



## Systematic study of the genus *Closterium* Nitzsch (Chlorophyta) in a tropical area in Côte d'Ivoire.

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### ABSTRACT

*Objectives:* take stock and contribute to the knowledge of the genus *Closterium* from rivers Boubo and Mé in South coast of Côte d'Ivoire.

*Methods and results :* Six deduction areas, three per rivers, Boubo and Mé, were defined upstream to downstream. The planktonic samples have been taken in the period between May 2009 and April 2010 and fixed with formalin of commerce at a final concentration of 5 %. The samples are analyzed using an optical microscope Olympus CX 31 brand equipped with a digital camera. Some twenty-three taxa were identified among which nine are new in the algal flora of this country.

*Conclusion and applications of observation:* The knowledge of the taxonomic composition of Desmids of freshwater will enable better assessment of the state of pollution in the coastal rivers of Côte d'Ivoire.

**Key words:** Phytoplankton, Desmidiaceae, *Closterium*, river, Côte d'Ivoire.

### INTRODUCTION

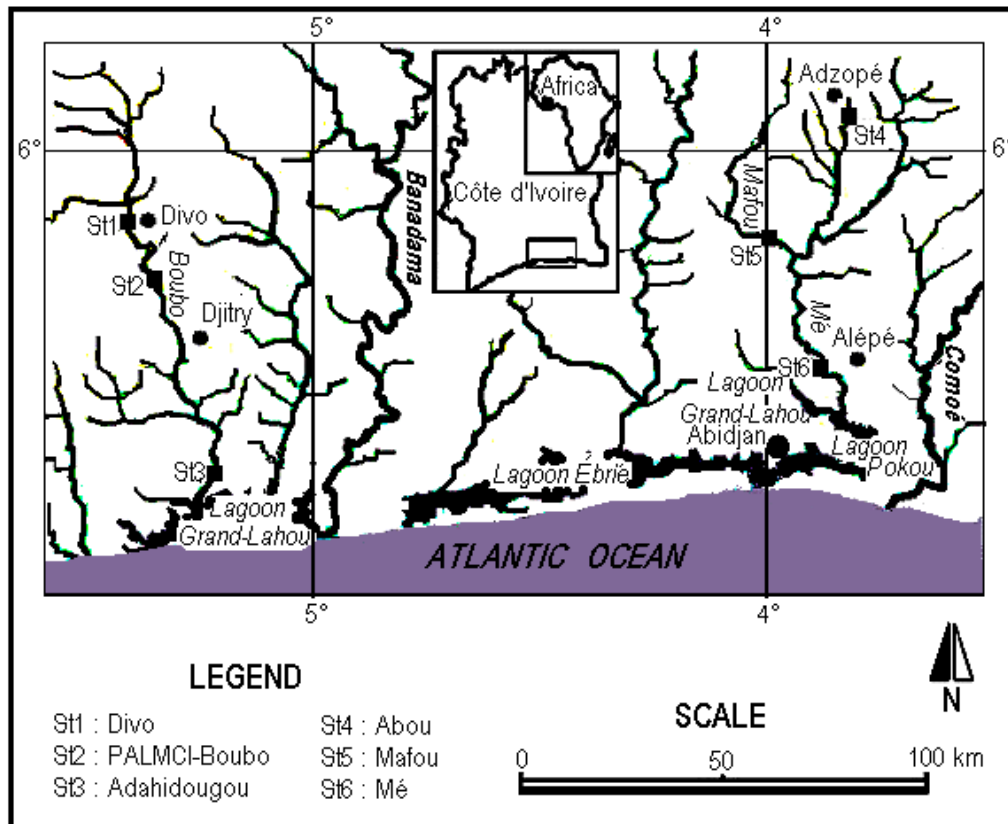
Côte d'Ivoire, a state of West Africa, has a dense river network, along with more than 11,000 square kilometers. The water system serves all areas, namely agriculture, industry, farming, boating, fishing and domestic needs. These environments are subject of study since (Zanon 1941) and (Bourrelly 1961) on almost all fresh water. A few systematic and ecological studies conducted on the running waters are from only Iltis (1982a), Da (1992), Ouattara et al. (2000) and Niamien (2010). The location of the study environment and coastal forest zone is a cause of rivers enrichment in organic running freshwater from domestic, agricultural and industrial matter. Algae are a material of choice for the study of water rich in organic matter and therefore the quality of water. The simple observation of an algal population can be determined and immediately provide information on the trophic state of the environment,

