fig. 4)
- *Ilexopollenites sp* (Thiergart, 1937 ex Potonie, 1960) (Pl. 2, Fig. 5)
  *Quercopollenites* (potonie, 1951)
- *Quercopollenites granulatus* (Nagy, 1956) (Pl. 2, Fig. 6)
  *Quercopollenites* (potonie, 1951)
- *Quercopollenites granulatus* (Nagy, 1956) (Pl. 2, Fig. 7)

Division Stephanoporatae (Iversen et. Troels-Smith, 1950)

  *Alnipollenites* Potonie 1932 ex Potonie 1960
- *Alnipollenites verus* (Pot.) Pot. 1960 (Pl. 2, Fig. 8)
  *Chenopodipollis* Krutzch, 1966
  *Chenopodipollis multiplex* (Weyl. & Pfl., 1957) Krutzch, 1966
- *Periporopollenites multiplex* (Weyland & Pflug, 1957) (Pl. 2, Fig. 9)
  *Caryapollenites* (Raatz, 1937 & 1938) ex Potonie, 1960
- *Caryapollenites simplex* (Raatz, 1937) (Pl. 2, Fig. 10)
  *Ulmuspollenites* (Raatz, 1937)
  *Ulmipollenites* (Wolff, 1934)
- *Ulmus-pollenites sudulosus* (Wolff, 1934) (Pl. 2, Fig. 11)
  *Plantaginacearumpollis* (Nagy, 1963)
- *Plantaginacearumpollis miocemous* (Nagy, 1963) (Pl. 2, Fig. 12)

Division Stephanocolporatae (Iversen et. Troels-Smith)

  *Psilastephanocolporites* (Leidelmeyer, 1966)
- *Psilastephanocolporites matapiorum* (Hoorn, 1994) (Pl. 2, Fig. 13)

Division Polycolporatae (Iverson et. Troels-Smith, 1950)

- *Utricularriae pollenites* (Nagy, 1969) (Pl. 2, Fig. 14)

Division Syncolpatae (Iversen et. Troels-Smith, 1950)

  *Spirosyncolpites spiralis* Gonzalez Guzman, 1967
- *Spirosyncolpites* (Gonzalez, 1967) (Pl. 2, Fig. 15)

Division Perporatae (Iversen et. Troels-Smith, 1950)

- *Echitriporites trianguliformis* (Van Hoekonklinkenberg, 1975) (Pl. 2, Fig. 5), x630

2-Group Sporites (Potonie, 1893):

Division Monolet Ibrahim, 1933

- *Levigatosporites* (Ibrahim, 1933) (Pl. 3, Fig. 1)
  *Polypodiaceaesporites* Thlergart ex Potonie, 1951
  *Polypodiaceaesporites heaardtii* (Pot. & Van.) Pot. 1951
- *Polypodiaceaesporites heaardtii* (Pot. & Van.) in Thlergart, 1931 (Pl. 3, Fig.2)

Division Trilctes (Reinsch) Dettmann, 1963

- *Deltoidospora sp.* (Miner, 1935), (Potonie, 1956) (Pl. 3, Fig. 3)
  *Faveotriletes sp.*

- *Faveotriletes ornatus* (Regali *et al.*, 1974) (Pl. 3, Fig. 4)
- *Cicatricosisporites sp* (Potonie & Gelletich, 1933) (Pl. 3, Fig. 5)
  *Sphagnumsporites* (Raatz, 1937 & 1938) ex Potenie, 1956
  *Sphagnumsporites stereolides* (Pot. & Ven) Raatz
- *Sporites stereolides* (Potenie & Venite, 1934) (Pl. 3, Fig. 6)

3-Fungi Group:
- *Lycoperdon* type (Pl. 3, Fig. 7)
- *Polyporisporites sp*. (Pl. 3, Fig. 8)
- *Lophiostome* Type (Pl. 3, Fig. 9)
- *Puccinia sp.* (Pl. 3, Fig. 10)
- *Dictyosporites sp.* (Felix, 1894) (Pl. 3, Fig. 11)
- Fungal hyphae type (4) (Pl. 3, Fig. 12)
- Form S1 Fungi (Pl. 3, Fig. 13)
- Form S2 Fungi (Pl. 3, Fig. 14)

