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# Factors determining phytoplankton community growth and succession in the water's surface of Mediterranean reservoir

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**ABSTRACT** In order to highlight the relationship between phytoplankton community and environmental variables under the Mediterranean climate, the algae community succession was investigated for the first time in the Hamiz reservoir (Algeria) from the point of view of several environmental controlling factors including: nutrient, water temperature, conductivity, turbidity and transparency. Samples of water were collected monthly over a year and analyzed for nutrient content and phytoplankton density. The total abundance of phytoplankton were particularly marked by two peaks, both of them occur in summer. The most diverse group was Bacillariophyta (38.29%), Chlorophyta (25.35%), and Euglenophyta (19.14%), among which Bacillariophyta and Chlorophyta were the frequently dominated group all over the study. The first two axes of Redundancy analysis (RDA) explained 82.34% of the correlation between phytoplankton group and environmental factors. Water temperature, transparency, nitrate, ammonium and total hardness represent the most significant environmental factors influencing phytoplankton communities structure including the presence of different preferences for environmental factors by algae group.

**KEY WORDS** Controlling factors; Dominate group; Environmental preferences; Mediterranean reservoir; Phytoplankton.

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## INTRODUCTION

Considering the current population explosion, we realize that freshwater resources are finite and human activities are one of the major causes of stress in aquatic ecosystems (Vasquez & Favila, 1998; Dokulil et al., 2000; Tazi et al., 2001). In Algeria, the water problem will undoubtedly be a major concern during this century, added that our water resources become more and more limited and difficult to exploit, in view of the fact that pollution risks are increasing in many regions of the country. Studies on algae communities have been shown of great importance to portray the water quality in water supply reservoirs. Algae are the common inhabitants of surface waters and are encountered in every water supply that is exposed to sunlight (Palmer, 1959). Phytoplankton are at the base of aquatic food webs and of global importance for ecosystems functioning and services (Sabita et al., 2018), for aquatic animals, they are of great importance as a major source of organic carbon (Gaikwad et al., 2004). Phytoplankton species diversity and dynamics are primarily controlled by hydrodynamics. They also respond to changes in environmental conditions such as temperature, light, nutrients (Reynolds, 1997; Grover & Chrzanowski, 2005) and various biological interactions namely grazing, parasitism and viral lysis (Griffin & Rippingale, 2001; Brussaard, 2004). In the end, human factors such as agriculture, irrigation, farming, and logging of forest trees for firewood can cause variation in hydrodynamic, physical and chemical properties of water, that influence phytoplankton community seasonally. Some phytoplankton species can cause nuisance blooms, causing many issues, like hypoxic, anoxic (Bennouna, 2000) and toxic problems (Konst et al., 1965). Excessive growth and accumulation of phytoplankton as blooms lead to the destruction of any water body resulting in dire consequences. Despite their importance, studies on phytoplanktonic populations of limnic systems in Mediterranean climates have been rarely estimated, especially in Algeria where it is limited to a few areas. In this context, Hamiz Reservoir provides a convenient study site regardless of its former existence, in addition, the reservoir is mostly used for irrigation of the perimeter of Mitidja-East in the North of Algeria and also provides a source of drinking water. This study pointed out for the first time in Hamiz Reservoir the succession of phytoplankton community and their relation with environmental factors.

## MATERIAL AND METHODS

### *Study area*

Hamiz reservoir in one of the eldest reservoirs in Algeria, situated in the area of Wadi Arbatache, in the Lower Kabylia of Djurdjura (36°35′59″N, 3°20′ 50″E). The reservoir is sited 158 meters above sea level and 35 kilometers east of Algiers in the plain of Mitidja in the Wilaya of Boumerdès (Ould Rouis et al., 2012). The impoundment of the dam was carried out in 1935. The maximum depth of the lake is 45 meters, corresponding to an initial capacity of 22 million m³ and an area of 128 hectares with an average length of 1,375 kilometers and an average width of 0.625 kilometers. The reservoir is located 25 kilometers from the Mediterranean Sea, making the climate of the study area basically Mediterranean with a dry and hot period of 6 months stretching from May until October, while the wet period fills up the remaining months of the year, mainly cold or cool seasons. The temperatures are often very high with a monthly average which vary between 11 °C and 26 °C (O.N.M, 2018) while the precipitations average is 851.9 millimeters per annum but it still variable.

