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(RESEARCH ARTICLE)

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Araphid pennate diatoms of Ngor (Dakar, Senegal)

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Abstract

The present study provides the first list of marine araphid pennate diatoms from Ngor (Senegal). A total of 18 taxa belonging to 9 genera, 9 families, and 8 orders of Fragilariophyceae Class were described and identified by light microscopy in Ngor's waters between July 2009 and November 2011. All these taxa are new for the microflora of Ngor.

Keywords: Diatoms; Araphid Pennate; Taxonomic Composition; Ngor; Senegal

1. Introduction

Diatoms are single-celled photosynthetic eukaryotes universally distributed in all types of aquatic environment. They are the most important group in terms of diversity, abundance and productivity in marine and continental environments [1]. Diatoms are important members of the phytoplankton as well as the benthic communities. It is estimated that these microalgae may account for 40 to 45 % of oceanic production making them more productive than all the world's rainforests. Diatom algae play an important role in global cycling of Silica and Carbon and in sustaining fisheries [2]. They are abundant, diverse, ubiquitous, and sensitive environmental indicators and, thus, have an enormous ecological importance [3]. However, despite their ecological importance, no morphological descriptive study relating to diatoms has been made in the marine waters of Ngor. Only inventory studies have been carried out in the Cape Verde peninsula by [4, 5]. Thus, the objective of this work is to describe and determine the taxonomic composition of pennate araphid diatoms from Ngor (Senegal).

2. Material and methods

2.1. Presentation of the study area

The study was carried out in Ngor, a commune located at the western tip of Dakar, at Senegal (Figure 1). Ngor constitutes a promontory which extends the head of the Cape Verde Peninsula into the Atlantic Ocean. Considered as the westernmost part of Africa, it covers an area of 4.5 km^2 and has the particularity of being located on a seaside site. Ngor, bounded from the northwest to the southwest by the Atlantic Ocean, consists of a village and an Island. Ngor Island is located in the Atlantic Ocean, 800 m from the Dakar coast at 14°45'30'N and 17°30'56'W. It is therefore located west of the village of Ngor in the middle of a protected bay and constituted by the Hawaiian flows with doleric texture of the quaternary basaltic volcanism of the Mamelles.

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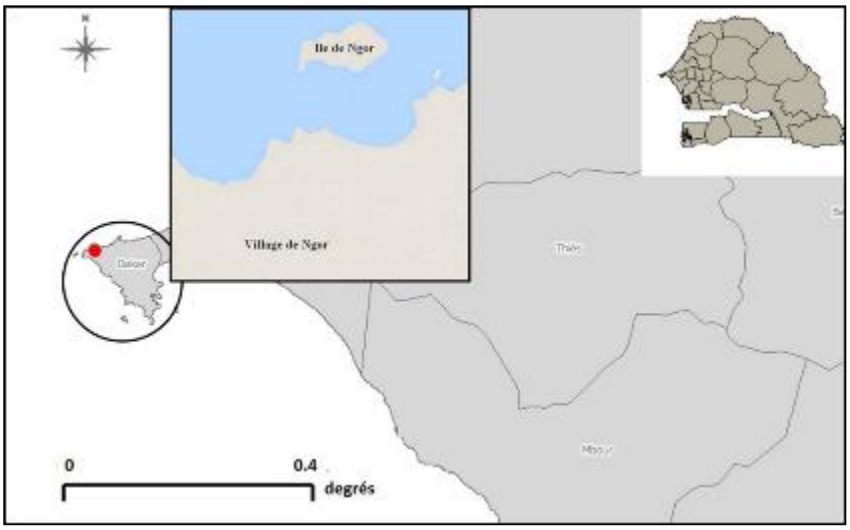

Figure 1 Location of Ngor

2.2. Sampling and observation

Sampling was carried out in marine waters, between the village and the island, from July 2009 and November 2011, with a plankton net and by scraping supports. Diatoms have been specially prepared to reveal the details of the ornamentation of the frustules. 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 [1].

