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RESEARCH ARTICLE

PHYTOPLANKTONIC DIVERSITY OF SOME RICE-GROWING DAMS IN YAMOUSSOUKRO (CÔTE D'IVOIRE)

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ABSTRACT

Many small dams for agropastoral purposes have been initiated in various regions of the country, with the aim of promoting economic and social development, particularly to facilitate rice yields. These aquatic environments are home to an important biodiversity, including phytoplankton, which are not well known and likely to be impacted by human activities. The objective of this work is to know the phytoplankton population of the Yamoussoukro rice-growing dams in order to prevent the risks of eutrophication. The physico-chemical parameters of the water were measured with a multi-parameter HANNA model HI 98194 in three stations (Nanan, Subiakro and Zatta). Nutrient salts were measured using HANNA digital mini-photometers model H1781. Taxa were sampled with a plankton net of 20 µm mesh size. A photonic microscope was used to observe the different samples collected. In total, one hundred and fourteen (114) phytoplankton taxa were inventoried and divided into for (4) phyla: Chlorophyta (44 taxa or 39%), the Euglenophyta (41 taxa or 36%), Cyanoprokaryota (16 taxa or 14%) and Heterokontophyta (13 taxa or 11%). Water reservoirs could be considered rich in taxa. Chlorophyta and Euglenophyta contain the greatest diversity and constitute more than half of all taxa collected. The study also revealed that the reservoirs are warm (29.86°C) and acidic with low dissolved oxygen (2.25 mg/l) and high nutrient values (ammonium, nitrate, nitrite and ortho-phosphate). This mineralization of these waters explains the high diversity of taxa in the Yamoussoukro dams.

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INTRODUCTION

Aquatic environments, in particular freshwater, are a source of environmental services and drinking water supply for human populations (Fonsceca *et al.,* 2014). Increasingly, the question of water quality and quantity is one of the environmental issues that generates discussions between researchers and decision-makers (Dodds *et al.,* 2009). This is related to the health and economic consequences of water pollution, the pressures exerted on aquatic resources due to the increase in water needs (Ben Abou *et al*., 2014). Indeed, human activities lead to several physical and chemical changes that can modify the structure and functioning of aquatic ecosystems. According to Silva *et al.* (2012), small basins represent means important for identifying changes in land use, because they are more efficient in processing and transporting elements, such as carbon, nitrogen, major cations and anions (Thomas *et al.*, 2004). In the department of Yamoussoukro, several agro-pastoral dams have been built, including rice dams on the Bandama River (Brou *et al*., 2005). These dams are home to aquatic biodiversity, including micro-algae. The objective of this work is to know the phytoplankton population of some dams of the department of Yamoussoukro.

MATERIAL AND METHODS

Study area: The study environment, with an area of 4.651 km², is located in the district of Yamoussoukro, capital of Côte d'Ivoire, between 6°15 and 7°35 north latitude and 4°40 and 5° 40 west longitude (Anader, 2006). The city has 31 lakes and other bodies of water, ten of which are artificial and were created in the 1970s (Kollia, 1998) to receive runoff water. The different dams in our study are Nanan, Subiakro and Zatta (Figure 1).

Measurement of environmental variables and Sampling: The main physico-chemical parameters were measured *in situ* using a HANNA brand portable multi-parameter model HI 98194. The levels of nutrient salts such as phosphates, nitrites, nitrates and ammonium were measured. To do this, a water sample was taken for field analysis using HANNA model H1781 mini digital photometers. The samples were taken using a plankton net with a 20 µm mesh vacuum between October 2021 and March 2022.

The sampling consisted on the one hand of filtering five buckets of 10 liters of water using of the plankton net and on the other hand, to take water directly from the environment using a pillbox. A photonic microscope with a 40x objective made it possible to observe the various samples taken. Documents from various authors have helped to identify the different taxa.

