

## A STUDY OF DIATOMS (BACILLARIOPHYTA) IN HOOR-AL-AZIM WETLAND, SOUTH-WEST IRAN, AND THEIR SEASONAL CHANGES

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### ABSTRACT

This study was aimed to identify the planktonic diatoms and their seasonal change in Hoor-AL-Azim wetlands, Iran. Diatoms are important algal groups in different aquatic ecosystem and considered as bioindicators for water quality and environmental health. Hoor-AL-Azim or Hoor-al-Hawizeh is one of the most extensive and ecologically important wetlands in the Middle East which is shared between Iran (south-west) and Iraq(south). A major part of the wetland area was exposed to drying completely or partially during last few decades due to two Country politics. The samples were taken on a monthly basis from four stations for year from January to end of December, for identification and seasonal changes of Diatoms (Bacillariophyta). In this study, totally 69 taxa belonging to 28 different genera were identified of which *Nitzschia* genus had the highest species diversity (13 species) and followed by *Navicula* genus (10 species) while the highest species diversity observed in autumn. The average density ranged from 4818 cells/ liter to 58625 cells /liter in spring and winter, respectively.

**Key words:** diatoms - Hoor-AL-Azim wetland, Iran, seasonal variations, aquatic ecology, Iran

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دراسة الدايتومات (Bacillariophyta) في الاراضي الرطبة في هور العزم , جنوب غرب ايران , وتغيرات الموسمية

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المستخلص

هدفت الدراسة الى تشخيص الدايتومات وتغيرات الفصلية في هور العزم , ايران. الدايتومات هي من المجاميع الطحلبية المهمة في مختلف النظم البيئية المائية وتعتبر كمؤشرات حيوية لنوعية المياه والصحة البيئية. هور العزم (او هور الحويزة) هي واحدة من الاراضي الرطبة الاكثر اتساعا ولها اهمية من الناحية البيئية في الشرق الاوسط والتي تشترك فيها ايران (جنوب غرب) والعراق (جنوب). وتعرضت هذه الاهوار الى الجفاف بسبب سياسات الدولتين. تم دراسة الهور لفترة سنة كاملة من كانون الثاني الى نهاية كانون الاول. شخيصت الطحالب الدايتومية والتغيرات الموسمية حيث اخذت العينات من اربع مواقع. في هذه الدراسة تم تشخيص 69 نوعا تعود الى 28 جنسا وسجلت جنس *Nitzschia* اكبر عدد من الانواع (13 نوعا) تليها جنس *Navicula* (10 انواع) ولوحظ اعلى تنوع للدايتومات في الخريف. وتراوح معدل كثافة الدايتومات بين 4818 خلية/لتر الى 58625 خلية/لتر خلال فصلي الربيع والشتاء على التوالي.

الكلمات المفتاحية: الدايتومات، هور العزم، الاراضي الرطبة، التغيرات الموسمية، البيئة المائية، ايران

## INTRODUCTION

Diatoms or Bacillariophyta are single-celled organisms and a distinctive group of algae that have a thick silica cell wall and yellow-brown coloration (6). The diatom group is frequently dominant and widely distributed in aquatic ecosystems (both marine and freshwater environment). They have many planktonic species, In addition, there is also benthic and epiphytic type in this ecosystem (9, 18). They are useful bioindicators of chemical and physical conditions in aquatic ecosystem and their distribution and seasonal changes influenced by a variety of environmental variables such as nutrient enrichment, salinity, pH status, hydrological conditions such as water level fluctuations, hydroperiod and drought and habitat property (4, 12, 15). Diatoms are sensitive to a variety of ecological conditions and have been widely used to detect changes in water quality problems such as organic pollution, trophic state and heavy metal pollution (13, 19, 21). Bacillariophyta are the most studied organisms in freshwater ecosystems, due to their use as environmental bioindicators (17). Hoor-al-Azim or Hoor-al-Hawizeh is one of the most important wildlife refuge and aquatic ecosystem which is shared between Iran (south-west) and Iraq (south). It is part of Mesopotamian wetland that the various changes has occurred on it during the last two decades which had significant effects

on both structure and function of it. Recently in Iraqi section of the wetland a few studies on phytoplankton (in general) and diatoms (specific) have been done (1, 2, 10, 14 ). but in Iranian section of wetland, no report about diatoms diversity has yet been published. The present study, aimed to identify planktonic diatoms and survey their seasonal changes in Iranian section of the Hoor-al-Azim wetland.

