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RESEARCH ARTICLE

NEW RECORDS AND RARE TAXA FOR THE FRESHWATER EPILITHIC DIATOMS OF CÔTE D'IVOIRE

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Abstract

The aim of the present study was to contribute to knowledge of the freshwater epilithic diatoms flora of Côte d'Ivoire. Diatoms were sampled in February and July 2012 on glass slides previously immersed during a period of 30 days at ten stations.The species composition of new and rare taxa was compiled, accompanied by illustrations. Forty two taxa distributed among 16 genera, 8 families and 5 orders were recorded in the temporal survey.Based on species occurrence frequency, 32 rare, 2 occasional, and 8 common species were registered. According to geographic distribution, taxa recorded were mostly cosmopolitan (47.72%) and tropical (43.18%), while 9.09% were endemic.Taking into account their affinity towards pH, 3 classes of diatoms : acidophilic taxa (35.47%), indifferent taxa (59.52%) and alkaliphilic taxa (4.76%)were found in the Mé River.

Introduction:-

Diatoms are an important group of algae in freshwater habitats worldwide. They are a major group of the algae and are one of the most common types of periphytic organisms in fresh water (Wehr and Sheat, 2003). Unicellular, eukaryotic algae, best known for their characteristic silica-based cell wall called a frustule,they are a major food source for grazing protozoa and animals (Mann and Droop,1996). Fast-reproducing organisms, most diatoms are widespread on different substrates and are closely associated with a certain microbiotope(Stenger-Kovacs et al., 2014). Diversity and systematics of these algae have been relatively well studied inRegions such as Europe (e.g.Krammer and Lange-Bertalot, 1986, 1998;Levkov,2009, Varol et al., 2018 andVan de Vijver et al., 2020among many others) and America (e.g.Morales and Vis, 2007; Wetzelet al., 2011;Rodrigues dos Santosand Ferragut, 2018;Ruwer and Rodrigues 2018; Bartozek et al.,2018;Fonseca et al.,2019 andAlves de Oliveira et al.,2020). Studies on diatoms in tropical West Africa areas are less frequent than Ameria and Europe zones. The known studies include Zanon (1941) in French West Africa, Foged (1966, 1986) in Ghana and Gambia, Cholnoky (1968) in south Africa, Carter and Denny (1982, 1987, 1992) in Sierra Leone, Compère (1991) on Lake Guiers in Senegal and Compèreand Riaux-Gobin (2009) in Guinea.

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In the specific case of Côte d'Ivoire, the diatoms have not been well studied yet. The literature is scattered and focused most often on lagoon ecosystems: Bourrelly (1961), Couté and Iltis (1985) at the Ébrié lagoon, Komoé et al. (2016) in the lagoon complex of Grand-Lahou and Konan et al. (2018) in fresco lagoon. These organisms are not sufficiently documented from rivers and streams and limited to works ofDa et al. (2004, 2009), Ouattara et al. (2000), Niamien-Ébrottié et al. (2013) and Kouassi et al. (2021).

The aim of the present study was to contribute to knowledge of the freshwater epilithic diatoms flora of Côte d'Ivoire, with special attention to ecology of new records and rare taxa from the Mé River.

Material and Methods:-

Description of study area

The Mé River is located in the south of Côte d'Ivoire. It rises in the North of Adzopé flows into the Poto lagoon in the North of Grand Bassam, with a catchment area of 4.300 km^2. Ten sampling sites were selected (Figure 1, Table 1). Epilithic diatoms were sampled in 2012, during the dry season (February) and the rainy season (July) simultaneously with physicochemical parameters.

Physicochemical Parameters

Physicochemical parametersincluded pH, dissolved oxygen, conductivity and temperature were measured in situ at each site using a HANNA HI 982804 multiparameter, and a mobileHANNA HI 98703 turbidimeter. At the same time, 500 ml of water was sampled in a free flowing area of the river, using a labelled plastic bottle and then cooled with ice in order to perform analysis with a photometer. Ionic compounds, including nitrates, Orthophosphates, silica were determined by the Hydrobiology unit of the Félix Houphouët-Boigny University using HANNA HI 83200, HANNA 736, HANNA HI 764 and HANNA HI 770 instruments.

Diatoms preparation and Data analysis

Diatoms were sampled on glass slides (76×26×1 mm) previously immersed during a period of 30 days. Ten slides were maintained in a cage made of polystyrene (38×13×6 cm), in the photic zone. After the immersion period, the cage was removed from the river; the glass slides were scraped using a razor blade and the bio-film was poured into a vial with distilled water and a few drops of 10% formalin. According to standardised protocols (AFNOR, 2003, NF EN 13946) samples were first treated with hot hydrogenperoxide (H_2O_2; 30%) for 30 minutes, and then for five minutes with hot hydrochloric acid (HCl; 35%) to clean them thoroughly. The hydrogen peroxide and the acid wastes were eliminated through successive centrifugation cyclesof 3 minutes at 4 000 rpm. A sample of this preparation was dried and mounted between slide and cover slip using the resin Naphrax, with a high refractive index. Diatoms were identified using light microscopy (LM) (Leica-DMRB) at 100 × magnification and scanning electron microscopy (SEM).

Diatoms were identified at a specific or infraspecific level according to Foged (1966, 1986), Carter and Denny (1982, 1987, 1992), Krammer and Lange-Bertalot (1986, 1988, 1991a, b), Levkov (2009), Lange-Bertalot et al. (2011) (Krammer (2000, 2002, 2003).

On average, 50 organisms were used for measurements. The frequency of each species present was determined according to Dajoz (2000). Three frequency groups were distinguished according tovalue of F: Common species (1): F> 50% ; occasional species (2): 25% < F < 50 % ; rare species (3): F < 25%.

In taxonomic part, for each taxon, the latin name with author's name (s), a year of description and reference to the illustration (s) in the iconographic part are given. The morphology (Morph.) in which the length and width of valves and the number of striae or fibulae are also given. The stations where the taxon is observed and the geographic distributionof each taxon are also given in Distribution (Distr.) section. Finally,the environment conditions in which the taxon has been harvested based on our own observations is presented in Ecology (Ecol.) section. The taxa are arranged following the classification of Guiry and Guiry (2021).

