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DOMINANT PHYTOPLANKTON SPECIES OF THE EJIDOS DE XOCHIMILCO AND SAN GREGORIO ATLAPULCO NATURAL PROTECTED AREA, CDMX, MEXICO, CORRESPONDING SEPTEMBER 2018

María Guadalupe Figueroa Torres
Laboratory of Phycology and Phytopharmacology, Department of Man and His Environment
https://orcid.org/0000-0002-8431-8088

Nahum Elias Orocio Alcantara
Laboratory of Phycology and Phytopharmacology, Department of Man and His Environment

José Roberto Angeles Vázquez
Laboratory of Phycology and Phytopharmacology, Department of Man and His Environment

José Antonio Ocampo Cervantes
Project Manager of the Cuemanco Biological and Aquaculture Research Center (CIBAC), ``Universidad Autónoma Metropolitana`` Mexico city, Mexico

Abstract: In Mexico, knowledge of freshwater phytoplankton began in 1843 and its study has been growing gradually. Due to the contamination of water bodies, the proliferation of species has increased, so the objective of this work is to contribute to its knowledge. in the Ejidos de Xochimilco and San Gregorio Atlapulco Natural Protected Area, Mexico City. Integrated phytoplankton samples collected at eight sampling stations were obtained and fixed with Lugol at the final 1%. Subsamples of 0.1 mL were analyzed with the help of a Zeiss bright-field optical microscope. A total of 72 species and varieties belonging to five taxonomic groups were recorded: 21 to the Bacillariophyta Division, 28 to the Chlorophyta Division, 12 to the Euglenophyta Division, two correspond to the Cyanoprocaryota Division and one to the Phyrrophyta Division.

The dominant species were Hantzschia amphioxys, Lepocinclis acus, Ankistrodesmus falcatus, Aulacoseira granulata, Cocconeis placentula, Desmodesmus communis, Chlorella sp., Stephanocyclus meneghinianus, Leptolyngbya foveolarum, Chlorella vulgaris. No toxic events were observed.

Keywords: Fresh water, eutrophication, Phytoplankton, Mexico, massive developments

INTRODUCTION

The Xochimilco lake system is a very important ecosystem in Mexico City, which is why it has been cataloged by UNESCO as a Natural and Cultural Heritage of Humanity, an Important World Agricultural Heritage System (GIAHS) by FAO, a Ramsar Site or Wetland. of International Importance, Area Subject to Ecological Conservation and Natural Area Protected by the Federal Government. In 1908, hydraulic works began to exploit the aquifer and its springs, considerably affecting the area. Currently, the existence of this body of water is mainly due to the contribution of treated wastewater that comes from the Cerro de la Estrella and Cerro de la Estrella treatment plants. San Luis Tlalxialtemalco.

The contribution of treated water, agrochemicals from agricultural activities and clandestine raw water dumps represent a serious problem for the system, causing an excess of nutrients such as nitrites, nitrates, ammonium, phosphates and heavy metals such as cadmium, copper, manganese and lead, as well as chemicals such as pesticides and fertilizers that affect the distribution and abundance of aquatic species.

In some cases, this excess of nutrients favors the abundance of phytoplankton species, among which are harmful or toxic species such as the cyanoprokaryotes Microcystis aeruginosa and Planktothrix agardhii, which cause multiple alterations in epicontinental aquatic systems (Viner. 1989; Watanabe et al., 1992) and that have been reported in the channels of the lake system (Aquino-Cruz et al., 2017).

Due to this problem, it is considered necessary to carry out periodic sampling like this one, to know the species and, where appropriate, prevent possible negative effects caused by some of them.

MATERIALS AND METHODS

The study area corresponds to the polygon of the Ejidos de Xochimilco and San Gregorio Atlapulco Natural Protected Area (ANP-EXSGA), which includes an area of 2,522 hectares and is located at the geographical coordinates 19° 15' 11" and 19° 19 15 " North latitude and 99° 00' 58" and 99° 07' 08" West longitude. Where eight sampling stations were established in four areas of special interest: Agricultural and Seasonal Chinampería Zone, Protection Zone, Restoration Zone and Public Use Zone (Figure 1).