### *Methods of sampling and analysis*

Water samples were collected monthly between January and December 2018 on the subsurface of water at a depth of 40 centimeter. Samples for physical and chemical analysis were collected in a polythene bottle and transported immediately to the laboratory in a cooler at 4 °C, while phytoplankton samples were preserved in a 5% neutralized formalin solution. Water temperature, pH, conductivity and oxygen saturation rate were meas-

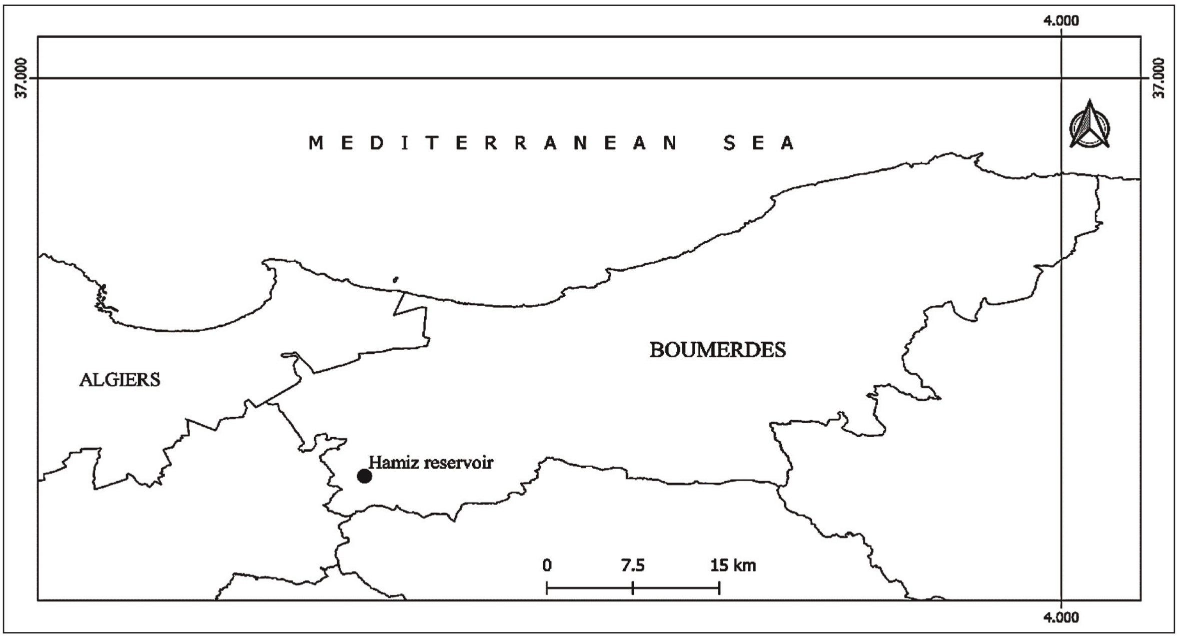



Figure 1. Map of the study area.

ured *in situ* using Multiparameter Hanna HI 9829. Water transparency was measured by a Secchi disk, sulfate by the gravimetric method and chloride with molar titration, while total hardness analysis was carried out by EDTA titrations methods as described by Rodier et al. To determine the nitrate, nitrite, ammonium, and phosphates levels, the colorimetric method with a continuous flow on an automated chain (SKALAR) was applicated, and turbidity was recorded by using a turbidity meter. Chlorophyll a was analyzed according to the protocol described by French standard AFNOR T90-114 for the determination of chlorophyll a. Phytoplankton samples previously agitated were settled in sedimentation chambers. The cells were counted on a ZEISS-WINKEL inverted microscope using the Utermöhl (1958) method. Taxa were identified using keys and monographs (Bourelly, 1972; 1981; 1985; Krammer & Lange-Bertalot, 1986; 1988; 1991; Komárek & Anagnostidis, 2005).

### *Statistical methods*

R packages available at the following address: https://cran.r-project.org/ was run for static analysis. Kruskal-Wallis tests were carried out for comparing environmental changes. First, Spearman correlation analysis was applied to highlight the relationship between phytoplankton community structure and environmental variables followed by Redundancy Analysis (RDA) with Monte Carlo permutation test to recognize the controlling factors (Borcard et al., 2011).