3. Results and discussion

3.1. Description and identification of taxa

Phylum Bacillariophyta

Class Fragilariophyceae Round

- **Order** Fragilariales Silva
- **Family** Fragilariaceae Greville
- **Genus** *Opephora* Small

3.1.1. Opephora pinnata var. lanceolata Boyer (Figure 2A)

Valve lanceolate (length 25 µm, diameter 7 µm) with ribs slightly radiating, areolate; median zone wide. The species presents the same morphological characters as those described by [6].

3.1.2. Opephora schwartzii (Grunow) Petit ((Figure 2B))

Valve oval to almost linear (length 28 µm, diameter 8 µm) with rounded apex; lower apex narrower. Valvaire surface with coarse areolas perpendicular to the pseudoraphe (3 to 4 areolas/10µm). [7, 8, 9] encountered a species with identical morphological characters to this specimen.

Ecology and distribution: littoral marine species, known in all the oceans.

- **Order** Licmophorales Round
- **Family** Licmophoraceae Kützing
- **Genus** *Licmophora* Agardh

3.1.3. Licmophora dalmatica var. tenella K. (Figure 2D)

Frustules broadly wedge-shaped with rounded corners; valves heteropolar (diameter 35 µm, length 65 µm) very finely striated (about 30/10 µm). This species was identified from the work of [10].

Ecology and distribution: widespread species.

3.1.4. Licmophora ehrenbergii (Kuetz.) Grun. ((Figure 2C)

Frustules narrowly wedge-shaped, with shallow septum. Valves elongated wedge-shaped (length 155 µm, diameter 18 µm), with straight edges, slightly swollen at the base, subcapitated. Striae very robust (8 to 10/10µm). The same species was described by [6, 10].

Ecology and distribution: coastal species.

3.1.5. Licmophora flabellata (Carm.) Ag. (Figure 2 E-F)

Syn. : Licmophora splendida Wm. Sm.

Frustule narrow and slightly wedge-shaped with rudimentary septa. Valves narrowly lanceolate (length 70-90 µm, diameter 7 µm) with subcapitated apex, narrowed and swollen base; valves in flabellate colonies. Striae very fine, about 30/10 µm. [6, 8, 10] described the same species.

Ecology and distribution: marine species, coastal, benthic or planktonic.

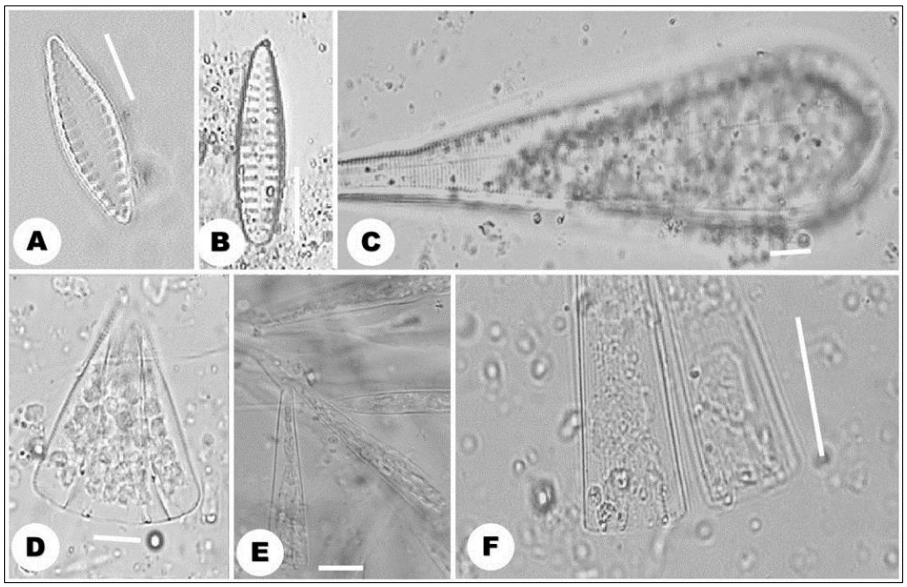

Figure 2 A: *Opephora pinnata var. lanceolata,* valve view; B: *Opephora schwartzii*, valve view; C: *Licmophora ehrenbergii,* valve view; D*: Licmophora dalmatica var. tenella*, girdle view; *Licmophora flabellata* : cells grouped in a stipitate colony (E), in girdle view (F). Scale Bars=10 µm