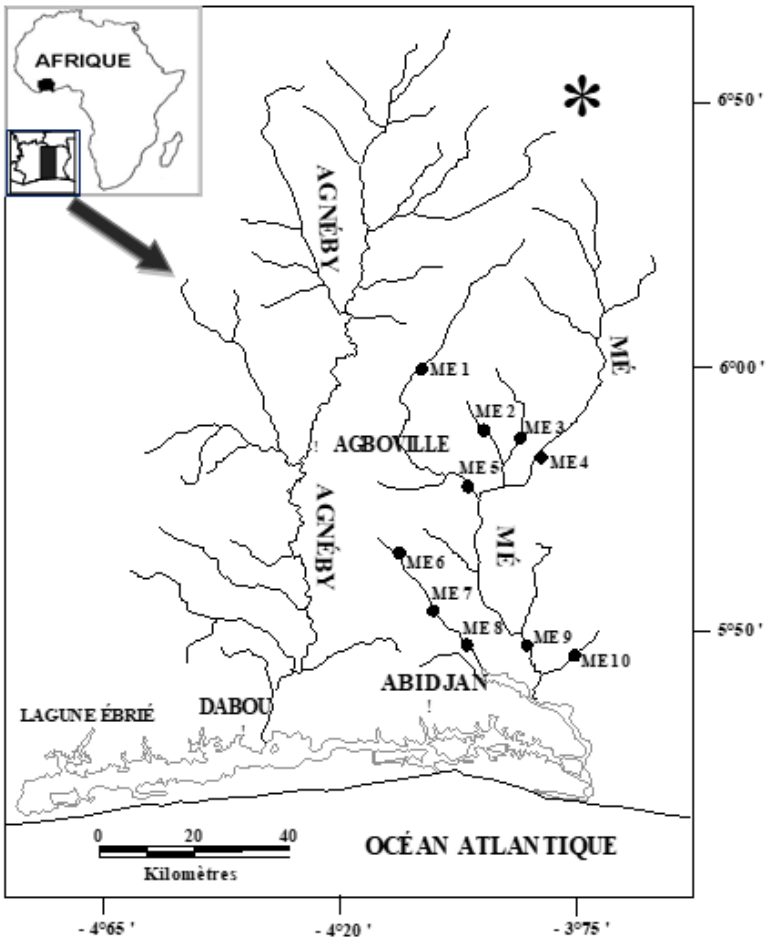

Figure 1:-Study area and location of sampling sites of river Mé in Côte d'Ivoire.

Table 1:- Geographical coordinates of ten sampling sites along the Mé River, Côte d'Ivoire.

Site code	Geographic coordinates	River or tributary	Locality
ME1	5°59'4.5''N-4°02'42.3''W	Mafou	Mafou-Boudépé road
ME2	5°52'40.9''N-3°54'37.8''W	Mambé	Abié-Lobo Opé road
ME3	5°52'27.9''N- 3°51'03.4''W	Mansan	Lobo Opé-Lobo Akoudzin road
ME4	5°50'25.5''N-3°49'01.4''W	Mé	Lobo Akoudzin-Kodioussou road
ME5	5°47'19.0''N-3°57'46.0''W	Mafou	Azaguié-Yakassé-mé road
ME6	5°38'15.1''N- 4°02'38.3''W	Abé	800 m from Azaguié corridor
ME7	5°31'34.7''N-4°02'49.7''W	Bété	800 m from Attiékoi
ME8	5°29'33.1''N-3°57'14.4''W	Bété	Bridge of Ahoué. Abobo-Baoulé- Ahoué road
ME9	5°28'26.3''N-3°50'00.9''W	Mé	5 km d'Ahoutoué Axe Ahoué-Ahoutoué
ME10	5°29'41.5''N-3°49'00.0''W	Ahoutoué	3.5 km from Ahoutoué- Ahoutoué-N'zodji road

Results and Discussion:-

Phylum: Bacillariophyta
Class: Bacillariophyceae
Order: Mastogloiales
Family: Achnanthaceae
Genus: Achnanthes
Achnanthes exiguavar.constricta Hustedt (1921)(Fig. 2A)
Morph.: Valve length: 14.7-16.4 µm, width: 4.5-6.5 µm, 7-10 striae in 10 µm; **Distr.:** ME2, M3, ME7 and ME9;

Ecol: This taxon grows in relatively warm (T=26.9°C), alkaline (pH=8.46), low mineralized (Cond=77.86) waters with nitrates, orthophosphates and silica concentrations around 28.6 mg/L; 0.73 mg/L and 18 mg/L respectively.

Order: Cymbellales
Family: Anomoeoneidaceae
Genus: Adlafia
Adlafia bryophila (Petersen) Lange-Bertalot (1994)(Fig.2B),
Basionym: Navicula bryophila Peterson (1928), Homotypic synonym: Navicula subtilissima var. bryophila (Peterson) Cleve (1934)
Morph.: Valve length: 10.9-17.2 µm, width: 2.9-4.1 µm, 20-24striae in 10 µm.; **Distr.:** ME2 and ME9; **Ecol:**This taxon is frequent in waters with concentrations of nitrates, orthophosphates and silica between 3.8 and 28.6 mg/L; 0.06 and 0.45 mg/L and 11 and 17 mg/L respectively, slightly mineralized (Cond=108.42), relatively hot (T=26.9°C) and alkaline (pH=8.46) waters

Family: Cymbellaceae
Genus: Cymbella
Cymbella asperavar.minor(Van Heurck) Cleve (1894)(Fig. 2C)
Basionym: Cymbella gastroides var. minor Van Heurck (1880).
Morph.: Valve length: 72.91 µm, width: 24.9 µm, 8-10striae in 10 µm; **Distr.:** ME8; **Ecol:**This taxon is frequent in the type locality, which corresponds to relatively shallow stream with warm (25.62°C), acidic< pH (5.99), relatively low conductivity (30 µS/cm) waters, in which concentrations of nitrates, orthophosphates and silica are 15.6; 0.05 and 10 mg/L respectively.

Genus: Geissleria
Geissleria schoenfeldii (Hustedt) Lange-Bertalot and Metzeltin (1996)(Fig.2D)
Basionym: Naviculaschoenfeldii Hustedt (1925), Homotypic synonyms: Navicula schoenfeldiiHustedt (1925), Navigeia schoenfeldii (Hustedt) Bukhtiyarova (2013), Placogeia schoenfeldii Bukhtiyarova (2013), Heterotypic synonym: Nitzschia schoenfeldii (Hustedt) Mills ((1934).
Morph.: Valve length: 12.1-24.2 µm, width: 25.6-6.6 µm, 13-16striae in 10 µm.; **Distr.:** ME2, ME3, ME4, ME5 and ME10; **Ecol:**This taxon is found in the current environment that presented a temperature of 27.9°C, slightly acidic to slightly alkaline pH (5.86 to 8.46),slightly to medium conductivity (39.14 to 137,14 µS/cm) and high concentration on nitrates (2.2 to 15.6 mg/L) and silica (10 mg/L).

Family: Gomphonemataceae
Genus: Encyonema
Encyonema moragoense (Foged) Krammer (1997)(Fig.2E)
Basionym:Cymbella moragoensisFoged (1966).
Morph.: Valve length: 16.4-18.6 µm, width: 5.3-5.9µm, 9-10striae in 10 µm ;**Distr.:** ME3; **Ecol:**This taxon occurs in acidic to neutral pH (6.26 to 7.08), medium conductivity (111.28 to 137.14 µS/cm) waters, which have high concentration of nitrates (7.3 to 8 mg/L) and silica (8 to 18 mg/L).

Genus: Gomphonema
Gomphonema acidoclinatiforme Metzeltin and Lange-Bertalot Metzeltin et al.(2002)(Fig.2F)
Morph.: Valve length: 29.8-45.3µm, width: 5.1-8.4 µm, 12-13striae in 10 µm ;**Distr.:** ME9; **Ecol:**This species have preference for acidic (pH: 5.58 to 6.42), high nutrient content (nitrates : 3.8 to 28.6 mg/L, silica :11 to 17 mg/L) and medium conductivity (76 to 87.5 µS/cm) waters.