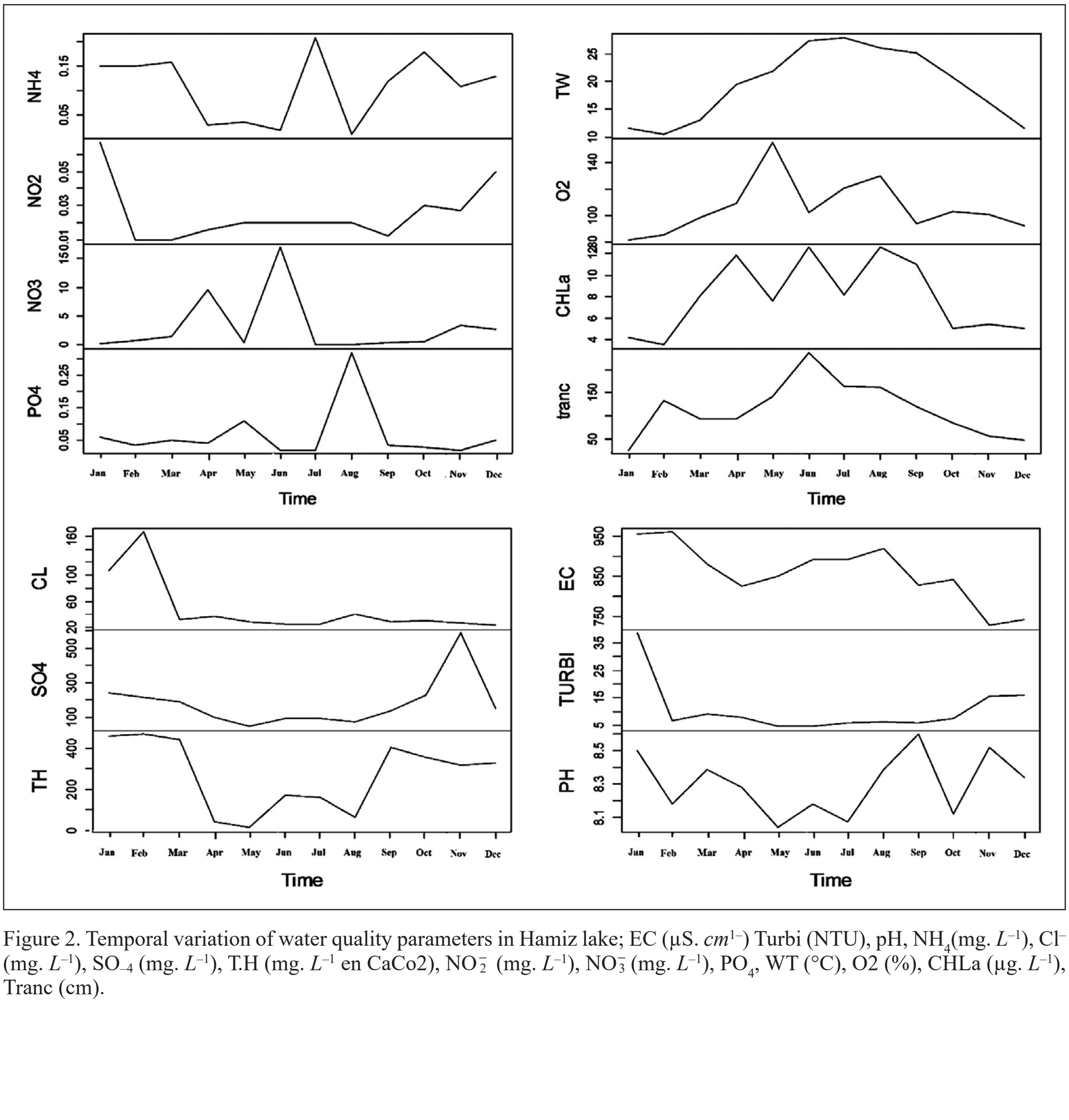



Figure 2. Temporal variation of water quality parameters in Hamiz lake; EC (µS. $cm^{1-}$) Turbi (NTU), pH, $NH_4$(mg. $L^{-1}$), $Cl^-$ (mg. $L^{-1}$), $SO_{-4}$ (mg. $L^{-1}$), T.H (mg. $L^{-1}$ en CaCo2), $NO_2^-$ (mg. $L^{-1}$), $NO_3^-$ (mg. $L^{-1}$), $PO_4$, WT (°C), O2 (%), CHLa (µg. $L^{-1}$), Tranc (cm).

## RESULTS

### *Physical and Chemical parameters*

Environmental variables of Hamiz water are presented in Fig. 2. Kruskal-Wallis test showed significant difference ($p$-value < 0.01) among physical and chemical parameters during study period. Water temperature (WT) showed an annual characteristic cycle reflecting the atmospheric temperature with higher values during July (28.3 °C) and lower values in February (9.32 °C); pH value indicating slightly alkaline water in most of the study sites. Electrical conductivity (EC) records its highest value in February (1090 µS. $cm^{-1}$), when the Oxygen saturation rate (O2 %) reaches its lowest value in January (76.8%) and were recorded during November. Total hardness (TH) and chloride ($Cl^-$) in various samplings record their maximum values in January and February periods, while turbidity (Turbi) higher value occurs during January. Chlorophyll a (CHL a) concentration was relatively high in June and August with an average concentration of 14,51 µg. $L^{-1}$, while Transparency (Tranc) of water had undergone large temporal variations in various samplings in Hamiz lake and it shows an average value of 112.77 cm.