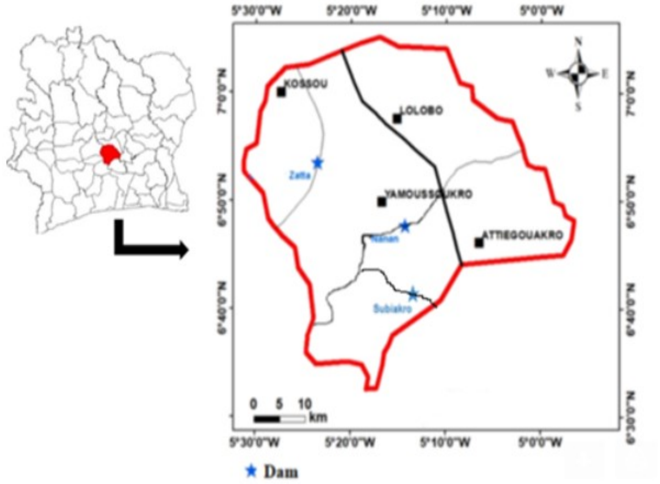

Figure 1. Map showing the collection sites

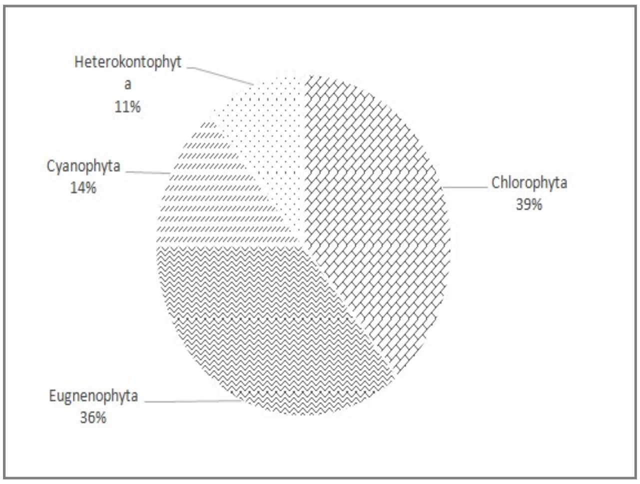

Figure 2. Proportion of different phyla

RESULTS AND DISCUSSION

Physico-chemical parameters: Table 1 presents the values of the different physicochemical parameters. The average temperature recorded in the study stations is 29.86°C. This temperature value indicates that the waters of these stations are relatively warm. According to Lemoalle (1999), the average water temperatures of aquatic environments in intertropical Africa are high and most often above 20°C. Water temperatures between 25 and 30°C are favorable to the development of aquatic life (Lwamba *et al.*, 2015).

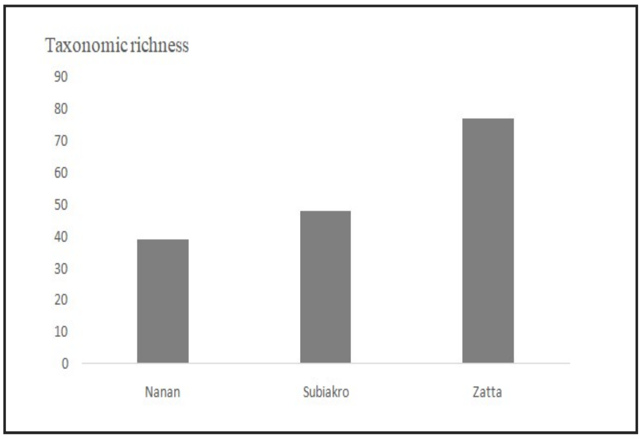

Figure 3. Taxonomic richness by station

The pH in this study is slightly alkaline and tends towards neutrality. Which would be favorable to the life of the organisms. Similar pH values were observed by (Koné *et al.*, 2022). The dissolved oxygen values recorded in this study are low. The low oxygen rate would be due to the presence of reducing deposits resulting from inputs from anthropogenic activities. These results are similar to those of Koné *et al.* (2022). The average conductivity value (159.25 µS/cm) recorded in this study is higher than those (123.2 and 133.8 µS/cm) obtained by Sanogo *et al.* (2014) on the agricultural perimeter of Bama and Boura in Burkina Faso. These high values indicate that the waters of these sites are highly mineralized. This significant mineralization is due to the use of chemical fertilizers by rice farmers (Nouayti *et al.,* 2015). According to N'guessan (2017), the electrical conductivity of Yamoussoukro waters generally exceeds 100 µS/cm. The average value of the nitrate rate (NO^{3-}) 0.35 mg/L. Nitrate, the last stage of nitrogen oxidation, is necessary for the development of aquatic flora. The different concentrations of nutrient salts (ammonium, nitrite and ortho-phosphate) in the study stations are due to anthropogenic activities. Indeed, the occupation of the banks by market gardening, the presence of rice plots in the perimeters and the use of chemical fertilizers by farmers, is at the origin of a significant spill of nutrients in these dams.