Gomphonema africanumG.S. West (1907)(Fig.2G)
Morph.: Valve length: 25.7-55.3 µm, width: 7.2-9.7µm, 8-11striae in 10 µm ;**Distr.:** ME1.**Ecol:**This taxon, also planktic, is commun in slightly acidic (6.45), high oxygen (7-9 mg/L) and high nutrient content (nitrates : 22.6 mg/L, silica :14 mg/L) waters.

Gomphonema guaraniarum Metzeltin and Lange-Bertalot (2007)(Fig. 2H)
Morph.: Valve length: 27.9-37.3 µm, width: 4.6-6.7 µm, 10-11striae in 10 µm ;**Distr.:** ME10; **Ecol:**Gomphonema guaraniarumprefers type of locality in which pH is acidic (5.91 to 6.38), medium conductivity (88.5 to 96.73 µS/cm) with moderate content of nitrates (1.6 to 3.1 mg/L).

Gomphonema lagenulaKützing (1844)(Fig. 2I-J)
Morph.: Valve length: 16.2-28.7 µm, width: 5.1-8.8µm, 11-12striae in 10 µm ; **Distr.:**ME1, ME2, ME3, ME4, ME5, M7, ME8, ME9 and ME10; **Ecol:**This species tolerate a large range of pH (5.86 to 8.46), conductivity (39.14 to 137.14 µS/cm) disolved oxygen (3.52 to 9.65 mg/L), nitrates (1.6 to 22.6 mg/L) and silica (3 to 18 mg/L).

Gomphonema parallelistriatum Lange-Bertalot and E. Reichardt (Lange-Bertalot (1993)(Fig. 2K)
Morph.: Valve length: 18.3-25.2µm, width: 4.5-6.1µm, 11striae in 10 µm ;**Distr.:** ME3; **Ecol:**This taxon prefers type of locality in which pH is slightly acidic to neutral (6.26 to 7.08)with high content of nitrates and silica.

Gomphonema tenerrinum Hustedt (1938)(Fig. 2L)
Morph.: Valve length: 15.8-23.6 µm, width: 4.2-6.1µm, 23-26striae in 10 µm ; **Distr.:**ME1, ME2, ME3, ME4, ME5 and ME9; **Ecol:**This species tolerate a large range of pH (5.58 to 8.46), conductivity (39.14 to 137.14 µS/cm) disolved oxygen (4.86 to 9.11 mg/L), nitrates (2.5 to 28.6 mg/L) and silica (3 to 18 mg/L).

Gomphonema wulasiense Foged (1966)(Fig. 2M)
Morph.: Valve length: 13.6-18.3 µm, width: 3.2-4.8µm, 20-25striae in 10 µm ; **Distr.:** ME2, ME3, ME4 and ME5; **Ecol:**This taxon occurs in the waters that presented a temperature of 27.9°C, acidic to slightly alkaline pH (5.86 to 8.46), slightly to medium conductivity (39.14 to 137,14 µS/cm) and and high concentration of nitrates (2.2 to 15.6 mg/L) and silica (10 mg/L).

Genus: Placoneis
Placoneis adampeensis Foged (1966)(Fig. 3A)
Morph.: Valve length: 27.5-43.4 µm, width: 514.5-16.5 µm, 11-13striae in 10 µm ;**Distr.:**ME3 and ME4; **Ecol:**This taxon prefers type of locality in which pH is slightly acidic to neutral (6.26 to 7.08) with high content of nitrates and silica.

Placoneis ashantiensis Foged (1966)(Fig. 3B)
Morph.: Valve length: 36.1-41.5 µm, width: 15.1-16.6 µm, 10-13striae in 10 µm ; **Distr.:**ME1, ME3 and ME4; **Ecol:** This taxon is found in the current environment that presented temperatures ranged to 23.3°C to 27.1°C, slightly acidic to neutral pH (6.26 to 7.08), slightly to medium conductivity (39.14 to 137,14 µS/cm),medium to high concentration of nitrates (5.5 to 20.3 mg/L) and silica (8 to 18 mg/L).

Placoneis constans var. symmetrica(Hustedt) H.Kobayasi Mayama al.(2002)(Fig. 3C)
Morph.: Valve length: 17.9-24.5 µm, width: 7.6-10.9 µm, 14-16striae in 10 µm ; **Distr.:**ME2 and ME3; **Ecol:**This species grows in environment with pH (6.26 to 8.46), conductivity (77.86 to 137.14 µS/cm) disolved oxygen (5.22 to 9.65 mg/L), nitrates (7.3 to 10.2 mg/L) and silica (8 to 17 mg/L).

Placoneis exigua (Gregory) Mereschkovsky (1903)(Fig. 3D)
Basionym: Pinnularia exigua Gregory (1854)
Morph.: Valve length: 28.8 µm, width: 18.1µm, 16striae in 10 µm ;**Distr.:** ME2; **Ecol:** This taxon prefers type of locality in which pH is slightly acidic to slightly alkaline (6.54 to 8.46), medium conductivity (77.86 to 108.42 µS/cm) with high content of nitrates and silica.

Placoneis exiguiformis (Hustedt) Lange-Bertalot Metzeltin et al. (2005)(Fig. 3E)
Basionym: Navicula exiguiformis Hustedt (1944).
Morph.: Valve length: 26.8-30.4 µm, width: 10.9-11.4 µm, 13-16striae in 10 µm ;**Distr.:**ME2, ME4 and ME9; **Ecol:**This taxon occurs in the waters that presented a temperature of 27.9 C, acidic to slightly alkaline pH (5.58 to 8.46), slightly to medium conductivity (39.14 to 137,14 µS/cm) and high concentration ofnitrates (3.8 to 10.2 mg/L) and silica (8 to 17 mg/L).

