



Bacillariophyceae (Heterokontophyta) from Bandama River in Côte d'Ivoire, West Africa

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1 SUMMARY

The main purpose of this study was to provide taxonomic and floristic accounts of Bacillariophyceae (Heterokontophyta) occurring in the Bandama river. The phytoplankton samples were collected with 20 µm mesh wide plankton net in four stations. 26 taxa were identified, distributed among 14 genera, 12 families and 1 order. Genera *Nitzschia* and *Pinnularia* with respectively 19 and 11% are best represented among all taxa identified. 35% of taxa were collected as the station St1. This study has improved the knowledge of the algae populations of the Bandama River. Twelve of these taxa have not been reported previously in Côte d'Ivoire. Results of this study can be used for teaching and algae taxonomy studies.

2 INTRODUCTION

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. Phytoplankton is usually at the base of aquatic food web and is the most important factor for production of organic matter in aquatic ecosystem. The study of freshwater algae in Côte d'Ivoire is recent. The literature of freshwater algae of Côte d'Ivoire is scarce and limited to a few areas. Vast areas (rivers) remain unexplored. However, the inventory works were conducted by Traoré (1979b), Ouattara *et al.* (2000 and 2001) and Grogga (2012) in large hydroelectric reservoir; Kouassi *et al.* (2010)

and Adon *et al.* (2012) in shallow or small reservoir (Kossou, Ayamé and Taabo respectively); Iltis (1982a, b), Lévêque *et al.* (1983) and Da *et al.* (2009) on the Bandama River. The present study contributes to the knowledge of the taxonomic composition of phytoplankton from Bandama river, especially some planktonic Bacillariophyceae (Heterokontophyta), including original pictures. Indeed, the key to the base of the food pyramid position, gives a fundamental role in phytoplankton and its study appears essential to better understand the functioning of aquatic systems. This systematic study is a contribution to the study of the main link which, to our knowledge, has been very little previous study at the Bandama river despite work already done.

3 MATERIAL AND METHODS

3.1 Study area: Study area ($4^{\circ}50'$ - $6^{\circ}30'$ W; $5^{\circ}30'$ - $7^{\circ}50'$ N) is located in means stream of Bandama River (97500 km², 1050 km long). The region is characterized by an equatorial of transition climate with two rain seasons (April-June and September-November) and two dry seasons (July-August and December-March).

Two dams were built for hydroelectric power, Kossou in 1972 and Taabo in 1978 (Traoré, 1996). Four sampling stations (St1 and St2: Lake of Taabo; St3: Lake of Kossou and St4: Marahoué) were selected for this study (Figure 1).

