Phytoplankton composition of the urban man-made lakes of Yamoussoukro (Côte d'Ivoire)

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ABSTRACT

Objective: Spatial and seasonal variations of phytoplankton composition in the urban man-made lake of Yamoussoukro city has been analysed to identify the most representative species of these polluted urban lake.
Methodology and results: The composition of phytoplankton assemblage in urban man-made lakes of Yamoussoukro City were investigated from December 2015 to October 2017 on a bi-monthly basis, at 28 stations on 8 lakes. One hundred and Ninety six (196) phytoplankton taxa were identified representatives of 63 genera, 33 families, 17 orders, 8 classes and 5 phyla. Most of these genera belong to Chlorophyta (34.8 %) followed by Euglenophyta (30.39 %) next Cyanobacteria (19.11 %), Bacillariophyta (14.16%) and Dinophyta (0.9 %). The Genera *Trachelomonas* (23 taxa), *Scenedesmus* (20 taxa), *Phacus* (16 taxa), *Lepocinclis* (9 taxa) were found to be dominant (>10%) in phytoplankton taxonomic richness. The greatest species richness was found in the lake 5 (99 taxa) and the smallest was recorded in the lake 7 (9 taxa).
Conclusion and application of results: This study revealed a first inventory of phytoplankton taxa of the Yamoussoukro's urban man-made lakes and proposes a pattern of the spatio-temporal variability of the phytoplankton community. The lakes were rich in the number of taxa (196), because the waters of the lake are stagnant. Chlorophyta and Euglenophyta dominated the phytoplankton communities. The highest number of taxa (99) was recorded in the lake 5, while the lowest number of taxa (10) was found in the lake 7. The best represented genus are by order of importance, Trachelomonas (23 taxa) scenedesmus (20 taxa), Phacus (16 taxa) and Lepocinclis (9 taxa). The results of the study of phytoplankton in Yamoussoukro urban lakes could serve as references to evaluate the ecological health of water bodies.
Key words: phytoplankton, urban man-made lake, taxonomic richness, Yamoussoukro.

INTRODUCTION

Eutrophication still represents a major problem worldwide (Ansari *et al.* 2011). Reservoirs are often inherently unable to supply safe and clean drinking water (Naselli-Flores, 2011, 2014), and expensive treatments are required to ensure adequate water supply for domestic uses. One of the consequences of eutrophication is the proliferation of planktonic cyanobacteria, which

impair water quality because of their actual or potential toxicity (Paerl *et al.* 2011). The onset of eutrophication causes an increase in phytoplankton biomass, but the composition of the phytoplankton community becomes uniform. Some species disappear, while at the same time, opportunistic species of phytoplankton begin to dominate (McQuatters- Gollop *et al.* 2009). At this point, species diversity is decreases because of the competitive exclusion between species, whereas with a slight increase in eutrophication, competition is relaxed, thus resulting in increased diversity. With a further increase in eutrophication, diversity reduces again and this time, because of the decrease in species due to stress (Spatharis *et al.* 2007). Eutrophication tends to favour small and fast-growing organisms, which implies that the proportion of the dominant taxa to the total biomass is relatively low, in others words, species the diversity higher than when large-sized taxa dominate (Uusitalo *et al.* 2013). In Côte d'Ivoire,

the majority of small surface reservoirs are presently considered to be threatened. Urban lakes of Yamoussoukro are not left out. Originally, these lakes had been created to serve drainage sites and added aesthetic value for the city. The misuse (practice of agriculture on the banks and discharge of solid and liquid waste), however, of these lakes has led to their eutrophication. Many studies have been conducted on these urban man-made lake of Yamoussoukro, relating to sediments fluxes (Kouakou *et al.* 2014), birds (Konan *et al.* 2015; Konan *et al.* 2014), eutrophication (Parinet *et al.* 2010), and anthropogenic pollution (N'guessan, 2011). There is much study, however, on the aquatic community in general and in particular the algae of these waters. Therefore, this paper study intends to investigate spatial and seasonal variations of phytoplankton composition in the urban man-made lake of Yamoussoukro city to bridge the existing knowledge gap.