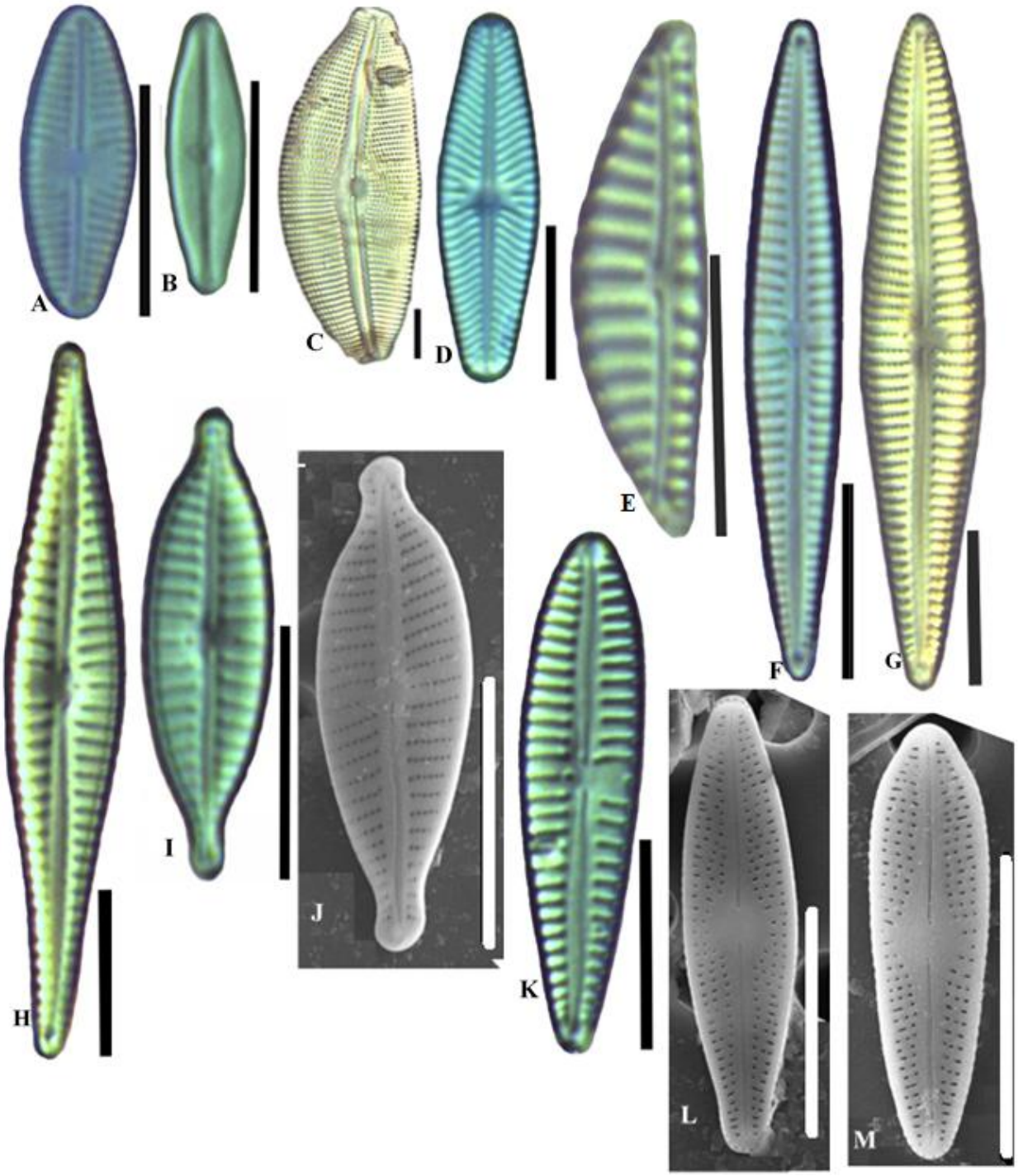

Figure 2:- A-M: A-Achnanthes exiguavar.constricta,B-Adlafia bryophila, C-Cymbella asperavar.minor, D-Geissleria schoenfeldii, E-Encyonema moragoense, F-Gomphonema acidoclinatiforme, G-Gomphonema africanum, H-Gomphonema guaraniarum, I-J-Gomphonema lagenula, K-Gomphonema parallelistriatum, L-Gomphonema tenerrinum, M-Gomphonema wulasiense. Scale bar = 10 µm.

Placoneis madagascariensis Lange-Bertalot and Metzeltin (2002)(Fig. 3F)
Morph.: Valve length: 18.6-18.9 µm, width: 7.5-7.6 µm, 14striae in 10 µm ;**Distr.:** ME10; **Ecol:**P. madagascariensis prefers type of locality in which pH is acidic (5.91 to 6.38), moderate conductivity (39.14 to 76 µS/cm) with moderate content of nitrates (3.8 to 4 mg/L).

Placoneis sepasiensis Foged (1966)(Fig. 3G)
Morph.: Valve length: 28.1-37.8 µm, width: 9.7-11.5 µm, 9-12striae in 10 µm ;**Distr.:**All sites; **Ecol:**This species tolerate a large range of pH (5.86 to 8.46), conductivity (39.14 to 137.14 µS/cm) disolved oxygen (3.52 to 9.65 mg/L), nitrates (1.6 to 22.6 mg/L) and silica (3 to 18 mg/L).

Placoneis symmetrica (Hustedt) Lange-Bertalot Metzeltin et al.(2005)(Fig. 3H)
Morph.: Valve length: 18.9-34.1 µm, width: 7.9-8.2µm, 9-15striae in 10 µm ;**Distr.:**ME2, ME3 and ME9; **Ecol:**This species grows in environment with disolved oxygen (5.22 to 9.65 mg/L), pH slightly acidic to slightly alkaline (6.26 to 8.46), conductivity (77.86 to 137.14 µS/cm), nitrates (7.3 to 10.2 mg/L) and silica (8 to 17 mg/L).

Order: Thalassiophysales
Family: Catenulaceae
Genus: Amphora
Amphora mansiensis Foged(1966)(Fig.3I-J)
Morph.: Valve length: 36.1-53.5 µm, width: 6.4-9.1 µm, 20-24striae in 10 µm ;**Distr:**All sites except ME1; **Ecol:**This species tolerate a large range of pH (5.86 to 8.46), conductivity (39.14 to 137.14 µS/cm) disolved oxygen (3.52 to 9.65 mg/L), nitrates (1.6 to 22.6 mg/L) and silica (3 to 18 mg/L).

Order: Cocconeidales
Family: Cocconeidaceae
Genus: Cocconeis
Cocconeis ankobraensis Foged(1966)(Fig.3K-L)
Morph.: Valve length: 17.5 µmµm, width: 8.5 µm, 13striae in 10 µm ;**Distr.:**ME8; **Ecol:**This species grows in environment with acidic pH (5.86 to 5.99), medium conductivity (79.33 to 84 µS/cm), moderate to high nitrates content (3.1 to 15.6 mg/L) and silica (10 mg/L).

Cocconeis feuerbornii Hustedt(1930)(Fig.3M-N-O)
Morph.: Valve length: 18.6-21.8 µm, width: 9.4-11.3 µm, 20-24striae in 10 µm ;**Distr.:**ME2, ME3, ME4, ME7 and ME10; **Ecol:** This species grows in environment with disolved oxygen (5.22 to 9.65 mg/L), pH slightly acidic to slightly alkaline (6.26 to 8.46), conductivity (77.86 to 137.14 µS/cm), nitrates (7.3 to 10.2 mg/L) and silica (8 to 17 mg/L).

Cocconeis microscopica Cholnoky Lange-Bertalot and Krammer (1988)(Fig.4A-B)
Morph.: Valve length: 10.1-12.1 µm, width: 5.61-6.8 µm, 20-22striae in 10 µm ;**Distr.:**ME4, ME8, ME9 and ME10; **Ecol:**Cocconeis microscopica species grows in environment with disolved oxygen (5.22 to 9.65 mg/L), pH slightly acidic to slightly alkaline (6.28 to 8.16), conductivity (112 to 137.14 µS/cm), nitrates (7.3 to 10.2 mg/L) and silica (8 to 18 mg/L).