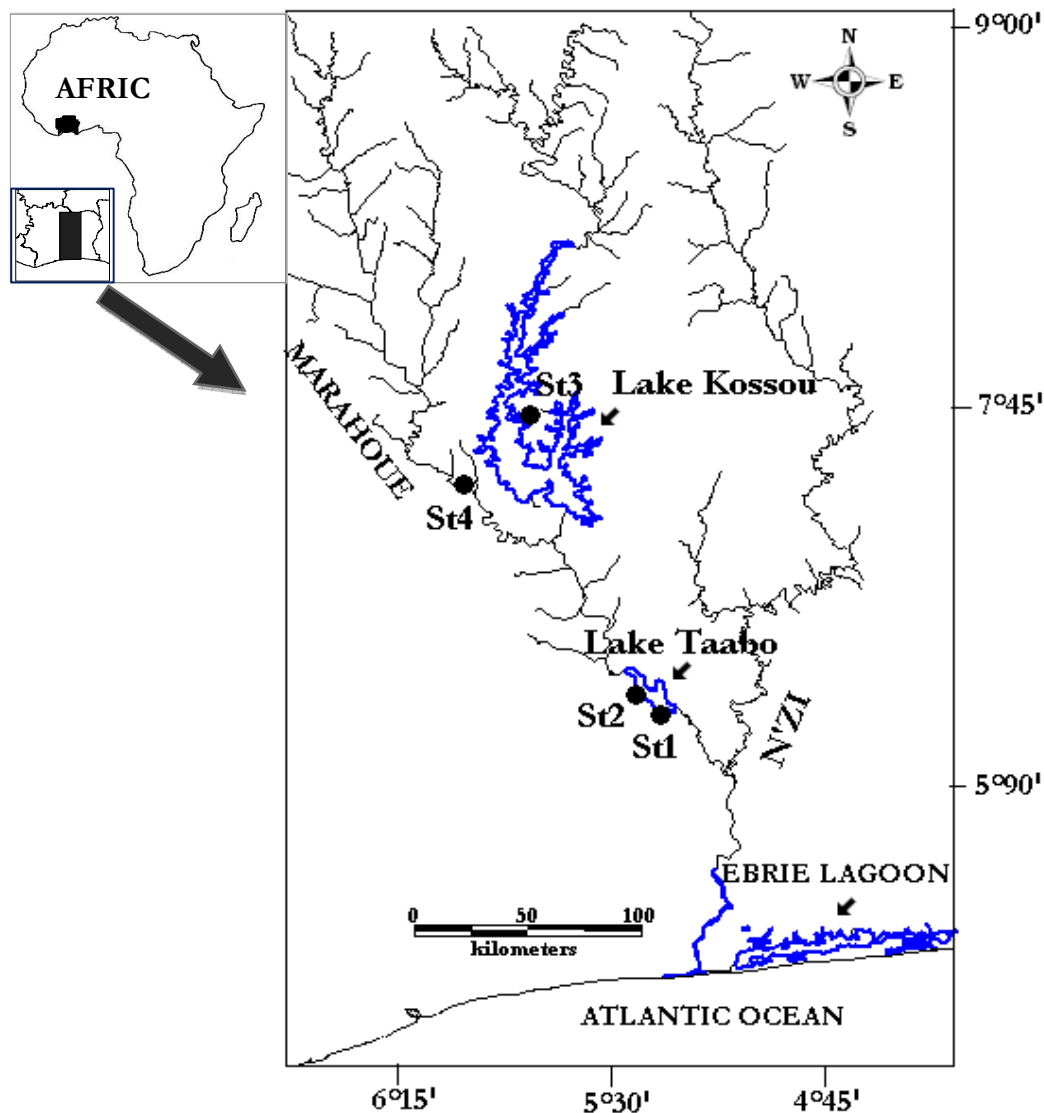


Figure 1: Map showing the sampling in the Bandama River, Côte d'Ivoire.

3.2 Collection of specimen: The phytoplankton samples for qualitative analyses were collected with 20 µm mesh plankton net

at every sampling station from October 2008 to September 2009. The samples were transferred into plastic vessel (50 ml) and stored



immediately in 5% formaldehyde. The different samples of phytoplankton samples were realized according to physico-chemical parameters. At each site some physico-chemical properties of water were measured *in situ*. Water temperature and pH were measured with a PH 300/310 pH-meter. Conductivity and substances dissolved were measured using portable meter (CON 400/410) and dissolved oxygen (DO 330).

4 RESULTS AND DISCUSSION

The water temperatures varied between 26, 20°C and 32, 10 °C and the pH values ranged between 6, 42 and 7, 96. Conductivity and substances dissolved values varied from 74, 45 to 129, 65 µS/cm and from 37, 3 to 58, 88 mg/l respectively. Lower dissolved oxygen value (2, 06 mg/l) was recorded at St4. High dissolved oxygen value (5, 59 mg/l) was recorded at St3.

Taxonomic remarks: The different species observed are described alphabetically. New taxa to the algal flora of Côte d'Ivoire are designated with one asterisk (*). Rule scale bars in illustrations represent 10µm.

Acanthoceras zachariasii (Brun) Simonsen

Cells free, solitary, valve elliptico-lanceolate, with elevation angles to each of the two valvate devoid of pseudocelle. Frustules cylindrical and ringed for connective view, with two long divergent on each side. The cingulum has many connective bands (**Figure 2**). Dimension without the bristles 19 x 16 µm; station St2.

* *Discotella pseudostelligera* Hustedt

Cells heterovalvar, shortly cylindrical frustules, 5–8 mm in diameter. Central area occupies half the valve diameter and is ornamented with a ring of areolae or short striae surrounding an isolated central areola. The striated marginal area has 20–24 (28) striae in 10 µm (**figure 3**). Station: St1

Frustulia saxonica Rabenhorst

Valve lanceolate and Rhombo-lanceolate, rhombic in outline. Ends rounded and rostrate.