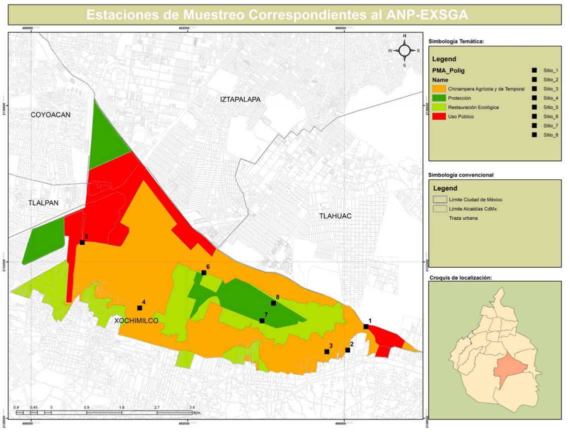

Figure 1: ANP-EXSGA polygon and sampling stations.

Number of stations	Name
Station 1	Rincón de la Laguna Place
Station 2	San Luis Tlaxialtemalco Treatment Plant Landfill
Station 3	Embarcadero de Cuacontle
Station 4	El Sabino
Station 5	Channel: Cuemanco Norte
Station 6	Japan Channel
Station 7	Southeast Shore of ``Lago de San Gregorio``
Station 8	Northeastern shore of ``Lago de San Gregorio``

Table 1: Sampling stations

For the study of phytoplankton, integrated water samples were collected on September 24, 25 and 27, 2018, at eight sampling stations, which were preserved with 1% final lugol and transferred to the Phycology laboratory of the Autonomous University. Metropolitana for analysis in an Olympus CH30 optical microscope. The composition, distribution and abundance of the species was evaluated, with emphasis on the most abundant and toxic or harmful species. Quantification was carried out by taking 0.1 mL aliquots of each sample and analyzed following the scanning technique proposed by Schwöerbel (1975).

The taxonomic identification of the species was based on their different morphological characteristics, with the support of keys and taxonomic descriptions from specialized literature (Tiffany and Britton, 1952; Pérez and Salas, 1958; Bourrelly. 1968 and 1970, Tavera et al., 2000 ; Komárek and Komárková-Legnerová, 2002; Figueroa et al., 2016; The updating of the names was carried out following the recommendations of the AlgaeBase website (Guiry and Guiry, 2024).

RESULTS

A total of 72 phytoplankton species were recorded (Table 2, Figure 2), belonging to five taxonomic groups: 21 to the Bacillariophyta Division, 28 to the Chlorophyta Division, 12 to the Euglenophyta Division, two correspond to the Cyanoprocaryota Division and one to the Phyrrophyta Division. Stations 4 (El Sabino) and 6 (Japan Channel) presented the highest species richness with 26 and 25 species respectively, while site 7 was the one with the lowest number (three species).

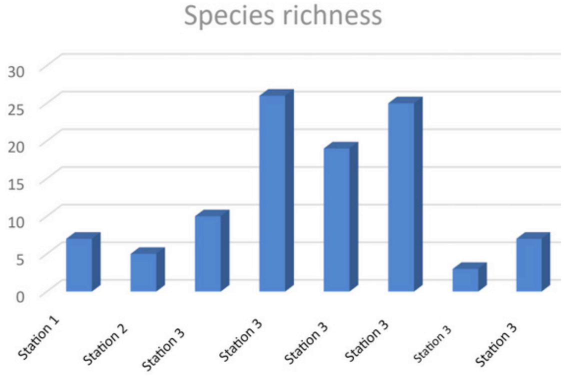

Figure 2: Species richness by sampling stations

The abundance of phytoplankton is presented in table 3 and figure 3. The sites with the highest abundance correspond to site 4 (``*El Sabino*``) with 1,540 x 10^3 cells/L and site 6 (Japan Channel) with 1,226,667 x 10^3 cells/L; while the station with the lowest cell density was site 7 (``*Laguna de San Gregorio*``) with 33.33 x 10^3 cells/L.

