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Original article

Marine diatoms from the Colombian Pacific: A list of species with some taxonomic annotations

Diatomeas marinas del Pacífico colombiano: Una lista de especies con algunas anotaciones taxonómicas

Humberto Luis Quintana-Manotas[1,*], Jesús Javier Hoyos-Acuña[2], Juan José Gallego-Zerrato[3], José Antolín Aké-Castillo[4]

[1]Grupo de investigación en Oceanografía Operacional, Centro de Investigaciones Oceanográficas e Hidrográficas del Caribe, Cartagena, Colombia
[2]Colección Hidrobiológica Colombiana, Grupo de Investigación en Hidrobiología Colombiana, MerGlen S.A.S., Magangué, Bolívar, Colombia
[3]Grupo de Investigación Ciencia Oceanográfica, Departmento de Biología, Facultad de Ciencias Exactas y Naturales, Universidad del Valle, Cali, Colombia
[4]Instituto de Ciencias Marinas y Pesquerías, Universidad de Veracruz, Veracruz, México

Abstract

This study compiles a list of diatom species recorded in the Colombian Pacific, based on a bibliographic review aimed at providing an updated reference for future research on Colombian diatoms. We analyzed 34 works comprising mainly undergraduate, Master's, and PhD papers, as well as scientific articles. We documented 340 taxa comprising 334 species, five varieties, and one form. Bacillariophyceae showed the highest species richness (151 species, 44.5%), followed by Mediophyceae (110 species, 32.3%), and Coscinodiscophyceae (79 species, 23.2%). Most records of these microorganisms concentrate in the oceanic zone of the Colombian Pacific and Tumaco Bay. Further sampling efforts are needed along the Colombian Pacific coast to improve biodiversity assessments.

Keywords: Review; Phytoplankton; Bacillariophyceae; Niskin; Biodiversity.

Resumen

Este estudio compila un listado actualizado de especies de diatomeas en el Pacífico colombiano a partir de una revisión bibliográfica exhaustiva, con el objetivo de servir como referencia para futuras investigaciones. Se analizaron 34 trabajos, principalmente tesis de pregrado, maestría y doctorado, complementados con publicaciones científicas. Se registraron 340 taxones, distribuidos en 334 especies, cinco variedades y una forma. La clase Bacillariophyceae presentó la mayor riqueza específica (151 especies, 44,5 %), seguida de Mediophyceae (110 especies, 32,3 %) y Coscinodiscophyceae (79 especies, 23,2 %). Hasta ahora los estudios se han concentrado en la zona oceánica y la bahía de Tumaco, lo que amerita ampliar los esfuerzos de muestreo en áreas costeras para una mejor comprensión de la biodiversidad diatomológica en la región.

Palabras clave: Revisión; Fitoplancton; Bacillariophyceae; Niskin; Biodiversidad.

Introduction

Diatoms are a group of autotrophic eukaryotic microorganisms characterized by a silica-based cell wall divided into an upper part (epitheca) and a lower one (hypotheca), with a series of intermediate bands called the cingulum (**Round *et al.***, 1990). Their classification relies primarily on the shape, ornamentation, and arrangement of the frustule (**Round *et al.***, 1990; **Hasle & Fryxell**, 1995). They are globally distributed across all aquatic environments, particularly in marine phytoplankton, with 16,158 species recorded worldwide (**Al-Yamani & Saburova**, 2019). Diatoms play a crucial ecological role in

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***Corresponding autor:**
Humberto Luis Quintana-Manotas; humberto19quintana@gmail.com

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marine systems, contributing 40–45% of oceanic primary productivity—equivalent to 20% of global carbon fixation and oxygen production (**Falkowski *et al.***, 1998; **Malviya *et al.***, 2016). Additionally, they facilitate the export of carbon dioxide and silica to the ocean floor (**Benoiston *et al.***, 2017).