3.3 Identification and taxonomy: A drop of water samples was taken and fixed mounted on a thin section then dried in an oven. Supra 40 VP Zeiss Scanning Electron Microscope (SEM) were used for observations. The authors consulted for species identification were Bourrelly (1961a, 1981), Compère (1975, 1991), Germain (1981), Da (2007), Jiunn-Tzong (2009) and Faria (2010).

Raphe is straight, striae 31 in 10 µm (**figure 4**), Dimensions: 57,40 x 13,53 µm. Station : St4.

* *Nitzschia dakariensis* Guermeur

Valves measure 26.17 x 3.02 µm and are linear, capitate at the poles. They have 7-12. Keel puncta and 20-25 striae in 10 µm (**Figure 5**). Station: St4.

* *Nitzschia intermedia* Hantzsch

Valves linear are 42,10 µm long and 3,46 µm wide. 6-10 keel puncta and 25-28 striae in 10 µm (**Figure 6**). Station St3.

Nitzschia palea (Kützinger) Smith

Valves linear-lanceolate or lanceolate; Poles shortly rostrate, subrostrate or subcapitate. keel puncta distinct. Valve surface striate, striae uniseriately punctate, parallel (**figure 7**). Dimension: 3-6 × 23-26 µm, station: St1.

* *Nitzschia tarda* Hustedt

Valves linear largely attenuated the poles. 8-13 keel puncta and 26-30 striae in 10 µm (**Figure 8**). Dimensions: 38.19 x 3.21µm, station: St4.

* *Nitzschia umbonata* (Ehrenberg) Lange-Bertalot

Valves are linear slightly constricted middle, usually well marked median nodule. 7-10 keel puncta and 24-30 striae in 10 µm (**Figure 9**). Dimensions: 37 x 3, 51 µm, station: St3.

Placoneis exigua (Gregory) Mereschowsky [= *Navicula exigua* Gregory]

Valves elliptical-lanceolate with ends rostrate-subcapitate. striaes 14 in 10 µm (**figure 10**). Dimension 11 31,1 µm, station : St1.

