Phytoplankton community structure and HAB monitoring in coastal Escuintla, Guatemala.

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Abstract

Phytoplankton is the foundation of primary production and biogeochemical cycles in marine environment. Nutrient enrichment in marine environments affecs directly on the Phytoplankton community, it also can lead to harmful algal blooms -HABs-, posing significant threats to marine life and human health.

This study was focused on researching the phytoplankton community structure in coastal waters of Escuintla, Guatemala, during 2024. Ten taxonomic classes were identified, notably, *Trichodesmium erythraeum* (cyanobacteria) exhibited high abundances in May, while *Skeletonema* sp. showed elevated abundances in July. Other significant observations included the detection of the genus *Karenia* (species pending on confirmation from experts).

This provides baseline data on phytoplankton diversity in coastal Escuintla, contributing to regional knowledge and supporting early detection of potential HAB events. Continued monitoring and refined methodologies are crucial for enhancing our understanding of phytoplankton dynamics and their ecological significance in Guatemalan coasts.

Introduction

Phytoplankton, the primary producers in oceanic pelagic zones, form the base of the food chain and comprise over 90% of organic matter. They produce around 70% of atmospheric oxygen, regulate biogeochemical cycles, and reduce atmospheric CO_2 [1]. The most dominant groups are:

- Dinoflagellates (Dinophyceae): Motile due to two flagella.
- Diatoms (Bacillariophyceae): Silica-based frustule cell walls.

Harmful Algal Blooms (HABs), caused by microalgal proliferation, degrade water quality, cause anoxia, alter pH, and harm public health and agriculture [10]. They thrive in estuaries and upwelling zones, characterized by nutrient enrichment, salinity and high chlorophyll levels. Toxin-producing species can affect organs and nervous systems in marine life and humans [4].

Guatemala has reported HABs since 1956 [8, 2, 3], with monitoring designated institutions. HABs negatively impact fisheries, tourism, and public health Monitoring toxin-producing species is vital to prevent poisoning, protect lives, and safeguard marine resources.

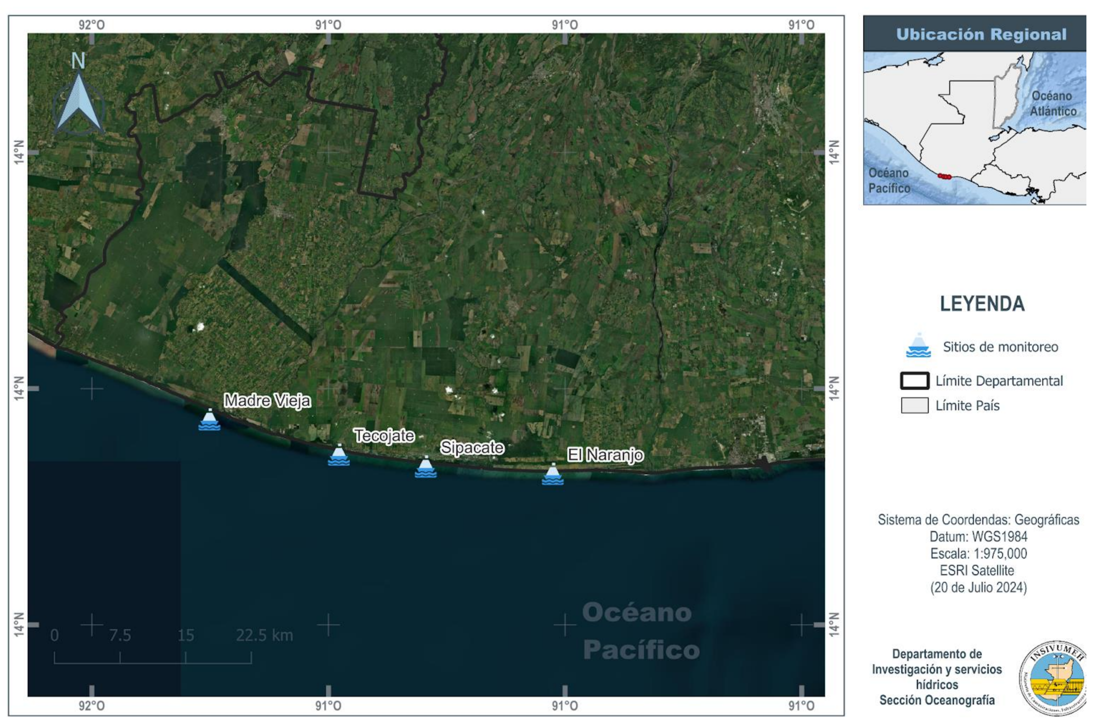

Figure 1. Sampling and monitoring sites on the Pacific coastline

Methods and Materials

This study was conducted in four sites within the coastal marine area of Escuintla, in the Pacific coast of Guatemala (Figure 1). At each site, a 500 mL seawater sample was collected. This sampling process was repeated every two months at the same locations.