## MATERIALS AND METHODS

In this study, Four stations were chosen in Hoor -AL-Azim wetland. Two sites in Shat-Ali (sites 3 and 4) and two sites in Rafi (sites 1 and 2) were selected (Figure 1). The samples were taken monthly during one year (January 2011 to December 2011) from four stations. For sampling, bottle used and sample were taken from the depth of 0/5 m. Then, they fixed and preserved in 4% Formalin. Species were studied using a Zeiss Axioinvert 35 inverted microscope at 40X magnification and to recognize the different taxa the valid identification keys were observed (6, 7, 12, 16, 20). The Frequency of species(cell/liter) were calculated. Three replicates (Each time one milliliter ) were performed for each station for each month. average abundance was recorded in triplicate. Calculations and plotting were performed using Excel software. The status of the valid names of each taxa were check with AlgalBase (8) and Al Hassany *et al.* (3).



Figure 1. Satellite Image of Hoor-AL-Azim wetland with the location of four sampling sites

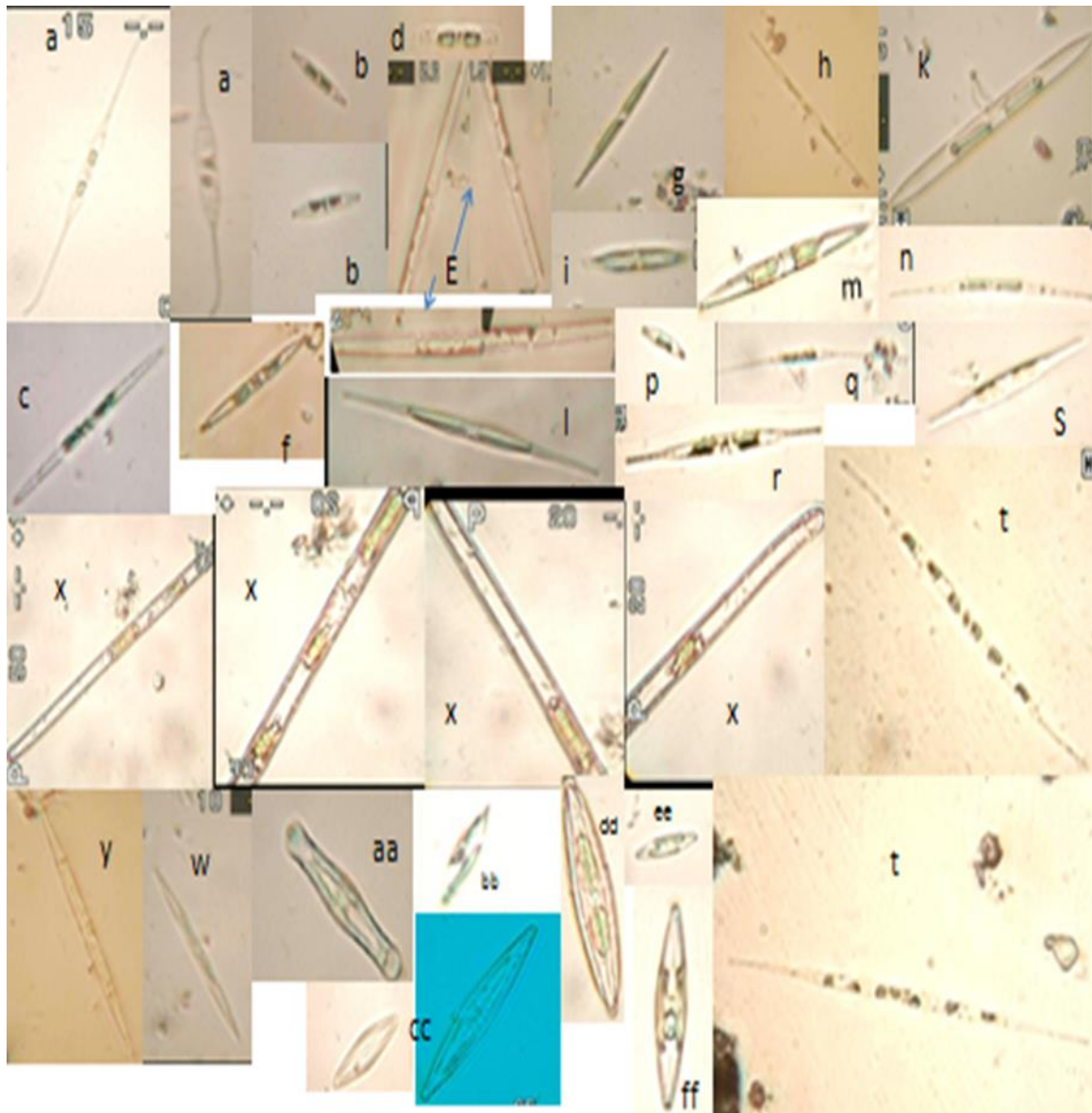
**RESULTS AND DISCUSSION**

In general, during this study, 69 diatom species belonging to 28 different genera were identified (Table 1, Figure 2 and 3). In different seasons, fall with 57 taxa and in winter, spring and summer 42, 32 and 27 taxa were observed, respectively. In different months, November