Family: Achnanthidiaceae
Genus: Planothidium
Planothidium comperei C.E.Wetzel et al. (2014)(Fig.4C-D)
Morph.: Valve length: 17.1- 23.1 µm, width: 7.7-9.1 µm, 11-13striae in 10 µm ;**Distr.:**All sites; **Ecol:**This species tolerate a large range of pH (5.86 to 8.46), conductivity (39.14 to 137.14 µS/cm) disolved oxygen (3.52 to 9.65 mg/L), nitrates (1.6 to 22.6 mg/L) and silica (3 to 18 mg/L).

Planothidium frequentissimum(Lange-Bertalot) Lange-Bertalot (1999)(4Fig. E-F)
Basionym:Achnanthes lanceolate subsp. frequentissima Lange-Bertalot (1993)
Morph.: Valve length:9.7-12.5 µm, width: 4.1-4.3 µm, 14striae in 10 µm ;**Distr.:**ME7; **Ecol:**Planothidium frequentissimum prefers type of locality in which pH is slightly acidic (6.52 to 6.93).

Planothidium piaficum (J.R. Carter and Denny) C.E. Wetzel et L. Ector N'Guessan et al. (2014)(Fig.4G-H)
Basionym:Achnanthes piafica J.R. Carter and Denny (1982)

Morph.: Valve length: 15.7-22.7 µm, width: 6.5-8.2 µm, 10-13striae in 10 µm ;**Distr.:**All sites;**Ecol:** This species tolerate a large range of pH (5.86 to 8.46), conductivity (39.14 to 137.14 µS/cm) disolved oxygen (3.52 to 9.65 mg/L), nitrates (1.6 to 22.6 mg/L) and silica (3 to 18 mg/L).

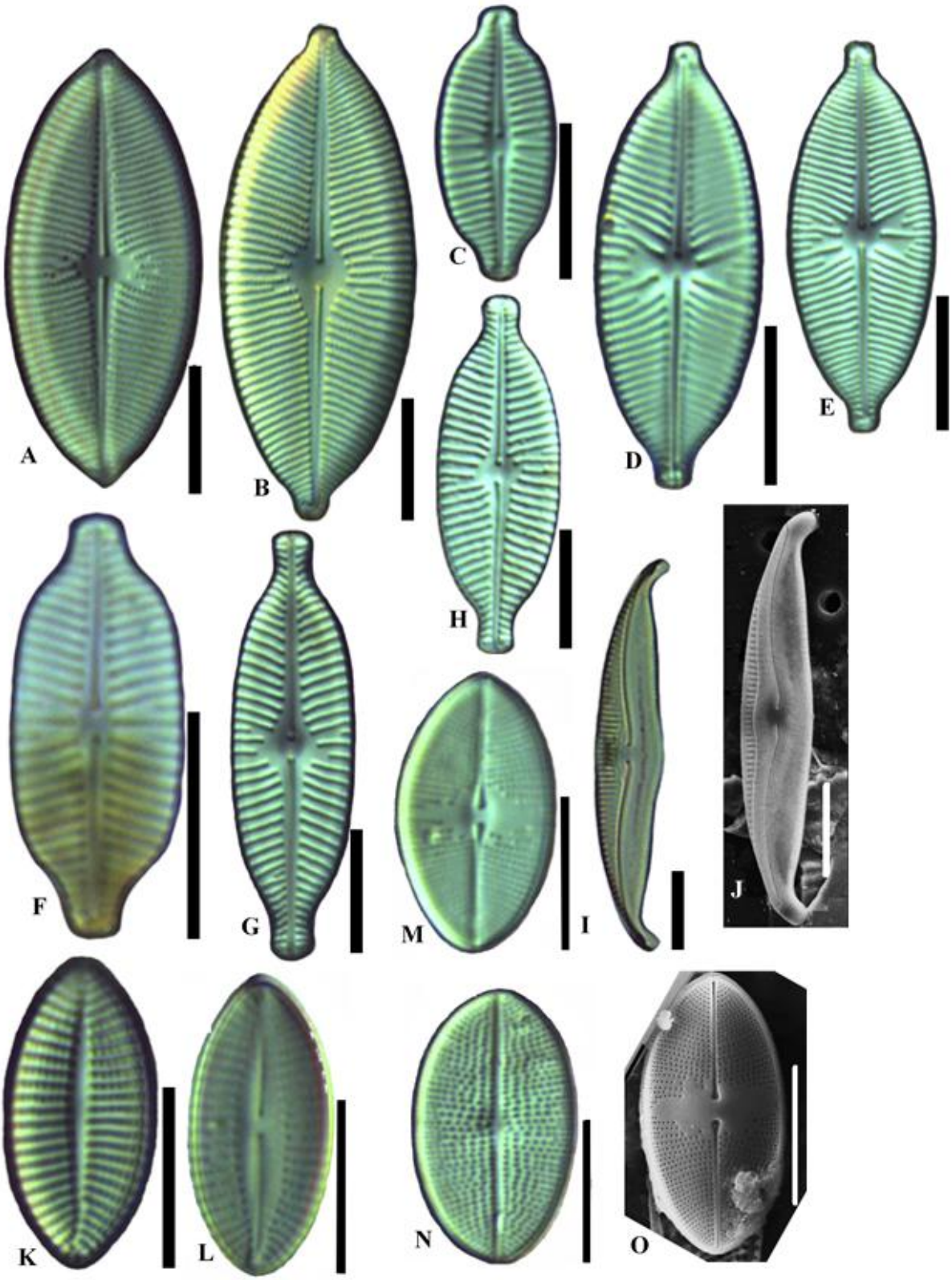

Figure 3:- A-O: A-Placoneis adampeensis, B-Placoneis ashantiensis, C-Placoneis constans var. symmetrica, D-Placoneis exigua, E-Placoneis exiguiformis, F-Placoneis madagascariensis, G-Placoneis sepasiensis, H-Placoneis symetrica, I-J-Amphora mansiensis, K-L-Cocconeis ankobraensis, M-N-O-Cocconeis feuerbornii. Scale bar = 10 µm.

Order: Eunotiales
Family: Eunotiaceae
Genus: Eunotia
Eunotia meridiana Metzeltin and Lange-Bertalot(1998)(Fig.4I)
Morph.: Valve length: 12.5-32.9 µm, width: 4.4-6.9 µm, 12-15striae in 10 µm ;**Distr.:** All sites, except ME1, ME2 and ME5; **Ecol:**E. meridiana grows in environment with disolved oxygen (4.13 to 9.12 mg/L), pH acidic to neutral (5.58 to 7.06), conductivity (39.14 to 137.14 µS/cm), nitrates (1.6 to 28.6 mg/L) and silica (3 to 18 mg/L).

Eunotia papilioforma Furey et al.(2011)(Fig.4J)
Morph.: Valve length: 30.7µm, width: 4.9 µm, 14striae in 10 µm ;**Distr.:**ME2; **Ecol:**Eunotia papilioforma prefers type of locality in which pH is slightly acidic (6.54 to 6.88).

Eunotia pararepens Kulikovsky et al.(2010)(Fig. 5A)
Morph.: Valve length: 76.3 µm, width: 3.9 µm, 9striae in 10 µm ;**Distr.:** ME10; **Ecol:**E. pararepensprefers type of locality in which pH is acidic (5.91 to 6.38), medium conductivity (88.5 to 96.73 µS/cm) with moderate content of nitrates (1.6 to 3.1 mg/L).