### *Analysis of Phytoplankton*

In the euphotic zone, phytoplankton density (cells. $L^{-1}$) showed a significant variation during study period with an average concentration of 141.3 x $10^4$ cells. $L^{-1}$ (Fig. 3).

The results revealed also the presence of two noticeable peaks recorded during summer period, the first one in June with 340.3 x $10^4$ cells. $L^{-1}$ and the second one in August with 278.9 x $10^4$ cells. $L^{-1}$. A total of 47 phytoplankton cosmopolitan species belonging to six phyla have been recorded for the first time in this study (Table 1). Diatoms represent the most diverse class with eighteen species (38.29% of the total species number) followed by twelve species belonging to Chlorophyta (25.4%) and nine species of Euglenophyta (19.1%). In addition, the samples included as well species belonging to Cyanophyta, Dinophyta and Chrysophyta (Table 1).

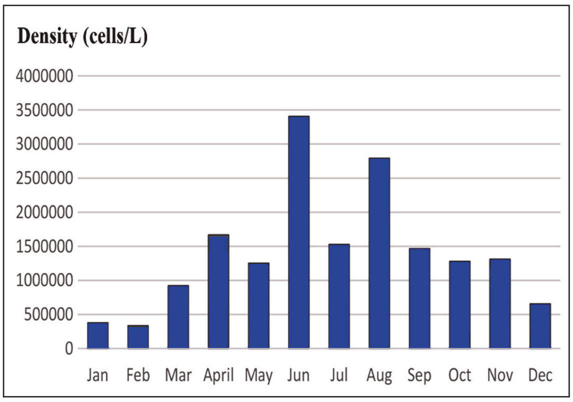



Figure 3. Phytoplankton variations in abundance.

### *Phytoplankton community: abundance and structure*

Our investigation revealed that Chlorophyta and Bacillariophyta were the frequently dominated group all over the study (Fig. 4). February was the most ascendancy period for Chlorophyta with 75.4% of dominance, while January encountered the highest share of diatoms in the total phytoplankton number by 72.0%. Dinophyta recorded the highest dominance in September reaching 44.51%. The most ascendancy period for Euglenophyta was in August attaining 11.76%, however it was not enough to dominate other phyla which is the same case for Cyanophyta and Chrysophyta.

### *Relationship between Phytoplankton community structure and environmental factors*

The eigenvalues of The RDA analysis of the first and second axes explain a total of 82.34 % of the total variance in the phytoplankton group data (RDA1= 48.10 % and RDA2= 34.24 %, respectively). Figures 5–7 describes the arrangement of the phytoplankton community regarding to environmental Factors. According to the first axis, Chlorophyta positively correlates with ammonium and total hardness while Bacillariophyta and Cyanophyta positively correlate with nitrite, nitrate, A1-A2. In the second axe Dinophyta, Chrysophyta and Euglenophyta show a significant positive correlation with water temperature and transparency (Figs. 5, 6). In conclusion, the results of the Monte Carlo permutation test (Figs. 7, 8) show that phytoplankton community structure was significantly linked to changes in water temperature, transpar-

