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Characterization of the Trophic State of Rivers' N'Gotopkré, Anvo, Mouyassué and Toudoum of Aboisso Region (Côte d'Ivoire) from Micro-Algae: Palmer Method (1969)

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Abstract **Original Research Article**

Aboisso region is known for its high agricultural productivity, its numerous agro-industrial units and its gold panning activities. These sectors of activity could have consequences on water quality, and lead to changes in the composition and structure of micro-algae. This study aims to determine the trophic quality of some rivers in Aboisso region. Campaigns were conducted in four rivers N'Gotopkré, Anvo, Mouyassué and Toudoum. Phytoplankton samples were collected by horizontal traction over 6 m from surface water, using a plankton net with a 20 µm mesh size. The samples were observed using an Olympus CKX 41 optical microscope. Some books were used to identify phytoplankton species. The counting of phytoplankton was carried out using the Malassez cell and the counting unit was the cell. According determination of waters quality, Palmer method was used. A pollution index factor of 1 to 5 was assigned to 20 types of algae most tolerant to organic pollution. The microalgal flora recorded in the rivers consists of 31 taxa and divided into 3 phyla, Chlorophyta, Bacillariophyta and Cyanoprokaryota respectively with 15, 10 and 6 taxa. According to floral diversity, N'Gotopkré and Mouyassué rivers recorded the most taxa respectively with 18 and16 taxa. Analysis of phytoplankton densities indicated a predominance of Chlorophyta with $13.180.10^3$ Cells/L and Mouyassué river with $13.080.10^3$ Cells/L recorded the highest densities. The lowest floristic density was observed in Toudoum river with 740.10^3 Cells/L. According to the quality of rivers, among the 20 genera presented by Palmer (1969) as bio-indicators of organic pollution, 5 were identified in the rivers. These are the genera *Oscillatoria*, *Scenedesmus*, *Navicula*, *Closterium* and *Pandorina*. The different scores ranging from 0 to 13, showed values below organic pollution.

Keywords: Trophic state, Palmer method, Micro-algae, Côte d'Ivoire rivers.

INTRODUCTION

The coastal areas of southern Côte d'Ivoire are places of human concentrations where the imperatives linked to the development of agriculture threaten the balance of small coastal river ecosystems. Agricultural activity occupies approximately 44% of the area of this region (Anonyme, 2001). We also note the presence of several agro-industrial units of oil palm and rubber trees adjacent to the watercourses. Added to this is an intensification of gold panning activity, directly or indirectly causing disturbances in these environments (Boyd *et al*., 2003). The southern region of Comoé has not remained on the sidelines of these anthropogenic activities which can disrupt the aquatic ecosystem of this area. These various anthropogenic activities carried out there could disrupt the ecology and biodiversity of the aquatic environment. It is therefore necessary to carry out environmental studies in order to measure the state of pollution of these waterways suitable for aquatic life and humans. It is sometimes useful and judicious to use living organisms whose sensitivity and ecological requirements are known to judge the state of an environment and its disturbances (Garrec *et al*., 2002). In fact, many microalgae have the ability to survive in polluted waters. These microalgae constitute pollution indicator species. Indeed, as a primary producer, phytoplankton use abiotic factors and processes such as photosynthesis to produce energy on which primary and secondary consumers depend. Phytoplankton is therefore very important for the existence of all aquatic ecosystems (Molles, 2005). In this study, Palmer's indices (1969) will be used to determine the state of pollution of some rivers (N'Gotopkré, Mouyassué, Anvo and Toudoum) in Aboisso region, which are the receptacle of agro-

industrial factory waste and domestic and recreational activities.

I. MATERIAL AND METHODS

I.1. Study environment

Aboisso is a town located in the South-East of Côte d'Ivoire. It is subject to a subequatorial climate (Attiéen) with an annual average temperature of 25°C to 33°C, precipitation of 1400 to 2500 mm/year and a humidity level of around 80 to 90% over the year (Niamien-Ebrottié, 2010). This region has a relatively dense hydrographic network, made up of several coastal rivers including the N'Gotopkré, Anvo, Mouyassué and Toudoum rivers, where we carried out this work (Figure-1). These rivers were chosen because of their proximity to oil palm and rubber processing factories and large industrial plantations. Sampling took place between February and August 2021, during 3 seasons: long dry season, long rainy season and short dry season.