had the highest diversity (38) and July and May had the lowest species diversity (6). Among different stations, stations 3 had 61 taxa and stations 4, 1, 2 had 49, 36 and 24 taxa, respectively. *Synedra nana* with 55% of the total frequency had highest total count (cell/liter), and *Diatoma* sp, *Fragilaria acus*, *Aneumastus tusculus*, *Nitzschia reversa*, *Navicula radiosa*, *Navicula inflata*, *Nitzschia palea*, *Nitzschia paleacea* had highest next total count respectively. Also *Synedra*, *Nitzschia* and *Navicula* genera had highest

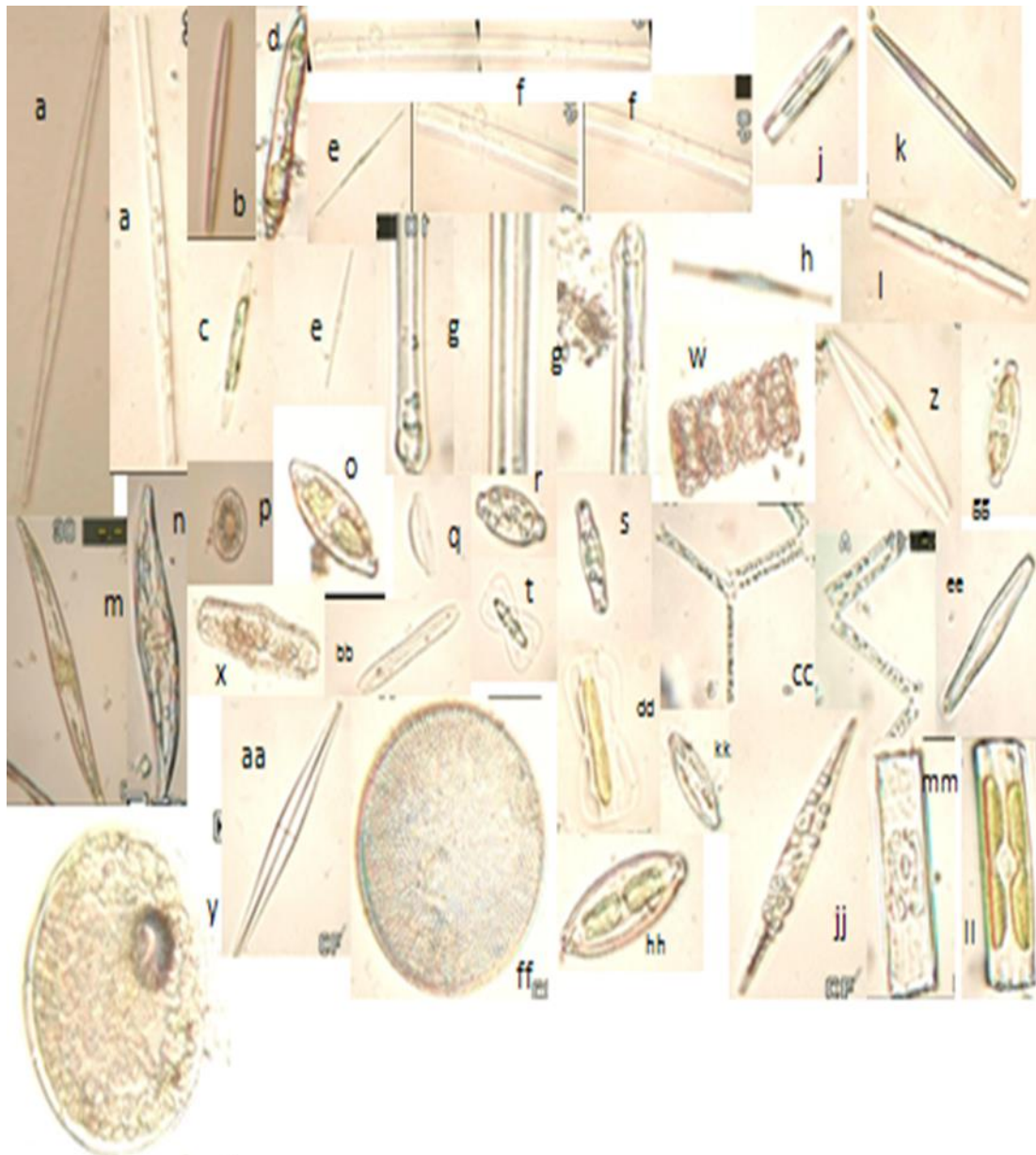
total abundance (59, 18, 8, 6%) respectively. *Nitzschia reversa*, *Nitzschia* sp.1, *Nitzschia acicularis*, *Nitzschia palea*, *Fragilaria acus*, *Navicula moumeni* were present in most of the different months in the wetland. *Nitzschia* and *Navicula* Genera had 30 and 11 species and *Synedra* and *Fragilaria* Genera had 7 and 6 species, respectively. Winter had highest (58625 cell / L) and the lowest average density (4818 cell / L) in Spring (Figure 5). The study results showed bimodal pattern of seasonal variations, the lowest peak in fall and the highest in winter. The highest number of diatomic species (57 spp) was recorded in the fall. Among different month, February had the highest average density (166750 cell / L) and July had the lowest average density (1375 cell / L), (Figure 4).