- **Family** Rhaphoneidaceae Forti
- **Genus** *Delphineis* Andrews

3.1.6. Delphineis surirella Ehr. Andrews (Figure 3A)

Valves (length 15 µm, diameter 8 µm) almost rounded in small specimens, lanceolate, with rounded, obtuse apices. Transapical striae, (9 to 12/10 µm) parallel to midline or slightly radiating; areoles rounded in slightly wavy longitudinal lines. Pseudoraphe narrow, linear in its middle part and widened in awl under the poles. [9, 11, 12, 13] described this species with the same morphological characteristics.

Ecology and Distribution: common marine species.

3.1.7. Delphineis surirella var. australis (Petit) Navarro ((Figure 3B)

Differs from *Delphineis surirella* in its linear-elliptical valves and greater length (length 47 µm, diameter 17 µm) ; 6 striae/10 µm. It was identified through the works of [8, 14].

Ecology and distribution: marine species.

- **Order** Ardissoneales Round
- **Family** Ardissoneaceae Round
- **Genus** *Ardissonea* De Notaris

3.1.8. Ardissonea fulgens (Greville) (Figure 3 C-D)

Syn. : *Synedra fulgens* (Greville) W. Smith 185

Cells linear as long sticks (diameter 12 µm). Apices and median region slightly dilated. Marginal ribs parallel to the apical axis and well-marked. Fine striation but robust, 13-15 striae/10 µm. The identification of this species was made through the works of [15, 16].

Ecology and distribution: widespread species, marine, brackish, coastal and estuarine, in tropical to temperate waters.

3.1.9. Ardissonea robusta (Ralfs) De Notaris & Baglietto (Figure 3E)

Syn.: *Synedra robusta* Walfs in Pritchard 1861

Cells linear-elliptical (diameter 30 µm). Valve margins straight or slightly curvilinear with obtuse attenuated apices. Apical axis and longitudinal bands well distinct. Robust transverse striae, 5 to 9/10 µm. This specimen is morphologically identical to those described by [10, 15, 17].

- **Order** Toxariales Round
- **Family** Toxariaceae Round
- **Genus** *Toxarium* Bailey