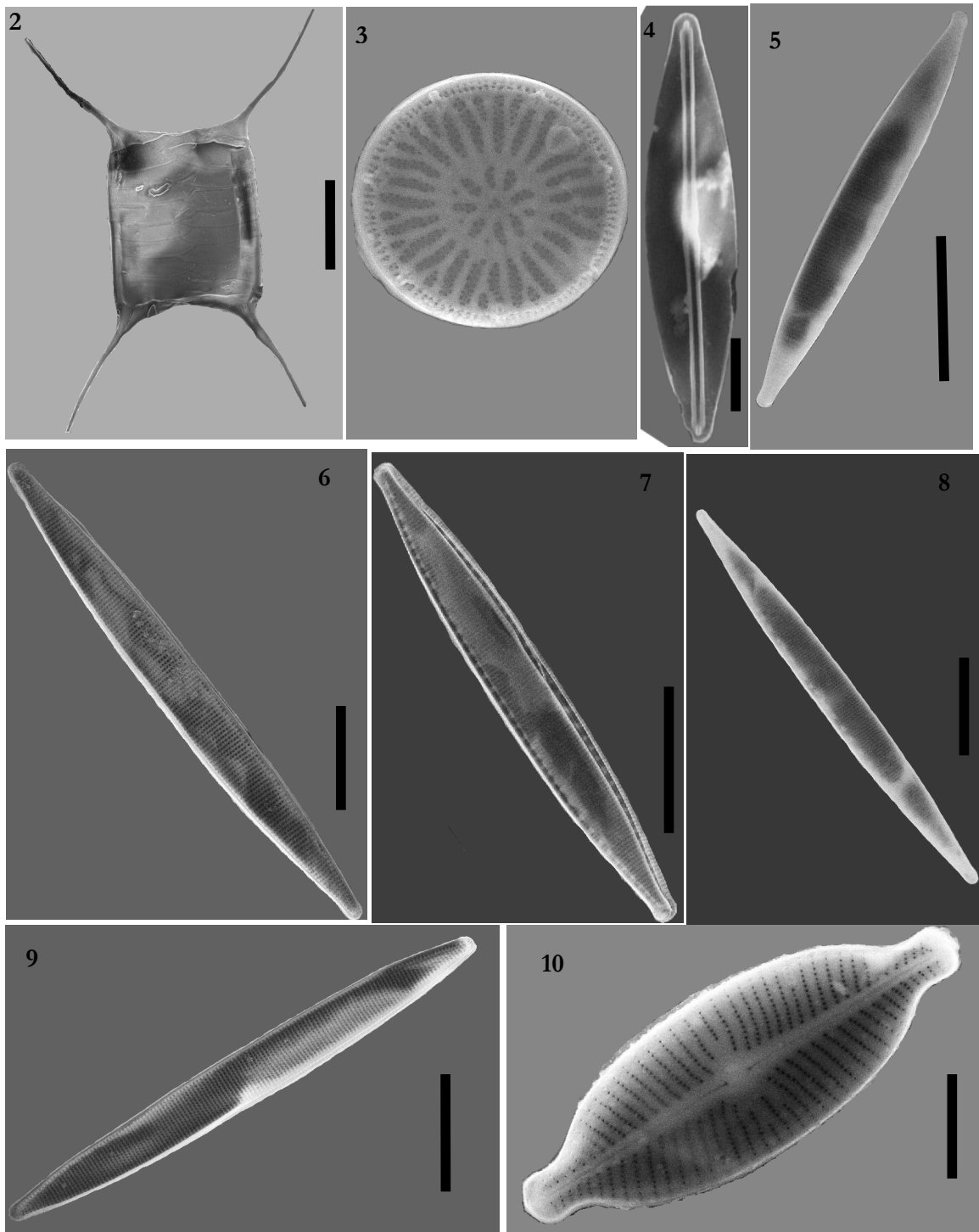


Figure 2-10 : 2- *Acanthoceras zachariasii* (Brun) Simonsen, 3 - *Discotella pseudostelligera* Hustedt, 4 - *Frustulia saxonica* Rabenhorst, 5 - *Nitzschia dakariensis* Guermeur, 6 - *Nitzschia intermedia* Hantzsch, 7 - *Nitzschia palea* (Kützing) Smith, 8 - *Nitzschia tarda* Hustedt, 9 - *Nitzschia umbonata* (Ehrenberg) Lange-Bertalot, 10 - *Placoneis exigua* (Gregory) Mereschowsky.



***Placoneis* aff. *gastrum* (Erhenberg) Mereschkowsky** [= *Navicula gastrum* (Ehrbg.) Kützing]

Valves elliptical-lanceolate, ends obtuse-rostrate. Raphe at each end of the valve is curved. Middle striae are different; we have alternating short and long striae, transapical striae 8-10 in 10 µm (**Figure 11**). Dimension: 35,6 x 19,8 µm, station : St2.

***Diadesmis confervacea* Kützing** [= *Navicula confervacea* (Kützing) Grunow in VAN Heurck] Valve broadly lanceolate to elliptic lanceolate with rounded apices. Raphe straight. Central raphe endings slightly expanded. Striae slightly radiate, comprised of distinct pores that are sometimes slightly elongate in a transapical direction. (**Figure 12**). Stria 22-30 in 10 µm. Dimensions: 15-20 × 5-8 µm ; station : St2.

****Luticola dismultica* (Hustedt) Mann**

Valves elliptical, ends rounded. Raphe is curved at the center of the valve, ends curving in the same direction. Axial area is narrowed and central area transversely extended to the sides. Punctate striae (striae 14-20 in 10 µm), converge towards the end of the valve (**Figure 13**). Dimensions: 11,11 x 4,55 µm, station : St3.

****Eunotia minor* (Kützing) Grunow in Van Heurck**

Dorsal edge of frustules is bent with the end curved; stiae 13-17 in 10 µm (**Figure 14**). Dimension: 26-45 x 5-8 µm, station St2.

****Gomphonema clavatum* Ehrenberg**

Valves heteropolar, asymmetrical to transapical. Apices rounded to broadly sub-rostrate. Raphe slightly sinuous. Striae 10 in 10 µm (**Figure 15**). Dimension: 66 x 15,3 µm, station: St1.