MATERIALS AND METHODS

Study area and sampling stations: Yamoussoukro (the political capital of Côte d'Ivoire is located geographically between 6°40' and 7°00'N, and 5°10' and 5°20'W (Fig 1). The capital has a total 31 lakes, ten of which are man-made lakes. These lakes communicate with each other by gravity and form a complex system covering approximately 140 ha with a catchment area close to 28.5 km^2. This study was carried out on seven (7) of the man-made lakes (lake 1, lake 5, lake 6, lake 7, lake 8, lake 9 and lake 10) and one natural lake (lake 0). These urban man-made lakes receive wastewater and solid waste from various human activities (domestic wastewater and solid waste,

urban agriculture, schools, hospitals, hotels, restaurants, military camps, car washing services, car garages, gas stations, cattle rearing activities,…) which make them eutrophic. Originally designed to beautify the city, 70% of the man-made lakes of are currently invaded by macrophytes **(N'guessaan *et al.* 2011).** The samples were collected from twenty-eight (28) stations chosen approximately 3 m from the water's edge. The number of sites per lakes depends of its surface area. Therefore, seven sampling sites were defined on Lake 5, four on lakes 0 and 1, three on lakes 6, 8 and 9 and two on lakes 7 and 10 (Fig. 1).
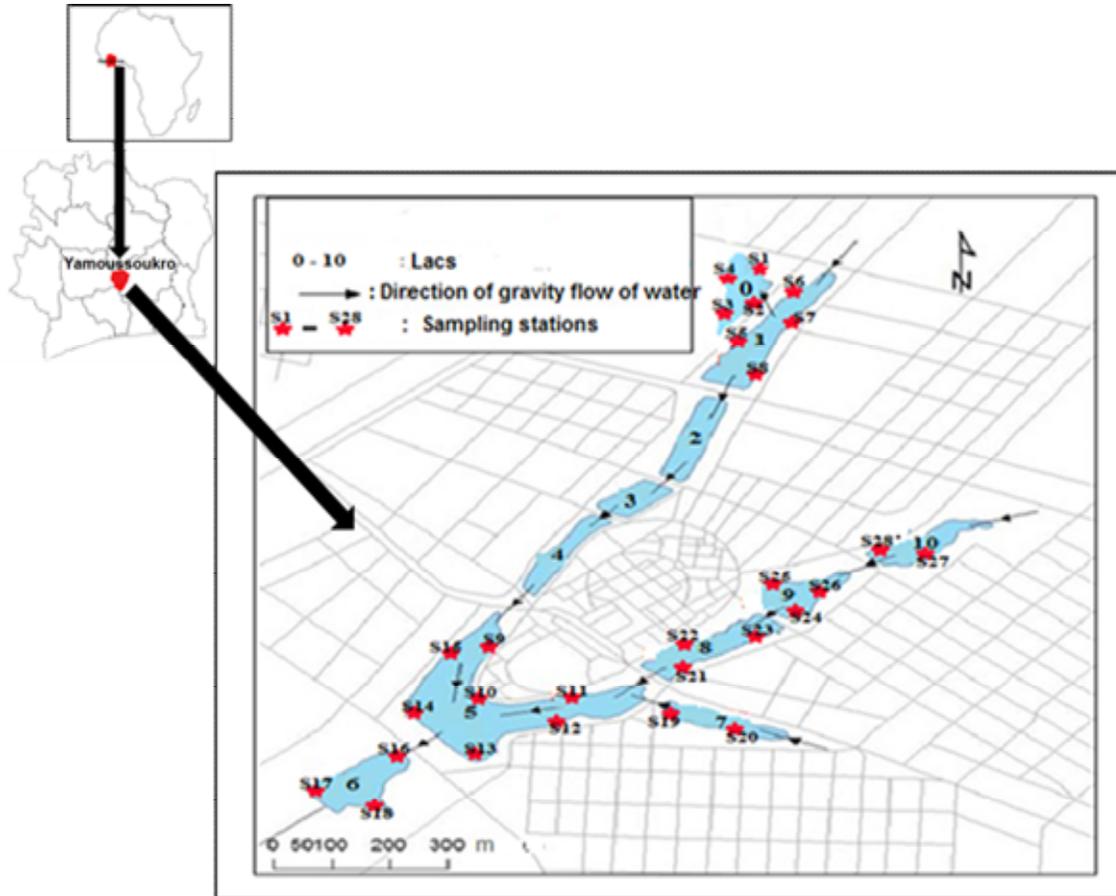
Figure 1: The map of Yamoussoukro City showing the study lakes and sampling stations