Specific composition: Table 2 lists the taxa inventoried in the different dams studied. The algal flora of all the environments studied includes 114 taxa belonging to for (4) phyla: Chlorophyta (44 taxa or 39%), the Euglenophyta (41 taxa or 36%), Cyanoprokaryota (16 taxa or 14%) and Heterokontophyta (13 taxa or 11%). Euglenophyta and Chlorophyta contain the greatest diversity and constitute more than half of all taxa encountered. It should be noted that Euglenaceae represent the only family Euglenophyta, while Chlorophyta are represented by 9 families of which the best represented is Scenedesmaceae with 17 taxa. This dominance of Chlorophyta and Euglenophyta would be due to the richness of organic substances in the environment (Kim and Boo, 1998). The wealth would be due to the fact that the waters of the reservoir are stagnant. This would promote biological processes such as the complete cycles of reproduction and development of algae. This observation was made by Ouattara (2000) on Lake Ayamé in Côte d'Ivoire.

Table 1: Spatial variation of physico-chemical parameters

Stations	T°C	pH	CND (µS/cm)	O_2 (mg/l)	NO_2^- (mg/L)	NO_3^- (mg/L)	PO_4^{2-} (mg/L)	NH_4^+ (mg/L)
Nanan	31.33	6.65	144.5	2,815	6.14	0.36	0.1	0.46
Subiakro	28.26	7.26	186.5	1.9	0.5	0.09	0.69	0.68
Zatta	29.98	7.03	146.75	2.02	14.81	0.49	0.46	0.37
Medium	29.86	6.98	159.25	2.25	7.15	0.31	0.42	0.50

Table 2. List of phytoplankton taxa collected at dams: x = species present

TAXA	Nanan	Subiakro	Zatta
Cyanophyceae Sachs			
Chroococcaceae Nageli			
Aphanocapsa elachista G.S. West	x	x	x
Aphanocapsa incerta Lemmermann	x	x	
Chroococcus dispersus (Keissler) Lemmermann			x
Chroococcus limneticus Lemmermann	x		x
Merismopedia elegans Braun			x
Merismopedia glauca (Ehrenberg) Nägeli	x		x
Merismopedia punctate (Ehrenberg) Nägeli			x
Microcystis aeruginosa (Kutzing) Kutzing	x	x	x
Microcystis wesenbergii Komarek		x	
Coelosphaeriaceae			
Coelomoron pusillum (Van Goor) Komarek		x	x
Nostocaceae Dumortier			
Anabaena mucosa Komarkov-Legnerova and Eloranta			x
Anabaena planctonica brunnthaler	x		x
Anabaena spiroides Klebahn		x	x
Anabaena sp.		x	
Oscillatoriaceae (Gray) Bory de St. Vincent			
Oscillatoria princeps Gomont		x	x
Spirulina princeps West & G.S. West			x
Heterokontophyta Van Den Hoek *et al.*			
Bacillariophyceae Haeckel			
Acanthocerataceae Crawford			
Aulacoseira granulata var. *granulata* (Ehrenberg) Simonsen			x
Aulacoseira granulata var. *angustissima* (O. Müller) Simonsen	x	x	x
Fragilariaceae Hustedt			
Fragilaria ulna (Nitzsch) Lange-Bertalot			x
Naviculaceae Kutzing			
Navicula cryptocephala Kutzing			x
Navicula sp.		x	
Pinnulariaceae Mann *in* Round *et al.*			
Pinnularia divergens W. Smith			x
Pinnularia interrupta Smith.		x	
Pinnularia microstauron (Ehrenberg) Cleve		x	x
Pinnularia sp.		x	
Stauroneidaceae Mann			
Stauroneis phoenicenteron (Nitzsch) Ehrenberg	x		x
Stauroneis sp.			x
Surirellaceae Kutzing			
Surirella sp.	x		
Chrysophyceae Pascher			
Pleurochloridaceae Pascher			
Pseudostaurastrum gracile (Reinsch) Chodat ex Bourrelly	x		x
Chlorophyta Cavalier-Smith			
Chlorophyceae Wille *in* Warming			
Ankistrodesmaceae Korshikov			
Ankistrodesmus gracillis (Reinsch) Korshikov	x		
Ankistrodesmus fusiformis Corda			x
Botryococcaceae Wille			
Dictyosphaerium pulchellum Van Goore	x	x	
Selenastraceae Blackman and Tansley			
Kirchneriella obesa (West & G.S. West) Schmidle			x
Hydrodictyaceae (Gray) Dumortier			
Pediastrum biradiatum Meyen	x		
Pediastrum duplex Meyen		x	
Pediastrum duplex Meyen var. *gracillimum* West and GS West	x	x	x
Pediastrum tetras (Ehrenberg) Ralfs			x
Pediastrum simplex Meyen	x		
Neochloridaceae Ettl and Komarek			
Tetraedron trigonum (Nägeli) Hansgirg	x	x	x