alkalinity and abundance of certain types of nutrients. Thus Desmids appear as a study material of the nutritive component rich area. However, the only work on Closteriaceae Côte d'Ivoire by Komoé and al. (2007), were carried out on the lagoon of Grand Lahou. No studies on this algal group have been conducted on running waters. To fill the lack of studies about Closteriaceae from running freshwater, two rivers, Boubo and Me, in the southern coastal, not yet surveyed were given preference for the choice of sampling areas. This work has focused on taxonomic knowledge of some taxa, essential and necessary for a good future ecological study. The study, which is part of a multidisciplinary program control hydro biological, has two components, namely systematic inventory (current study) and to conduct an ecological study of water quality from the phytoplankton.

**MATERIALS AND METHODS**

The place of study is in the southern part of Côte d'Ivoire. It is between 5°15' and 6°20' west longitude, 3°45' and 5°30' north latitude. Rivers Boubo and Mé on which we conducted our crops cover respectively 4702

km<sup>2</sup> and 2458 km<sup>2</sup>. Three stations (St) per river, numbered from St1 to St6 from downstream to upstream, were selected for this study (Figure 1).



**Figure 1:** Map showing the sampling stations in the rivers Boubo and Mé

Algal samples were performed on the various stations of rivers Boubo and Mé, throughout the collect from May 2009 to April 2010, using net for plankton of 20 µm of empty of mesh size. These algal samples were placed in 40 ml of pillboxes and fixed in place using formalin trade (whose acidity was neutralized with sodium borate) at a final concentration of 5 %. The

physicochemical parameters were measured "in situ" with a pH meter (HACH EC 10) for measuring pH, and conductivity (HACH CO 150) to those of the conductivity and temperature. The devices are first turned on before the dive of the probe to a digital display of values. Chemicals parameters (Phosphate and BOD<sub>5</sub>) were analyzed in laboratory.

**RESULTS**

On both rivers, the localization and the average temperature, conductivity, pH, Transparency, Phosphate, BOD<sub>5</sub> are given from upstream to downstream. Thus on the river Boubo there are the

deduction areas of Divo, PALMCI-Boubo, Adahidougou and those of Abou, Mafou and Mé on river Mé (table below).

Table some physical and chemical parameters of the freshwater zones of the sampling

Station	GPS	Temperature (°C)	Transparency (m)	Conductivity ( $\mu\text{S cm}^{-1}$ )	pH	BOD <sub>5</sub> (mg L <sup>-1</sup> )	Phosphate (mg L <sup>-1</sup> )
Divo	5°75' N 5°31' W	25,7	0,8	122,4	7,0	29,7	0,15
PALMCI-Boubo	5°61' N 5°25' W	25,9	0,7	113,4	7,3	30,0	0,20
Adahidougou	5°18' N 5°11' W	26,0	0,9	293,7	6,7	28,0	0,25
Abou	5°72' N 3°68' W	25,0	0,4	133,9	6,9	44,0	0,30
Mafou	5°70' N 3°77' W	25,8	0,4	78,5	6,9	34,0	0,12
Mé	5°32' N 3°67' W	25,4	0,4	75,0	6,7	16,7	0,27

The following description and classification are those proposed by Bourrelly (1961), Compère (1977), Prescott et al. (1981), Da (1992), Mpawenayo (1996), Opute (2000), Ouattara et al. (2000).

All dimensions are given in micrometer ( $\mu\text{m}$ ), L. = length of cell, W. = maximum width of cell. The magnifications are as indicated in plates for photomicrographs, while they are represented by bar lines side the figures, each bar line equal to 20  $\mu\text{m}$ . Taxa indicated by an asterisk (\*) are observed for the first time in Côte d'Ivoire.