**Table 1. Identified diatoms during the study period in Hoor-AL-Azim**

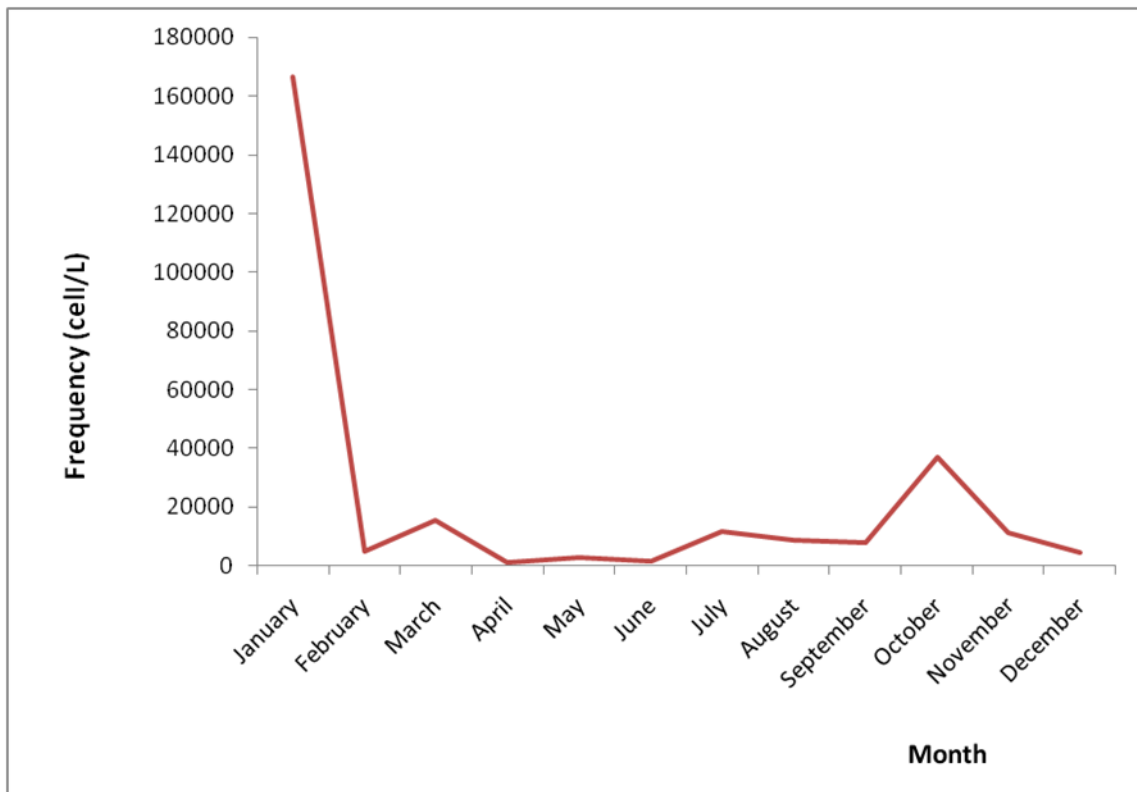
Taxa	Taxa
<i>Cyclotella</i> sp	<i>Gomphonella olivacea</i> (Hornemann) Rabenhorst
<i>Cosinodiscus</i> spp	<i>Gomphonema acuminatum</i> Ehrenberg
<i>Amphiprora alata</i> (Ehrenberg) Kützing	<i>Gyrosigma attenuatum</i> (Kützing) Rabenhorst
<i>Aneumastus tusculus</i> (Ehrenberg) D.G.Mann & A.J.Stickle	<i>G.acuminatum</i> (Kützing) Rabenhorst
<i>Aneumastus</i> sp.	<i>Halamphora veneta</i> (Kützing) Levkov
<i>Cylindrotheca closterium</i> (Ehrenberg) Reimann & J.C.Lewin	<i>Navicula cryptocephala</i> Kützing
<i>Cymbella affinis</i> Kützing	<i>N.incertata</i> Lange-Bertalot in Krammer & Lange-Bertalot
<i>Epithemia gibba</i> (Ehrenberg) Kützing	<i>N.incertata</i> Lange-Bertalot in Krammer & Lange-Bertalot
<i>Encyonema lacustre</i> (C.Agardh) Pantocsek	<i>N. radiosa</i> Kützing
<i>Eunotia</i> sp.	<i>N. radiosa</i> Kützing
<i>Diatoma moniliformis</i> (Kützing) D.M.Williams	<i>N. viridula</i> (Kützing) Ehrenberg
<i>Diatoma</i> sp	<i>N. cincta</i> (Ehrenberg) Ralfs in Pritchard
<i>Fragilaria vaucheriae</i> (Kützing) J.B.Petersen	<i>N. mournei</i> R.M.Patrick
<i>F. rumpens</i> (Kützing) G.W.F.Carlson	<i>N. angusta</i> Grunow
<i>F. crotonensis</i> Kitton	<i>N. capitata</i> Fritsch & Rich
<i>Frustulia saxonica</i> Rabenhorst	<i>Neidium bisulcatum</i> (Lagerstedt) Cleve