4-Dinoflagellate Group:
- Cyst of *protoperidinium* (Pl. 4, Fig. 1)
- *Spiniferites sp.* (Pl. 4, Fig. 2), x400
- *Brigatidinium sp.* (Pl. 4, Fig. 3)

5-Foraminefral Tast Lining:
 (Planispiral) Genus: *Ammonia* Brunnich*,* 1772.
- *Ammonia beccarii* (Linne') (Pl. 4, Fig. 4)

**Discussion**

Han *et al.* (2007) stated that ecosystems consist of groups of self-organizing organisms that exist in a constant state of equilibrium with the natural factors in the surrounding environment, and therefore any change that occurs to the composition of the species affects the entire ecosystem as it is known that the systems. The environment is highly variable and developed by environmental influences, and this relationship depends in the past on natural causes, but at the present time human and his modern technologies play an important role in determining geographical, climatic and biological changes. There are several methods may be employed to gather information related to the ancient environment, conditions and climatic changes that occurred during the different geological times. The study of pollen and spores is one of the most important approaches to understand the botanical history of an area, which in turn assists to conclude its climatic history. Because pollen and spores are preserved within sedimentary layers in form of fossils and according to their shapes, information about the climate can be revealed whether it is warm, cold or moderate. Pollen and spores also vary depending on the type of plant, which in turn varies in different climatic regions (Al-Saadi, 2009). Plant communities and ecosystems change according to changes in the climate (Oswald *et al.*, 2003). Based on the study of the quantitative distribution of pollen in the recent sediments of the two sites of the current study area, it was possible to determine the ecological zone and climatic changes during the late Holocene epoch. The pollen diagram for both sites was plotted and compared with the diagram of historical geological events during the Holocene period (Paepe *et al.*, 1998) and the specific age of the Harier area (Al-Sudani, 2015).