***Gomphonema gracile* Ehrenberg**

Valves lanceolate, narrowed since the mid to ends. Transapical striae 9-17 in 10 µm (**Figure 16**). Dimension: 25-70 x 4-11 µm, station: St4.

***Navicula cryptocephala* Kützing**

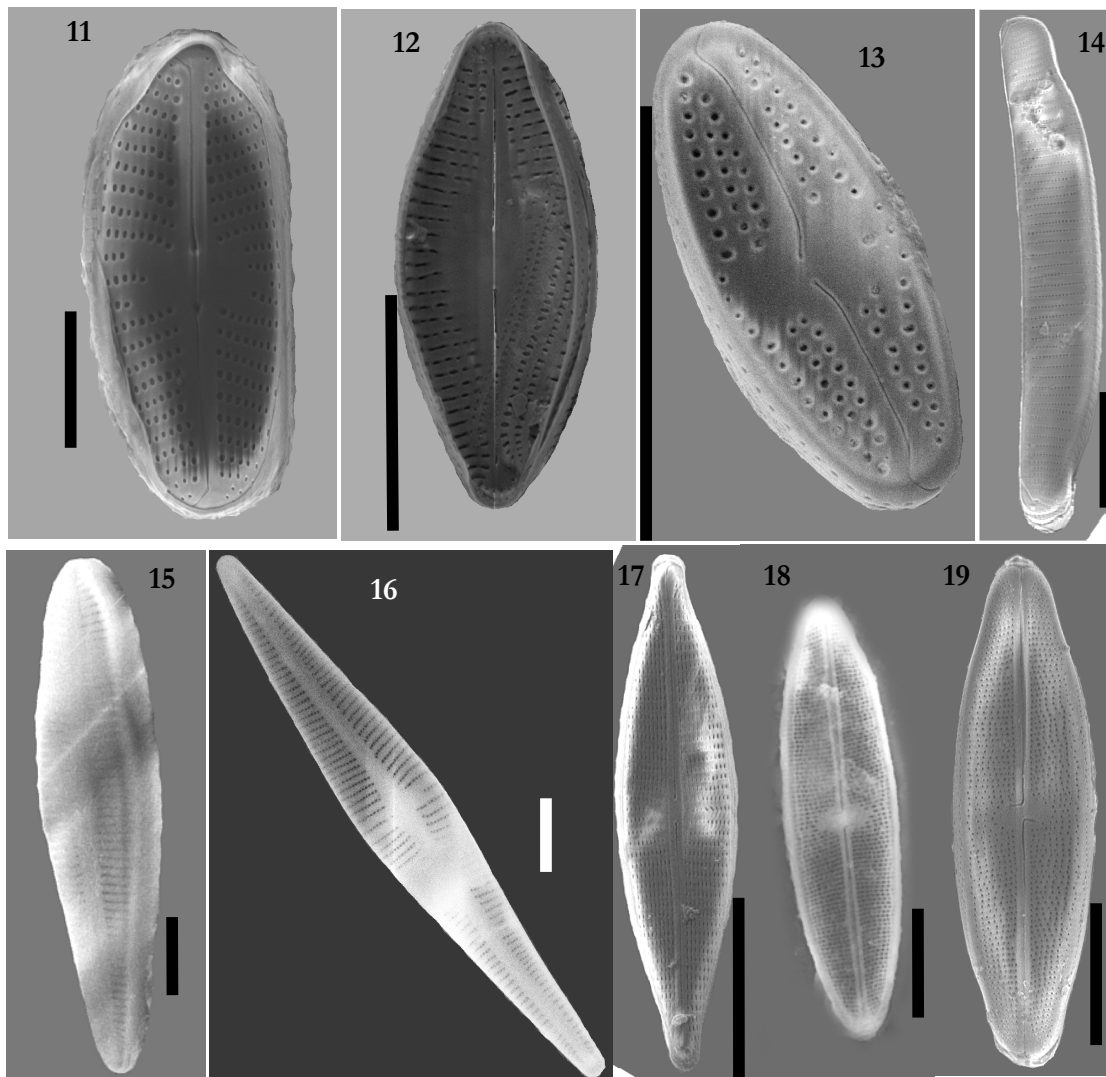
Valves broadly lanceolate; ends obtuse. Axial area narrow; slightly widened towards the center of the valve. Raphe straight; proximal ends closed. Central area small, orbicular. Striae uniseriately punctate, radiate centrally, parallel or slightly convergent at the ends. Striae 17 in 10 µm (**Figure 17**). Dimension: 27,5 x 6,8 µm, station : St3.