<i>F. rhomboides</i> (Ehrenberg) De Toni	<i>Nitzschia acicularis</i> (Kützing) W.Smith
<i>Mastogloia elliptica</i> (C.Agardh) Cleve in A.W.F.Schmidt	<i>N. agnita</i> Hustedt
	<i>N. acidoclinata</i> Lange-Bertalot
Taxa	Taxa
<i>Nitzschia obtusa</i> W.Smith	<i>Nitzschia palea</i> W.Smith
<i>N. bacilliformis</i> Hustedt	<i>N. paleacea</i> (Grunow) Grunow in Van Heurck
<i>N. dissipata</i> (Kützing) Rabenhorst	<i>N. supralitorea</i> Lange-Bertalot
<i>N. communis</i> Rabenhorst	<i>N. subacicularis</i> Hustedt
<i>N. filiformis</i> (W.Smith) Van Heurck	<i>Placoneis anglophila</i> (Lange-Bertalot) Lange-Bertalot
<i>N. gracilis</i> Hantzsch	<i>P. anglophila</i> (Lange-Bertalot) Lange-Bertalot
<i>N. graciliformis</i> Lange-Bertalot & Simonsen	<i>Planothidium lanceolatum</i> (Brébisson ex Kützing) Lange-Bertalot
<i>N. hantzschiana</i> Rabenhorst	<i>Pleurosigma elongatum</i> W.Smith
<i>N. linearis</i> W.Smith	<i>Pleurosigma</i> sp
<i>N. longissima</i> (Brébisson) Ralfs in Pritchard	<i>Sellaphora pupula</i> (Kützing) Mereschkovskiy
<i>N. microcephala</i> Grunow	<i>Stauroneis spicula</i> Cleve & Grunow
<i>N. rostellata</i> Hustedt	<i>Synedra nana</i> F.Meister
<i>N. pura</i> Hustedt	<i>Tabularia affinis</i> (Kützing) Snoeijs
<i>N. pumila</i> Hustedt	<i>Ulnaria ulna</i> (Nitzsch) Compère
<i>N. solita</i> Hustedt	<i>U. acus</i> (Kützing) Aboal
<i>N. reversa</i> W.Smith	<i>U. capitata</i> (Ehrenberg) Compère