3.1.10. Toxarium undulatum Bailey (Figure 3F)

Syn.: *Synedra undulata* (Bailey) Gregory 1857

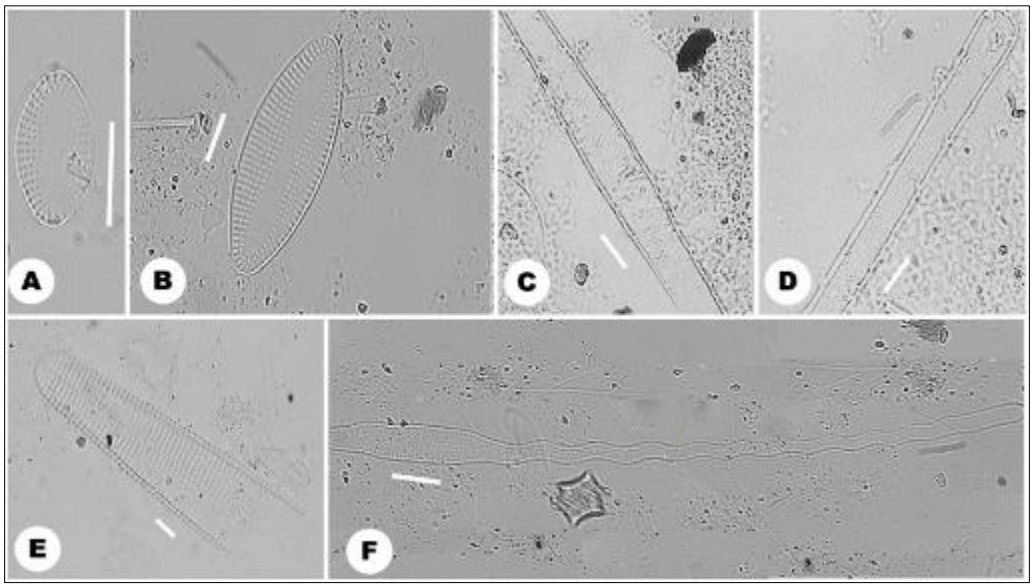

Figure 3 A: *Delphineis surirella*, valvaire view; B: *Delphineis surirella var. australis*, valve view; C-D: *Ardissonea fulgens*, (C) median region dilated and (D) extremity dilated; E: *Ardissonea robusta*: valve view with obtuse attenuated extremity; F: *Toxarium undulatum* with median region and rounded apex dilated. Scale Bars=10 µm

Cells more or less arcuated with wavy valve edges. Valves (length 260 µm, diameter 8 µm) widened in the middle; apex dilated and rounded. Ornamentation finely punctuated-striated. The specimen is morphologically identical to those encountered by [9, 15, 16]. Ecology and distribution: marine and estuarine species, common in tropical and subtropical waters.

- **Order** Thalassionematales Round
- **Family** Thalassionemataceae Round
- **Genus** *Thalassionema* Grunow

3.1.11. Thalassionema bacillare (Heiden) Kolbe (Figure 4A)

Valve (length 82 µm, diameter 4 µm) linear, slightly widened in the center with rounded apex. Area axial distinct; ornamentation formed by a row of marginal areoles (granules).

The specimen is morphologically identical to those described by [11, 18].

Ecology and distribution: species reported in the waters of warm regions.

- **Order** Rhabdonematales Round and Crawford
- **Family** Rhabdonemataceae Round and Crawford
- **Genus** *Rhabdonema* Kützing

3.1.12. Rhabdonema adriaticum Kuetz (Figure 4B)

Cells quadrangular in girdle view with rounded and hyalins corners. Valves linear-elliptical with transverse striae, 8-9/10 µm. Presence of many septa, pierced by three foramina, It presents the same morphological characters as those described by [9, 15, 17].

Ecology and distribution: cosmopolitan littoral species, rarer in cold seas.

3.1.13. Rhabdonema punctatum (Hawey & Bailey) Stodder ex Boyer (Figure 4C)

Quadrangular cells in connective view with rounded and hyalins corners. Girdle widened by numerous intercalar bands, as well as numerous septa and foramen. Striped ornamentation with regular punctuations.

Dimension: diameter 85 µm, length 145 µm.

The species was identified from the works of [9, 15].

Ecology and distribution: tropical coastal marine species.

- **Order** Striatellales Round
- **Family** Striatellaceae Kützing
- **Genus** *Grammatophora* Ehrenberg

3.1.14. Grammatophora hamulifera Kützing (Figure 4D)

Syn.: Grammatophora angulosa var. hamulifera Kuetz:

Frustule rectangular in cingular view with two septas finished in hook. Striae transapical and fine, 15 / 10 µm. Dimensions: length 23 µm, width 16 µm. This specimen was identified through the works of [19, 20].

Ecology and distribution: coastal species.

3.1.15. Grammatophora marina (Lyngbye) Kützing (Figure 4E)

Frustule rectangular (length 30 µm, width 18 µm) in connective view, linear-elliptical and swollen in the center with rounding in valve view. Septa slightly wavy (two undulations) and terminated by a nodule. 15 striae/10 µm. [7, 20] have identified this species.

Ecology and distribution: coastal species frequent in warm and temperate waters.