Sampling and identification of phytoplankton: Samples were collected from December 2015 to November 2017 at 28 stations in the 7 urban man-made lakes and one natural lake. Sampling was bi-monthly and samples collected from each lake's stations were mixed into a single sample. The samples are grouped into the four climatic seasons. December to February for the long dry season (LDS), March to July for the long rainy season (LRS), August to September for the short dry season (SDS) and October to November for the short rainy season (SRS). For each sample, a multiparameter HQ40d was used to measure water temperature, conductivity, dissolved oxygen and pH. For nutrients (nitrates, nitrites ammonium salt and orthophosphates), samples of 500 ml were collected and refrigerated for later analysis at laboratory following the spectrometric method (AFNOR, 2005). The turbidity of the water was measured by a Secchi disk. Samples for phytoplankton composition determination, were collected from surface water using a plankton net (20 μm mesh, 0.64 m radius coupled with a collector) and fixed with 5% formaldehyde. For

species identification, phytoplankton samples were examined in the laboratory using a Carl Zeiss microscope equipped with a calibrated micrometer. The algal classification scheme proposed by van den Hoek *et al.* (1995) was adopted. Identification of the phytoplankton taxa was made with reference to works to Desikachary (1959) and Komárek and Anagnostidis (2005) (Cyanobacteria), Huber-Pestalozzi (1955) (Euglenophyta), Komárek and Frott (1983) (Chlorophyta), Krammer and Lange-Bertalot (1988, 1991), Tomas (1995) (Bacillariophyta) and Von Stosch (1969) Dinophyta.

Data analyses: Differences of physico-chemical parameters among sampling seasons and lake were tested using ANOVA (significance level 0.05). For this analysis the Turkey test was used for the two by two comparison in case the variables show a difference ($p < 0.05$) between the groups (lakes, seasons). However, means and standard deviation of all measurements were recorded for each parameter. The coefficient of variation (CV %) was computed according to **Zar (1999) :**

$$CV(\%) = \frac{\sigma}{\mu} \times 100$$

Where σ the standard deviation and μ is the mean of the measurements of each parameter.

According to the value of CV, three categories of variations are highlighted:

- If CV is inferior to 2%, there is very little variation in the parameter
- If CV is between 2 and 25%, the parameter variation is low
- If CV is superior to 25%, the parameter varies greatly. The similarity between two communities (habitats) was estimated by Jaccard's similarity index. According to **Schaeffer** *et al* **(2005),** this index varies from 0 (no similarity) to 1 (identical environments). The formula is the following

$$c_j = \frac{j}{a + b - j}$$

c_j: similarity index of Jaccard

a: the number of taxa specific to lake 0

b: the number of taxa specific to Lake 1

j: the number of species common to both lakes

Grouping of phytoplankton species in terms of frequency coefficient was used following frequency groups to show the presence frequency of species in the community during the year. Three frequency groups were noted according to value of F (**Dajoz, 2000**)

$F > 50\ \%$: continuous species; $25\ \% < F < 50\ \%$: common species; $F < 25\ \%$: rare species in the community. Frequency was calculated with the following equality:

$$F = \frac{Fi}{Ft} \times 100$$

F_i: presence number of i species in total sampling; F_t=: total number of sampling of whole Species.

Then, hierarchical cluster analysis (HCA) was carried out from the values of Jaccard similarity index calculated between the lakes. The analyses were performed using Past 3.0.

RESULTS

Physico-chemical variables of the lakes: The measured physico-chemical variables at all eight sampling lakes are presented in Table 1. The mean values (0.21mg/l), of the orthophosphate, dissolved oxygen (8.27 mg/l), pH (8.62) and ammonium (0.98mg/l) were slightly higher at the lake 8, than the others lakes. In addition, turbidity presented the highest values at lake 10 (30.09cm) and the highest value of temperature was recorded at the lake 9 (30.55°C). Finally, the mean values of conductivity (965µS/cm), nitrates (22.10 mg/l) and nitrite (0.08mg/l) were high at the lake 7. Dissolved oxygen, turbidity, orthophosphate, nitrate and ammonium showed high coefficient of variation values (CV > 25%). Concerning nitrite, only Lake 8 not presented high variability. The parameters as temperature, conductivity and pH in the eight sampling sites were similar (CV < 25%), .Turbidity displayed a high variability (CV > 25%) at the lakes 1 and 10. There was significant differences in the physico- chemical parameters such as temperature, dissolved oxygen, nitrites and orthophosphate between the eight lakes (turkey test; p < 0.05).