Species	Stations							
	1	2	3	4	5	6	7	8
Achnantidium minutissimum (Kützing) Czarnecki	-	-	-	-	x	-	-	-
Ankistrodesmus falcatus (Corda) Ralfs	-	-	-	x	x	x	-	x
Ankistrodesmus septatus Chodat & Oettli	-	-	-	-	-	x	-	-
Aulacoseira granulata (Ehrenberg) Simonsen	-	-	-	x	x	x	-	-
Chlorella sp	-	-	-	-	-	-	-	x
Chlorella vulgaris Beijerinck	-	-	-	x	x	x	-	-
Cocconeis placentula var. *placentula* Ehrenberg	-	-	x	x	-	-	-	-
Coelastrum astroideum De Notaris	x	-	-	-	-	x	-	-
Comasiella arcuata (Lemmermann) E.Hegewald, M.Wolf, Al.Keller, Friedl & Krienitz = *Scenedesmus* cf. *arcuatus*	-	-	-	x	-	x	-	x
Cymbella cf. *mexicana*	-	-	-	x	-	-	-	-
Cymbella lanceolata C.Agardh	-	-	-	-	x	-	-	-
Cymbella sp	-	-	-	x	-	-	-	-
Desmodesmus abundans (Kirchner) E.H.Hegewald= -*Scenedesmus quadrispina*	x	-	-	-	-	-	-	-
Desmodesmus cf. *opoliensis* (P.G.Richter) E.Hegewald	-	-	-	x	-	-	-	-
Desmodesmus communis (E. Hegewald) E. Hegewald = *Scenedesmus quadricauda*	x	-	-	x	x	x	-	-
Encyonema minutum (Hilse) D.G.Mann =-*Cymbella* cf. *minuta*-	-	-	-	-	x	-	-	-
Epithemia adnata (Kützing) Brébisson= -*Epithema zebra*-	-	-	-	x	-	-	-	-
Epithemia turgida (Ehrenberg) Kützing	-	x	-	-	-	-	-	-
Euglena cf. *exilis* Gojdics	-	-	-	-	-	x	-	-
Euglena deses (O.F.Müller) Ehrenberg	-	-	-	x	-	x	-	-
Euglena sp2	-	-	-	-	x	-	-	-
Euglena sp3	-	-	-	-	-	x	-	-
Fragilaria virescens Ralfs	-	x	-	-	-	-	-	-
Golenkinia radiata Chodat	-	-	-	-	-	x	-	-
Golenkinia sp	-	-	-	-	-	-	-	x
Gomphonema cf. *grunowii* R.M.Patrick & Reimer	-	-	-	-	x	-	-	-
Gomphonema lagenula Kützing	-	-	-	-	x	-	-	-
Hantzschia amphioxys (Ehrenberg) Grunow	-	-	-	-	x	-	-	-
Lepocinclis acus (O.F.Müller) B.Marin & Melkonian= -*Euglena* acus	-	-	x	x	-	x	-	-
Lepocinclis ovum (Ehrenberg) Lemmermann	-	-	-	x	x	x	-	-
Lepocinclis sp	-	-	-	x	-	x	-	-
Leptolyngbya foveolarum (Gomont) Anagnostidis & Komárek = Phormidium foveolarum	-	-	x	-	-	-	-	-
Melosira sp	-	-	-	-	x	-	-	-
Monactinus sturmii (Reinsch) M.Jena & C.Bock	-	-	x	-	-	-	-	-
Morfoespecie 1	-	x	-	-	-	-	-	-
Morfoespecie 2	-	-	x	-	-	-	-	-
Morfoespecie 3	-	-	x	-	-	-	-	-
Morfoespecie 4	-	-	x	-	-	-	-	-
Morfoespecie 5	-	-	-	x	-	-	-	-
Morfoespecie 6	-	-	-	-	x	x	-	-
Morfoespecie 7	-	-	-	-	-	-	x	-