#### Chlorophyta - Conjugatophyceae - Desmids - Closteriaceae

***Closterium acerosum* (Schrank) Ehrenberg ex Ralfs (Figure 2)**: Cells length are 7-16 times the width, slightly curved, almost straight, narrowly fusiform, the inner margin straight or slightly convex, 20 to 34° arc, gradually tapering to poles which are narrow and truncate rounded, often angularly thickened ; chloroplast with 7-9 longitudinal ridges of pyrenoids. L. 254.7-268  $\mu\text{m}$  ; W. 25.5-30.2  $\mu\text{m}$ . Phytogeographical distribution cosmopolitan ; area of collect: PALMCI-Boubo.

***Closterium archerianum* Cleve (Figure 3)**: Cells length are 10-11 times the width, strongly curved, 106 to 145° of arc, inner margin not tumid, gradually and uniformly attenuated to the apices, the poles narrow and obtusely rounded, or angled on the dorsal side ; chloroplast with 2 or 3 ridges and 5 to 8 pyrenoids in a series. L 209-213.7  $\mu\text{m}$ ; W 18.7-21.5  $\mu\text{m}$ . Phytogeographical distribution cosmopolitan ; area of collect: Adahidougou.

**\**Closterium calosporum* Wittrock (Figure 4)**: Cells length are 9-10 times the width ; moderately curved,

100-110° of arc ; ventral margin almost straight in the middle portion, thereafter attenuated to obliquely rounded apices ; cell wall smooth; chloroplast with 4-6 pyrenoids in each semi-cell. L 107.5-110  $\mu\text{m}$ ; W 12-13.5  $\mu\text{m}$ . Phytogeographical distribution cosmopolitan; area of collect: PALMCI-Boubo.

**\**Closterium cornu* (Ehrenberg) Ralfs var. *javanicum* Gütwinski (Figure 5)**: Cells length are 11-25 times the width, more slender than the typical; pyrenoids 4 or 5 in a series ; L 112-114.2  $\mu\text{m}$  ; W. 5.8-7  $\mu\text{m}$ . Phytogeographical distribution cosmopolitan ; area of collect: PALMCI-Boubo.

***Closterium Cynthia* De Notaris (Figure 6)**: Cells length are 7-10 times the width, strongly curved, 110-145° of arc; in most cases with a straight parallel median portion, thereafter gradually and evenly attenuated to bluntly rounded apices ; chloroplast with 3-6 pyrenoids. L. 125.8-129.6  $\mu\text{m}$ ; W. 15-17.1  $\mu\text{m}$ . Phytogeographical distribution cosmopolitan; area of collect: Adahidougou.

***Closterium ehrenbergii* Meneghini ex Ralfs var. *ehrenbergii* (Figure 7)**: Cells stout and large, strongly curved, 115-140° of arc; tumid at the mid-region, narrowing progressively to broadly rounded apices; dorsal margin broadly convex; wall smooth, chloroplast with many scattered pyrenoids. L. 390-407  $\mu\text{m}$ ; W. 60-71.7  $\mu\text{m}$ . Phytogeographical distribution cosmopolitan; area of collect: Adahidougou, Divo.

***Closterium ehrenbergii* var. *malinvernianum* (De Notaris) Rabenhorst (Figure 8)**: Cells length are 4 to 6 times the width, curved, slightly swollen in the middle, curvature 90 to 110° of arc ; slightly shorter than the type species, finely striated wall, chloroplasts with pyrenoids numerous scattered. L. 490-510  $\mu\text{m}$ ; W. 90-

100 µm. Phytogeographical distribution cosmopolitan; area of collect: Adahidougou.

**\**Closterium ehrenbergii* var. *michailovskoense* Elenkin (Figure 9)** : Cells arched, attenuated at the poles, larger than those of the type species, strongly arched in the dorsal and expanded in the middle. L. 210-220 µm; W 46-50.4 µm µm. Phytogeographical distribution cosmopolitan; area of collect: Adahidougou.

***Closterium gracile* Brébisson ex Ralfs var. *gracile* (Figure 10)** : Cells very slender, straight and cylindrical with parallel margins gracefully incurved and slightly tapered towards obtuse apices which are rounded-truncate; walls smooth and colorless; chloroplast with 7-9 pyrenoids. L. 230-243 ; W. 5-7 µm. Phytogeographical distribution cosmopolitan ; area of collect: PALMCI-Boubo.