| **Taxa** | **Freq (%)** |
|---|---|
| *Achnanthidium catenatum* Bily & Marvan (Lange-Bertalot, 1999) | **5.47** |
| *Cyclotella ocellata* Pantocsek, 1901 | **13.21** |
| *Cymatopleura elliptica* (Brébisson) W.Smith, 1851 | **0.01** |
| *Cymatopleura solea* (Brébisson) W.Smith, 1851 | **0.60** |
| *Cymbella ventricosa* (C. Agardh- 1830) | **0.86** |
| *Gyrosigma acuminatum* (Kützing) Rabenhorst, 1853 | **0.17** |
| *Gyrosigma parkeri* (M.B. Harrison) Cleve, 1921 | **0.02** |
| *Navicula erifuga* Lange-Bertalot, 1985 | **0.02** |
| *Nitzschia angustata* (W. Smith) Grunow, 1880 | **0.01** |
| *Nitzschia draveillensis* Coste & Ricard, 1980 | **0.63** |
| *Nitzschia filiformis* (W.Smith, 1896) | **1.18** |
| *Nitzschia* sp. | **0.01** |
| *Pinnularia viridiformis* Krammer, 1992 | **0.04** |
| *Surirella brebissonii* Krammer & Lange-Bertalot, 1987 | **0.20** |
| *Tryblionella levidensis* W. Smith, 1856 | **0.07** |
| *Ulnaria acus* (Kützing) M. Aboal, 2003) | **0.21** |
| *Ulnaria* sp. | **5.28** |
| *Ulnaria ulna* (Nitzsch) Compère, 2001 | **0.49** |
| *Closterium acutum* var. *variabile* (Lemmermann) Willi Krieger, 1935 | **4.94** |
| *Coelastrum microporum* Nägeli, 1855 | **1.63** |
| *Didymocystis* sp. | **7.67** |
| *Gonium* sp. | **0.21** |
| *Macrochloris* sp. | **5.63** |
| *Monoraphidium contortum* (Thuret) Komárková-Legnerová 1969 | **2.66** |
| *Monoraphidium* sp. | **0.82** |
| *Oocystis* sp. | **4.36** |
| *Pandorina morum* (O.F.Müller) Bory, 1826 | **3.95** |
| *Scenedesmus* sp. | **1.29** |
| *Straurastrum* sp. | **0.01** |
| *Tetraëdron minimum* (A. Braun) Hansgirg, 1889 | **3.95** |
| *Euglena oxyuris* Schmarda, 1846 | **1.33** |
| *Euglena* sp. | **0.81** |
| *Phacus acuminatus* A. Stokes, 1885 | **1.82** |
| *Phacus longicauda* (Ehrenberg) Dujardin, 1841 | **1.74** |
| *Phacus* sp. | **0.28** |
| *Trachelomonas caudata* (Ehrenberg) F. Stein, 1878 | **0.28** |
| *Trachelomonas* sp. 1 | **3.92** |
| *Trachelomonas* sp. 2 | **0.90** |
| *Trachelomonas volvocina* (Ehrenberg) Ehrenberg, 1834 | **1.44** |
| *Anabaena* sp. | **0.18** |
| *Microcystis* sp. | **0.49** |
| *Oscillatoria* sp. | **0.02** |
| *Spirulina* sp. | **0.24** |
| *Ceratium hirundinella* (O.F.Müller) Dujardin, 1841 | **0.35** |
| *Peridinium* sp. | **1.26** |
| *Peridinium umb.* var. *umbonatum* (F. Stein, 1883) | **15.20** |
| *Dinobryon sociale* var. *americanum* (Brunnthaler) Bachmann, 1911 | **3.89** |

Table 1. Frequencies (Freq) of phytoplankton taxa. Frequency (Freq. %) indicates percentage of species occurrence from samples; Freq= Pi/P*10 where Pi = number of samples in which the species "i" is found and P = total number of samples.

ency and nitrate at $\alpha = 5\%$ (p-value $\leq 5\%$) as well as ammonium and Total hardness at $\alpha = 10\%$ (p-value $\leq 10\%$).

## DISCUSSION

### *Study of Phytoplankton communities*

The total abundance of phytoplankton were particularly marked by two peaks during summertime. The first one in June and the second one in August, both peaks occur in the period of warm weather with longer hours of sunshine, which concord with many studies that suggest that phytoplankton proliferation is mostly due to the balance between light and nutrient availability (Molly et al., 2013; Becker et al., 2010; Naselli-Flores, 2000). The results revealed also the presence of 47 species of phytoplankton belonging to 6 phyla in Hamiz reservoir, co-dominated mostly by Bacillariophyta and Chlorophyta all over the study, except for September where Dinophyta became more numerous. The dominance of Chlorophyta during February is mainly caused by the proliferation of *Closterium acutum* var. *variabile*; the dominance of large green algae are not frequent in winter, but it exists some common adaptations that allow them to grow in low values of light and temperature (Squires & Rushforth, 1986; McKnight, 2000).

*Closterium acutum* var. *variabile* high growth rate (relative to that of others desmid species) at a low temperature and light intensity allows the specie to have a distinct potential of population increase in wintertime (Coesel & Kooijman-Van-blokland, 1991). Bacillariophyta highest dominance encountered mostly in January where *Achnanthidium catenatum* stretched to 86.11% of Bacillariophyta species. According to Cecilia et al. (2008), this high dominance of diatoms during winter can be interpreted as a net growth of phytoplankton that is possibly favored by low predation and high nutrient availability. The high proliferation of Dinophyta (44.51%) in September was explained in many studies by the fact that Dinohyta has species with high plasticity including the ability to develop in different reservoir conditions (Lopes et al., 2009; Cardoso et al., 2010). This good adaptation aptitude is maybe due to the