Eunotia tenella (Grunow) HustedtSchmidt (1913)(Fig.5B)
Morph.: Valve length: 13.4-17.8 µm, width: 3.7-5.2 µm, 12-14striae in 10 µm ;**Distr.:** ME4; **Ecol:**This species grows in environment with slightly acidic pH(6.53 to 6.56), slightly to high conductivity (39.14 to 137.14 µS/cm), medium to high nitrates content (5.5 to 13.7 mg/L) and silica (12 to 18 mg/L).

Order: Bacillariales
Family: Bacillariaceae
Genus: Hantzschia
Hantzschia distinctepunctata Schmidt (1921)(Fig.5C)
Morph.: Valve length: 56.7-61.7 µm, width: 5.8-7.2 µm, 12-13 striae in 10 µm ;**Distr.:**ME3, ME6 and ME10; **Ecol:**Hantzschia distinctepunctataprefers type of locality in which pH is acidic to neutral (5.91 to 7.08) and conductivity low to high (45 to 137.14 µS/cm).

Genus: Nitzschia
Nitzschia fonticola GrunowVan Heurck (1881)(Fig.5D)
Morph.: Valve length: 9.8-13.5 µm, width: 2.9-4.7 µm;8fibulae in 10 µm; **Distr.:** M3 and ME4; **Ecol:**Nitzschia fonticolaprefers type of locality in which pH is slightly acidic to neutral (6.54 to 7.08).

Nitzschia fonticolavar. pelagica (Grunow) HustedtSchmidt et al.(1959)(Fig.5E)
Morph.: Valve length: 15.8-26.1 µm, width: 3.6-4.2 µm, 11-13fibulae in 10 µm ;**Distr.:** ME4; **Ecol:**This species prefers type of locality in which pH is slightly acidic (6.53 to 6.56).

Nitzschia lorenziana Grunow, Cleve and Möller (1879)(Fig.5F)
Morph.: Valve length: 89.6-110.3 µm, width: 4.1-5.9 µm, 28-45striae in 10 µm ;**Distr.:**ME3, ME4, ME7, ME8, ME9 and ME10; **Ecol:**Nitzschia lorenzianagrows in environment with disolved oxygen (4.13 to 9.12 mg/L), pH acidic to neutral (5.58 to 7.06), conductivity (39.14 to 137.14 µS/cm), nitrates (1.6 to 28.6 mg/L) and silica (3 to 18 mg/L).

Nitzschia serrata Manguinin Bourrelly and Manguin (1952)(Fig.4G)
Morph.: Valve length: 204.7 µm, width: 8.2µm, 18striae in 10 µm; **Distr.:**ME8; **Ecol:**Nitzschia serrata prefers type of locality in which pH is acidic (5.86 to 5.99).

Nitzschia ventricosa Kitton(1873)(Fig.5H)
Homotypic synonym: Homoeocladia ventricosa (Kitton) Küntze (1898)
Morph.: Valve length: 4.4µm, width: 39.9 µm, 15striae and 9 fibulaein 10 µm ;**Distr.:** ME1; **Ecol:**This species prefers type of locality in which pH is slightly acidic (6.45 to 6.51).

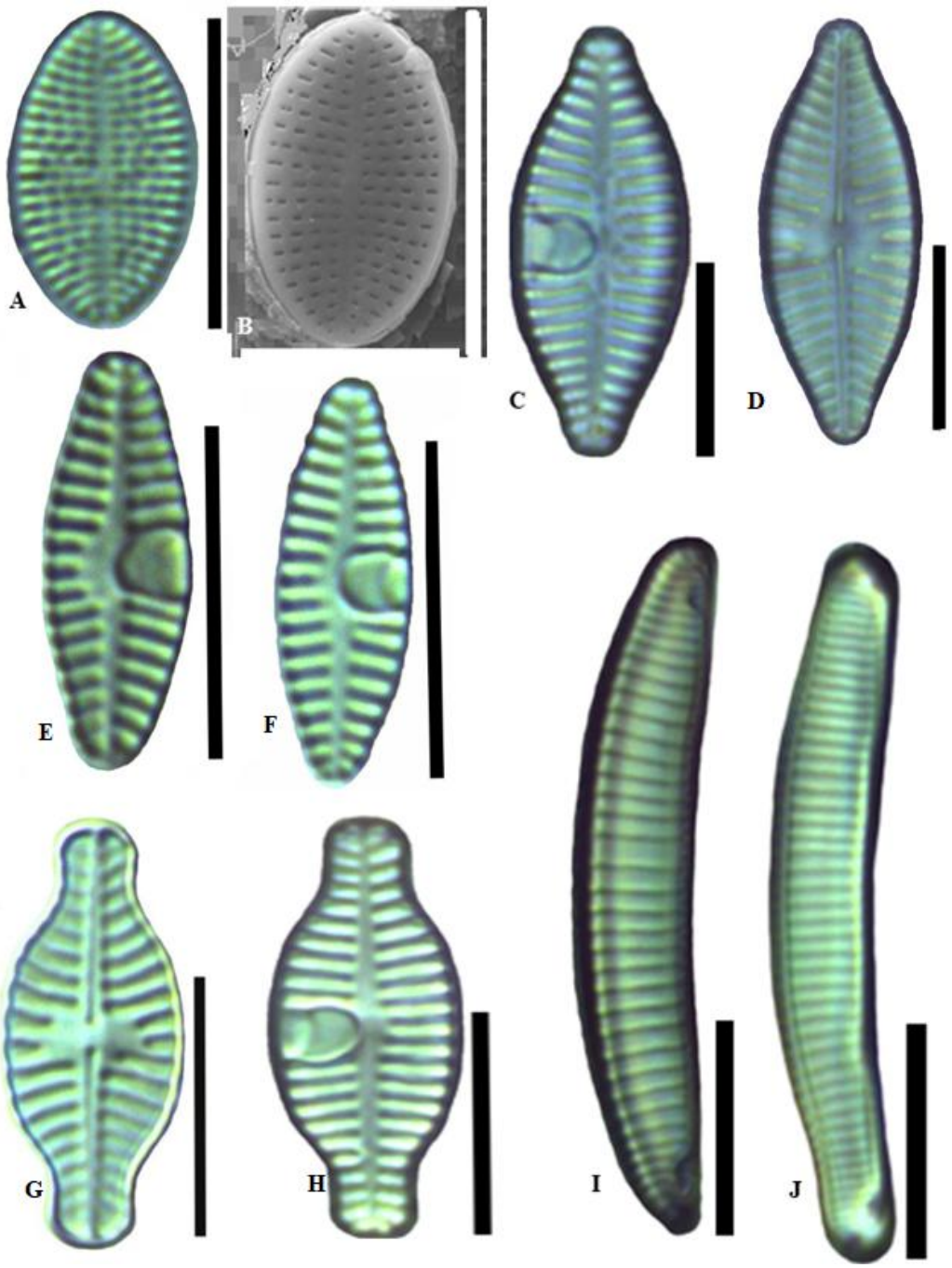

Figure 4 A-J:- A-B-Cocconeis microscopica, C-D-Planothidium comperei, E-F-Planothidium frequentissimum, G-H-Planothidium piaficum, I-Eunotia meridiana,J-Eunotia papilioforma.
Scale bar = 10 µm.