****Neidium ampliatus* (Ehrenberg) Krammer**

Valves linear, ends rostrate. Transapical striae (18-22 in 10 µm) are finely punctate (**Figure 18**). Dimension: 39,49 x 10,29 µm, station : St1.

****Neidium hercynicum* Mayer**

Valves elliptical, ends rostrate and apiculate. Transapical striae (20-24 in 10 µm) are clearly oblique (**Figure 19**). Dimension: 36,4 x 10 µm, station : St2.



Figures 11-19: 11-*Placoneis* aff. *gastrum* (Erhenberg) Mereschkowsky, 12-*Diadesmia confervacea* Kützing, 13-*Luticola dismutica* (Hustedt) Mann, 14-*Eunotia minor* (Kütz.) Grunow, 15-*Gomphonema clavatum* Ehrenberg, 16-*Gomphonema gracile* Ehrenberg, 17- *Navicula cryptocetabula* Kützing, 18-*Neidium ampliatus* (Erhenberg) Krammer, 19- *Neidium bercynicum* Mayer.

****Pinnularia apendiculata* (Agardh) Cleve**

Valves linear, ends slightly rostrate, axial area narrow. Striae 15 in 10 microns (**Figure 20**). Dimension: 41 x 7.5 µm, station: St4

***Pinnularia interrupta* Smith**

Valve linear to slightly narrowly lanceolate, ends subcapitate. Axial area broad, striae strongly radiate at the center of the valve, convergent towards the ends, lacking in central area. Striae 10-12 in 10 µm (**Figure 21**). Dimension: 41x6,7 µm, station : St3.

****Pinnularia microstauron* Ehrenberg**

Frustules are reversed by striae, ends rostrate. Striae 10-13 in 10 µm (**Figure 22**). Dimension: 10.2 x 48 µm ; station: St1.

***Sellaphora pupula* (Kütz.) Mereschkowsky**
 [= *Navicula pupula* Kützing]

Valves lanceolate, ends broadly, obtusely rostrate. Raphe central, straight, lied between two thickened ribs; distal ends curving in the same direction. Striae 18-26 in 10 µm. (**Figure 23**). Dimension: 6-10 x 23-35 µm, station: St1.

***Craticula cuspidata* (Kützing) Mann**
 [= *Navicula cuspidata* Kützing]



Valves rhombo-lanceolate. Transapical striae (14-15 in 10 microns) are perpendicular to the raphe. Longitudinal striae 25 in 10 μm (**Figure 24**). Dimension: 44.8 x 207.9 μm , station: St1.