**\**Closterium gracile* (Brébisson) Ralfs var. *elongatum* W. & G.S. West (Figure 11)** : Cells length is 45 to 96 times the width, than the typical. L. 270-284.6 µm; W. 3.2-6 µm. Phytogeographical distribution cosmopolitan ; area of collect: Adahidougou.

***Closterium kuetzingii* Brébisson (Figure 12)** : Cells length are 23-35 times the width, mostly straight, the middle portion fusiform with ventral and dorsal margins almost equally convex, gradually attenuated into long cylindrical processes which are incurved towards the slightly swollen apices. Chloroplast with 5-8 pyrenoids. L. 330.8-360 µm; W. 13.7-17 µm. Phytogeographical distribution cosmopolitan; area of collect: Divo.

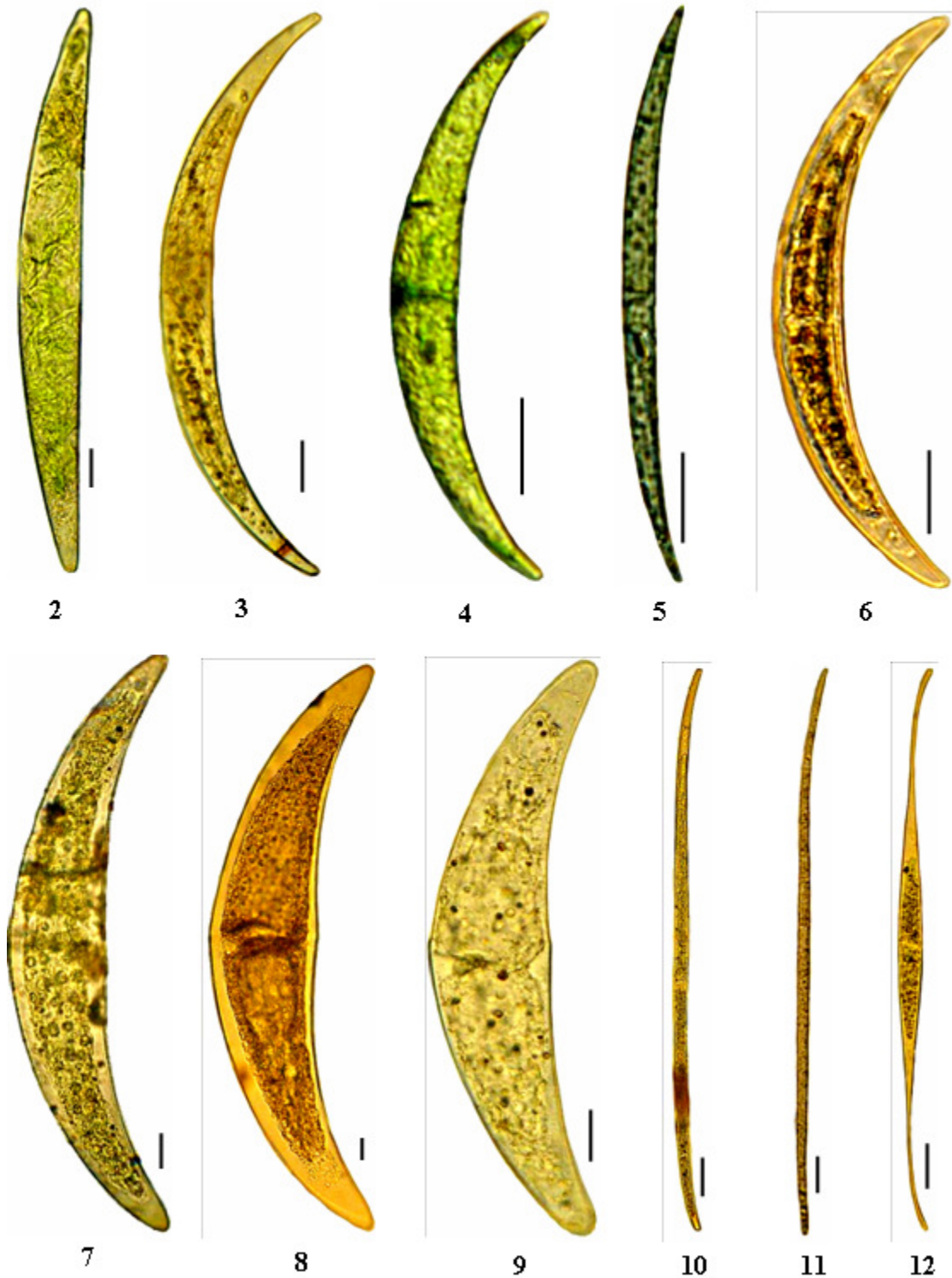
***Closterium lineatum* Ehrenberg ex Ralfs (Figure 13)** : Cells long and linearly narrow, 21-40 times the width ; median portion straight and cylindrical, gradually

