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(RESEARCH ARTICLE)

Systematic study of the diatoms (Bacillariophyta) of Joal-Fadiouth Lagoon (Senegal)

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Abstract

This work constitutes a first study on the diatoms of Joal-Fadiouth Lagoon (Senegal). It was undertaken to describe, identify and determine the taxonomic composition of these diatoms. Observation of the samples collected between March and June 2013 made it possible to inventory 21 species belonging to 18 genera and divided into 13 families, 11 orders and 3 classes. These 21 species are new for the microflora of Joal-Fadiouth Lagoon.

Keywords: Systematic study; Diatoms; Lagoon; Joal-Fadiouth; Senegal.

1. Introduction

Relationship between biodiversity and functioning of ecosystems being a fundamental ecological question, to understand the structure and functioning of an ecosystem, it's essential to know the different elements that compose it [1]. Phytoplankton occupies a central place in all the problems of environmental imbalances at the interface between continent and marine environment [2]. Lagoons, estuaries and mangroves, characterized by a relatively diverse phytobenthos community dominated by diatoms [3], can also play a very important role in the proper functioning of the fishery resources of the continental shelf. Knowledge of diatoms in these coastal areas is therefore essential. The objective of this work is to describe, identify and determine the taxonomic composition of the diatoms of Joal-Fadiouth Lagoon.

2. Material and methods

The study was carried out in Joal-Fadiouth Lagoon located on the Petite Côte, 114 km southeast of Dakar (Senegal); the Lagoon presents an inverse hydrological functioning characteristic of a lagoon-estuarine system where marine influences predominate and are permanent [4]. Six samples (phytoplankton and phytobenthos) were collected (March-June 2013) and fixed (formalin 4%). Sub-samples underwent a treatment of cleaning of the frustules by combination of calcination to chemical attack of the organic matter, before being mounted with Canada Balsam to prepare permanent slides for microscopy. The systematic arrangement of the diatoms list was made by according to [6].

3. Results and discussion

3.1. Description and identification of taxa

Phylum: Bacillariophyta

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Class: Coscinodiscophyceae

Order: Melosirales

Family: Melosiraceae

Melosira crenulata (Ehr.) Kuetz (Figure 1A)

References: [7]

Cylindrical frustules with more or less square (length 15 µm, diameter 12 µm) toothed valve margins; points arranged in longitudinal rows.2 cylindrical frustules (length 15 µm, diameter 12 µm) in chain, with fine granules, dispersed in the center and radiating towards the periphery; denticulated valve margins at cell junction.

Order: Paraliales

Family: Paraliaceae

Paralia sulcata (Ehrenberg) Cleve (Figure 1B)

Syn.: *Melosira sulcata* Van Heurck

References: [8, 9, 10]

Valve circular, punctuated-areolate (diameter 47 µm). Margin with row appearing as a crown of teeth.

Class: Fragilariophyceae

Order: Fragilariales

Family: Fragilariaceae

Opephora schwartzii (Grunow) Petit (Figure 1C)

References: [11, 12]

Valve oval to linear (length 28 µm, diameter 8 µm) with rounded upper apex. Valve surface with coarse areoles (3-4/10µm) perpendicular to the pseudoraphe.

Order: Striatellales

Family: Striatellaceae

Grammatophora marina (Lyngbye) Kützing (Figure 1D)

References: [10, 13]

Frustule rectangular (length = 30 µm, width = 18 µm). Septa slightly undulating (two undulations) with nodule at the ends. 15 striae/10 µm.

Order: Thalassionematales

Family: Thalassionemataceae

Thalassionema bacillare (Heiden) Kolbe (Figure 1E)

References: [14, 15]

Valve linear (length 82 µm, diameter 4 µm) slightly expanded in the middle; apex rounded. Axial area distinct; ornementation formed by a row of marginal areolas.