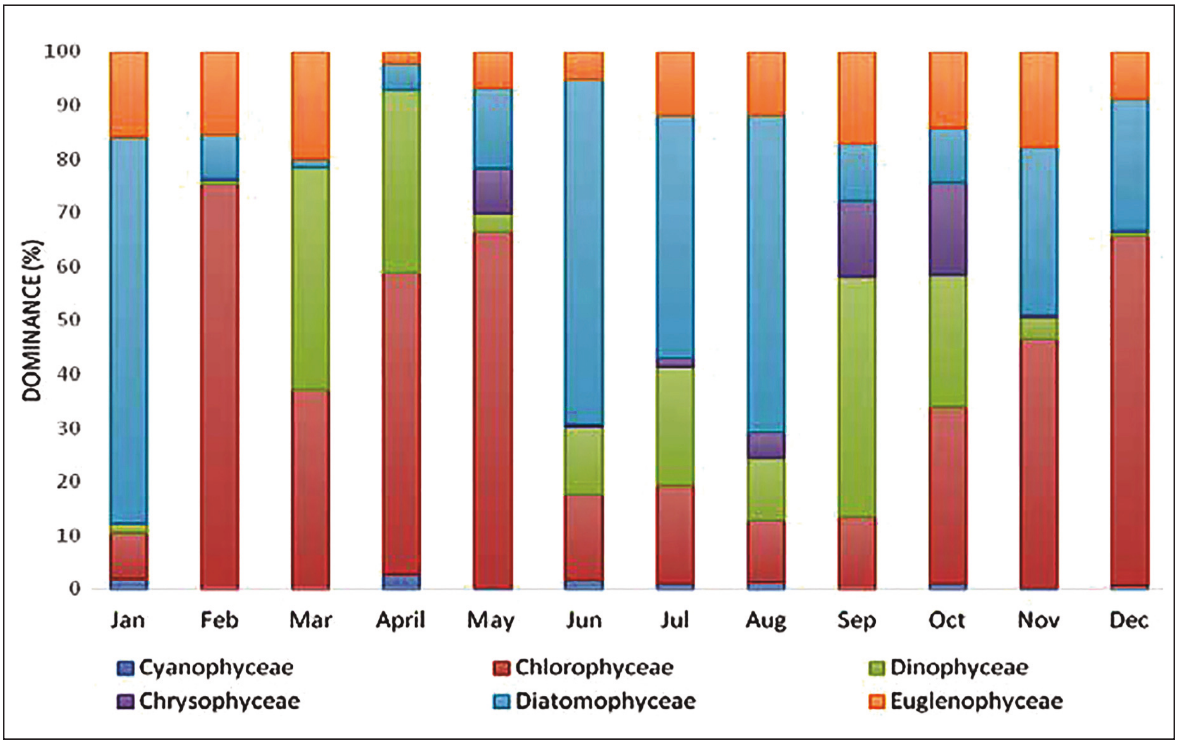
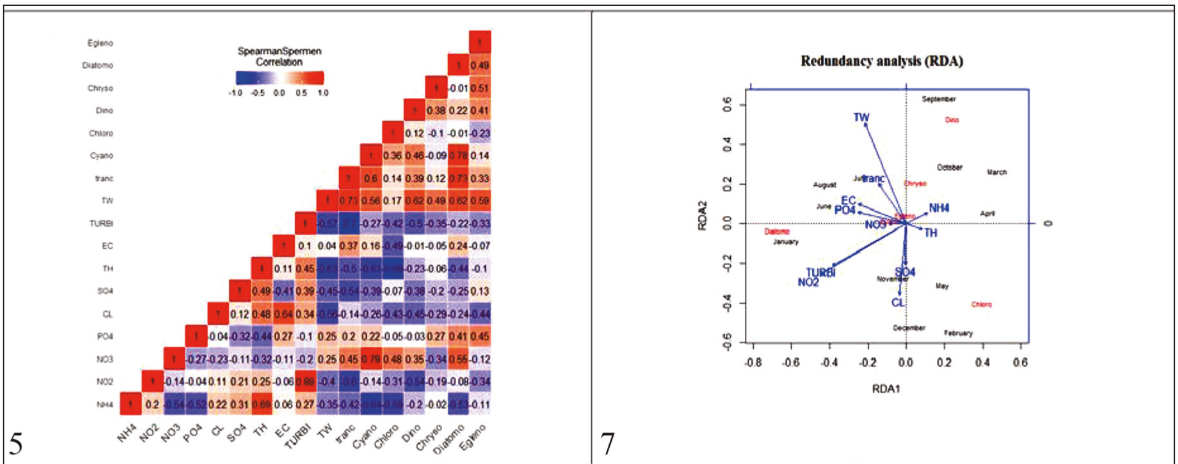



Figure 4. Annual variations with relative dominant phytoplankton groups.




