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Stucture and Diversity of Phytoplantkton's Communities in a Ramsar Wetland (Sebkhet Bazer, Setif, Eastern Of Algeria)

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ABSTRACT

An inventory was made during the period from March 2014 to March 2016 in a Ramsar wetland, it's the Salt Lake (Sebkhet) of Bazer, Setif region, Algeria, to study inventories of phytoplanktons and to understand the structure and the distribution of micro-algae groups according to season or function of the biotic and also physicochemical parameters of the environment. Water samples are collected bi-monthly and preserved by a special technique to conserve microelements and to better identify phytoplankton. 33 genera were identified using an optical microscope, these genera belong to 13 orders, 18 families and 6 classes: Zygophylaceae, Chlorophyceae, Diatomophyceae, Cyanophyceae, Euglenophyceae and Dinophyceae, where, the Diatomophyceae class is the most important with 12 species or 37.50%, 5 families or 27.77% and 3 orders or 23.08%.What's more, 21, 21% of species are considered toxic, represented by 7 genera; in which 3 genera belonging to the Dinophyceae while 4 genera belonging to the Cyanophyceae. In addition, the statistical analyzes of these groups such as AFC, and PCA which were carried out using R software, confirms that the phytoplankton populations and distribution are linked to abiotic conditions, and vary with the seasons and depend both on the physicochemical factors of the environment such as the pH and temperature. These phytoplankton groups are bio-indicators of pollution, of which we noted that despite the importance of this area but it is polluted and required long-term protection.

KEYWORDS: Phytoplankton, structure, diversity, sebkhet bazer, Setif, Algeria

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1. INTRODUCTION

Wetlands are complex ecosystems due to various interactions between their biotic and abiotic components (Ramamurthy and Rajakumar, 2014), where changes in wetlands components can cause complex interaction between ecological processes (Lagos et al., 2008). More specifically, sensitive communities, which are phytoplankton communities, these groups are sensitive to any changes in their aquatic ecosystems (Hamaidi-Chergui et al., 2014).

Phytoplankton is made up of all plant plankton, i.e. Photosynthetic microorganisms (Jeffrey et al., 1997) drifting in bodies of water. These are cells, colonies or filaments whose movements depend essentially on those of the aquatic environment and / or which are mobile but whose movements are relatively restricted in the body of water. Phytoplankton populations are made up of a considerably wide range of groups (Jeffrey and Vest, 1997). They are important primary producers in the base of the food chain, constitute a vital link and an important biological indicator of the water quality (Laskar and Gupta, 2009). The study of phytoplankton distributions and groupings appears to be a useful approach to apprehend and understand the links between the functioning of ecosystems and the composition of assemblages as well as their possible future modifications under the effect of environmental changes (Barton et al., 2013). What's more studying the composition, diversity, and abundance of a water body's phytoplankton communities can be used as a tool to monitor and evaluate its water quality (Pawar et al., 2006).

Phytoplankton populations vary with seasons and depend on both physical and chemical factors of water (Hamaidi-Chergui et al., 2014), when Bharati et al. (2020) showed that the abundance of different phytoplankton communities showed significant correlations with temperature, depth, transparency, pH and alkalinity. In addition, seasonal variation in environmental conditions also influences the composition and succession of phytoplankton assemblages (Gailhard, 2003; Peng et al., 2012; Song et al., 2015; Saoudi et al., 2015; Djabourabi et al., 2017; Draredja et al., 2019). Salm et al. (2009) believe that understanding the community structure of phytoplankton, the seasonal evolution of plankton communities in response to environmental changes will contribute to the conservation and future management of these valuable and climate-sensitive systems, it may be used as an indicator of water quality (Saha et al.,2000). Furthermore, the diversity and abundance of phytoplankton is an ecological indicator of the nutritional status of aquatic ecosystems and helps to assess the level of eutrophication (Weysi et al., 2014).

Several recent studies in Algeria have been the subject of the phytoplankton community in different marine ecosystems and also wetlands as Lella Fatma and Zerzaim (Khellou et al., 2018), in Boukourdane Lake (Arab et al., 2019), in Salt wetland (Ben Bayer et al., 2019), in reservoirs of Ghrib and Harreza in semi-arid zone of Algeria (Djezzar et al., 2020).