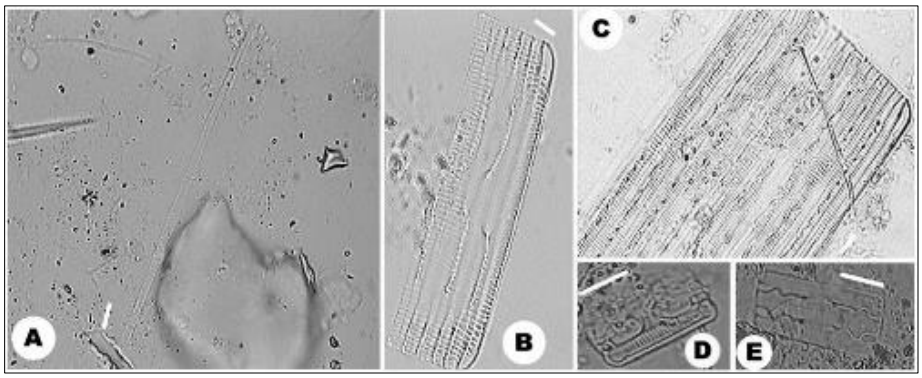

Figure 4 A: *Thalassionema bacillare*, valve view; B: *Rhabdonema adriaticum*, tabular frustule; C: *Rhabdonema punctatum*, tabular frustule; D: *Grammatophora hamulifera*, girdle view; I: *Grammatophora marina*, girdle view. Scale Bars=10 µm

3.1.16. Grammatophora oceanica Ehrenberg (Figure 5A)

Frustules rectangular (length 27 µm, width 10 µm).in connective view. Septa with a slight undulation near the base and terminated in nodular formation. Valves linear, slightly bulged in the middle. Transapical stries finely punctuated, 25-28 in 10 µm.

This description is identical to those of [7, 10, 16].

Ecology and distribution: cosmopolitan marine and brackish species.

3.1.17. Grammatophora oceanica f. minuscula Per. (Figure 5B)

It differs from *G. oceanica* only by its very small size and the specimen encountered is more or less square (side 15 µm). The species was identified through the work of [10].

Ecology and distribution: very widespread species.

- **Order** Climacospheniales Round
- **Family** Climacospheniaceae Round
- **Genus** *Climacosphenia* Ehrenberg

3.1.18. Climacosphenia moniligera Ehrenberg ((Figure 5 C-D-E)

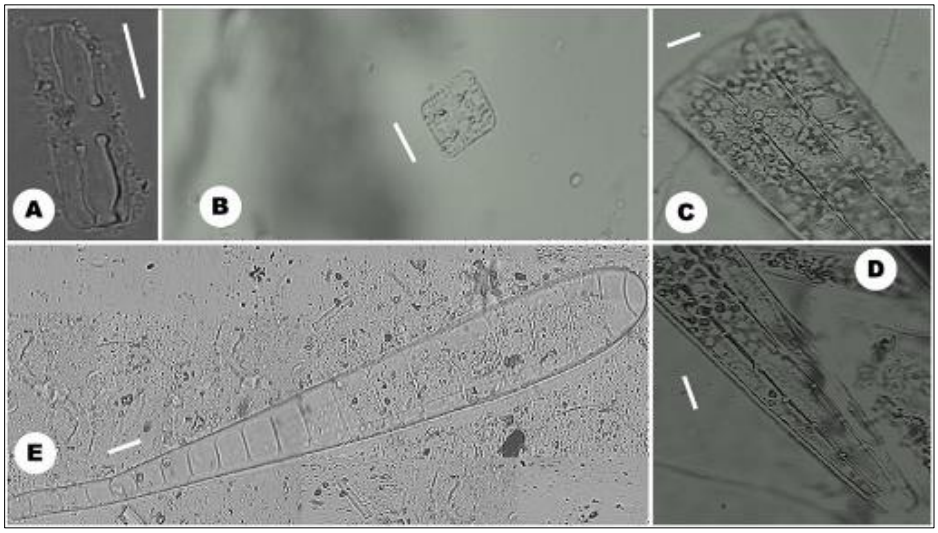

Figure 5 A: *Grammatophora oceanica*, girdle view; B: *Grammatophora oceanica f. minuscula*, girdle view; *Climacosphenia moniligera*: C-D: girdle view (E) valve view showing the partition. Scale Bars=10 µm

Frustules very elongated wedge-shaped presenting along their entire length a partition pierced with long openings separated by fairly wide bands. Valves (length 190 µm) clavate, rounded, with two submarginal longitudinal lines. Striae punctate and relatively visible, 16 to 17 below, 19 to 20 above on the valves, 13 from above to below on the connectives.