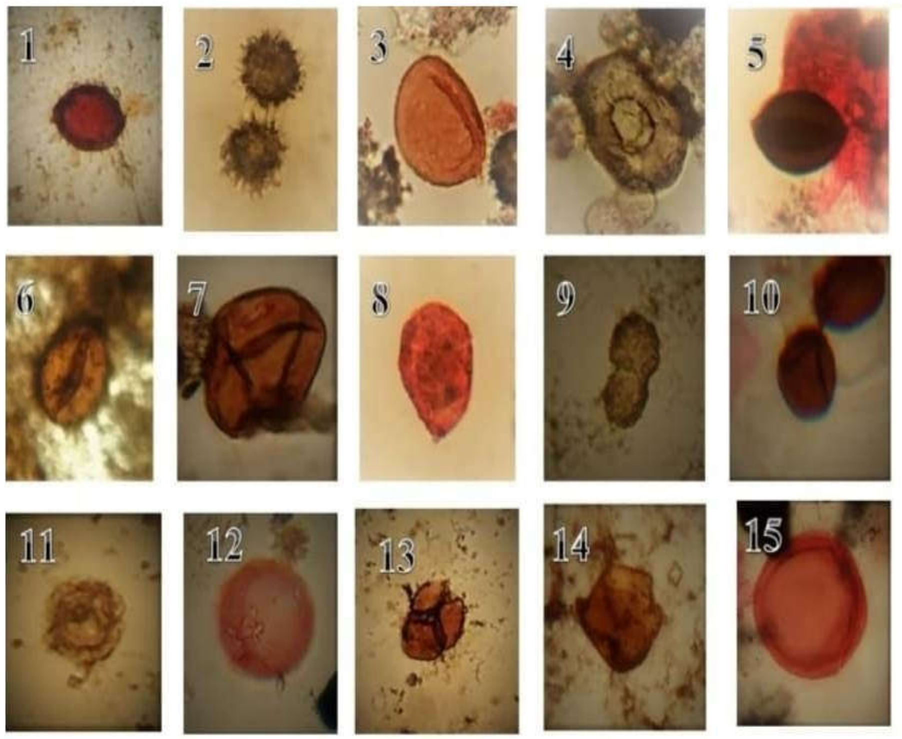


Plate 1.
1-*Clavamonocolptes sp.*, x400, Sample (320-340cm)/A
2-*Nypa sp.*, x630, Sample (240-260cm)/B
3-*Pollenites tranguillus*, x630, Sample (360-380cm)/B
4-*Pritcharida pacifica*, x630, Sample (360-380cm)/B
5-Psilamono colpites maximus., x630, Sample (340-360cm)/B
6-*Psilamono colpites nanus*, x 630, Sample (80-100cm)/A
7-*Graminidites media*, x400, Sample (160-180cm)/B
8-*Cyperaceapllis sp.*, x400, Sample (240-260cm)/A
9-*Umbelliferoipollis sp.*, x630, Sample (180-200cm)/B
10-*Aceripollenites reticulatus*, x400, Sample (320-340cm)/A
11-*Convolucea convolvulus*, x400, Sample (140-160cm)/B
12-*Crototricolpites sp.*, x630, Sample (160-180cm)/A
13-*Salix discoloripites*, x630, Sample (80-100cm)/A
14-*Betulaepollenites microexcelsus*, x400, Sample (300-320cm)/A
15-*Corsinipollenites oculusnoctis*, x400, Sample (340-360 cm)/B

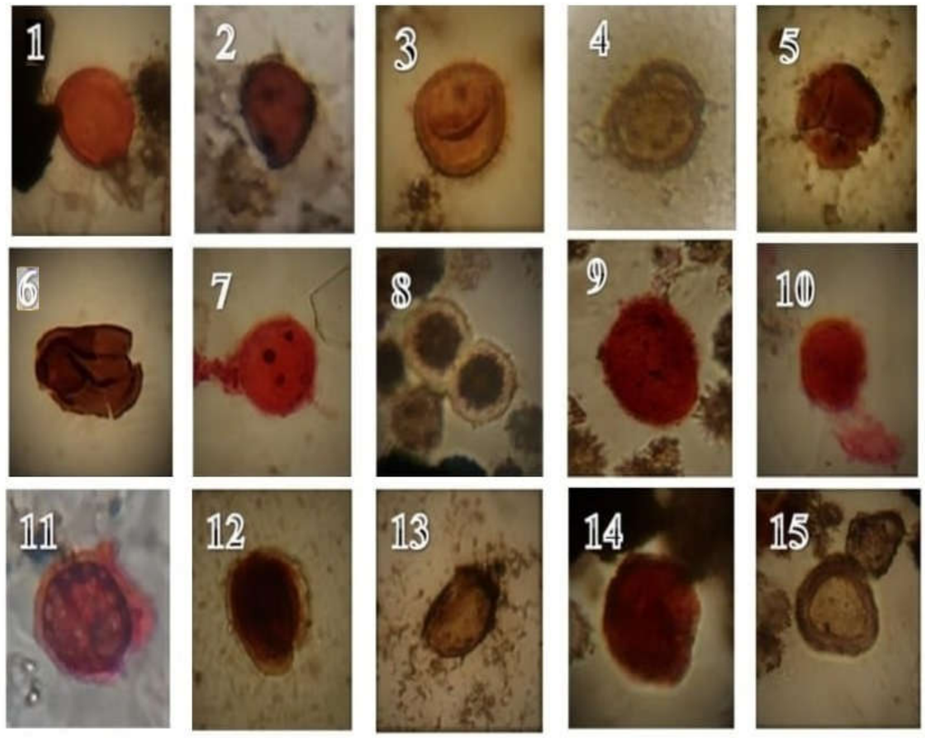


Plate 2.
1-*Psilatriporites sarmientoni*, x630, Sample (340-360cm)/B
2-*Proteacidites c.f triangulates*, x400, Sample (320-340cm)/A
3-*Artemisiaepollenites*, x630, Sample (140-160cm)/A
4-*Bombacacidities baculatus*, x400, Sample (160-180cm)/B
5-*Ilexopollenites sp.*, x400, Sample (180-200cm)/A
6-*Quercopollenites granulatus*, x630, Sample (160-180cm)/B
7-*Alnipollenites verus*, x630, Sample (100-120cm)/B
8-*Periporopollenites multiplex*, x630, Sample (240-260cm)/A
9-*Caryapollenites simplex*, x400, Sample (200-220cm)/B
10-*Ulmus-pollenites sudulosus*, x630, Sample (280-300cm)/A
11-*Plantaginacearumpollis miocemous*, x400, Sample (300-320cm)/B
12-*Psilastephanocolporites matapiorum*, x630, Sample (20-40cm)/A
13-*Utricularriae pollenites*, x630, Sample (200-220cm)/B
14-*Spirosyncolpites*, x400, Sample (300-320cm)/B
15-*Echitriporites trianguliformis*, x630, Sample (160-180cm)/A