Sebkhet Bazer is one of the wetlands of international importance, but this wetland has not been the subject of any studies on the temporal variability of phytoplankton or the impact of biotic and abiotic factors on these types of organisms. For this our study made the objective to determine the phytoplankton diversity and the abiotic factors responsible for their distribution, this is the first report on the phytoplankton composition. The main objectives of the present study wereto establish the inventories of phytoplanktons and to understand the distribution of micro-algae groups according to season or function of the biotic and physicochemical parameters of the environment. Through this study, we can also see the general state of this ecosystem and the level of humanization in this protected area.

2. MATERIALS AND METHODS

2.1. Site description

This study was carried out in the Salt Lake (Sebkhet) of Bazer (36 ° 05'N and 5 ° 45›E, 917 m), (Algeria) which covers 4.379 ha and is located in the Eco-wetland complex of the Setif region (northeastern Algeria). This wetland is classified as a Ramsar site since 2004 by the criterions 2 and 6, among others reasons for its importance of wintering for Greater Flamingo *(Phoenicopterus roseus)* and Common Shelduck (*Tadorna tadorna*).

The site is characterized by the presence of halophilic groups represented by *Salicornia fruticosaSuaedafruticosa*, and *Atriplex glauca*and also by the presence of aquatic vegetation such as *Typha angustifolia* and *Phragmites sp*wich play important biological role for the maintenance of nesting aquatic birds

2.2. Climatic characteristics

SebkhetBazer is belonging to the semi-arid bioclimatic region with a cold winter. The annual average temperature of Sebkhet Bazer is 15.1°C in the last fourteenyears. where, January is the coldest month when the average monthly temperature is 5°C and the hottest month is August with average temperature of 26.6°C. The annual precipitation is 318.26 mm, being spring considered as the rainiest season, particularly in March, when the highest precipitation (83.3 mm) is recorded.

2.3. Collection of samples

Our work was carried out during the period from March 2014 until March 2016, of which two sampling points were chosen. The microalgae were collected using a plankton net (silk net with a mesh less than 1 mm in diameter. A constant volume (20 liters of natural surface water) is filtered. They were fixed immediately with an aqueous solution. of formaldehyde at 10% and kept in the dark to reduce the risk of too rapid depigmentation, to each liter of filtered water is added 20 ml of Sournia (1986) formaldehyde, the net method is useful for determining the composition species (Ccme, 2011), the water bottles must be referenced by labels, indicating the station number, date and temperature.

2.4. Identification of phytoplankton

In the laboratory, a few drops of concentrated lugol are added, which gives the sample a slight brown coloration (to fix the sample) (Druart et al., 2005). Samples of phytoplankton that are attached to the lugol should be kept in dark and cool containers (between 4 and 10°C) (Druart and Rimet, 2008). The identification of phytoplankton genera is carried out using an optical microscope, this technique is the oldest and it allows the observation of sedimented samples, the identification and counting of phytoplankton cells (Broutin et al., 2010). These microscopes allow, thanks to their technology, to achieve a very precise identification of phytoplankton by its external morphology. They have been used to differentiate species of the genus (Guiselin et al., 2009; Sazhin et al., 2007). It is also necessary to study the abundance of "key" species, namely the predominant and / or harmful and / or potentially toxic species. The predominant and / or harmful species and / or likely to be of interest are, for example: *Alexandrium (Gonyaulax), Ceratium, Chrysochromulina popylepis, Corymbellus aureus, Coscindiscus wailesii, Dinophysis acuminata, Gymnodinium catenatum, Gyrodinium aureolum, Lepidodinium viride, Noctiluca scintillans, Phaeocystis, Prorocentrum balticum, Prorocentrum minimum, Prymnesium parvum, Pseudonitzschia.*

3. RESULTS AND DISCUSSION

3.1. Taxonomic composition of the microalguale flora identified

According to Karr (1991), knowledge of the taxonomic composition of communities is a necessary source of information. Indeed, the taxonomic composition of phytoplankton communities makes it possible to establish real tools for the diagnosis and evaluation of pollution, such as diatomic indices (Descy and Coste, 1990).

During our study cycle and the observation of the morphological characters of the phytoplankton genera collected in the sebkhet of Bazer, we identified 33 genera belonging to 6 main classes. Table 1 represents the systematic list of phytoplankton collected according to the classification established by Bourrelly (1970), Sournia (1986). We also used a website (algaebase.org) specializing in the systematics of microscopic alges.