Samples were taken 0.5 km offshore and preserved using acidic Lugol's solution. Phytoplankton cells were counted and identified using a Sedgewick-Rafter chamber in an Olympus CX43 optical microscope equipped with an Olympus EP50 camera.

Organisms were identified through dichotomous keys, identification guides, and by examining their structural characteristics.

Statistical analyses (diversity indices) were performed using Rstudio to elucidate the composition of the phytoplankton community, HAB species present in the samples and the diversity of each site.

Results

In the analyzed samples, **Bacillariophyceae** class (diatoms) was the most abundant, which is common in coastal zones due to the **high influx** of nutrients from estuaries [5].

During the month of March, there was no detection of **high abundances** of **toxin-producing or harmful** organisms to marine life. Rather, a greater quantity of organisms associated with HABs was observed. Additionally, several species of silicoflagellates **(Dictyochophyceae)** were found at one site.

In May, high abundances of diatoms and **cyanobacterial filaments** were recorded (Figure 2). These species are potentially toxic and accounted for 56.4% of the species significant for HABs.

In July, high abundance of ***Skeletonema*** diatoms was observed (Figure 3), which can pose a **risk** to marine life at high concentrations [6].

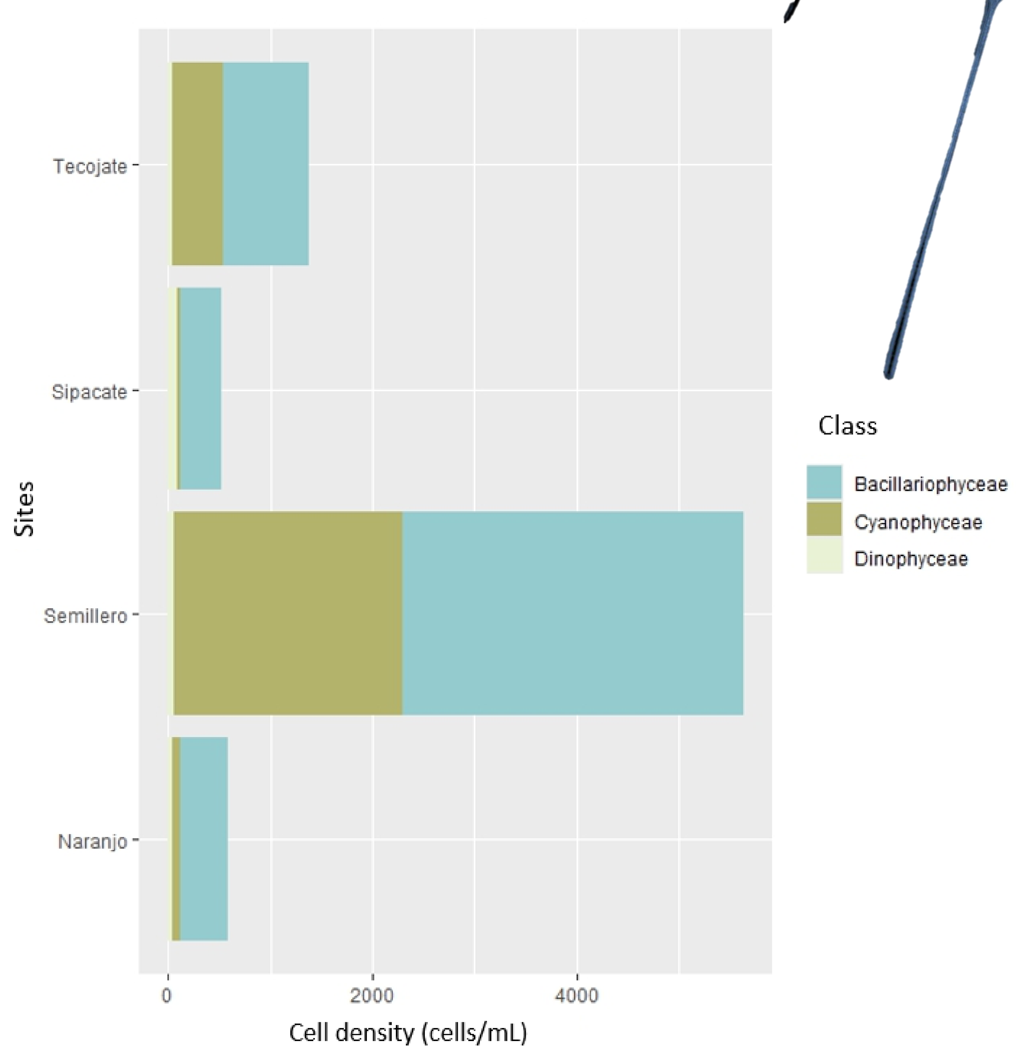

Figure 2. Taxonomic Classes observed in May 2024..