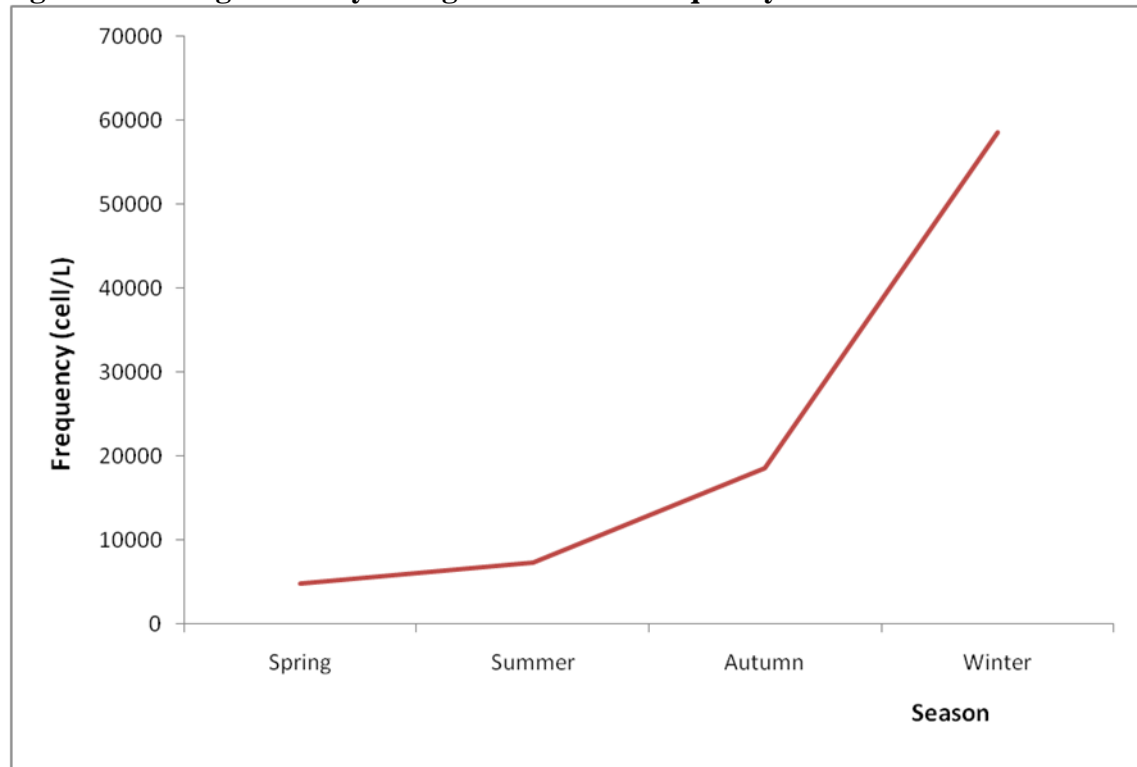
**Figure 2. Microscopic images of planktonic diatoms in Hoor-AL-Azim wetland: a- *Nitzschia reversa* b-*Nitzschia palea* c-*Nitzschia paleacea* d-*Nitzschia bacilliformis* e-*Nitzschia filiformis* f-*Nitzschia hantzschiana* g-*Nitzschia dissipata* h-*Nitzschia graciliformis* i-*Nitzschia* spp.1 k-*Nitzschia linearis* l-*Nitzschia rostelata* m-*Nitzschia* sp.2 n- *Cylindrotheca closterium* p-*Nitzschia microcephala* q-*Nitzschia longissima* r-*Nitzschia acicularis* s-*Nitzschia pumila* t- *Nitzschia* sp x-*Nitzschia obtuse* y-*Nitzschia subacicularis* w-*Nitzschia* sp aa- *Navicula moumeni* bb-*Navicula incertata* cc-*Navicula radiosa* dd-*Navicula viridul* ee-*Navicula* spp1 ff-*Navicula cryptocephala* gg- *Navicula cincta* hh- *Navicula angusta* jj- *Navicula* spp.2 kk- *Navicula* spp.3 ll-*Navicula* spp.4**