Table 1: Systematic list of identified phytoplankton

Classes	Orders	Families	Species
zygophyla-ceae	Desmediales	Desmidiacea	*Cosmarium* sp.
			Closterium sp.
Chloro-phyceae	Chlorococ-cales	Scenedesma-cea	*Coelastrum* sp.
			Scenedesmus sp.
		Oocystacea	*Oocystis* sp.
		Chlorococ-cacea	*Tetracystis* sp.
		Palmellacea	*Sphaerocystis* sp.
	Volvocales	Volvocacea	*Eudorina* sp.
			Pandorina sp.
			Chlamydomo-nas sp.
	Chlamydo-monadales	Chlamydo-monacea	*Carteria* sp.
Diato-mophyceae	Naviculales	Naviculacea	*Frustulia* sp.
			Navicula sp.
			Pinnularia sp.
			Stauroneis sp.
			Amphora sp.
			Caloneis sp.
		Pleurosigma-tacea	*Gyrosygma* sp.
			Pleurosigma sp.
		Nitzschiacea	*Nitzchia* sp.
	Diatomales	Diatomocea	*Synedra* sp.
	Achnan-thales	Achnantha-cea	*Achnantes* sp.
			Cocconeis sp.
Cyanophy-ceae	Oscillato-riales	Oscillatoria-cea	*Phormidium* sp.
			Lyngbya sp.*
			Oscillatoria sp.*
	Chroococales	Chroococ-cacea	*Microcystis* sp.*
	Nostocales	Nostocacea	*Anabaena* sp.*
Eugleno-phyceae	Euglenales	Euglenacea	*Euglena* sp.
			Phacus sp.
	Peridiniales	Peridinicea	*Peridinium* sp.*
Dinophy-ceae	Gonyaula-cales	Gonyaulaca-cea	*Gonyaulax* sp.*
			Alexandrium sp.*

Analyzes of the phytoplankton data identified show that the microalgal flora is composed of 33 genera belonging to 13 orders, 18 families and 6 classes which are: Zygophylaceae, Euglenophyceae, Cyanophyceae, Diatomophyceae, Chlorophyceae and Dinophyceae. In terms of number of species, the Diatomophyceae class is the most important with 12 species or 37.50%, 5 families or 27.77% and 3 orders or 23.08%.

This class is followed by the class of Chlorophyceae which is presented by 9 genera (28.12%), 6 families (33.33%) and 3 orders (23.03%). The class of Cyanophycea is also well presented by 5 genera (15.62%), 3 families (16.66%) and 3 orders (23.08%) where 4 species are toxic, we speak of Lyngbyasp, Oscillatoria sp, Microcystis spand Anabaena sp. The class of Dinophyceae is represented by 2 toxic genera; it's Gonyaulax and Alexandrium. On the other hand, Zygophylaceae and Euglenophyceae are weakly presented by 2 genera for each (Table 2).

Table 2: Percentages by number of genera, orders and families of the identified phytoplankton classes

Classes	Orders	Families	Genras
Zygophylaceae	7.69%	5.55%	6.25%
Chlorophyceae	23.08%	33.33%	28.12%
Diatomophyceae	23.08%	27.77%	37.50%
Cyanophyceae	23.08%	16.66%	15.62%
Euglenophyceae	7.69%	5.55%	6.25%
Dinophyceae	15.36%	11.11%	6.25%

The study of phytoplankton stands is very informative in determining the level of community structuring and in evaluating the efficiency of the functioning of an aquatic ecosystem (Reynolds et al.,1981; Aleya et al.,1994). A few studies have been the subject of an exhaustive inventory with an adaptation of the spatiotemporal distribution of phytoplankton in Algerian wetlands, where Bensafia et al (2020) found that the monthly fluctuations of the water physicochemical parameters show variations that follow a seasonal rhythm and are strongly dependent to the abiotic and biotic factors as phytoplanctons in the region of national Park of El Kala.

Moreover, the specific composition of diatoms communities of Reghaïa Lake and their temporal and spatial distribution were influenced by the change of parameters of the medium (ElHaouati et al.,2015).