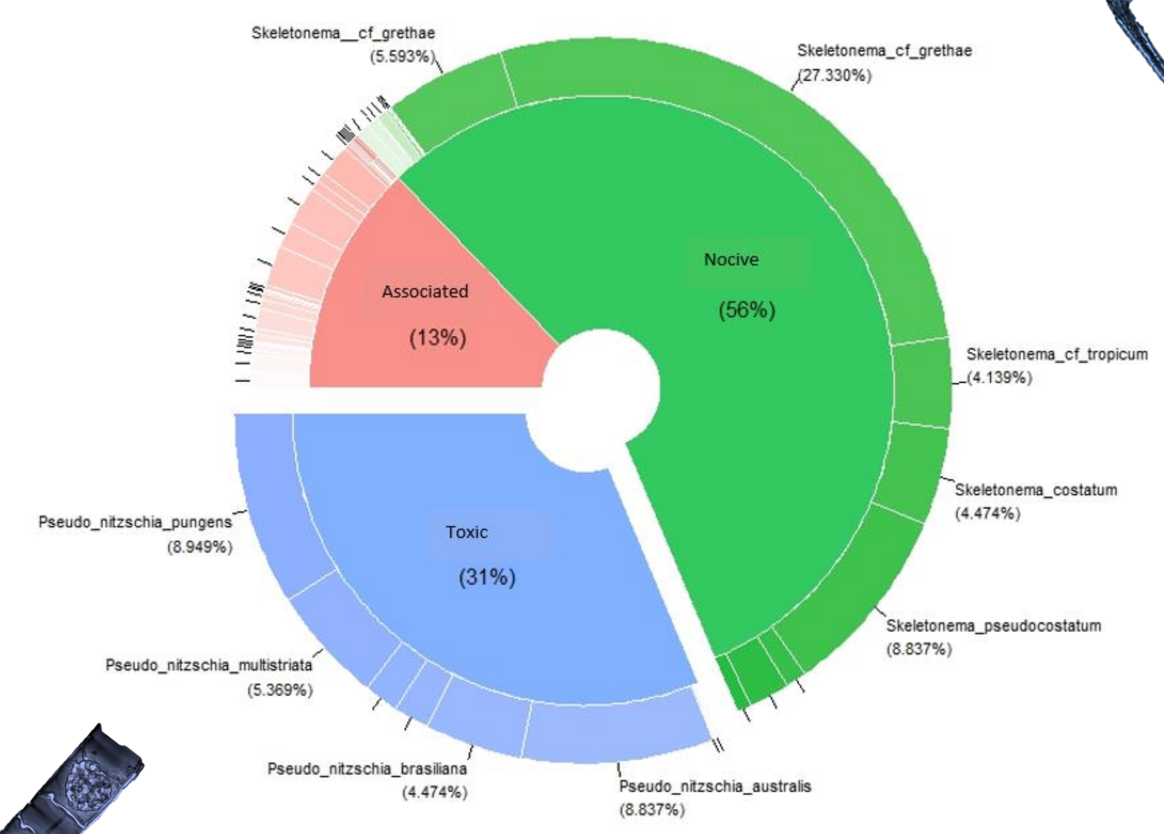

Figure 3. Important HAB species observed during July 2024.

Main findings

During March, four species of **silicoflagellates** were identified in Tecojate, marking a **significant finding** due to the limited information available on these organisms in the area. Among the species relevant to harmful algal blooms (HABs), ***Pseudo-nitzschia pungens*** was detected, albeit in low densities.

In May, high densities of ***Trichodesmium erythraeum***, a cyanobacterium with toxicity reports in coastal regions worldwide [9, 11], were observed. Given its potential **ecological impact**, the presence and bloom dynamics of this species require further analysis.

By July, a **bloom** comprising four species of the genus *Skeletonema* (*S. costatum, S. pseudocostatum, S. tropicum, and S. c.f. grethae*) was documented. Additionally, cells of the genus ***Karenia*** were detected. However, it needs expert identification as well as advanced visualization and molecular identification techniques [7].

Throughout all sampling months and across all locations, **cysts** of potentially toxic dinoflagellates (*Gymnodinium catenatum, Margalefidinium polykrikoides, Alexandrium tamarense*) and other unidentified species were **consistently detected**.

Given their ecological and potential **health impacts**, it is recommended to implement continuous monitoring programs and establish cyst germination cultures. This approach will help **elucidate the full diversity** of species present and assess their potential risks.

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