Table 1: Mean and coefficient of variation (CV) of the physico-chemical variables in Yamoussoukro's urban man-made lakes (L0 – L10).

variables	L0 Mean	CV (%)	L1 Mean	CV (%)	L5 Mean	CV (%)	L6 Mean	CV (%)	L7 Mean	CV (%)	L8 Mean	CV (%)	L9 Mean	CV (%)	L10 Mean	CV (%)
T (°c)	27.87a	3.50	27.67a	5.65	28.82a	4.06	27.21a	5.37	28.02a	9.63	30.17a	7.95	30.55a	2.83	28.15a	2.96
Conductivity (µS/cm)	344.29 ac	15.92	383.82 ab	6.70	441.52 b	5.08	435.87a b	7.71	965.22 c	3.70	412.17 b	7.26	369.87 ab	21.99	293.87 ab	12.92
pH	6.74a	2.77	6.75ab	12.22	7.41ab c	7.92	7.56bc	5.78	8.14c	6.56	8.62c	8.74c	8.34c	6.67	8.30d	5.57
dissolved oxygen (mg/L)	2.05a	52.00	1.82a	60.08	5.65a	29.35	1.10a	70.02	4.35a	97.50	8.27a	52.14	5.67a	49.70	3.87a	111.32
Turbidity(cm)	25.12a	20.06	20.65a	30.39	25.5a	14.09	25.65a	24.28	16.43b	10.70	22.20a	12.18	27.2a	11.84	30.09a	27.51
Orthophosphate(mg/L)	0.07a	86.85	0.05a	44.65	0.11a	64.39	0.12a	33.62	0.07a	30.58	0.21a	83.59	0.06a	95.92	0.07a	99.65
Nitrate(mg/L)	4.60a	19.84	4.37a	15.76	9.10ab	45.13	12.95ab	56.50	22.10a b	69.31	11.95a b	47.79	5.97ab	15.05	6.40b	9.37
Nitrite(mg/L)	0.02a	54.79	0.05a	160.07	0.03a	31.79	0.019a	124.47	0.08a	88.48	0.018a	19.16	0.01a	40	0.01a	61.44
Ammonium(mg/L)	0.19a	118.48	0.10a	34.14	0.15ab	93.80	0.88ab	162.32	0.60a	136.33	0.98ab	177.73	0.11a	43.60	0.07	79.10

The letters indicate the significant difference between variables (Tukey test, $p < 0.05$). There is no significant difference between the mean with suffix a on the same row (Tukey test, $p > 0.05$)

Table 2. Mean of physico-chemical variables and their coefficient of variation (CV) in Yamoussoukro's urban man-made lakes at different periods.

variables	LDS Mean	CV (%)	SDS Mean	CV (%)	LRS Mean	CV (%)	SRS Mean	CV (%)
T (°C)	27.36a	7.34	28.17a	6.44	28.93a	3.62	29.76a	5.76
Conductivity(µS/cm)	444.89a	45.52	490.26a	44.35	454.38a	48.19	433.78a	50.15
pH	7.57a	7.06	7.42a	14.11	7.67a	9.01	8.27a	11.57
dissolved oxygen (mg/L)	3.88a	76.83	3.35a	106.33	5.27a	65.69	3.88a	105.69
Turbidity(cm)	19.30a	17.14	25.03b	24.48	24.59b	18.80	27.5b	25.48
Orthophosphate (mg/L)	0.08a	50.18	0.05a	70.13	0.05a	46.78	0.19b	67.04
Nitrate(mg/L)	12.92a	71.47	12.73a	94.59	6.7a	34.72	6.36a	40.53
Nitrite(mg/L)	0.01ab	56.77	0.06b	104.20	0.01a	47.70	0.035b	132.56
Ammonium(mg/L)	0.22a	72.69	0.08a	55.57	0.09a	92.70	1.15a	126.66

CV: coefficient of variation. The letters indicate the significant difference between variables (Tukey test, $p < 0.05$). There is no significant difference between the mean with suffix-a on the same row (Tukey test, $p > 0.05$); LRS: long rainy season; SDS: short dry season; SRS: short rainy season; LDS: long dry season.