tapered to incurved obliquely truncate apices; walls striate. L. 300-330 µm; W. 11-15 µm. Phytogeographical distribution cosmopolitan; area of collect: Adahidougou.

**\**Closterium littoral* Gay (Figure 14)** : Cells length are 9 to 11 times the width, slightly curved 35 to 50° of arc, ventral margin straight, or slightly swollen, tapered symmetrically to the often recurved apical region, the poles round ; chloroplast with 6 to 11 longitudinal ridges and 3 to 10 axial pyrenoids. L. 295.7-312 µm; W. 23-28.6 µm. Phytogeographical distribution sub cosmopolitan; area of collect: PALMCI-Boubo.

***Closterium macilentum* Brébisson (Figure 15)** : Cells length are 24 to 40 times the width, approximately straight with parallel margins. Slightly curved inward in the apical region, curvature 35 to 50° of arc ; poles truncate and with an inner wall thickening ; wall smooth ; chloroplast with a few longitudinal ridges and with from 6 to 14 pyrenoids in a series ; terminal vacuoles with 2 to 10 granules, L. 250-268 µm ; W. 10.2-12.7 µm. Phytogeographical distribution cosmopolitan ; area of collect: Adahidougou.

***Closterium moniliferum* (Bory) Ehrenberg ex Ralfs var. *moniliferum* fo. *moniliferum* (Figure 16)** : Cells generally large and strongly curved, 105-150° of arc; ventral margin slightly swollen in the median portion, and strongly attenuated to truncate acute rounded apices ; cell wall smooth ; 7-10 pyrenoids in the central chloroplast ridge; in some forms pyrenoids are many and scattered. L. 186.2-210.5 µm; W. 30-40 µm. Phytogeographical distribution cosmopolitan; area of collect: PALMCI-Boubo.



**Figures 2-12 :** 2- *Closterium acerosum* ; 3- *Closterium archerianum* ; 4- *Closterium calosporum* ; 5- *Closterium cornu* var. *javanicum* ; 6- *Closterium cynthia* ; 7- *Closterium ehrenbergii* var. *ehrenbergii* ; 8- *Closterium ehrenbergii* var. *malinvernianum* ; 9- *Closterium ehrenbergii* var. *michailovskoense* ; 10- *Closterium gracile* var. *gracile* ; 11- *Closterium gracile* var. *elongatum* ; 12- *Closterium kuetzingii* var. *kuetzingii* fo. *kuetzingii*.

**\**Closterium moniliferum* var. *concovum* Klebs fo. *concovum* (Figure 17)** : Cells length are 5 to 7 times the width and strongly curved than the typical, 115 to 120° of arc, the ventral margin straight in the midregion, or concave ; chloroplasts 6-8 pyrenoids in a row by midregion. L. 140-156 µm W. 28.6-38 µm. Phytogeographical distribution cosmopolitan; area of collect: PALMCI-Boubo.

**\**Closterium nordstedtii* Gutwinski (Figure 18)** : Cells length are 25 to 40 times the width , almost straight or slightly curved more slender than the typical ; 10-11 pyrenoids in chloroplasts by midregion. L. 190-212 µm; W. 11-19.6 µm. Phytogeographical distribution cosmopolitan; area of collect: Divo.