The identified number of phytoplankton at sebkhetbazer is important comparing with other wetlands, but it is less important than the number found in the lake of Megarine (it is divided into two small lakes namely Lella Fatma andZerzaim), where khellou et al(2018) have found a total of 58 spices belonging to 20 family, 14 orders, 5 classes and to 3 phylums (Bcillariophyta, Euglenophyta and Cyanobacteria). A total of 23 species of Cyanophyceae, 21 species of Bacillariophyceae, 12 species of Mediophyceae, 1 species of Coscinodiscophyceae, and 1 species of Euglenophyceae

Moreover, a total of 162 phytoplankton species were recorded in Boukourdane Lake. The taxa belonging to Chlorophyceae exhibited the highest number of species (55), followed by Bacillariophyceae (diatoms) (47), Cyanophyceae (17), Euglenophyceae (15) and the less diverse Dinophyceae (10), Zygnematophyceae (10), Chrysophyceae (6), Xanthophyceae (1), and Coccolithophyceae (1) (arab et al.,2019).

Chaibi (2014), at the level of Aurès and the northern Sahara show the microalguale flora identified is composed of 97 genera, the class of Bacillariophyceae includes the largest proportion of the phytoplankton population with 44 genera (i.e. 46%), followed by Dinophyceae with 12 genera (i.e. 13%) and 11 genera (i.e. 11%) for Cyanophyceae and Chlorophyceae.

3.1.1. *Toxic species*

Among the phytoplankton species identified, a percentage of 21.21% represents environmental toxicity, from which 7 genera identified in Bazer'ssebkhet are recognized as potentially toxic; in which 3 genera belonging to the Dinophyceae while 4 genera belonging to the Cyanophyceae. According to Paulmier (1994), some proliferating dinophyceae can also be toxic, such as Alexandriumcatenella, this microalgae has two flagella, it has toxic potential (Vila et al., 2001; Turki and Balti, 2005; Frehi et al., 2007 and Herzi, 2013). Cyanobacteria of the genus Oscillatoria and Lyngbya are regularly suspected during poisoning by cyanobacterial blooms. The toxins of Oscillatoria have a hepatic tropism (Silvano, 2005; Benoufella et al., 1995), while the toxins produced by Lyngbia have a nervous and skin tropism (Silvano, 2005; Benoufella et al., 1995), these two genera are dermatotoxic (Bourelly, 1985). However, the majority of the genera of cyanophyceae in eastern Algeria are recognized as toxic potential (Nasri, 2001; Bensafia, 2005; Nasri et al.,2007; Ouartsi et al., 2011), according to Silvano (2005), the development of watercourses, their pollution by human activity and summer temperatures are all ecological and climatic factors that seem essential in the display of toxic cyanobacteria blooms, these blooms can have impacts important socio-economic and ecological (Hoagland et al., 2002; Hoagland and Scatasta, 2006).

3.2. *Relationship of environmental factors and phytoplankton*

In order to better understand the relationship between phytoplankton and their environments, statistical analyzes have been carried out by several authors, such as the PCA (Liu et al., 2014), this analysis is used by (Becker et al.,

2009) for determine the spatial and temporal changes in physical and chemical conditions, as well as the CCA The CCA was carried out to analyze the relationship between phytoplankton and environmental variables, as well as to better understand the determining factors that control the structure of the community of the phytoplankton (Li et al., 2013). In our study, a factorial correspondence analysis (CFA) was carried out on all the observations in order to identify assemblages of phytoplankton species (Figure 1). The first two axes of the factorial correspondence analysis (CFA) describe 28.47%+24.45% of the total inertia. Axis 1 reflects the seasonal distribution of species so that axis 2 presents a decreasing gradient of number of presence and occurrence hence the species cluster 1 (*Phacus* sp., *Microcystis* sp) are the rare species presented only once so that cluster 5 species (*Oscillatoria* sp.*, *Lyngbya* sp.* *Achnantes* sp. *Synedra* sp. *Caloneis* sp. *Navicula* sp. *Carteria* sp. *Pandorina* sp. *Tetracystis* sp. *Eudorina* sp.) Are most abundant and constant throughout the year.