Class: Bacillariophyceae

Order: Mastogloiales

Family: Mastogloiaceae

Mastogloia exigua Lewis (Figure 1F)

References: [16]

Valve lanceolate to linear-lanceolate (length 22 µm, diameter 10 µm). Presence of 4 larger locules in the middle, with rounded contours.

Order: Achnanthales

Family: Achnanthaceae

Achnanthes brevipes Ag. (Figure 1G-H)

Syn.: *Achnanthes seriata* Agardh 1827

References: [16]

Inflected frustules (length 52 µm, diameter 15 µm). Linear-oblong valves with cuneiform apices, slightly constricted in the middle. Raphid valve with roughly punctuated, radiant 8-9/10 µm transapical striae, crossed by longitudinal ribs. Several golden-brown chloroplasts arranged around girdle.

Achnanthes brevipes var. Agardh intermedia (Figure 1I-J)

Syn.: *Achnanthes intermedia* Kützing 1833

Achnanthes subsessilis Kützing 1833

References: [10, 16]

Frustules inflected in the middle (length 46 µm, diameter 12 µm); linear valves with widely rounded apex. Raphid valve with roughly punctured transapical ridges, 6-9/10 µm, crossed by irregularly wavy longitudinal ribs. Several golden-brown chloroplasts arranged around the girdle.

Achnanthes longipes f. lata Agardh? (Figure 1L)

References: [17]

Linear-elliptical to broadly elliptical valves (length 35 µm, diameter 15 µm) with cuneiform apices, very slightly constrited in the middle with robust ribs; upper valve with pseudo-raphe and lower valve with axial area and narrow stauros.

Achnanthes subconstricta (Meister) Toyoda (Figure 1K)

Syn.: *Achnanthes javanica var. subconstricta* Meister 1932.

References: [18]

Valves linear-elliptical (length 80 µm, diameter 15 µm), constricted in the middle, and slightly curved in cingular view. Cuneiform apices with orbiculi. Striae bi-tetraseriate (4-6 striae/10 µm) on the both valves.

Family: Cocconeidaceae

Cocconeis scutellum Ehr. (Figure 1M)

Syn.: *Rhaphoneis scutellum* Ehrenberg 1844

References: [19, 20]

Valves elliptic; upper valve with large punctuation in radiating lines; lower valve with straight raphe, very straight axial area, small central and rounded; radial striae, finely punctate (8-10/10 µm), in marginal loculiform crown near the edges**.**