Genus: Tryblionella
Tryblionella apiculata Gregory (1857)(Fig. 5I)
Homotypic synonyms :Nitzschia apiculata (Gregory) Grunow (1878), Homoeocladia apiculata (Gregory) Küntze (1898).Heterotypic synonyms : Synedra constricta Kützing (1844), Nitzschia constricta (Kützing) Ralfs (1861), Nitzschia dubia var. constricta (Kützing) Carruthers (1864), Tryblionella constricta (Kützing) Poulin (1991), Tryblionella kuetzingii Alvarez-Blanco and Blanco (2014).

Morph.: Valve length: 22.2-24.1µm, width: 6.8-7.5 µm, 15 fibulae in 10 µm ;**Distr.:** All sites except ME4, ME6, ME7 and ME8; **Ecol:**Tryblionella apiculate prefers type of locality in which pH is acidic to neutral (5.91 to 7.08) and conductivity low to high (45 to 137.14 µS/cm).

Tryblionella debilis Arnott ex O'Meara (1873)(Fig. 5J)
Homotypic synonyms:Nitzschia debilis (Arnott ex O'Meara) Grunow (1880), Homoeocladia debilis (Arnott ex O'Meara) Kuntze (1898), Nitzschia tryblionella var. debilis (Arnott ex O'Meara) Hustedt (1913).
Morph.: Valve length: 21.8-24.4 µm, width: 8.8-11.9 µm, 8 fibulae in 10 µm ;**Distr.:** ME10; **Ecol:**T. debilis prefers type of locality in which pH is acidic (5.91 to 6.38), conductivity ismedium (88.5 to 96.73 µS/cm) with moderate content of nitrates (1.6 to 3.1 mg/L).

Order: Surirellales
Family: Surirellaceae
Genus: Stenopterobia
Stenopterobia delicatissima(Lewis) Van Heurck(1896)(Fig.5K)
Basionym:Surirella delicatissima Lewis 1864
Morph.: Valve length: 50.3-59.6 µm, width: 5.3-6.7 µm, 7-7 fibulae in 10 µm ;**Distr.:** ME9; **Ecol:**Stenopterobia delicatissima has preference for acidic (pH: 5.58 to 6.42), high nutrient content (nitrates : 3.8 to 28.6 mg/L, silica :11 to 17 mg/L) and medium conductivity (76 to 87.5 µS/cm) waters.

Genus: Surirella
Surirella tenuissima Hustedt(1938)(Fig. 5L)
Morph.: Valve length: 23.7-28.9 µm, width: 6.4-7.4 µm, 6 channels in 10 µm ; **Distr.:**ME3, ME8 and ME9; **Ecol:**Surirella tenuissima grows in environment with disolved oxygen (4.13 to 9.12 mg/L), pH acidic to neutral (5.58 to 7.06), conductivity (76 to 137.14 µS/cm), nitrates (1.6 to 28.6 mg/L) and silica (8 to 18 mg/L).

Surirella vasta var. linearis Hustedtand Huber-Pestalozzi (1942)(Fig. 5M)
Morph.: Valve length: 82.5µm, width: 26.42µm, 2 channels in 10 µm ;**Distr.:** ME9; **Ecol:**this taxon grows in type of locality in which pH is acidic (5.91 to 6.38), moderate conductivity (39.14 to 76 µS/cm) with moderate to high content of nitrates (3.8 to 28.6 mg/L).

Diatom composition
In river Mé, a total of 192 infrageneric diatoms taxa was identified. Pennates represented 94.5% of the species, while only 5.5% were centrics. According to new and rare epitlithic diatom taxa, except naviculales, 42 taxa (Tab. 2) distributed among 16 genera, 8 families and 5 orders were recorded.

Based onspecies occurrence frequency, 32 rare, 2 occasional, and 8 common species were found in Mé River. According to geographic distribution, new and rare taxa recorded in MéRiver were mostly cosmopolitan (47.72%) and tropical (43.18%), while 9.09% were endemic.

Taking into account their affinity towards pH, 3 classes of diatoms are found in the waters of the Mé River. These are acidophilic taxa (35.47%), indifferent taxa (59.52%) and alkaliphilic taxa (4.76%).

According to Varoletal. (2018), floristic studies on freshwater microalgae are of greatinterest since they provide a scientific basis for thevalidation of biogeography and biodiversity models withinmicroorganisms.

This study reports 42 rare and new taxa for the freshwater diatoms from the Mé river in Côte d'Ivoire, among them, N'Guessan et al. (2014) described recently two taxa (Planothidium comperei and Planothidium piaficum) as new to science.

This high number can be explain in some cases by the lack of iconographic material or precise taxonomic descriptions in previous works or technical reports prevents the confirmation of certain early records.

Most of taxa (47,72%) found here are well known worldwide. According to Round et al. (1990), diatoms are one of the most widespread group of unicellular algae, being reported for all types of water bodies and from all continents. The capacity for dispersal, wide environmental tolerances and interbreeding between morphologically distinct units

should result in wide, perhaps ubiquitous distributions (Finlay et al., 2002; Finlay and Fenchel, 2004). Cosmopolitan species reported by several authors around the world are found for the first time in Côte d'Ivoire. These are species such as Stenopterobia delicatissima according to the work of Takeshi and Taisuke (2016) in Japan, Planothidium