Pairwise two-sided p-values of Spearmen correlation (Sig. α = 5%; Sig. α = 10%)

| | Chloro | Chryso | Cyano | Diatom | Dino | Egleno | CL | EC | NH4 | NO2 | NO3 | PO4 | SO4 | TH | tranc | TURBI | TW |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Chloro | | | | | | | | | | | | | | | | | |
| Chryso | 0.8360 | | | | | | | | | | | | | | | | |
| Cyano | 0.2979 | 0.8174 | | | | | | | | | | | | | | | |
| Diatomo | 0.9141 | 0.2924 | 0.0488 | | | | | | | | | | | | | | |
| Dino | 0.6403 | 0.5413 | 0.3610 | 0.8968 | | | | | | | | | | | | | |
| Egleno | 0.4845 | [illegible] | 0.6698 | 0.3191 | 0.2207 | | | | | | | | | | | | |
| CL | 0.2116 | 0.4182 | 0.5943 | 0.1737 | 0.5113 | 0.6962 | | | | | | | | | | | |
| EC | [illegible] | 0.8275 | 0.8360 | 0.6646 | 0.4094 | 0.7954 | 0.0583 | | | | | | | | | | |
| NH4 | 0.1237 | 0.8230 | 0.2303 | 0.1817 | 0.4450 | 0.8287 | 0.9224 | 0.6092 | | | | | | | | | |
| NO2 | 0.8429 | 0.7853 | 0.2482 | 0.1131 | 0.1567 | 0.8689 | 0.3404 | 0.5488 | 0.8556 | | | | | | | | |
| NO3 | [illegible] | 0.1942 | 0.7555 | 0.5121 | 0.6163 | 0.2852 | 0.3831 | 0.0893 | 0.2951 | 0.7361 | | | | | | | |
| PO4 | 0.7940 | 0.5354 | 0.6676 | 0.5841 | 0.3742 | 0.8109 | 0.0918 | 0.4134 | 0.4257 | 1.0000 | 0.2816 | | | | | | |
| SO4 | 0.4568 | 0.2816 | 0.2264 | 0.2551 | 0.2444 | 0.8799 | 0.4907 | 0.6331 | 0.1509 | 0.3878 | 0.4094 | 0.4134 | | | | | |
| TH | 0.0126 | 0.3931 | [illegible] | 0.1309 | 0.3182 | 0.9312 | 0.2643 | 0.3541 | 0.0562 | 0.8000 | 0.9655 | 0.8109 | [illegible] | | | | |
| tranc | 0.8459 | 0.1866 | 0.2924 | 0.1993 | 0.2028 | 0.6175 | 0.6801 | 0.1993 | 0.3126 | 0.1071 | 0.6169 | 0.5995 | [illegible] | 0.1182 | | | |
| TURBI | 0.7954 | [illegible] | 0.5835 | 0.3079 | 0.1621 | 0.4845 | 0.4767 | 0.4986 | 0.3182 | 0.1692 | 0.6561 | 0.5243 | [illegible] | 0.1667 | [illegible] | | |
| TW | 0.7787 | [illegible] | 0.0793 | [illegible] | [illegible] | 0.1063 | 0.2300 | 0.8629 | 0.4159 | 0.8429 | 0.3473 | 0.3751 | [illegible] | [illegible] | [illegible] | [illegible] | |

6

Statistical influence of the significant and non-significant physico-chemical factors on the phytoplankton groups according to the RDA

| | Df | AIC | F | Pr(>F) |
|---|---|---|---|---|
| tranc | 1 | 175.63 | 7.5687 | 0.005 |
| TW | 1 | 177.28 | 5.3103 | 0.010 |
| NO3 | 1 | 178.51 | 3.8225 | 0.050 |
| NH4 | 1 | 178.73 | 3.5702 | 0.070 |
| TH | 1 | 179.62 | 2.6008 | 0.100 |
| PO4 | 1 | 180.69 | 1.5258 | 0.155 |
| TURBI | 1 | 181.37 | 0.8930 | 0.300 |
| CL | 1 | 181.33 | 0.9298 | 0.305 |
| EC | 1 | 181.53 | 0.7526 | 0.450 |
| SO4 | 1 | 181.61 | 0.6758 | 0.465 |
| NO2 | 1 | 181.87 | 0.4498 | 0.685 |

8 Sig. α = 5% Sig. α = 10%

Figures 5–8. Diatomo: Bacillariophyta, Chloro: Chlorophyta, Dino: Dinophyta, egleno: Euglenophyta, Cyano: Cyanophyta, Chryso: Chrysophyta. TW: water temperature, EC: electrical conductivity, Tranc: transparency, SO4: sulfate, CL: chloride, TH: Total hardness, NO2: nitrate, NO3: nitrite, NH4+: ammonium, PO4: phosphates and Turbi: turbidity.

nature of the cell wall of dinoflagellates; Hamm & Smetacek (2007) argued that the cellulosic cell wall of dinoflagellates provides them lightweight and armored protection against predators. Other research related their accommodation under conditions of low-nutrient availability to their capacity of storing phosphates for several generations (Serruya & Bermann, 1975).