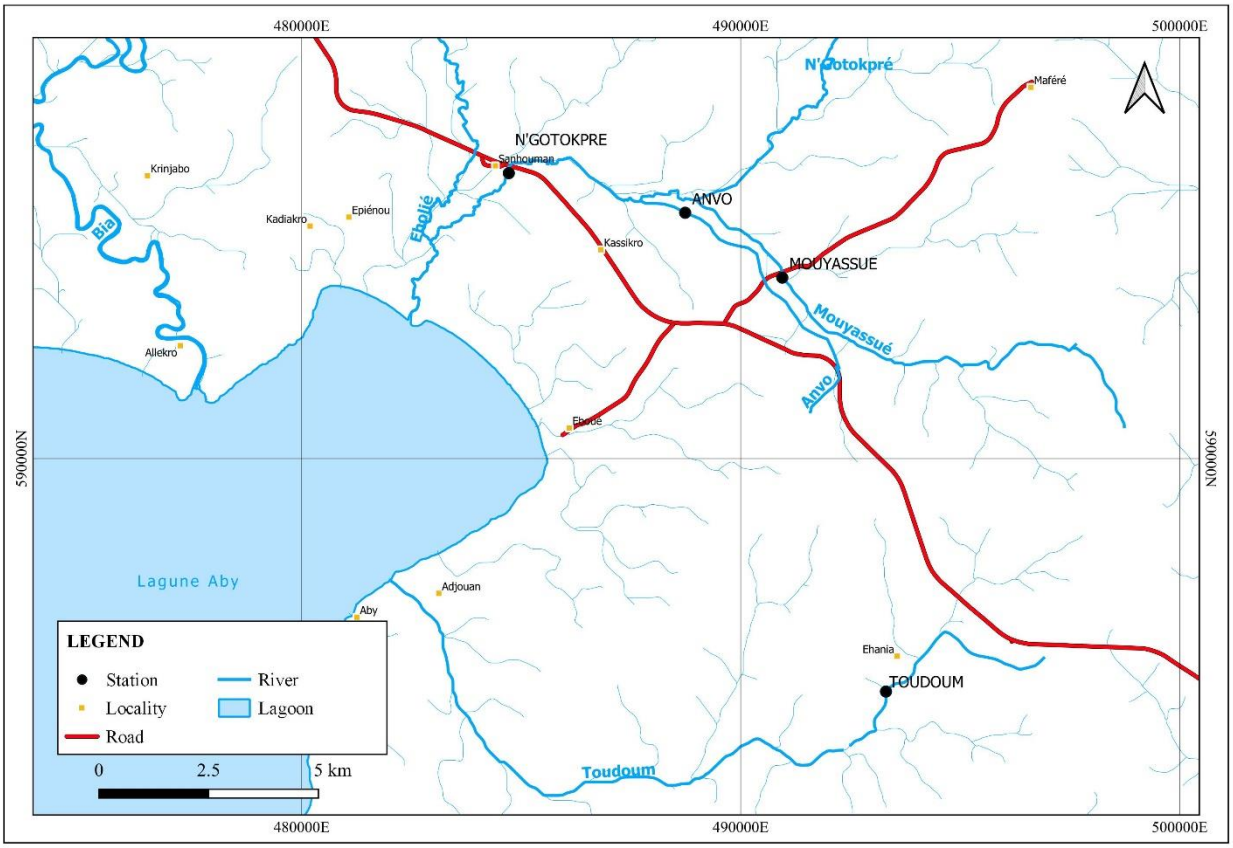

Figure-1: geographical location of rivers

I.2. Phytoplankton study method (sampling, observation, identification and counting)

Phytoplankton samples were collected by horizontal traction over 6 m from surface water, using a plankton net with a 20 µm mesh size. The samples were observed using an Olympus CKX 41 optical microscope. Specimen identification was based on cellular morphology and undertaken to species level, using the species' identification detailed in the literature: Iltis (1980), Bourrelly (1981), Komoé (2010), Seu-Anoï (2012) et Konan (2014). The counting of phytoplankton was carried out using the Malassez cell and the counting unit was the cell.