***Closterium parvulum* Nägeli (Figure 19)**: Cells length are 7 to 15 times the width, strongly curved, 110-170° of arc, ventral wall concave or straight in the midregion, gradually attenuated to the apical region, the poles sharply rounded and often with an inner thickening of the wall; chloroplast with 3 or 6 longitudinal ridges and with from 2 to 6 axial pyrenoids. L. 113-145 µm; W. 12.7-17 µm. Phytogeographical distribution cosmopolitan; area of collect: Adahidougou.

***Closterium setaceum* Ehrenberg ex Ralfs (Figure 20)** : Cells slender, median portion fusiform ;whose length is 16-30 times the width, tapers abruptly into long slender and cylindrical processes longer than the swollen median portion and nearly straight except at their incurved obtuse apices; chloroplast with 4-6 pyrenoids restricted to the midregion. L. 320-385 µm; W. 14.3-16.8 µm. Phytogeographical distribution cosmopolitan; area of sample: PALMCI-Boubo.

**\**Closterium strigosum* var. *elegans* (G.S. West) Krieger (Figure 21)** : Cells length are 11-12 times the

width ; slightly bent, 20-30° of arc; ventral margin straight or very slightly tumid ; poles slightly incurved with narrow sub acute apices ; chloroplast with 5-10 pyrenoids by midregion. L. 135-150; W. 7.4-9.5 µm. Phytogeographical distribution cosmopolitan; area of collect: Adahidougou.

**\**Closterium tacomense* Prescott (Figure 22)** : Cells relatively large, 10 to 15 times the width, lunar curved, to 135° of arc, the ventral margin straight or very slightly tumid in the midregion abruptly curved near the apices, attenuated in the apical region to be rounded poles ; chloroplast with 6 longitudinal ridges and 3 pyrenoids in series. L. 345-368.8 µm; W. 40-47 µm. Phytogeographical distribution cosmopolitan; area of collect: Adahidougou, Divo, Mé, Mafou, PALMCI-Boubo.

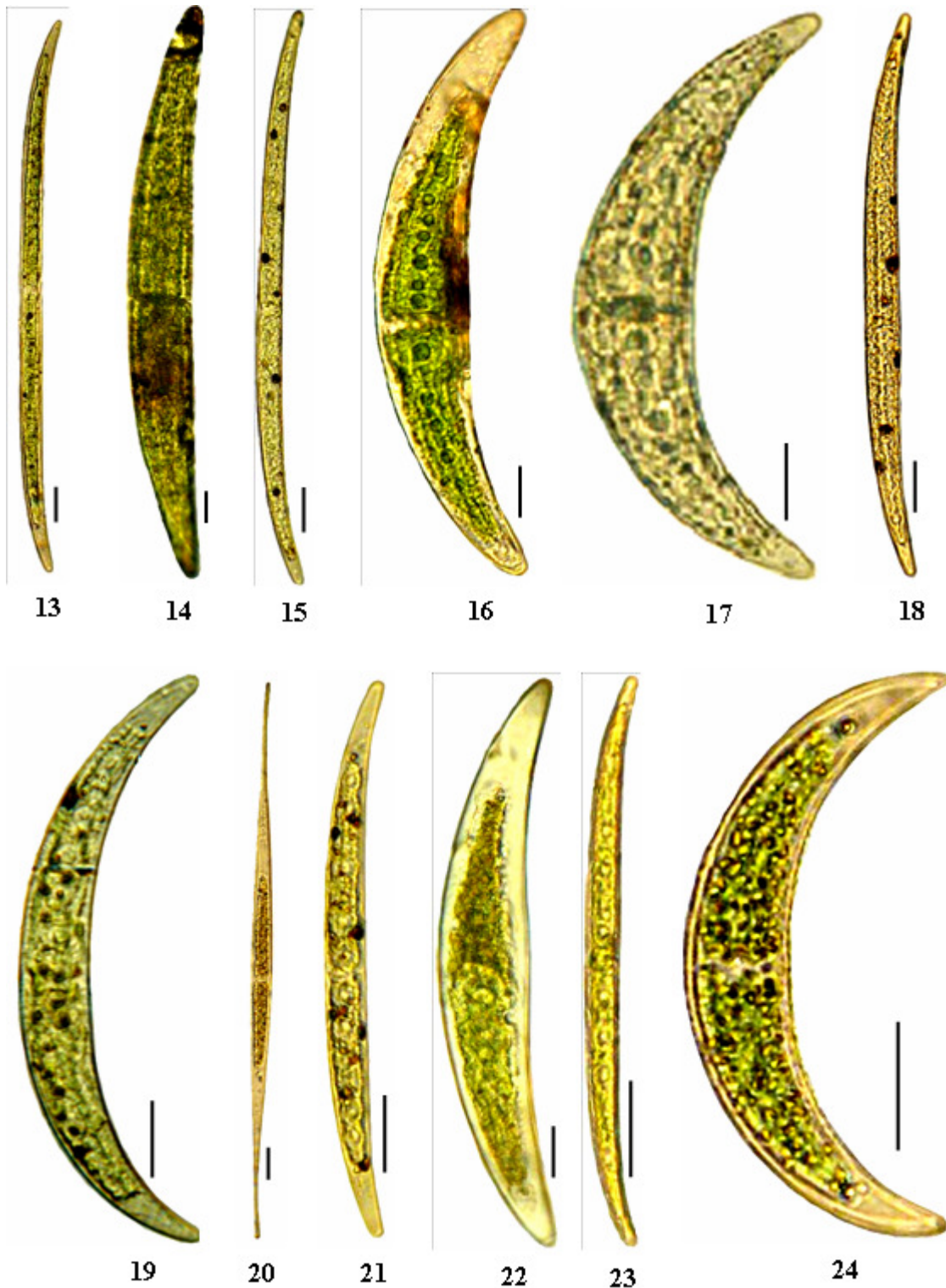
***Closterium toxon* W. West (Figure 23)** : Cells length are 13 to 30 times the width, straight in the midregion parallel margins, apical region inwardly curved, curvature 10 to 35° of arc broadly truncate ; chloroplast 4 to 9 pyrenoids. L. 160-168 µm; W. 6.5-20 10-12 µm. Phytogeographical distribution cosmopolitan; area of collect: PALMCI-Boubo.