In this study, there were significant differences in turbidity between the long dry season and the others seasons (p < 0.05). Orthophosphate showed significant seasonal variation between short rainy season and the others seasons (p < 0.05). For nitrites, significant variation was observed between all seasons (p < 0.05), except between the long rainy season and the long dry season and between the short rainy season and the short dry season. Variables such as temperature, conductivity, pH, dissolved oxygen, ammonium and nitrate do not vary significantly between seasons (turkey test; p > 0.05) (Table 2). Temperature, pH, ammonium, orthophosphate and turbidity recorded the highest values during short rainy season, conductivity and nitrite showing increased during short dry season. However, nitrate was high in the long dry season and dissolved oxygen presented high values in the long rainy season. The lower concentrations of salts ammonium, pH and dissolved oxygen were observed during the short dry season. Orthophosphates was low during the short rainy season. The Conductivity, temperature, nitrite and turbidity were low during long dry season and nitrates were low during long rainy season. Conductivity, nitrites, salts ammonium, nitrites, orthophosphates dissolved oxygen displayed a high variability (CV > 25%) between all the seasons. Turbidity showed a high variability during the short rainy season (CV > 25%).

Phytoplankton community: The analysis of phytoplankton composition at the investigated urban man-made lake of Yamoussoukro provided 196 phytoplankton taxa representative of 63 genera, 33 families, 17 orders, 8 classes and 5 phyla. Most of these species belong to Chlorophyta (34.8 %) followed Euglenophyta by (30.39 %) next Cyanobacteria (19.11 %), Bacillariophyta (14.16%) and Dinophyta (0.9 %) (Fig.2). In terms of number of species, Chlorophyta and Euglenophyta are the most diverse. They are followed by Cyanobacteria and Bacillariophyta. Among Chlorophyta, the order of Chlorococcales (65 taxa) is the most diverse. At the level of this order the best represented genus are in decreasing order, *Scenedesmus* (20 taxa), *Monoraphidium* and *Pediastrum* (6 taxa) and *Tetraedron* (5 taxa). The Euglenophyta consists solely of the order of the Euglenales. This order is mainly represented by taxa of the genera *Trachelomonas* (23 taxa), *Phacus* (16 taxa), *Lepocinclis* (9 taxa) and *Euglena* (8 taxa). Of the 40 taxons of Cyanobacteria recorded, 23 taxa belong to the order of Hormogonal and 15 taxa to the order of Chroococcal. The best-represented genera are *Oscillatoria* (7 taxa) then *Merismopedia* and *Pseudanabaena* (5 taxa each). The number of Baccillariophyta species is low compared to the first three groups. In this branch, the genera *Pinnularia* (7 taxa) and *Gomphonema* (3 taxa) contain the largest number of taxa. The branch of Dinophyta is represented only by the genus *Peridinium*. The highest number of taxa (99) was recorded in the lake 5, while the lowest number of taxa (10) was found in the lake 7. 26 taxa were recorded in lake 10, 39 taxa in lake 0, 46 taxa in lake 0 and 9, 55 taxa in lake 6 and 62 taxa in lake 8. The similarity expressed by the Jaccard index indicates that the phytoplankton composition of lakes 5,6,8,9 and 10 have a certain affinity between them (Cj: 0.3-0.45), lakes 0 and 1 have a floristic affinity (Cj: 0.3) and lake 7 has no affinity with another lake. The distribution of the lakes makes by the ascending hierarchical classification made from the values of Jaccard similarity index calculated between the different lakes, it possible to specify more or less the similarities or the differences in their algal composition. The dendogramm delimits the lakes in three groups (Fig.3). Group I pooled together lakes 0 and 1, they are moderately rich in taxa and Euglenophyta dominates the algal composition. The second group includes the lake 7 a low number of taxa characterizes this lake. Group III consists of lakes 5,6,8,9 and 10 located in the center of city whose phytoplankton composition are relatively rich in Chlorophyta.
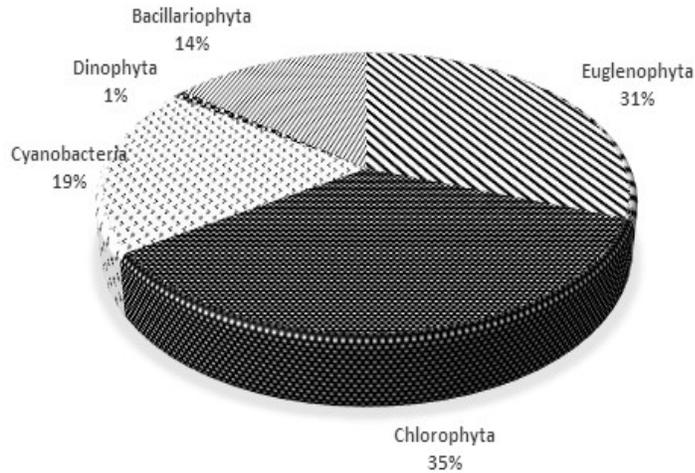
Figure 2: Relative taxonomic richness of phytoplankton in the urban man-made lakes of Yamoussoukro
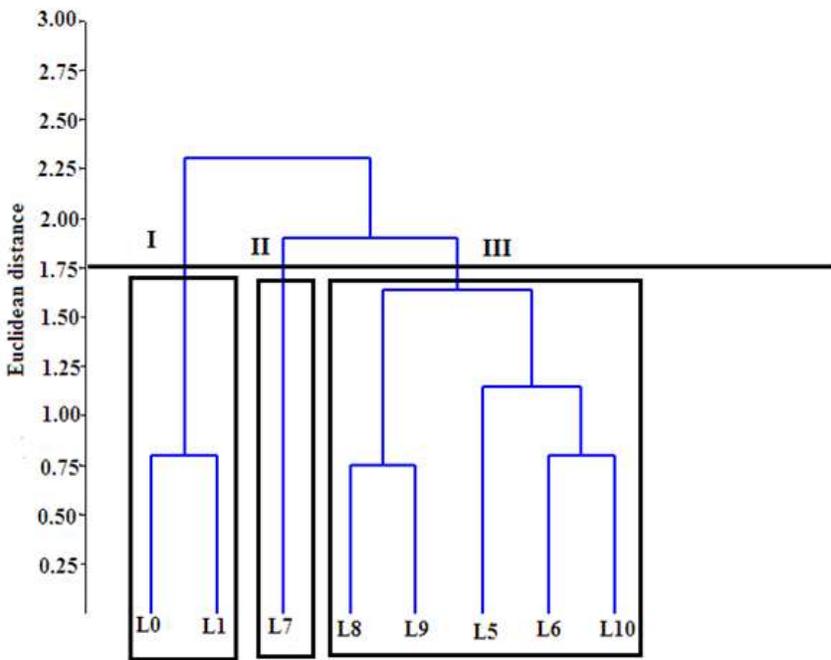
Figure 3: Dendogram showing the taxonomic similarities between lakes: L0- L10: codes of lakes, I, II and III: constituted groups