Diatom research in Colombia began with the works of **Arosemena *et al.*** (1973), **Caycedo** (1977), and **Vidal and Carbonell** (1977), which focused on phytoplankton characterization in the Colombian Caribbean. Subsequent studies expanded to species inventories (**Lozano-Duque *et al.,*** 2010) and new records for the country (**Arbeláez & Vidal**, 2014; **Medina-Tombé *et al.,*** 2019). In contrast, research on diatoms in the Colombian Pacific Basin (CPB) started with species records from neritic phytoplankton in Tumaco Bay (**Calderón**, 1979). The 1980s saw the initiation of the Regional Study of El Niño (ENSO: El Niño-Southern Oscillation), which generated much of the available data (**Corchuelo & Moreno**, 1983; **Constaín & Delgado**, 1985; **Castillo & Vizcaíno**, 1993; **Medina**, 1998; **Uribe-Palomino**, 2003; **Ramírez *et al.***, 2006). Over the past two decades, research efforts in the CPB have intensified (**Peña & Pinilla**, 2002; **Lozano-Triana**, 2009; **Giraldo-López & Ramírez**, 2010; **Osorio-Cardoso**, 2019). The most recent phytoplankton inventory for the Colombian Pacific reported 262 diatom species in Tumaco Bay (**Hoyos-Acuña *et al.***, 2021).

Species inventories are valuable tools for monitoring biodiversity changes and developing conservation strategies at local, regional, and national levels. They help identify critical trends, such as species extinctions and the spread of invasive organisms (**Gilman *et al.***, 2009), and serve as essential databases for ecological, taxonomic, and biogeographical studies. In this sense, our study aimed to compile existing literature to generate a detailed list of marine diatom species in the Colombian Pacific and to assess the historical progress and current state of research in this field.

Materials and methods

We conducted a bibliographic review of studies identifying phytoplankton and diatom species in the coastal and oceanic waters of the Colombian Pacific. The review included theses and publications from documentation centers such as the Instituto de Investigaciones Marinas y Costeras (INVEMAR), the Centro de Investigaciones Oceanográficas e Hidrográficas del Pacífico (CCCP), and the libraries of Valle, Jorge Tadeo Lozano, Javeriana, and Mississippi Universities. We also searched through databases, scientific journals, and online resources using the following keywords: algae, diatoms, plankton, phytoplankton, Colombian Pacific, Panama Basin, and Eastern Tropical Pacific.

We included only those studies reporting identifications to the species level, though some genera were also noted due to their limited records or taxonomic significance. The taxonomic classification follows **Guiry and Guiry** (2025) for higher-level categories (classes), while orders, families, and genera were arranged alphabetically, with corrections based on **Guiry and Guiry** (2025). Scientific names and authorship were also updated according to these authors. For species with revised nomenclature, the current valid name is presented first, followed by the original recorded synonym (indicated by the symbol "=").

To assess spatial research coverage, a map was created to highlight areas with concentrated sampling efforts as well as understudied or unexplored zones. This spatial analysis was performed using ArcGIS® (version 18.2).

Results

We recorded 340 marine diatom taxa comprising 334 species, five varieties, and one form distributed across three classes, 41 orders, 71 families, and 131 genera (**Table S1,** https://www.raccefyn.co/index.php/raccefyn/article/view/3258/4657). Bacillariophyceae was the most species-rich class with 151 taxa (44.5%), followed by Mediophyceae (110 taxa, 32.3%) and Coscinodiscophyceae (79 taxa, 23.2%). Three orders accounted for 40.6% of

the total diversity: Chaetocerales (54 species), Naviculales (50 species), and Bacillariales (29 species). At the family level, Chaetocerotaceae showed the highest species richness (51 species), followed by Bacillariaceae (29 species) and Rhizosoleniaceae (23 species). We excluded *Actinoptychus mediterraneum* reported by **Rojas and Ortiz** (2007) due to its absence in both the World Register of Marine Species (WoRMS) and AlgaeBase databases. *Proboscia alata* var. *curvirostris*, mentioned by **Uribe** (2003), was omitted for the same reason.

Our review identified 34 publications on Colombian Pacific diatoms spanning from 1979 to 2021. Half of these were thesis works (including one PhD, one MSc, and 17 undergraduate theses), while the remainder consisted of scientific articles (14 in national and three in international journals, **Table 1**) Universidad del Valle contributed most significantly, with seven undergraduate theses, followed by Universidad Jorge Tadeo Lozano, with one master's thesis and five undergraduate theses.

Research efforts have been unevenly distributed geographically. The oceanic zone of the Colombian Pacific, sampled during the "Estudio Regional del Fenómeno El Niño" (ERFEN) program, accounted for 20 studies. Other biologically significant areas included Tumaco Bay (eight studies), Ensenada de Utría (two studies), Gorgona Island (one study), Cabo Marzo and Punta Cruces (one study), Bahía Málaga (one study), and a combined study of Solano Bay, Buenaventura, and Tumaco.