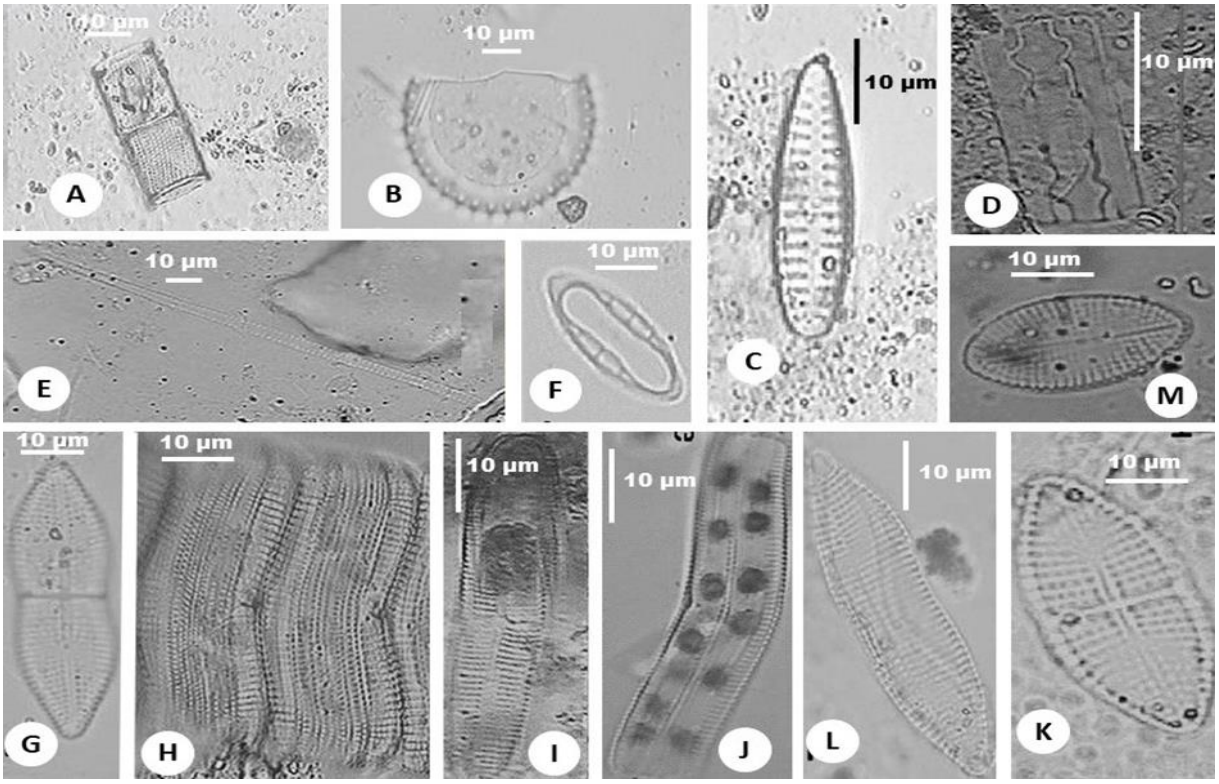

Figure 1 A: *Melosira crenulata*, girdle view; B: *Paralia sulcata*, valve view; C: *Opephora schwartzii*, valve view; D: *Grammatophora marina*, girdle view; E: *Thalassionema bacillare*, valve view; F: *Mastogloia exigua*, valve view; G-H: *Achnanthes brevipes*, (G) valve view and (H) colony of 2 cells in girdle view; I-J: *Achnanthes brevipes var. intermedia*, (I) valve view and (J) girdle view; L: *Achnanthes longipes f. lata*, valve view; K: *Achnanthes subconstricta*, valve view with orbicles at the apices; M: *Cocconeis scutellum*, valve view.

Order: Naviculales Bessey, 1907

Family: Diploneidaceae

Diploneis gruendleri (A. Schmidt) Cleve (Figure 1N)

References: [11]

Valve panduriform (length 44 µm, lobe diameter 20 µm) with deep and tight median constriction. Axial zone bordered by two lines of cells; ribbed-punctuated structure, 8/10 µm. Transverse ribs crossed by longitudinal ribs, interrupted in the middle towards the margin.