The distribution of species, constantly present in the different groups formed by HCA is summarized in table 3. Group I comprises 18 of these taxa, with 10 Euglenophyta, 3 Chlorophyta and 3 Bacillariophyta and 2 taxa belong to Cyanobacteria. Concerning group II, we have 5 taxa, constantly present: two Bacillariophyta and Euglenophyta and one Cyanobacteria. The group III is best structured with 29 taxa constantly present: these are 8 Chlorophyta, 7 Euglenophyta, 7 Bacillariophyta and 7 Cyanobacteria. 2 taxa were common in the three groups (*Trachelomonas volvocina and Lepocinclis fusiformis)*. The groups II and I have 2 constant taxa, the groups III and I have 9 taxa common and the groups II and III have 5 taxa common.

Spatio-temporal patterns of phytoplankton in the lakes: The temporal variation of the different phytoplankton groups indicates a clear predominance of Chlorophyta and Euglenophyta (Fig.4) followed by Cyanobacteria, Bacillariophyta and Dinophyta that represent only between 0 and 19% of the total

taxonomic richness. The Cyanobacteria, Bacillariophyta and Dinophyta constitute unessential taxa in all sampling stations and seasons. Their numbers are between 1 and 11 taxa for Bacillariophyta, between 0 and 2 taxa for Dinophyta and between 0 and 7 for Cyanobacteria, with the exception of Lake 5, where Cyanobacteria are permanent at all seasons. In contrast, Chlorophyta and Euglenophyta were permanently present in the all lakes and at all sampling seasons. However, Chlorophyta is poorly represented at lakes 1 and 7 and Euglenophyta at lakes 7, 9 and 10 at all sampling seasons.
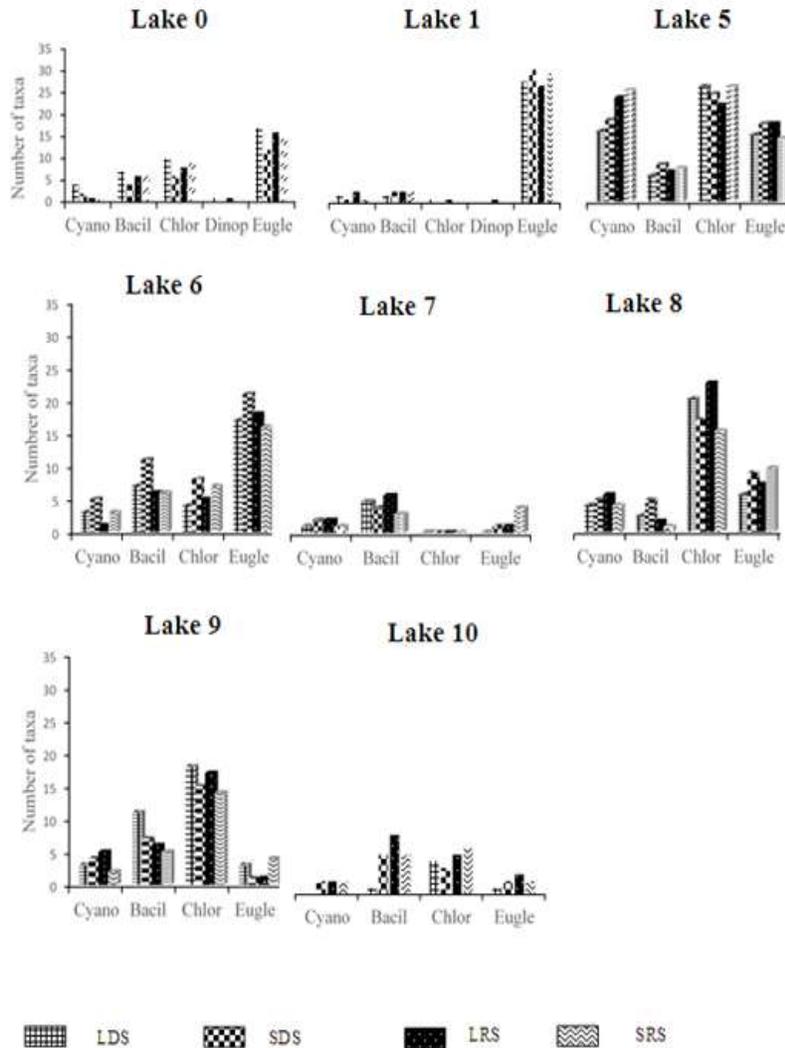