Morfoespecie 8	-	-	-	-	-	-	-	x
Naiadinium polonicum (Wołoszyńska) Carty = *Peridiniopsis polonicum*	-	-	-	x	-	-	-	-
Navicula cryptocephala Kützing	-	-	-	-	x	-	-	-
Navicula sp1	-	-	x	-	-	-	-	-
Navicula sp2	-	-	x	-	-	-	-	-
Nitzschia constricta f. *parva Grunow*	-	-	-	-	x	-	-	-
Oscilatoria limosa C.Agardh ex Gomont C.Agardh ex Gomont	-	x	x	x	-	-	-	-
Pectinodesmus javanensis (Chodat) E.Hegewald, C.Bock & Krienitz =- *Scenedesmus javanensis*	-	-	-	x	-	-	-	-
Pediastrum duplex Meyen	-	-	-	x	-	x	-	-
Pediastrum duplex var. *reticulatum* Lagerheim	-	-	-	x	-	-	-	-
Peranema sp1	-	-	-	-	-	-	x	-
Phacus cf. *pleuronectes* (O.F.Müller) Nitzsch ex Dujardin	-	-	-	x	-	x	-	-
Phacus curvicauda Svirenko	-	-	-	-	-	x	-	-
Phacus longicauda (Ehrenberg) Dujardin	x	-	-	x	-	-	-	-
Phacus tortus (Lemmermann) Skvortsov	-	-	-	-	-	x	-	-
Pinnularia cf. *viridis* (Nitzsch) Ehrenberg	-	x	-	-	-	-	-	-
Pseudostaurosira brevistriata (Grunow) D.M.Williams & Round-=-*Fragilaria bevistriata*	x	-	-	-	-	-	-	-
Radiosphaera cf. *negevensis* Ocampo-Paus & Friedmann	x	-	-	-	-	-	-	x
Scenedesmus maximus (West & G.S.West) Chodat = Scenedesmus quadricauda var. *westii*	-	-	-	x	x	-	-	-
Scenedesmus sp	-	-	-	x	-	-	-	-
Schroederia setigera (Schröder) Lemmermann	-	-	-	-	-	x	-	-
Sellaphora sp	-	-	-	x	-	-	-	-
Staurastrum sp	-	-	-	-	-	x	-	-
Stephanocyclus meneghinianus (Kützing) Kulikovskiy, Genkal & Kociolek= Cyclotella meneghiniana	x	-	-	x	x	x	x	x
Surirella sp	-	-	-	-	-	x	-	-
Tetradesmus obliquus (Turpin) M.J.Wynne = -*Scenedesmus obliquos*-	-	-	-	-	-	x	-	-
Tetrastrum glabrum (Y.V.Roll) Ahlstrom & Tiffany	-	-	-	-	-	x	-	-
Ulnaria ulna (Nitzsch) Compère =-*Synedra* sp-	-	-	-	-	x	-	-	-

Table 1. Presence of phytoplankton species in the sampling stations of the Ejidos de Xochimilco and San Gregorio Atlapulco Natural Protected Area. The x represents the presence of the species at the sampling stations; while the hyphen represents its absence and the = sign refers to synonyms.

Station	Cells / Liter
Station 1	60×10^3
Station 2	46.667×10^3
Station 3	436.667×10^3
Station 4	1540×10^3
Station 5	226.667×10^3
Station 6	1226.667×10^3
Station 7	33.333×10^3
Station 8	240×10^3

Table 2: Phytoplankton abundance in the different sampling stations of the Ejidos de Xochimilco and San Gregorio Atlapulco Natural Protected Area.

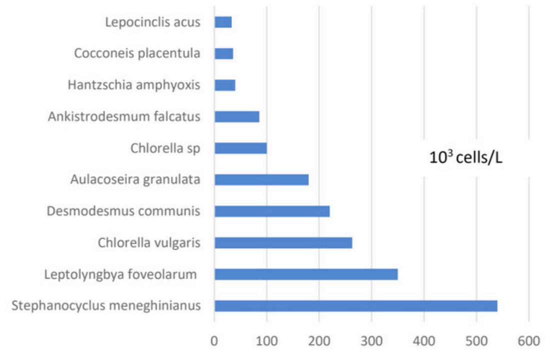

Figure 4: Most abundant species in the Ejidos de Xochimilco and San Gregorio Atlapulco Natural Protected Area

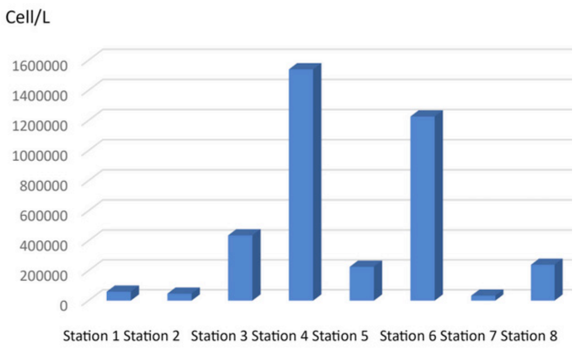

Figure 3: Phytoplankton abundance by sampling station.