The densities were evaluated on the 5 double-gridded rectangles of the diagonal of the Malassez cell. The contents of the double-gridded rectangles are counted using a 40x objective (Gueret, 2002). The calculation of concentrations (C) or cell densities was done according to the following formula:

$$C = \frac{N}{n\ X\ Vr}$$

With C = Cell density in Cells/ml, N = total number of taxa counted in n double-gridded rectangles of the Malassez cell. Vr = 0,2 x 0,25 x 0,2 = 0,01 mm^3 = 10^{-5} ml = volume of a double -gridded rectangle in ml. Densities were evaluated in Cells/L.

I.3. Palmer'index, 1969

Scientists have determined a method to assess the level of organic pollution by studying the microalgae present in a water sample. A pollution index factor of 1 to 5 was assigned to 20 types of algae most tolerant to

organic pollution (Table I). The microalgae most tolerant to organic pollution received a factor of 5 and the least tolerant a factor less than 5 (between 1 and 4). All microalgae not listed have an index of zero. If pollution index score is 20 or more, this score is evidence of high organic pollution. A score of 15 to 19 indicates probable organic pollution. Lower scores indicate that organic pollution is not high.

Table I: Genera of tolerant microalgae of pollution (Palmer pollution index in descending order)

Genera	Index of pollution (Palmer, 1969)
Euglena	5
Oscillatoria	5
Chlamydomonas	4
Scenedesmus	4
Chlorella	3
Navicula	3
Nitzschia	3
Ankistrodesmus	2
Phacus	2
Stigeoclonium	2
Synedra	2
Anacystis	1
Closterium	1
Cyclotella	1
Gomphonema	1
Lepocinclis	1
Melosira	1
Micractinium	1
Pandorina	1
Phormidium	1

II. RESULTS AND DISCUSSION

II.1. RESULTS

II.1.1. Phytoplankton composition

The microalgal flora recorded in the rivers consists of 31 taxa and divided into 3 phyla, 4 classes, 8 orders, 16 families and 23 genera. The most diverse phylum is Chlorophyta with 15 taxa, followed by Bacillariophyta with 10 taxa and Cyanoprokaryota with 6 taxa. Analysis of phytoplankton densities indicated a predominance of Chlorophyta with $13.180.10^3$ Cells/L, followed by Cyanoprokaryota with $5.142.10^3$ Cells/L and Bacillariophyta with $1.400.10^3$ Cells/L.

According to floral diversity, N'Gotopkré, Mouyassué, Anvo and Toudoum rivers recorded 18, 16, 7 and 4 taxa respectively. Mouyassué river with $13.080.10^3$ Cells/L recorded the highest densities. Anvo river with $3.120.10^3$ Cells/L seconds Mouyassué and the long dry season, with $2.120.10^3$ Cells/L, recorded also the highest densities. N'Gotopkré river with a total of $2.780.10^3$ Cells/L, also recorded the highest densities during the long dry season with $1.782.10^3$ Cells/L. Finally, Toudoum river, with a total density of 740.10^3 Cells/L, is the least rich in phytoplankton' density.

II.1.2. Assessment of organic pollution according to the Palmer index

The values of the Palmer pollution index and the results of different scores at the rivers are recorded in the Table II below. Among the 20 genera presented by Palmer (1969) as bio-indicators of organic pollution, 5 were identified in the rivers. These are the genera *Oscillatoria*, *Scenedesmus*, *Navicula*, *Closterium* and *Pandorina*. The different scores recorded, showed values below organic pollution as indicated in the table.

Table II: Genera of microalgae tolerant to pollution (Palmer pollution index in descending order in the N'Gotopkré, Mouyassué, Anvo and Toudoum rivers (+) = Presence, (-) = Absence

Genres	Indices de pollution (Palmer, 1969)	N'Gotopkré	Mouyassué	Anvo	Toudoum
Euglena	5	_	_	_	_
Oscillatoria	5	_	+5	+5	_
Chlamydomonas	4	_	_	_	_
Scenedesmus	4	+4	+4	+4	_
Chlorella	3	_	_	_	_
Navicula	3	+3	+3	_	_
Nitzschia	3	_	_	_	_
Ankistrodesmus	2	_	_	_	_
Phacus	2	_	_	_	_