Figure 4: Spatio-seasonal in the taxonomic richness of the phytoplankton communities of the urban Yamoussoukro lakes. LDS=Long Dry Season. SDS=short Dry season. LRS=Long Rainy season. SRS= Short Rainy season, Cyano= Cyanobacteria, Bacil= Bacillariophyta, Chlor= Chlorophyta, Eugl= Euglenophyta, Dinop=Dinophyta

Table 3: list of species to different groups formed by HCA in Yamoussoukro urban lakes

	I	II	III
CYANOBACTERIA	F	F	F
Chroococcus minutus (Kützing) Náge.			***
Aphanocapsa elachista G.S. W.			***
Merismopedia elegans Ehrenb.			***
Merismopedia glauca Neg.			***
Merismopedia punctata Mey.			***
*Oscillatoria limosa (*Dillwyn) Agar.	***		***
Oscillatoria lutae Agar.	***		
Oscillatoria subbrevis Schm.		***	***
EUGLENOPHYTA			
Euglena rustica Schil.			***
Euglena proxima (Dangard) Lemm.			***
Euglena variabilis Lemm.	***		***
Lepocinclis caudata defl.	***		***
Lepocinclis fusiformis Ehrenb.	***	***	***
Lepocinclis ovum Ehrenb.			
Phacus swirenkoi Skvort.	***		
Trachelomonas ensifera Dad.			***
Phacus undulatus (Skv) Pochm.			***
Trachelomonas hispidia var.crenulatocollis Lemm			
Trachelomonas dastuguei Bal.			
Trachelomonas armata f.inevoluta Lemm.			
Trachelomonas hispidia var. duplex Pert.	***		
Trachelomonas volvocina Defl.			***
CHLOROPHYTA			
Monoraphidium griffitii (Berk.) Kom.	***		***
Monoraphidium circinale (Nygaard) Nyg.	***		***
Monoraphidium arcuatum (Korshikov) Hind.		***	***
Oocystis borgei J.Sno.			***
Desmodesmus quadricuada Turp.		***	***
Scenedesmus acuminatus (Lagerheim) Chod.		***	
Scenedesmus bijugatus var.graeventzii Bern.			***
Scenedesmus dimorphus (Turp.) Kuetz.			
Pandorina morum Ehrenb.			
Spyrogira sp.1			
BACILLARIOPHYTA			
Gomphonema augur Ehrenb.			
Gomhonema affine Ehrneb.			
Gomphonema gracile Ehrneb.			
Gomphonema parvulum Kützing			
Pinnularia interrupta Sm.			
Pinnularia gibba Ehrenb.			
Pinnularia acrospheria W.Sm.			
Ulnaria ulna (Nitzsch) Comp.			
Podosira sp.1			