Continue …………

Tetraedron sp.			x
Scenedesmaceae Oltmanns			
Coelastrum astroideum From Notaris			x
Coelastrum indicum Terner			x
Coelastrum cambricum W. Acher			x
Coelastrum microporum Nageli			x
Coelastrum pulchrum Schmidle	x		
Crucigenia quadrata Morren			x
Crusigeniella rectangularis (Nägeli) Komarek		x	
Scenedesmus acuminatus (Lagerheim) Chodat	x		x
Scenedesmus acutiformis Schröde	x		
Scenedesmus bernardii Chodat		x	x
Scenedesmus bicaudatus Dedussenko			x
Scenedesmus naegelii Brebisson		x	
Scenedesmus smithii Teiling			x
Scenedesmus sp.			x
Dimorphococcus lunatus A. Braun		x	
Desmodesmus denticulatus (Lagerheim) SSAn			x
Desmodesmus quadricaudatus (Turpin) Hegewald	x		x
Volvocaceae Ehrenberg			
Eudorina elegans Ehrenberg	x		x
Pandorina morum (Müller) Bory			x
Conjugatophyceae Engler			
Closteriaceae Bessey			
Closterium laeve Kutzing		x	
Closterium kuetzingii Brebisson			x
Closterium sp.1		x	
Closterium sp.2			x
Desmidiaceae Kützing ex Ralfs			
Cosmarium contraction O. Kirchner		x	
Cosmarium pseudodecoratum Schimile			x
Cosmarium kidney -shaped (Ralfs) W. Archer			x
Cosmarium vexatum West		x	
Cosmarium sp.1		x	x
Cosmarium sp.2			
Staurastrum leptocladum var. *cornutum* Wille			x
Staurastrum tetracerum Ralfs		x	x
Staurastrum sp.1			x
Teilingia granulata (Roy and Bisset) Bourrelly		x	x
Euglenophyta Pascher			
Euglenophyceae Schoenichen			
Euglenaceae Stein			
Euglena proxima P.A. Dangeard	x	x	
Lepocinclis acus(Müller) Marin and Melkonian		x	x
Lepocinclis pinworm var. pinworm (Schmarda) Marin and Melkonian	x	x	x
Lepocinclis ovum Ehrenberg		x	x
Lepocinclis salina Fritscher	x	x	x
Lepocinclis texta (Dujardin) Lemmerman	x	x	x
Lepocinclis sp.			x
Phacus angulatus Pochmann	x		
Phacus glaber Pochmann			x
Phacus heimii Lefevre		x	
Phacus longicauda var. *longicauda* (Ehrenberg) Dujardin	x		x
Phacus longicauda var. *torta* Lemmermann		x	
Phacus onyx Pochmann	x	x	x
Phacus platalea Drezepolski			x
Phacus pleuronectes (Müller) Dujardin		x	x
Phacus suecicus Lemermann	x		x
Phacus tortus (Lemermann) Skvortzov		x	x
Phacus sp.1	x		
Phacus sp.2		x	x
Strombomonas acuminata (Schmarda) Deflandre			x
Strombomonas fluviatilis (Lemmermann) Deflander		x	x
Strombomonas gibberosa (Playfair) Deflandre	x		
Strombomonas girardiana (Playfair) Deflandre			x
Strombomonas lanceolata (Playfair) Deflandre			x
Strombomonas verrucosa (Daday) Deflandre			x
Strombomonas sp.			x
Trachelomonas abrupta Svirenko	x		
Trachelomonas armata (Ehrenberg) F. Stein	x		x
Trachelomonas armata var *.gordeievii* Skvortzov	x		x
Trachelomonas bernardinensis Vischer		x	
Trachelomonas hispida var. *crenulatocollis* (Maskel) Lemmermann	x		
Trachelomonas hispida var. *hispida* (Perty)Stein	x	x	x
Trachelomonas oblonga Lemmermann	x		
Trachelomonas pisciformis Prescott		x	
Trachelomonas similis Stokes		x	x
Trachelomonas sydneyensis Playfair	x		
Trachelomonas volvocina Ehrenberg	x		x
Trachelomonas volvocinopsis Svirenko		x	
Trachelomonas sp.1		x	
Trachelomonas sp.2			x
Trachelomonas sp.3		x	
Total = 114	39	48	77

The proliferation of Chlorophyta in these nutrient rich media is in agreement with the observations of Beman *et al*. (2005) that the availability of nutrients is an essential factor for the proliferation of Chlorophyta. Alkaline pH favors the development of many Desmids (Da, 2007). Concerning the number of taxa per station (figure 3), we observe that Zatta is the richest with 77 taxa listed. The high taxonomic richness of this station is explained by the fact that the richness in nutrients would favor the proliferation of microalgae.

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