[15, 21, 22, 23] made it possible to identify this species.

Ecology and distribution: coastal species more common in warm tropical and subtropical waters.

3.2. Taxonomic composition

The results of the study showed that 18 taxa of araphid pennates diatoms (Class Fragilariophyceae) belonging to 9 genera and divided into 9 families, 8 orders were observed. The families Striatellaceae, Licmophoraceae are dominant with respectivly four and three species. *Grammatophora*, with 4 species, is the most representative genera followed by *Licmophora* with 3 species. The Genus *Rhabdonema*, *Ardissonia*, *Delphineis*, *Opephora* each have 2 species, the rest with one species.

These species are almost all marine and coastal; which explains their presence in the marine waters of Ngor.

Species like comme *Grammatophora hamulifera*, *Grammatophora marina, Delphineis surirella, Delphineis surirella* var. *australis, Opephora schwartzii, et Licmophora flabellata* were encountered by [8] from subtropical mangroves environments in Mexico. It could be linked to their euryhaline nature because according to [24] diatoms are the most representative group of algae in these areas in relation to the euryhaline nature of the majority of these taxa.

Species like *Delphineis surirella, Grammatophora oceanica et Grammatophora marina* have been found in phytoplankton by [7, 16] and others like *Rhabdonema adriaticum, Ardissonea robusta, Grammatophora oceanica, Licmophora ehrenbergii, Toxarium undulatum* in phytobenthos by [8, 17]. In benthic diatoms, forms with true raphe have a higher binding capacity, due to the excretion of mucilaginous substances through this raphe [25]. However, the taxas described here are araphids. But, according to [20], when diatoms do not have a raphe, the adhesion of the valve can take place thanks to the secretion of extracellular mucilaginous substances by other parts of the frustule or by the pseudoraphe characteristic of most species of Fragilariophyceae. This could explain their presence in both phytoplankton and phytobenthos.

4. Conclusion

The descriptive study of Ngor's diatoms showed 18 taxa of araphid pennate diatoms distributed in 9 genera, 9 families, 8 orders and one class. It has contributed to the creation of a database of diatomic communities. The knowledge of the diversity level of diatom in Ngor will allow further studies such as the use of diatomic index methods and therefore a very reliable assessment of the biological quality of the water.

Compliance with ethical standards

Acknowledgments

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References

[1] Round FE, Crawford R, Mann DG. The Diatoms. Morphology and biology of the genera. New York: Cambridge University Press; 1990.

[2] Mann DG. The species concept in diatoms. Phycologia. 1999; 38(6): 437-495.

[3] Al-Yamani FY, Saburova MA. Marine phytoplankton of Kuwait's Waters. Volume II. Diatoms. Kuwait: Institute for Scientific Research. 2019.

[4] Leuduger-Fortmorel G. Marine diatoms of the West Coast of Africa. Memoirs of the Société d'Emulation des Côtes-du-Nord. St., Brieuc: Imprimerie Francisque Guyon; 1898.

[5] Amossé A. Marine and brackish diatoms from Senegal and Ivory Coast. IFAN Bulletin, A. Series. 1970; 32 (2): 289-311.

[6] Boyer CS. The Diatomaceæ of Philadelphia and Vicinity. Philadelphia: Press of J.B. Lippincott Co; 1916.

[7] Al-Kandari M, Al-Yamani FY, Al-Rifaie K. Marine Phytoplankton Atlas of Kuwait's Waters. Kuwait: Kuwait Institute for Scientific Research; 2009.

[8] López FFO, Siqueiros BDA, Navarro JN. Benthic diatoms associated with mangrove environments in the Northwest Region of México. 1st ed. Mexico: Cicimar-Oceánides; 2010.