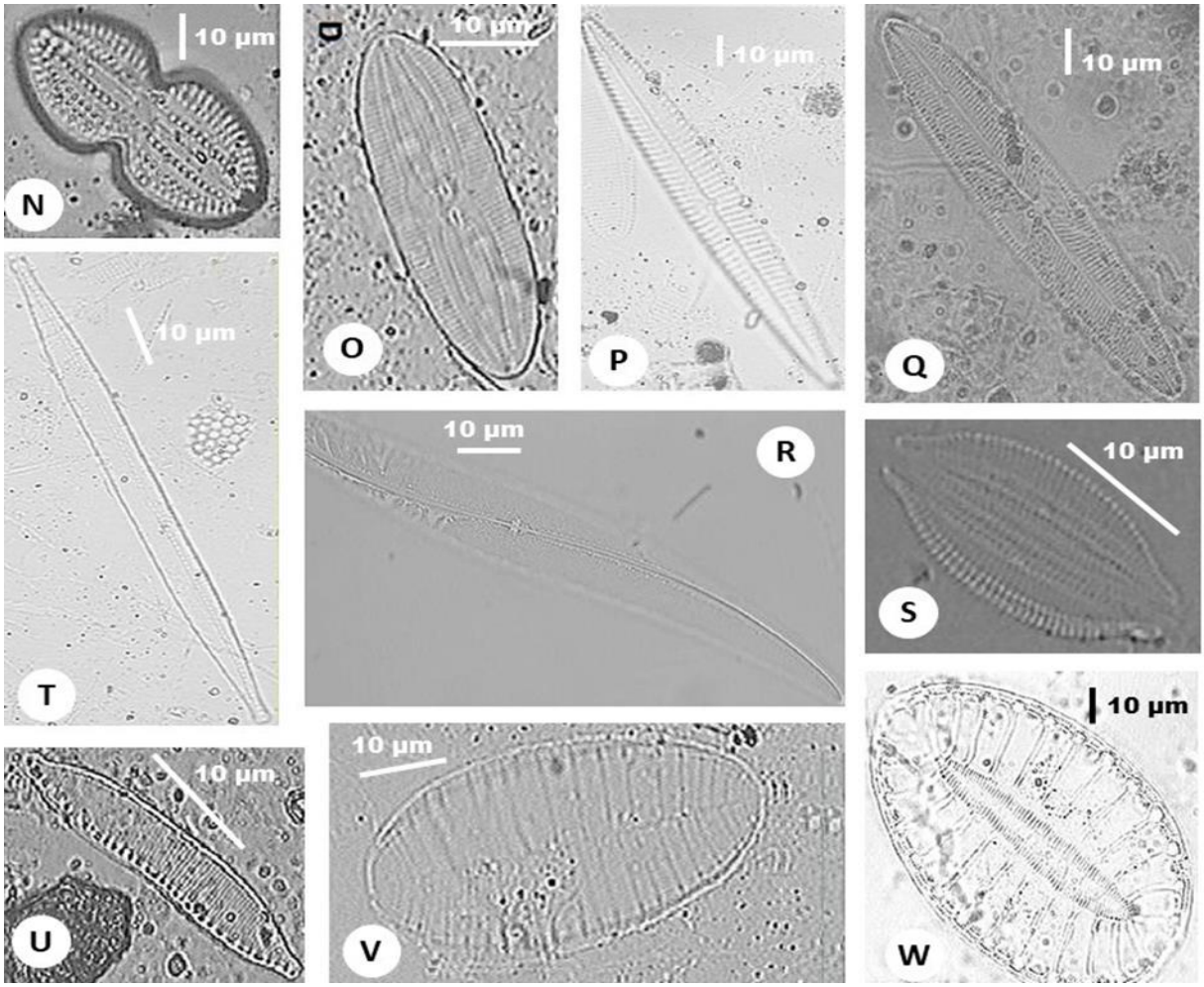

Figure 2 N: *Diploneis bombus*, valve view; O: *Fallacia forcipata*, valve view; P: *Navicula pennata*, valve view; Q: *Trachyneis aspera*, valve view; A: *Pleurosigma diverse-striatum*, valve view with central area; S: *Amphora turgida*, girdle view; T: *Nitzschia scalpelliformis*; U: *Hantzschia amphioxis*, valve view; V: *Petrodictyon gemma*; W: *Surirella fastuosa*.

Family: Sellaphoraceae

Fallacia forcipata (Greville) Stickle and Mann (Figure 1O)

Syn.: *Navicula forcipata* Grev.M.

References: [11, 12]

Valve linear (length 38 µm, diameter µm) with rounded ends; axial area extended by lateral extensions forming a hyaline H-shaped area, narrowed in the middle, widened towards apices. Valve surface striated.

Family: Naviculaceae

Navicula pennata A. S. (Figure 1P)

References: [9, 21]

Valve lanceolate (length 50-113 µm, diameter 7-14µm) subacute to acute with coarse and clearly lineal radiating striae (5/10 µm); Axial area narrow; central area more or less square with 3 pairs of shorter central ridges.

Trachyneis aspera Ehr. (Figure 1Q)

Syn.: *Trachyneis aspera var. pulchella* (Wm. Smith) Cleve, 1894.