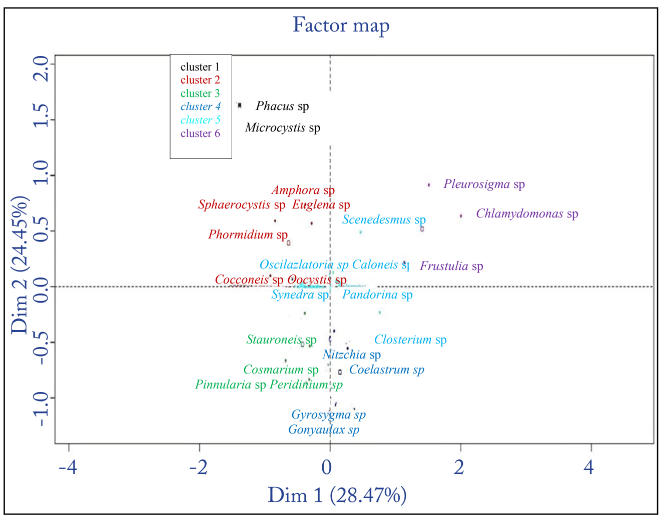

Figure 1: Factorial analysis of phytoplankton groups

The plan of the first two axes clearly shows the seasonal variability of species as a function of these abundances. This projection made it possible to separate the species into 6 distinguished groups, in addition, the clusters identified on the dendrogram carried out from the Hellinger distance were represented in the form of ellipses on the graphic representation of the AFC (Figure 2) which indicates congruent groupings between the two analyzes and thus reinforcing their power.

Ascending hierarchical classification (AHC) (Figure 2) highlights the seasonal distribution and appearance of phytoplankton assemblages

a. Constant annual assemblage : this group is well represented in Figure 2 where these species are present throughout the year, they are considered as constant

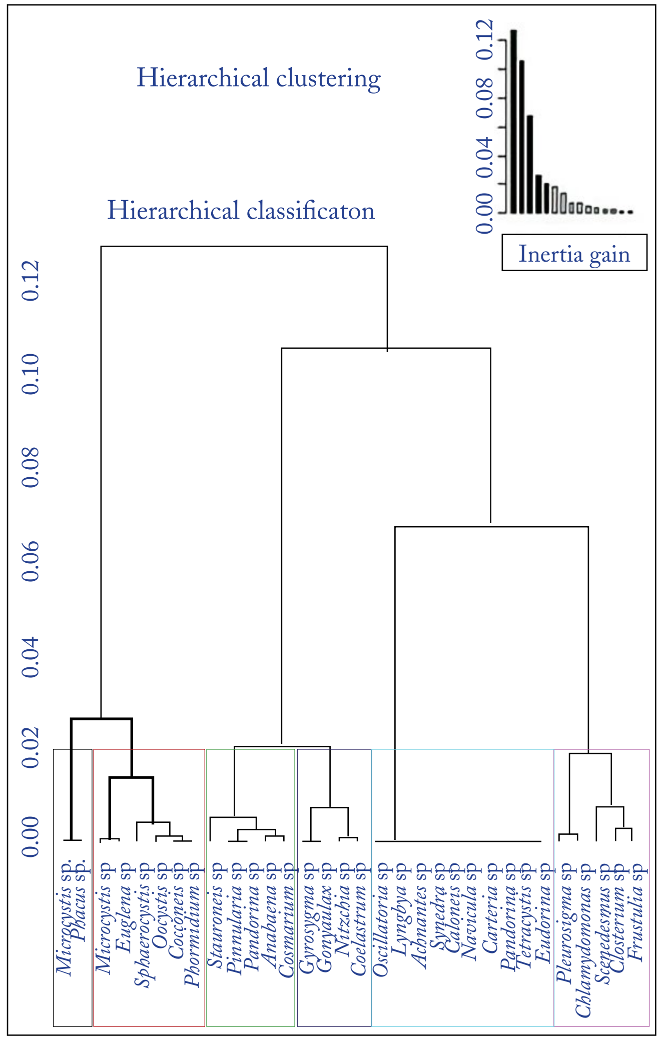

Figure 2: Hierarchical distribution of phytoplanktonic assemblages

phytoplankton elements characteristic of the region, this is the 5th cluster represented by: *Oscillatoria* sp.*, *Lyngbya* sp.*, *Achnantes* sp., *Synedra* sp., *Caloneis* sp., *Navicula* sp., *Carteria* sp., *Pandorina* sp., *Tetracystis* sp. and *Eudorina* sp.