### *Correlations between Phytoplankton communities and environmental factors*

A relationship was identified between phytoplankton community and environmental factors using Redundancy analysis (RDA) revealing that water temperature, transparency and nutrient concentration including nitrate, ammonium and Total hardness were the most significant environmental factors influencing phytoplankton communities. High phytoplankton density during summer was directly related to the high multiplication of phytoplankton species which preferred high temperature.

The results obtained concord with many other findings (Bierman & Dolan, 1981; Masaki & Seki, 1984), that came up with the same results in which water temperature played a fundamental role in increasing phytoplankton density. Transparency is a fundamental environmental factor influencing the multiplication of phytoplankton. The fact that algae need sunlight to increase makes them only able to grow in the areas where the sun penetrates. During our study, transparency recorded a very low level in both periods of January and December, followed by a decrease in phytoplankton abundance and chlorophyll a. The decrease can be explained by the highest concentration of turbidity in both months; according to Ewa et al. (2018), a turbid state is typical of lakes with a high concentration of Suspended Particulate Matter (SPM), responsible for low water transparency. As a consequence, phytoplankton abundance (including chlorophyll a) reduces since algae productivity is largely controlled by light availability. This conclusion is consistent with many other findings (Wofsy, 1983; Peterson & Festa, 1984); in addition results of RDA analysis show a significant correlation between Dinophyta, Chrysophyta, Euglenophyta community and transparency; the more water transparency rises– the more phytoplankton grow; to put it another way, when the lighted area grows the photosynthesis rate becomes higher, this results are supported by other studies like Jin et al. (2010) and Ewa et al. (2018) in which they found that the phytoplankton group was strongly affected by the light under high transparency.

Phytoplankton are also influenced by physical-chemical parameters including nitrate and ammonium. It is a fact that nutrient enrichment typically stimulates phytoplankton growth in lakes, especially Nitrogen (N), which are often considered as the principal limiting nutrients for aquatic algal production due to their short supply compared to cellular growth requirements. According to Hu et al. (2013), in Lake Erhai, total phosphorus, water temperature, and total nitrogen are important factors influencing the phytoplankton abundance and community structure (Wang et al., 2011). In addition to the positive correlation of diatoms with nitrate, which is one of most important predictors among the macronutrients with a positive effect on diatom abundance (Gligora et al., 2007), the same group showed another positive correlation with turbidity in which several studies related the proliferation of diatoms to the physical alterations of water including factors like: depth variation, turbulence, deforestation, and hydrological changes regardless of trophic state (Dong et al., 2008; Costa-Boddeker et al., 2012).

According to RDA results, Total hardness (TH) has significantly influenced phytoplankton community's structure; as a sum of calcium and magnesium ions, the increase of TH can affect the change in calcium concentrations, the reaction of calcium with inorganic carbon and bicarbonate leads to the formation of carbonate and carbon dioxide which is taken up by algae during photosynthesis (Jiunn-Tzong & Lai, 2010), these prevailing conditions result in phytoplankton proliferation, in addition to RDA analysis, the results of the Monte Carlo permutation test reveal a positive correlation between Chlorophyta and total hardness. Reporting from Jiunn-Tzong & Lai (2010), high value of water hardness played a selective force, possibly through altering carbon and phosphate availabilities in water, in affecting the dominance of phytoplankton and also experiments evaluating enrichment with calcium confirmed that an elevation in calcium levels would enhance the proliferation of chlorophytes.

## CONCLUSIONS

This paper studies the factors determining phytoplankton community growth and their succession in Mediterranean reservoirs. The results show a total of 47 species belonging to six phyla in which Bacillariophyta represents the most diverse class covering 18 species reaching 38.29%, followed by 12 species of Chlorophyta (25.35%) and 09 species belonging to Euglenophyta (19.14%). The samples included as well species belonging to Cyanophyta, Dinophyta, and Chrysophyta. The succession of phytoplanktons all over the study were mostly co-dominated by Bacillariophyta and Chlorophyta; the most ascendant period for both groups were during winter season. Chlorophyta dominance is mostly due to the well adaptation of *Closterium acutum* var. *variabile and* diatoms dominance is interpreted by the low predation and high nutrient availability in winter. Phytoplankton abundance was particularly marked by two peaks recorded during summer; The first one in June (340.3 x $10^4$ cells. $L^{-1}$) and the second one in August (278,9 x $10^4$ cells. $L^{-1}$); the algae proliferation in summertime period was mostly due to warm weather with longer hours of sunshine. A relationship was identified between phytoplankton community and environmental factors using Redundancy analysis (RDA) revealing that water temperature, transparency, and nutrient concentration including nitrate, ammonium and Total hardness, were the most significant environmental factors influencing phytoplankton communities in this Mediterranean reservoir.

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