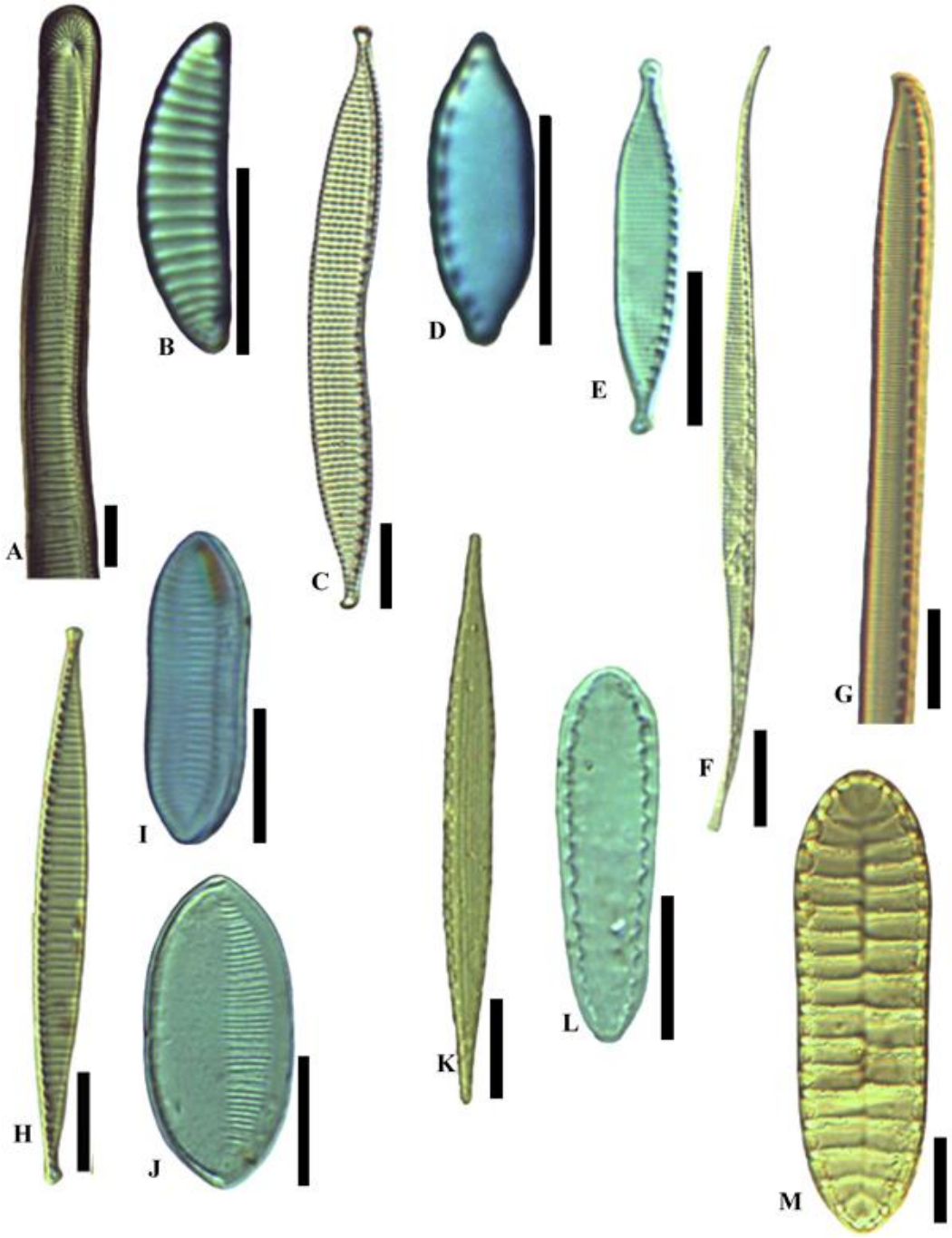

Figure 5 A-M:- Eunotia pararepens, B-Eunotia tenella, C-Hantzschia distinctepunctata, D-Nitzschia fonticola, E-Nitzschia fonticolavar.pelagica, F-Nitzschia lorenziana, G-Nitzschia serrata, H-Nitzschia ventricosa, I-Tryblionella apiculate, J-Tryblionella debilis, K-Stenopterobia delicatissima, L-Surirella tenuissima, M-Surirella vastavar. linearis.Scale bar = 10 µm.

frequentissimun in Germany (Szabó et al., 2017). This confirms the area of the cosmopolitan distribution already indicated by various works.

Some taxa identified in this study have a typically tropical distribution. For example Encyonema moragoense already met by Foged (1966) in Ghana, Cocconeis microscopica observed in Sonfon and Popei lakes by Carter and Denny (1992), Gomphonema guaraniarum in Piraquara II reservoir in Brazil (Marraet al., 2016), Eunotia meridian from a subtropical stream adjacent to Iguaçu National Park in Brasil (Favaretto et al.,2021)and Gomphonema africanum collected in Lake Tanganyika (Cocquyt et al., 1991). The particularity of the tropical climate, characterized by relatively high water temperatures throughout the year could explain this presence. Other species considered as tropical to date have been observed in other parts of the world. For example Geissleria schoenfeldii mentioned in the Baltic Sea by Plinski and Witkowski (2020). This allows to redefine the distribution range of the species.

Conclusion:-

This study, done in Mé Riverhighlighted 42new and rare epilithic diatoms. Itoffers an importantcontribution to characterize Côte d'Ivoire freshwater algae. The appearance of several rare and new species withinthis geographical area reveals one of the aspects of thebiogeographic particularities of Côte d'Ivoire aquatichabitats.

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Table 2:- List of taxa observed in the Mé river (D: Distribution; C: cosmopolitan species, E: endemic species, T: Tropical species; F: species occurrence frequency, 1: Common species , 2: occasional species , 3: rare species ; * presence, ME1, ME2, ME3, ME4, ME5, ME6, ME7, ME8, ME9, ME10: sampling sites)

	D	F	ME1	ME2	ME3	ME4	ME5	ME6	ME7	ME8	ME9	ME10
Achnanthaceae												
Achnanthes exigua var. constricta	C	1		*	*				*		*	
Anomoeoneidaceae												
Adlafia bryophila	C	3		*							*	
Cymbellaceae												
Cymbella aspera var. minor	T	3								*		
Geissleria schoenfeldii	T	3		*	*	*	*					*
Gomphonemataceae												
Encyonema moragoense	T	3			*							
Gomphonema acidoclinatiforme	C	3									*	
Gomphonema africanum	T	3	*									
Gomphonema guaraniarum	T	3										*
Gomphonema lagenula	C	2	*	*	*	*	*		*	*	*	*
Gomphonema parallelistriatum	E	3			*							
Gomphonema tenerrinum	T	1	*	*	*	*	*				*	
Gomphonema wulasiense	T	3		*	*	*	*					
Placoneis adampeensis	T	3			*	*						
Placoneis ashantiensis	T	3	*		*	*						
Placoneis constans var. symmetrica	C	3		*	*							
Placoneis exigua	C	3		*								
Placoneis exiguiformis	C	3		*		*					*	
Placoneis madagascariensis	T	3										*
Placoneis sepasiensis	T	3	*	*	*	*	*	*	*	*	*	*
Placoneis symmetrica	C	3		*	*						*	
Catenulaceae												
Amphora mansiensis	T	1		*	*	*	*	*	*	*	*	*
Cocconeis ankobraensis	T	3								*		
Cocconeis feuerbornii	C	3		*	*	*			*			*
Cocconeis microscopica	T	3				*				*	*	*
Achnanthidiaceae												
Planothidium comperei	T	3	*	*	*	*	*	*	*	*	*	*

Planothidium frequentissimum	C	3							*			
Planothidium piaficum	T	1	*	*	*	*	*	*	*	*	*	*
Eunotiaceae												
Eunotia meridiana	T	1			*	*		*	*	*	*	*
Eunotia papilioforma	E	3		*								
Eunotia pararepens	T	1										*
Eunotia tenella	E	3				*						
Bacillariaceae												
Hantzschia distinctepunctata	C	3			*			*				*
Nitzschia fonticola	C	3			*	*						
Nitzschia fonticolavar. pelagica	C	3				*						
Nitzschia lorenziana	C	3			*	*			*	*	*	*
Nitzschia serrata	E	3								*		
Nitzschia ventricosa	C	3	*									
Tryblionella apiculata	C	3	*	*	*		*				*	*
Tryblionella debilis	C	3										*
Surirellaceae												
Stenopterobia delicatissima	C	3									*	
Surirella tenuissima	C	3			*					*	*	
Surirella vasta var. linearis	T	3									*	

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