Figures 4 and 5 and Plate 1 show the 10 most frequent and abundant phytoplankton species. *Stephanocyclus meneghinianus* reached densities of 540 X 10^3 cells/L and was present in five stations (1, 4, 5, 6, 7 y 8), *Leptolyngbya foveolarum* presented a density of 350 X 103 cells/L, however it was only observed in one station (Station 3), in contrast to Desmodesmus communis whose peak abundances were less than 6 to 220 X 10^3 cél/L, but it was presented in a greater number of stations (1,4, 5 and 6).

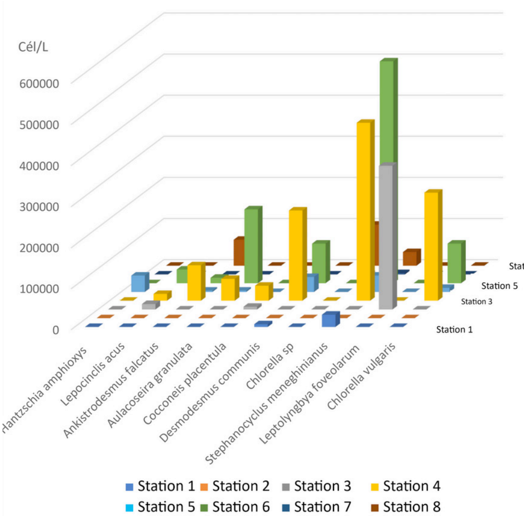

Figure 5: Spatial behavior of the 10 most abundant species of the ANP-EXSGA -

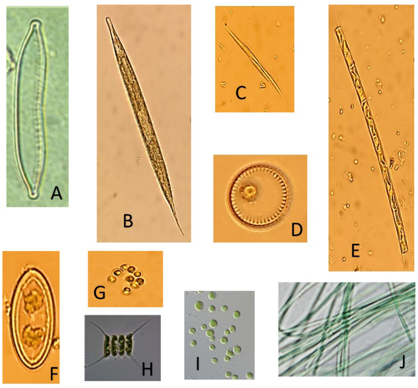

Plate 1. *A) Hantzschia amphioxys, B) Lepocinclis acus, C) Ankistrodesmus falcatus D) Stephanocyclus meneghinianus,,E) Aulacoseira granulata, F) Cocconeis placentula, G) Chlorella sp., H) Desmodesmus communis, I) Chlorella vulgaris and J) Leptolyngbya foveolarum,*

DISCUSSION AND CONCLUSIONS

The composition and distribution of phytoplankton organisms for the sampled period was characterized by the presence and abundance of species from the Bacillariophyta and Chlorophyta Divisions, which indicates a good state of health of the ecosystem. This may be due to the fact that the phytoplankton itself purifies water, considering that this environment functions as a wetland or stabilization lagoon and that zooplankton populations could have prevented a greater increase in algal populations, as they are planktophagous, in addition to the fact that the water is used for irrigation, removing a large part of chemical compounds such as nutrients and heavy metals (López et al., 2002; Cañizares et al., 2013; Ávila, 2015), other associated factors that can be considered are the time of year with lower temperatures and at the Cerro de la Estrella and San Luis Tlaxialtemalco treatment plants, workers could have cleaned the water efficiently.

It is striking that on this occasion the ANP-EXSGA did not present massive developments of harmful and toxic Cyanoprocaryotas such as Microcystis aruginosa, Planktothrix agardhii and Anabaenopsis circularis (previously reported by Tavera et al., 2000; Alva-Martínez et al. 2004, 2007a, 2007b, 2009; Figueroa et al., 2015 and Aquino-cruz et al., 2017) since the ANP-EXSGA is characterized by being frequently eutrophicated with high concentrations of nitrogen and phosphorus (Bojórquez Castro, 2017; Pronatura México A.C. 2021.), which promote its growth. The absence of individuals of Limnospira maxima also stands out in stations 7 and 8 where it is usually frequent and abundant (Figueroa et al., 2015) and which has been recently observed in the years 2023 and 2024 by the authors of this work.

It can be concluded that the composition and distribution of phytoplankton organisms for the ANP-EXSGA is diverse and heterogeneous in the different sampling stations since the ecosystem presents great variations given by anthropic, microenvironmental and climatic factors that are reflected in the diversity of species and their abundances in the study area.

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