***Closterium venus* (Kützing) Ralfs (Figure 24)**: Cells length are 6 to 10 times the width, strongly curved with 150 to 160° of arc dorsal margin convex, the ventral always concave, not inflated in the midregion, gradually attenuated toward the apical region, the poles acutely rounded, with a thickening of the inner wall in the dorsal side of the apex; wall colorless to somewhat brownish, smooth; chloroplast with 1 longitudinal ridge and 1 or 2 pyrenoids. L. 70-91.5 µm; W. 10-16 µm. Phytogeographical distribution cosmopolitan; area of collect: PALMCI-Boubo.

## DISCUSSION

The twenty three taxa collected in rivers and Me Boubo present unequal distribution of large phytoplankton in the determinations of the two rivers. Although nearly all cosmopolitan like in Komoé's work (2007), almost all of these species, varieties and forms were sampled from the river Boubo. This richness could be explained by

the fact that this river receives more especially waste from the watershed and the many agro-industrial plantations (palm grove, rubber) that surround it. Station PAMLCI-Boubo explains the abundance of taxa identified.



**Figures 13-24 :** 13- *Closterium lineatum* ; 14- *Closterium littorale* ; 15- *Closterium macilentum* ; 16- *Closterium moniliferum* var. *moniliferum* fo. *Moniliferum*; 17- *Closterium moniliferum* var. *concavum* FO. *concavum* ; 18- *Closterium nordstedtii* ; 19- *Closterium parvulum* var. *parvulum* fo. *parvulum* ; 20- *Closterium setaceum* ; 21- *Closterium strigosum* var. *elegans* ; 22- *Closterium tacomense* ; 23- *Closterium toxon* ; 24- *Closterium venus*

## CONCLUSION

This study is a draft that outlines the very incomplete wealth of algal in southern Côte d'Ivoire, particularly the order of Desmids. Specimens of this kind are able to proliferate in the acidic and rich inorganic matter, thus

able to determine water quality. This article, although brief, is a partial contribution to the inventory of the existing diverse algal flora in the freshwater of the rivers Boubo and Mé.

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