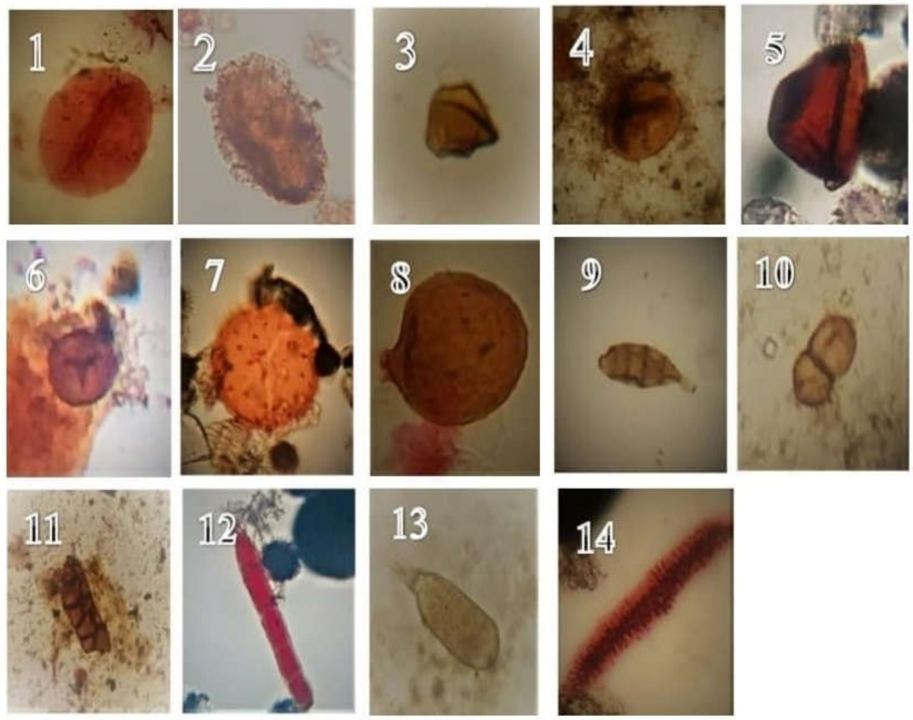


Plate 3.
1-*Levigatosporites*, x400, Sample (340-360cm)/B
2-*Polypodiaceaesporites heaardtii*, x400, Sample (240-260cm)/A
3-*Deltoidospora sp.*, x400, Sample (140-180cm)/B
4-*Faveotriletes ornatus*, x400, Sample (220-240cm)/A
5-*Cicatricosisporites sp.*, x400, Sample (280-300cm)/A
6-*Sporites stereolides*, x400 Sample (320-340cm)/A
7-*Lycoperdon type*, x630, Sample (240-260cm)/A
8-*Polyporisporites sp.*, x400, Sample (340-360cm)/B
9-*Lophiostome type*, x630, Sample (240-260cm)/B
10-*Puccinia sp.*, x630, Sample (80-100cm)/A
11-*Dictyosporites sp.*, x630, Sample (0-20cm)/A
12-Fungal hyphae type, x400, Sample (240-260cm)/A
13-Form S1 Fungi, x400, Sample (100-120cm)/B
14-Form S2 Fungi, x 400, Sample (320-340cm)/B

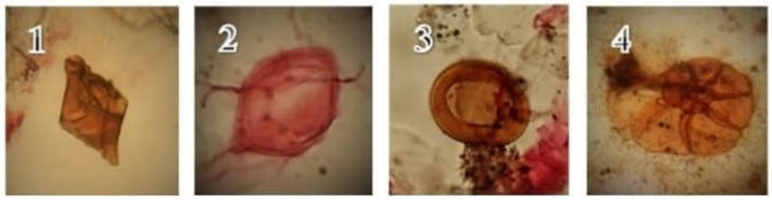


Plate 4.
1-Lophiostome type, x630, Sample (240-260cm)/B
2-*Puccinia sp.*, x630, Sample (80-100cm)/A
3-*Dictyosporites sp.*, x630, Sample (0-20cm)/A
4-*Ammonia beccarii* (Linne'), x400, Sample (240-260cm)/A

Palynological-analysis and palynozones of the late Holocene:

Pollen diagrams had drawn for the two localities by counting the percentage of pollen, spores and others which had a climatic evidence and effects. Five zones were recognized in the present study (from older to younger):

Zone I:

This zone was recognized at depth 360-340cm at the first locality, and at 380-360cm at the second. This zone is characterized by the presence of about 55-37% of Poaceae pollen and about 33-25% of Palmae Pollen. The presence of these caused increase in rainfall and cool climate with rare effect of drought and cold because of rare amount of *Artemisia* and *Chenopods* pollens. Aqrawi (1994) suggested a period of 4200-2700Y.B.P. for this zone. So the Age of the zone is about 4200-2700Y.B.P. therefore, this coincides with Aqrawi (1994); Yan & Petit-Maire (1994). This period coincided with periods of severe drought that led to the collapse of the great civilizations of the Akkadian Empire at 4200 years before the present (Cullen *et al.*, 2000; Al-Tawash *et al.*, 2013).

Zone II:

This zone was recorded at depth 240-200cm at tow location. This zone is characterized by the presence of about 36-65% of Chenopodiaceae and decrease in the presence of Poaceae pollen (<15%), and increase in *Artemisia* pollen (21%). These collection of pollen indicate cold and drought climate and this is correlated with period of (2700-2000 Y.B.P) (Al-Sudani, 2015).

Zone III:

This zone was recorded at depth 200-160cm and 180-160cm at two localities, respectively. This zone represented by a few Poaceae (about 8%) and increase in *Artemisia* pollen (about 25%), and about 65% of Chenopodiaceae in the first locality and about 50% in the second. This is suggested a drought climate with less rainfall. This zone aged 2000-1650Y.B.P (Aqrawi, 1994).

Zone IV:

This zone was recorded at depth 160-120cm in both localities and represented by an increase in Poaceae pollen and decrease in Chenopodiaceae pollen (>5%). This suggest cool and high humidity environment and aged about 1650-950Y.B.P (Paepe *et al.*, 1978). This period correlated with high level of sea (about 2m), which caused the transgression in North Europe at a period of 1650-1350Y.B.P, and caused also the flooding of the Nil River and correlated with Sassanian period in Iraq (about 1724-1314Y.B.Y) (Wright, 2001). Al-Jibouri (1997) recorded a period of drought in 1350-1150 Y.B.P, which caused the Arab migration with the beginning of the Islamic period at 1314 Y.B.P.

Zone V:

This zone was characterized by commonness of Chenopodiaceae pollen (about 70%) at the first locality and increase of *Artemisia* (about 25-27%) in both localities also a decrease of Poaceae and Palmae pollen was occurred. This represent a drought and very cold period that correlated with arid period in North Europe and arid to semi-arid period in Africa (Paepe *et al.*, 1978; Yan & Petit-Maire, 1994). This zone aged about 60 Y.B.P. and extends till now which is coincide about 1850 Gregorian year.