[9] Stidolph SR, Sterrenburg FAS, Smith KFI, Kraberg A. Stuart R. Stidolph Diatom Atlas. U.S. Geological Survey Open-File Report; 2012–1163. 2012. Avalaible online at http://pubs.usgs.gov/of/2012/1163/ . 2012

[10] Peragallo MMH, Peragallo M. Marine diatoms from France and neighboring maritime districts. Tempere, J. (Ed.). Grez-sur-Loing (S & M): Micrographe-Editeur; 1908.

[11] Hasle GR, Syvertsen EE, Steidinger KA, Tangen K, Tomas CR. Identifying Marine Diatoms and Dinoflagellates. C.R. Tomas. London: Academic Press; 1996.

[12] Paulmier G. Atlas of diatomophyceae of French coasts and adjacent oceanic areas. Rapport. DRV/RH/RST/97-14. https://archimer.ifremer.fr/doc/00000/2452/ . 1997.

[13] Park J, Khim JS, Ohtsuka T, Araki H, Witkowski A, Koh CH. Diatom assemblages on Nanaura mudflat, Ariake Sea, Japan: with reference to the biogeography of marine benthic diatoms in Northeast Asia. Botanical Studies. 2012; 53: 105-124.

[14] Fernandes LF, Brandin FP, Gutseit KS, Fonseca AL, Pellizar FM. Benthic diatoms growing on glass slides in the Paranaguá Bay, Southern Brazil: taxonomic structure and seasonal variation. Insula Florianópolis. 1999; 28: 53-100.

[15] Paulmier G. Microplankton from marine and brackish waters of French Guiana and the West Indies. Editions of ORSTOM. Paris: Collection Study and Theses; 1993.

[16] Al-Yamani FY, Saburova MA. Illustrated guide on the benthic diatoms of Kuwait's Marine Environment. Kuwait: Kuwait Institute for Scientific Research; 2011.

[17] Al-Handal AY, Compere P, Riaux-Gobin C. Marine benthic diatoms in the coral reefs of Reunion and Rodrigues Islands, West Indian Ocean. Micronesica. 2016; 3: 1–78.

[18] Rivera P, Cruces F, Avaria S. Thalassionema bacillare (Heiden) Kolbe (Thalassionemataceae, Bacillariophyceae): A special species now unknown to Chilean waters near the phytoplankton near the north. Cienc. Tecnol. 2006; 29: 59-70.

[19] Rivera P, Gebauer M. Chilean diatoms included in the Boyer´s, Cleve & Moeller´s, Schulze´s and Smith´s collections, deposited at the Academy of Natural Sciences of Philadelphia. Gayana Bot. 1989; 46: 89-116.

[20] Moura A, Bittencourt-Oliveira M, Nascimento E. Benthic Bacillariophyta of Paripe river estuary in Pernambuco state, Brazil. Brazilian Journal of Biology. 2007; 67(3): 393-401.

[21] Cupp EE. Marine plankton diatoms of the West Coast of North America. Berkeley and Los Angeles: University of California Press; 1943.

[22] Siqueiros-Beltrones DA, Valenzuela-Romero G, Hernández Almeida O, Argumedo-Hernández U, López Fuerte FO. Iconographic catalogue of diatoms of rocky habitats and their incidence in the diet of abalone (Haliotis spp.) young people of Baja California Sur, México. CICIMAR Oceánides. 2004; 19(2): 29-103.

[23] Siqueiros-Beltrones DA, Hernández UA. Diversidad de diatomeas en la dieta in situ de *Chiton virgulatus* (Mollusca: Polyplacophora) de Baja California Sur, México. Hidrobiológica. 2012; 22(3): 267-281.

[24] Pritchard DN. What is an estuary: Physical view point? In Lauff GH. Ed. Estuaries. Washington: Am. Ass. Adv.Sci Publication. 1967; 83. p. 3-5.

[25] Watherbee R, Lind JL, Burke J, Quatrano RS. The first kiss: Establishment and control of initial adhesion by raphid diatoms. J. Phycol. 1998; 34: 9-15.