Regarding methodologies, phytoplankton sampling primarily employed water collection using Nansen or Niskin bottles at standard depths (1, 10, 30, 50, and 100 m; 48.5% of studies) and surface trawls with 50-64 µm mesh phytoplankton nets (42.4% of studies). For diatom identification, aliquot dilution with microscopic observation dominated (81.8% of studies), while the Utermöhl method was used in the remaining 18.2%.

Discussion

The total number of diatom species recorded in this study exceeds that reported in comparable regional studies. While **Lozano-Duque *et al.*** (2010) documented 337 taxa in the Colombian Caribbean, this lower figure likely reflects the fewer studies conducted in that region (17 versus 34 in the Colombian Pacific; **Table 1**). However, our results show lower species richness than other tropical eastern Pacific regions, including the southern Gulf of Mexico (413 taxa; **Licea *et al.***, 2016) and southeastern Mexican Pacific (498 species; **Torres-Ariño *et al.***, 2019). These disparities may stem from methodological limitations in the Colombian Pacific studies, which primarily employed Niskin or Van Dorn bottles (5-10 L samples) that capture limited water volumes, and 50-64 µm mesh nets that fail to retain smaller microorganisms. Additionally, the scarcity of high-resolution techniques, particularly the use of high-refractive-index mounting media (e.g., Naphrax) and scanning electron microscopy (SEM), has hindered the identification of small or taxonomically challenging genera such as *Minidiscus, Thalassiosira, Cyclotella,* and *Pseudo-nitzschia*.

Research efforts in the Colombian Pacific have predominantly focused on oceanic zones through the ERFEN program conducted by the CCCP since 1983, while coastal and transitional areas remain understudied. The exception is Tumaco Bay, which has received relatively more attention (**Calderon**, 1979; **Hoyos-Acuña *et al.,*** 2021; **Figure 1**) due to the CCCP's local presence, which facilitates sampling. This geographic bias has created significant knowledge gaps along most of Colombia's Pacific coastline.

Most of the studies surveyed (primarily unpublished theses) suffer from methodological limitations that constrain their scientific value. Many of these works lack drawings, photographs, and descriptions to support identification. Many identifications rely on fresh mounts without frustule cleaning, obscuring diagnostic features. These limitations reflect both historical technical constraints (particularly pre-2000 printing costs for illustrated diatom catalogs) and a chronic shortage of taxonomic specialists in the region.

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Table1. Records of published and unpublished bibliographic references (PhD, MSc, and undergraduate theses) on diatoms in the Colombian Pacific

Author	Year	Type of document
Calderón	1979	Undergraduate thesis
Corchuelo & Moreno	1983	Undergraduate thesis
Castillo-González	1984	**Scientific article**
Calderon	1986	Undergraduate thesis
Oviedo-Parra	1989	Undergraduate thesis
Castillo & Vizcaino	1992	**Scientific article**
Collazos	1992	Undergraduate thesis
Castillo & Vizcaino	1993	**Scientific article**
Vizcaíno-Bravo	1993	Undergraduate thesis
Mendoza	1996	Undergraduate thesis
Sánchez	1996	Undergraduate thesis
Garcés y Medina	1997	Undergraduate thesis
Medina	1997	**Scientific article**
Medina	1998	**Scientific article**
Quiñonez	2000	Undergraduate thesis
García-Hansen & Malikov	2002	**Scientific article**
Peña y Pinilla	2002	**Scientific article**
Torres-Salazar	2003	Undergraduate thesis
Uribe	2003	Undergraduate thesis
Ramírez *et al.*	2006	**Scientific note**
Ramírez-Roa	2006	Undergraduate thesis
Ramírez & Giraldo	2006	**Scientific article**
Rojas & Ortiz	2007	**Scientific article**
Arteaga-Sogamoso *et al*	2008	**Scientific article**
Galeano	2008	PhD thesis
Lozano	2009	Undergraduate thesis
García-Hansen	2009	Doctoral theses
Galeano-Chavarría & Arteaga-Sogamoso	2010	**Scientific article**
Giraldo & Ramírez	2010	**Scientific article**
Giraldo A *et al*.	2014	**Scientific article**
Guzmán *et al.*	2014	**Scientific article**
Arteaga-Sogamoso & Perdomo-Trujillo	2016	**Scientific article**
Osorio	2019	Master's thesis
Hoyos-Acuña *et al.*	2021	**Scientific article**