**Figure 3. Microscopic images of planktonic Diatoms in Hoor-AL-Azim wetland: a- *Ulnaria acus* b-*Tabularia affinis* c- *Fragilaria rumpens* d- *Synedra vaucheriae* e-*Synedra nana* f- *Ulnaria ulna* g- *Ulnaria capitata* h-*Fragilaria crotonensis* j-*Fragilaria* spp.1 k-*Fragilaria* spp.2 l- *Fragilaria* spp.3 m-*Gyrosigma attenuatum* n-*Gyrosigma acuminatum* p-*Cyclotella* sp o- *Aneumastus tusculus* q-*Cymbella affinis* r-*Placoneis pseudanglica* s-*Sellaphora pupula* t- *Amphiprora alata* w-*Achnanthes* sp.1 x- *Epithemia gibba* y-*Coscinodiscus* spp1 z-*Frustulia rhomboids* aa- *Stauroneis spicula* bb-*Neidium bisulcatum* cc-*Diatoma moniliformis* dd- *Amphiprora* sp. ee- *Gomphonema acuminatum* ff- *Coscinodiscus* spp.2 gg- *Aneumastus* sp.1 hh-*Aneumastus* sp.2 jj-*Pleurosigma* sp kk-*Mastogloia elliptica* ll-*Eunotia* sp. mm-*Diatoma* sp.**



**Figure 4.** Average monthly changes in diatoms frequency of Hoor-AL-Azim wetland



**Figure 5.** Average seasonal changes in diatoms frequency of Hoor-AL-Azim wetland

In the present study, 69 diatoms taxa belonging to 28 genera were identified. from 14 stations in 8 of the Iraqi marshes, 164 species of diatoms had been reported (14). Jassim et al (10) studied the phytoplankton of several wetlands in Iraq that Hoor-AL-Azim was one of them, they reported that in all wetlands, diatoms had 81 species. AL-Obaidi

et al (10) in the study of several wetlands in Iraq that Hoor-AL-Azim was one of them, reported that 204 diatoms taxa belonging to 32 genera exist. Furthermore, a total of 74 epiphytic diatom taxa belonging to 38 genera were recorded in this wetland (2). In general, all genera and most identified species in this study has been reported from Mesopotamian

wetlands Including Hoor-AL-Azim (1, 2, 5, 10, 14). In the present study, *Nitzschia*, *Navicula*, *Synedra* and *Fragilaria* Genera had 32, 11, 8 and 5 species, respectively. In this study *Nitzschia* and *Navicula* genera had highest total abundance. Usually, among different algal groups of nutrient-rich, temperate freshwater wetlands, diatoms genera such as *Achnanthes*, *Fragilaria*, *Navicula*, and *Nitzschia* are dominant (16). in the study of several wetlands in Iraq by AL-Obaidi et al. (10), reported that *Cyclotella meneghiniana*, *Kirchneriella irregularis*, and *Nitzschia palea* were dominant species with great abundance and *Nitzschia palea* was one of the common species. *Nitzschia palea* in this study also was one of the species that had a high frequency and also was a common species. This species often found in organically polluted aquatic environment (22). Jassim and Hamadi (10) in the study of several Iraqi wetlands (Hoor-AL-Azim, Al-Shuyukh, and Hammar) recorded that *Nitzschia*, *Navicula*, *Fragillaria* and *Cymbella* Genera have 16, 9, 7 and 5 species, respectively. in the study of Al-Obaidi et al. (10) in several wetlands in Iraq, including Hoor-AL-Azim, *Nitzschia*, *Navicula* and *Gomphonema* Genera had 15, 37, 17, 15 species and Genera of *Fragilaria*, *Achnanthes* and *Gyrosigma* each one had 9 species, respectively. In general, according to the mentioned above and present study, in the Iraqi and Hoor-AL-Azim wetlands, *Nitzschia* and *Navicula* Genera are the most diverse genus. Wetlands are dynamic ecosystems, Continuously undergoing natural changes due to sediments and nutrients regeneration and diatoms diversity, community structure, and their seasonal changes effected by wide range of environmental and physical variables (such as light intensity, temperature fluctuations, intensity of turbulent mixing, sediment character, and depth) and Chemical factors (such as nutrients enrichment, essential nutrients concentrations, salinity and pH status (13, 15, 11) Therefore, to examine the effects of physical and chemical factors on seasonal changes of diatoms in this wetland, a separate study is required.

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