b. Spring blend : This period is represented by Cluster 2 and Cluster 3; the species abundant in this period are mainly: *Amphora* sp., *Euglena* sp., *Sphaerocystis* sp., *Phormidium* sp., *Cocconeis* sp., *Oocystis* sp., *Stauroneis* sp., *Cosmarium* sp., *Pinnularia* sp., *Peridinium* sp. * and *Anabaena* sp. *

c. Summer assemblage: According to AFC analysis, the 4th cluster is the most abundant in this period, represented by *Nitzchia* sp., *Coelastrum* sp., *Gyrosygma* sp. and *Gonyaulax* sp.*.

d. Autumnal assemblage : presented by cluster 6 species which are mainly: *Chlamydomonas* sp., *Pleurosigma* sp., *Closterium* sp., *Scenedesmus* sp., *Frustulia* sp.

e. Winter assemblage: this period is represented by cluster

1 species which are: *Phacus* sp., *Microcystis* sp.

The study of the projection of phytoplankton species has allowed us to see the importance of Cluster 5, in addition, several clusters meet in the center, this richness is expressed by the provision of favorable conditions presented especially in the spring and summer period of which the average temperature in the site is 15.36C °, this value is ideal for the presence and development of the microalgal community. What is already confirmed by Neal et al (2006) and Kennedy and Whalen (2007), according to them, the important seasonal patterns of phytoplankton were observed in spring and summer, related to an increase in temperature and weather of residence, these parameters influence the biomass, composition and succession of plankton in aquatic systems (Salmaso and Braioni, 2008; Song et al., 2015). From our results, cyanophytes appear constant in the spring and summer groups such as *Anabaena* sp., *Oscillatoria* sp., and *Lyngbya* sp. These species are marked by its tolerances to high summer temperatures, of which its numbers are high in this period, in addition, the low temperature conditions do not allow phytoplankton to develop and / or to physically remain in the water column. The presence of cyanophytes is especially marked in cluster 5 of annual assemblages and that of spring groupings such as *Phormidium* sp., *Lyngbya* sp., *Oscillatoria* sp., *Microcystis* sp., and *Anabaena* sp., the distribution of these species is closely related to the High pH, while Boussadia et al (2015) asserts that cyanobacteria and cyanophyte biomass positively correlates with pH values, as well as Rantala et al. (2006) and Ye et al. (2009) reported that pH values are generally higher during a flowering period due to photosynthesis by algae and cyanobacteria. Bazer'ssebkhet is characterized by an average pH of 7.78 which provides phytoplankton with a favorable environment for its existence and development. These results are consistent with Garg et al. (2010). In addition, Carlsson and Graneli (1999), suggest that the dominance of Diatomophyceae is associated with environments rich in nutrient salts, and a basic pH, which our results justify, where the average pH of the summer period is 8.33, this period is marked by the abundance of diatomophyceae such as Nitzchiaspand Gyrosygmasp, in addition, the presence of diatoms such as Achnantes sp., Synedra sp., Caloneis sp., Navicula sp. From the distribution of phytoplankton assemblies that we have obtained, we can say that these groupings reflect the interaction and influence of environmental conditions on the distribution of these groupings, therefore these assemblages having one or more biogeochemical functions in common (Falkowski et al., 2003; Hood et al., 2006), they do not necessarily correspond to a taxonomic classification of organisms, but they are groupings of species according to their physiology, morphology or other factors that respond to the same way to recurrent variations in environmental conditions (Estrada, 2000). So the set of environmental conditions (biotic and abiotic) in which the species or group is able to develop and survive defines the ecological niche of the latter (Cadier, 2016). According to Peng et al (2012) and Song et al (2015) the annual and seasonal dynamics of the composition and abundance of phytoplankton and dominant species were probably controlled by the environmental conditions of the habitat. Just as the analysis of phytoplankton species has shown different ecological preferences in various environmental conditions, hence the succession of the composition of these groups seems to be strictly associated with the temporal variation of environmental factors (Zhao et al., 2015). In addition, various physicochemical parameters are responsible for the growth and reproduction of phytoplankton; among these parameters pH, water temperature, light conditions, nutrient concentrations and predation by zooplankton and fish (Salmaso and Braioni, 2008; Yu, 2010; Song et al., 2015).

4. CONCLUSION

Sebkhet Bazer was characterized by an important phytoplankton diversity (represented by 33 genera 18 families and 6 classes), a significant relationship was found between these groups and their ecological and aquatic environments. This study confirmed that the composition, structure, and distribution of these phytoplankton communities were related to environmental factors such as climate, which has contributed to seasonal diversification.

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