***constant species, F: Frequency

DISCUSSION

The mean values of conductivity, nitrates and nitrites were high at the lake 7and there is significant difference in the conductivity and nitrate between Lake 7 and others lakes. Indeed, the Lake 7 is situated close to a much-inhabited zone, thus it receives the most quantity of wastewater with a high organic content and sediments. Besides, this lake presents the smaller surface, the processes of dilution of the pollutants are few intense. That favour high concentration of nutriments and high conductivity in this lake compared to the others lakes. Mean values of the orthophosphate, dissolved oxygen, and ammonium were slightly higher at the lake 8, than in the others lakes. The high values of dissolved oxygen are due to the strong dissolution of atmospheric oxygen in this ecosystem, whose surface is permanently cleared of its aquatic vegetation (Parinet *et al.* 2000). The high level of ammonium and Orthophosphates can be explained by the contribution of domestic wastewater and runoff that carry nutrients in the watershed. Moreover, the high values of the other environmental variables would be due to the anthropic pressure. Indeed, the man-made lakes of Yamoussoukro received important quantities of erosion products and waste (domestic waste, oil, sewage, sludge drain), and significant quantities of wastewater and solid waste. According to N'guessan *et al.* (2011), these urban lakes received about 38 300 m^3 of wastewaters (black waters, gray waters, sludges) annually. In addition, the nearby agricultural activities and use of chemical fertilizers is at the origin of a large spill of nutrients in the various lakes. The phytoplankton communities found in urban man-made lakes of Yamoussoukro can be considered as rich in the number of taxa (196 taxa). This richness may be related to the fact that the waters of the lakes are stagnant. Indeed, the development of phytoplankton communities is highly dependent on the stability of the water column. In addition, the stagnant nature of the lakes promotes biological processes such as complete cycles of reproduction and development of algae (Ouattara, 2000). Besides this richness could be due to less depth of the lakes, allowing lighting of substantially the entire water column, in fact, light plays an important role in the growth, diversity and density of

aquatic flora. Algal growth has been reported to increase with light intensity, and luminescence was found most favorable (Shen, 2002). The assemblage of phytoplankton is dominated by the Chlorophyta and Euglenophyta. The high number of Chlorophyta is due to high diversity of Chlorococcals (60 taxa) observed in this group. In addition, the physical and chemical characteristics of lakes are favorable for a specific diversification of Chlorophyta. Indeed the Chlorophyta are typically thermophilous and photophilic (Cabioc'H *et al.* 1992; Sheath and Wehr, 2003). As to Euglenophyta, its diversity could be explained by the impact of external and internal flows in the lakes so the organic matter available (Kim and Boo, 1998; Dia and Reynaud, 1982). The genera like *Trachelomonas* and *Scenedesmus* dominated the taxonomic richness, because these genera were growing in waters with a high organic matter content. The high quantity of organic matter comes from to toilets sewage and wastewater from hotels, restaurants, hospital, markets and agricultural. The lake 5 was the most specific rich and the lake 7 poor. The high number of taxa in Lake 5 can be explained by the fact that it is located in the center of the city. It receives the waters of the lakes with the exception of the lake 6 located downstream. While the lake 7 was poor because it's considered as a receptacle of waste water of the town (Parinet *et al..* 2000). Hierarchical cluster analysis presented three clusters. The third cluster contains the majority of lakes in the populated area receiving domestic and agricultural wastewater. The algal composition of lakes in cluster III is different from cluster I and II, because these lakes have higher mean Conductivity and salts ammonium value. However, the isolation of the lake 7 in the cluster II can be explained by the high average values of Conductivity and Nitrates. The grouping of sampling sites with similar algal assemblages showed that the type of pollution influenced communities. The phytoplankton composition of the different urban lakes of Yamoussoukro is different. This difference can be explained by the difference in physical and chemical parameters and nutrients.

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