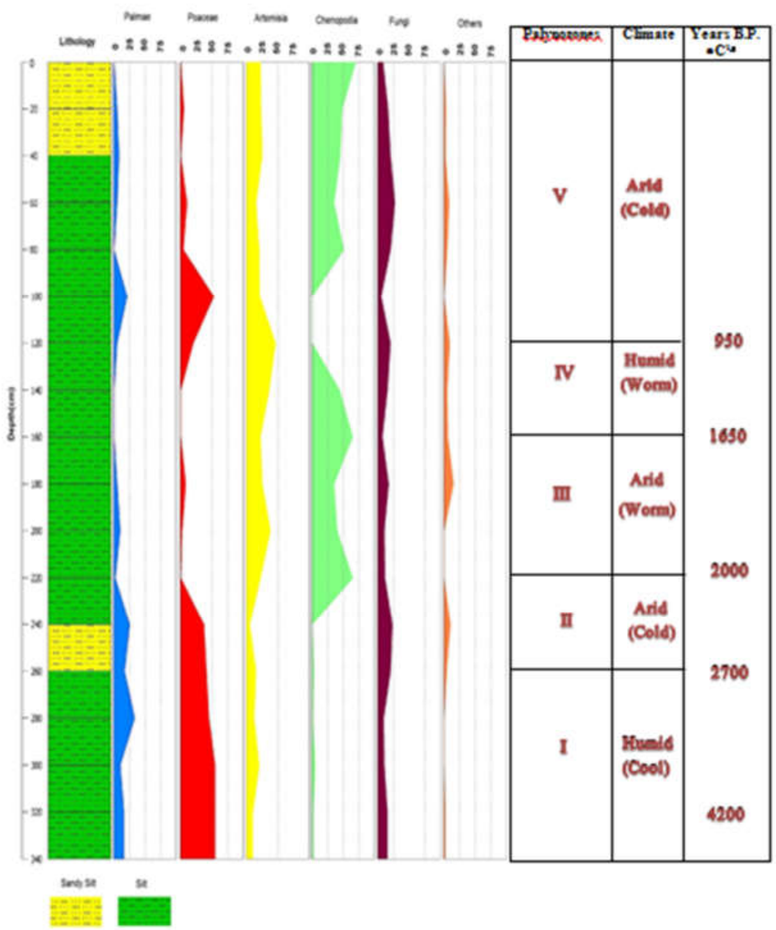


Figure 3. Pollen diagram and palynozones at the late Holocene in the first location (A) Basrah area.

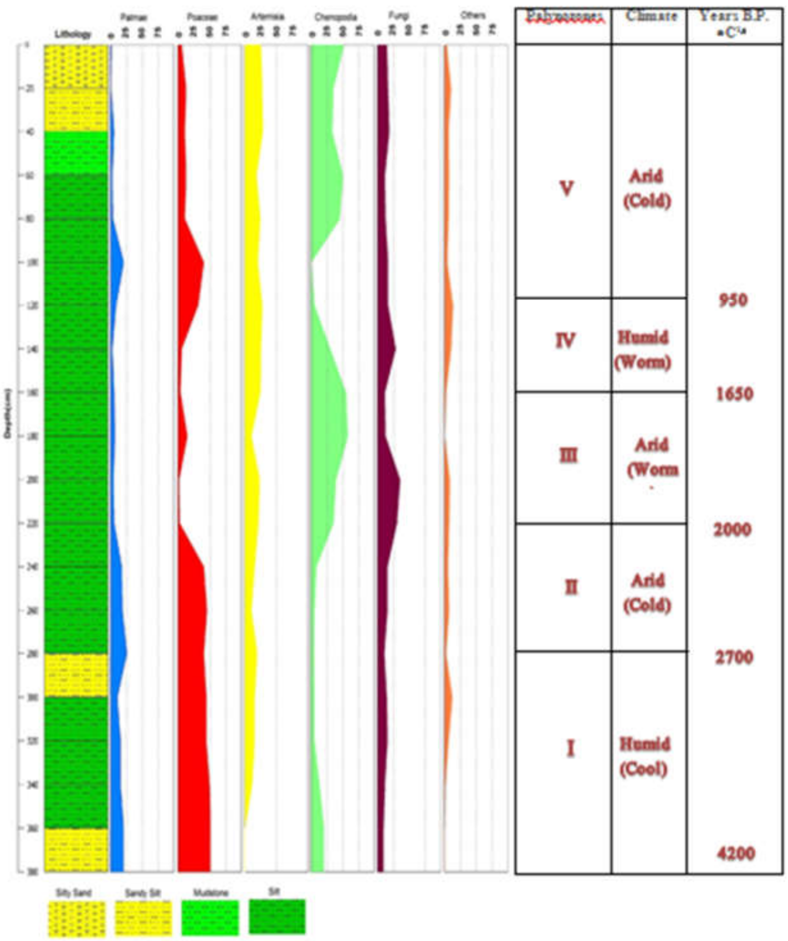


Figure 4. Pollen diagram and palynozones at the late Holocene in the second location (B) Basrah area.

**Conclusion**

The present study recorded the climatic changes in the Late Holocene in the Marsh area of the south of Iraq as follows:

1. About 30 species and 14 Genera of pollen, 6 species of spores, 8 forms of fungi and Dinoflagellate were recorded.
2. Pollen diagram was drawn by counting the percentage of some climate indicated pollen, spores and others.
3. Five climatic zone were suggested for the Late Holocene in the studied area.
4. The climatic changes in the Late Holocene in southern Iraq were correlated with climatic changes in the world.
5. The sea level of the Arabian Gulf and the lines of its beaches was apparently constant throughout the period 1000Y from now.

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