***Stauroneis phoenicenteron* (Nitzsch) Ehrenberg**

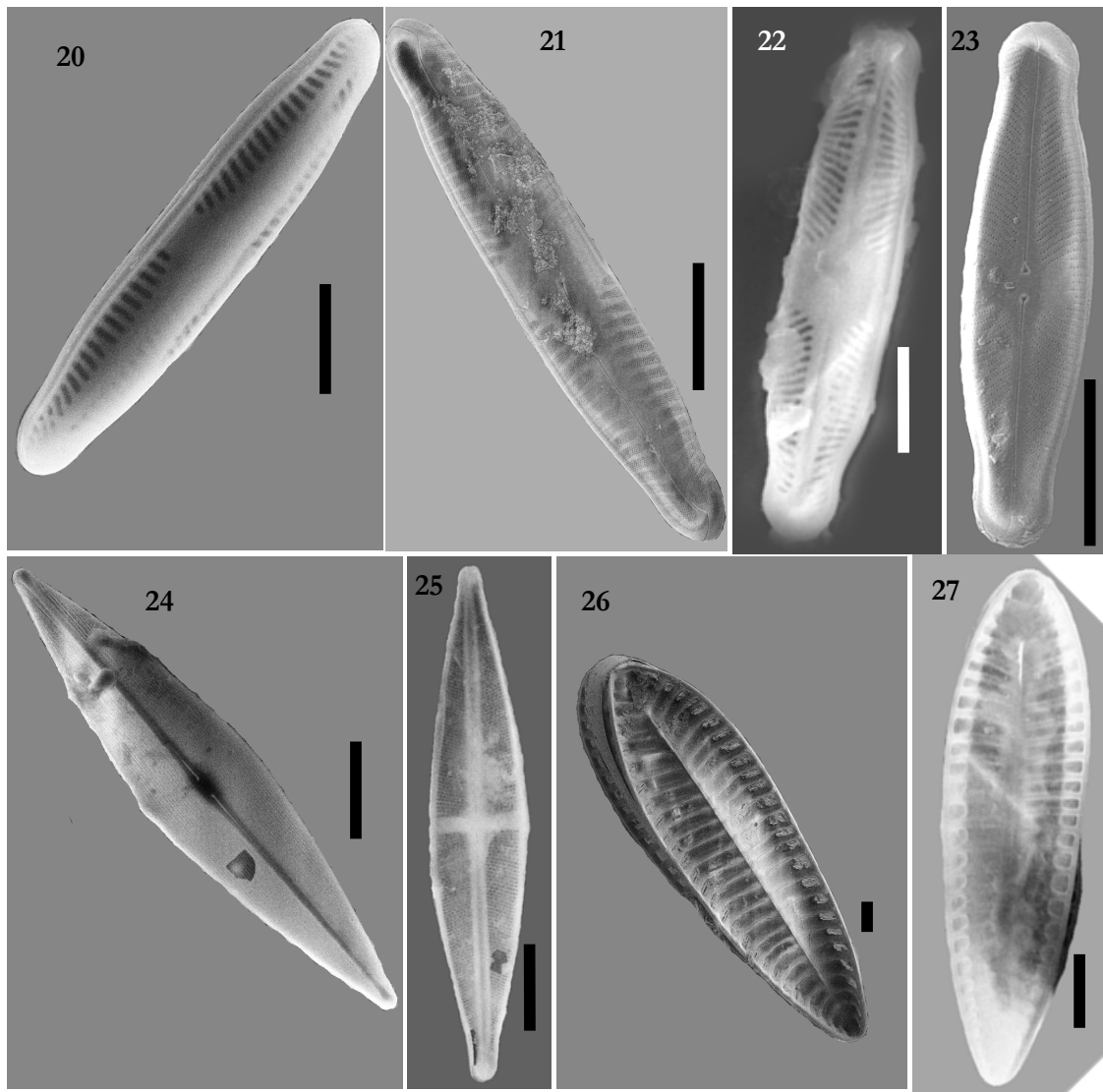
Valves lanceolate attenuated and rounded at the ends. Transapical striae 12-18 in 10 μm (**Figure 25**). Dimensions: 59.7 x 12.03 μm , station: St4.

***Surirella elegans* Ehrenberg**

Valves elliptical and heteropolar. They measure 33 x 117.6 to 127 μm (**Figure 26**), station St3.

***Surirella tenera* Gregory**

Valves elliptical, heteropolar, wings developed. They measure 67-100 x 23-30 μm and are 20-30 ribs in 10 μm (**Figure 27**). Station St1



Figures 20-27 : 20- *Pinnularia apendiculata* (Agardh) Cleve, 21- *Pinnularia interrupta* Smith, 22- *Pinnularia microstauron* Ehrenberg, 23- *Sellaphora pupula* (Kütz.) Mereschkowsky, 24- *Craticula cuspidata* (Kütz.) Ehrenberg, 25- *Stauroneis phoenicenteron* (Nitzsch) Ehrenberg, 26- *Surirella elegans* Ehrenberg, 27- *Surirella tenera* Gregory.

5 CONCLUSION

Twenty-six taxa belonging to 14 genera, 12 families were identified in this study. Of these, 12 taxa are new for Côte d'Ivoire. Genera *Nitzschia* and *Pinnularia* with 30% and 27%

respectively are best represented among all taxa identified. The station St1 where we collected the most taxa.

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