References: [10, 22]

Valves elliptical to linear-elliptical (length 87 µm, diameter 15 µm) with obtuse rounded apices. Axial area narrow and unilateral; central area stauroneiform; raphe straight. Transapical striae composed of rectangular alveoli, arranged in transverse rows, radiate, (6-8/10 µm).

Family: Pleurosigmataceae

Pleurosigma diverse-striatum Meister 1935 (Figure 1R)

References: [16, 22]

Valve sigmoid (length 104 µm, diameter 18-22 µm), lanceolate in the middle, slightly tapered with rounded apices. Raphe central, strongly sigmoid, eccentric near the apices. Nodule central rounded. 18-19 oblique striae/10 µm, 16 transapical striae/10 µm.

Order: Thalassiophysales

Family: Catenulaceae

Amphora turgida Gregory (Figure 1S)

References: [10, 21]

Frustules broadly elliptic to orbicular (diameter 12 µm, length 24 µm) with rostrate ends. Valves semi-lanceolate with right ventral margin, wide and arched dorsal margin; apex slightly produced. Straight raphe near ventral margin; transapical striae parallel in the middle, becoming radiate towards apices, 13/10 µm.

Order: Bacillariales

Family: Bacillariaceae

Hantzschia amphioxis (Ehrenberg) Grunow (Figure 1U)

References: [10, 23]

Valves slightly curved (length 58 µm, diameter 14 µm); apices slightly attenuated, and rostrous; 5-10 carinal points/10 µm; transapical striae punctate, 15-25 / 10 µm. Raphe eccentric.

Nitzschia scalpelliformis Grunow (Figure 1T)

References: [24]

Valves linear, weakly sigmoid (length 102-115 µm, diameter 6-7 µm) with slightly oblique and round apices. Keel almost central but slightly deflected in at the center of the valve. Fibulae evenly spaced (6-7 fibules/10 µm) with two central distant ones.

Order: Surirellales

Family: Surirellaceae

Petrodictyon gemma (Ehrenberg) D. G. Mann (Figure 1V)

Syn.: *Surirella gemma* Ehr.

References: [11, 25]

Valve elliptic ovate with round apices (length 57 µm, diameter 23 µm). Alae reduced. Axial area very narrow. Costae unevenly spaced, transverse in mid-valve, about 2/10 µm, alternate toward the apices, 5-6/10 µm.

Surirella fastuosa (Ehrenberg) (Kützing, 1844) (Figure 1W)

References: [10, 26]

Cell solitary (length 90 µm), cuneate, with rounded angles. Valves broadly ovate, marginal alae small. Few costae, 1-2/10 µm, dilated towards the margin, becoming narrow towards the broadly lanceolate central area. Valve surface striate (11-12/10 µm, striae evident at the margin, and in a narrow band about half-way between the margin and the center of the valve. Narrow striate zone almost parallel with the valve margin.

3.2. Taxonomic composition

The results of the study showed that 21 species of diatoms belonging to 18 genera and divided into 13 families, 11 orders and 3 classes were observed. The two most represented families, Achnanthaceae and Diploneidaceae, are each with four species. The families Naviculaceae, Bacillariaceae and Surirellaceae each have two species; the others, with one. *Achnanthes* is the most representative genera with four species. The large diversity of diatoms in this high salinity environment could be linked to the euryhaline nature of the majority of these taxa [27, 28]. 16 of these 21 diatoms are raphid species (Bacillariophyceae). The dominance of these forms could be due to their higher fixation capacity, based on the excretion of mucilaginous substances through the raphe [29]; which allows them to support, without damage, periods of exondation in regions subject to tidal regime [21].

4. Conclusion

This study provided the first detailed list of diatoms in Joal-Fadiouth Lagoon. 21 species belonging to 18 genera and divided into 13 families, 11 orders and 3 classes were inventoried. These diatoms species are new for the microflora of Joal-Fadiouth Lagoon.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest.

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