Genres	Indices de pollution (Palmer, 1969)	N'Gotopkré	Mouyassué	Anvo	Toudoum
Stigeoclonium	2	_	_	_	_
Synedra	2	_	_	_	_
Anacystis	1	_	_	_	_
Closterium	1	+1	_	_	_
Cyclotella	1	_	_	_	_
Gomphonema	1	_	_	_	_
Lepocinclis	1	_	_	_	_
Melosira	1	_	_	_	_
Micractinium	1	_	_	_	_
Pandorina	1	_	+1	_	_
Phormidium	1	_	_	_	_
Total score		8	13	9	_

II.2. DISCUSSION

The number of the phytoplankton community of the rivers studied, estimated at 31 taxa, showed a low number compared to the studies carried out by Niamien-Ébrottié (2010), who worked on 4 rivers in the South-East of Côte d'Ivoire. This author, identified 193 taxa grouped into 5 phyla. The densities are also low compared to the work of Niamien-Ébrottié (2010). Indeed, Niamien-Ébrottié (2010) collected up to 99.5 10^6 Cells/L at the Eholié station.

The low values observed in this work could be due to agricultural activities and industrial units, and the increase in gold panning activity during this last decade tending to disrupt these environments. The gold panning activities lead to a drastic reduction in the richness and specific diversity of biocenoses within and near watercourses (Affessi *et al.*, 2016). Indeed, the abusive use of toxic products (mercury, cyanide, etc.) and various technical equipment (dredgers, machines, etc.) causes deterioration of the natural environment and in particular of aquatic fauna and flora (Maiga *et al*., 2022). These low values observed at these rivers could also be explained by the fact that these waters are not stagnant but in perpetual movement. This turbulence could prevent microalgae from reproducing or completing their reproduction (Ouattara, 2000).

According to the both predominance of Chlorophyta for the floristic composition and for the phytoplankton densities, this predominance would be due to the freshwater nature of the environments sampled. Indeed, according to Kramer and Lange-Bertalot (1991), this group predominates in freshwater environments. Additionally, Chlorophyceae have the widest ecological range of all algae classes. They are marine (planktonic or fixed), freshwater (planktonic or fixed), terrestrial, saxicolous or epiphytic. They are also cosmopolitan. These characteristics allow them to effectively colonize environments (Zebsa, 2021). Concerning the determination of the state of pollution of rivers based on the Palmer index, 5 genera divided into 7 taxa were counted. Species of the genus: *Oscillatoria*, represented by the taxa *Oscillatoria* sp. and *O. ornata*, *Scenedesmus* represented by the species *Scenedesmus quadricauda*, *Navicula* represented by *Navicula* sp., *Closterium* represented by *Closterium abruptum* and *C. ehrenbergii* and finally the genus *Pandorina* represented by species *Pandorina morum*, are the characteristic species of organic pollution identified in the rivers studied. The different scores obtained show values below the organic pollution threshold. These scores are of the order of: 7, 13, 9 and 0 respectively in the N'Gotopkré, Mouyassué, Anvo and Toudoum rivers. However, it is important to specify that Mouyassué station has the highest score and tends towards probable organic pollution (score between 15 and 19). Indeed, Mouyassué station is subject to strong anthropogenic pressure. It is located between two oil palm factories, and is bordered by plantations of industrial and food crops. These waters are also used for recreational (swimming) and domestic (bathing, laundry and dishwashing) activities. As for Toudoum station, the score being zero, demonstrates that no microalgae characteristic of organic pollution was found in this station. The waters of this river could be of very good quality. The Toudoum river has dried up a lot, offering a small surface area compared to other rivers which were larger. Although this study did not show any organic pollution, the presence of certain species characteristic of eutrophic environments such as *Pandorina morum* and *Scenedesmus quadricauda* were observed.

CONCLUSION

The study of the water quality of N'Gotopkré, Anvo, Mouyassué and Toudoum rivers showed apparently healthy waters. However, given the importance of gold panning activities in this region, in addition to determining the state of pollution by microalgae, it would be also necessary to carry out studies relating to chemistry for best evaluation of the quality of these rivers.

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