The genus *Pseudo-nitzschia* deserves special attention due to its ecological significance in harmful algal blooms (HABs) and domoic acid production (**Bates *et al*.**, 2018). While five morphotypes (representing the *delicatissima* and *seriata* complexes) have been tentatively identified in Colombian waters, these records require confirmation using modern techniques (electron microscopy or molecular methods). The presence of confirmed toxigenic species in the broader South American Pacific (*P. australis, P. pseudodelicatissima,* etc.) (**Álvarez *et al*.**, 2009; **Tenorio *et al*.**, 2021) suggests Colombia's current records likely represent actual occurrences, though only *P. lineola* has been definitively documented.

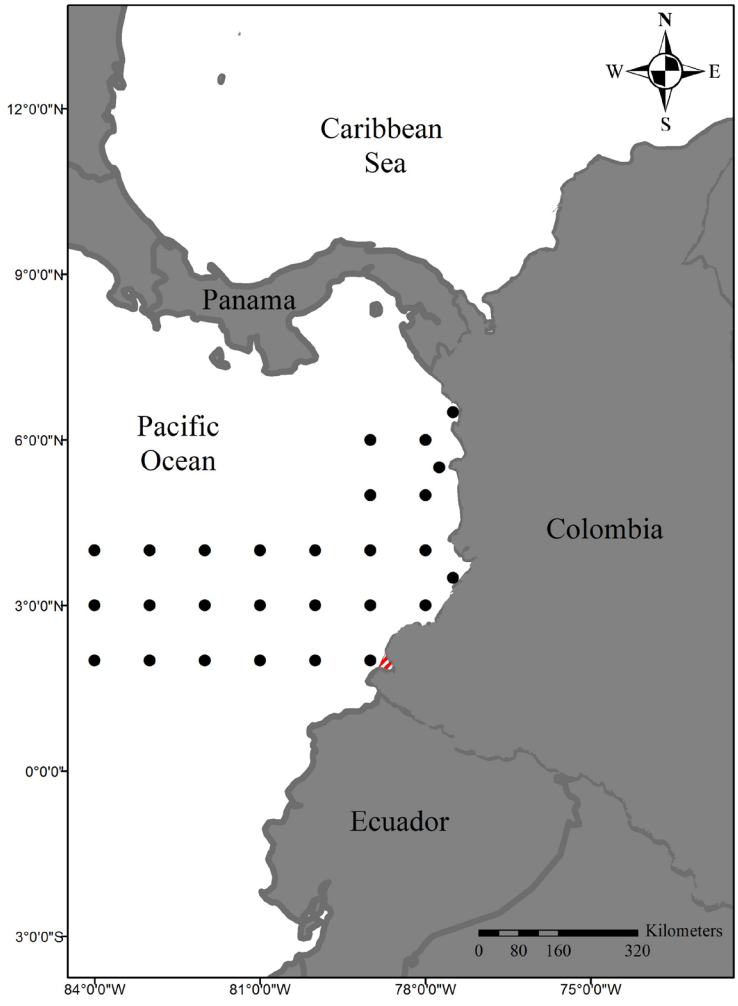

Figure 1. Most studied sites regarding diatoms in the Colombian Pacific. Black dots indicate stations visited during ERFEN cruises; the red striped area shows Tumaco Bay.

To advance diatom research in the Colombian Pacific, we strongly recommend: 1) expanding sampling to understudied coastal areas; 2) implementing integrative taxonomy for species validation; 3) including comprehensive morphological descriptions (with measurements, habitat data, and cleaned-frustule micrographs); 4) incorporating benthic diatom studies (epiphytic and epipsammic taxa), and 5) depositing voucher specimens in biological collections, particularly for new records.

Supplementary material

See the supplementary material in https://www.raccefyn.co/index.php/raccefyn/article/view/3258/4657

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Authors' contributions

HLQM, JJHA, and **JGS** gathered the information; **HLQM** prepared the tables; **JGZ** made the map; **JAAC** revised the nomenclature and the manuscript. All authors contributed to the writing of the paper.

Conflict of interest

The authors declare that there is no conflict of interest of any kind that could affect the publication or the results of this research process.

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