



# First report of occurrence, abundance, and spatial distribution of *Pyrodinium bahamense* L. Plate, 1906 in Shark Fin Bay, Palawan, Philippines

Edgar P. Paalan<sup>\*</sup>, Avien Ynna M. Hasan, Noe D. Reyes, Herminie P. Palla and Jhonamie A. Mabuhay-Omar

College of Fisheries and Aquatic Sciences, Western Philippines University - Puerto Princesa Campus

\*Corresponding author: [eppaalan@gmail.com](mailto:eppaalan@gmail.com)

Received: 12 Nov. 2024 || Revised: 27 Aug. 2025 || Accepted: 29 Dec. 2025 || Available online: 22 Jan. 2026

©Western Philippines University  
ISSN: 1656-4707  
E-ISSN: 2467-5903  
Homepage: [www.palawanscientist.org](http://www.palawanscientist.org)

## How to cite:

Paalan EP, Hasan AYM, Reyes ND, Palla HP, Mabuhay-Omar JA. 2026. First report of occurrence, abundance, and spatial distribution of *Pyrodinium bahamense* L. Plate, 1906 in Shark Fin Bay, Palawan, Philippines. *The Palawan Scientist*. 18(1):57-62. <https://doi.org/10.69721/TPS.J.2026.18.1.06>

## ABSTRACT

Harmful Algal Blooms (HABs) pose a significant threat to many coastal communities worldwide, with their spatial distribution steadily increasing over the years. In the Philippines, *Pyrodinium bahamense* L. Plate, 1906 has been identified as the culprit behind paralytic shellfish poisoning. Therefore, it is necessary to monitor *P. bahamense* to ensure public safety during blooms. Hence, we investigated the occurrence, abundance, and spatial distribution of *P. bahamense* in Shark Fin Bay, Palawan, using conventional microscopy techniques. Results revealed the presence of *P. bahamense* in all six sampling stations, with a mean cell density ranging from 15 to 442 cells L<sup>-1</sup>. In addition, the measured water physicochemical parameters showed no significant correlation ( $P > 0.05$ ) with cell density, suggesting that other factors may potentially influence the abundance and distribution of *P. bahamense* in this area. Thus, we recommend further monitoring efforts to determine the bloom dynamics of the species.

**Keywords:** dinoflagellate, harmful algal blooms, paralytic shellfish poisoning, red tide

Harmful Algal Blooms (HABs) are recurring events resulting from the proliferation of harmful and toxic microalgae in aquatic environments. In addition, HABs have impacted the tourism industry, food security, livelihood, local economy, and human health of many coastal communities worldwide (Gobler 2020). According to the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (IOC–UNESCO), there are about 119 species of toxic dinoflagellates (Lundholm et al. 2009 onwards), including *Pyrodinium bahamense* L. Plate, 1906. The species is a tropical, euryhaline dinoflagellate that

produces saxitoxins and causes paralytic shellfish poisoning (PSP) (Morquecho 2019).

The first occurrence of a toxic bloom involving *P. bahamense* took place in Papua New Guinea in 1972 (Maclean 1989). Following the initial occurrence, blooms of this species were subsequently reported in Southeast Asian countries, particularly in Malaysia and the Philippines (Yñiguez et al. 2021). In the Philippines, the most notable incident caused by *P. bahamense* occurred during red tide events from 21 June to September 1983, resulting in blooms mostly in Maqueda Bay and Villareal Bay, Samar. A total of 278 paralytic shellfish poisoning (PSP) cases were reported, with 21 deaths, primarily due to consumption



This article is licensed under a [Creative Commons Attribution-NonCommercial 4.0 International License](https://creativecommons.org/licenses/by-nc/4.0/)

of green mussels, *Perna viridis* (Linnaeus, 1758), from the affected bays (Estudillo and Gonzales 1984). Since then, blooms caused by toxic *P. bahamense* have been documented in different parts of the country (Gacutan et al. 1985; Montojo et al. 2006; Siringan et al. 2008; Yap-Dejeto et al. 2018). The expansion of these sites is still increasing, but at a slower pace compared to the 1990's (Yñiguez et al. 2021).

One of the impacted areas is the island of Palawan, where several coastal areas, such as Malampaya Sound, Honda Bay, and Puerto Princesa Bay, are currently being monitored for occurrences of PSP-causing species (BFAR 2024). One area of interest is Shark Fin Bay, located on the east coast of mainland Palawan, within the same municipality where the first case of PSP in the province was recorded (Furio and Gonzales 2002). Studying this area and identifying HAB species within the province are essential not only for the sustainable management of marine ecosystems but also for protecting public health, preserving economic activities, and contributing to global efforts in understanding and addressing the impacts of these blooms. This paper aimed to investigate the occurrence of *P. bahamense* in Shark Fin Bay, Taytay, Palawan. Specifically, it aimed to: (1) measure the physicochemical parameters of the water; (2) determine the presence, density, and spatial distribution of *P. bahamense* in the area; and (3) explore the relationship between water physicochemical parameters and *P. bahamense* cell density.

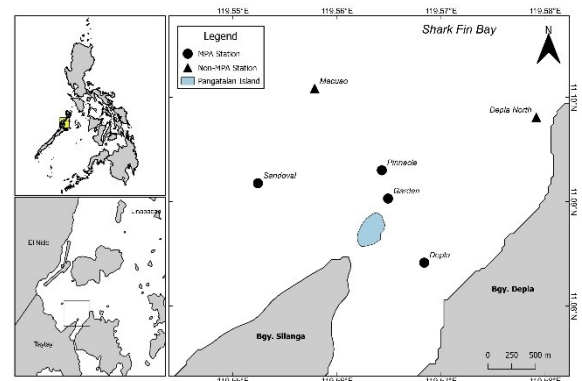
The sampling stations (Table 1) were established as part of the ongoing research partnership between the Western Philippines University and Sulubaa Environmental Foundation. The Marine Protected Areas comprise Depla, Garden, Pinnacle, and Sandoval, while deeper, non-Marine Protected Areas include Depla North and Macuao (Figure 1).

**Table 1.** Coordinates of sampling stations in the study area.

Station	Latitude (°N)	Longitude (°E)
Depla	11°5.049'	119°34.130'
Depla North	11°5.890'	119°34.747'
Garden	11°5.416'	119°33.894'
Macuao	11°6.057'	119°33.470'
Pinnacle	11°5.579'	119°33.859'
Sandoval	11°5.506'	119°33.143'

In-situ measurements of water physicochemical parameters and collections of *P. bahamense* were conducted every other month from August to December 2023 and in March 2024, all during the daytime. However, *P. bahamense* cells were only observed in the December samples, which

were then subjected to further analysis. Dissolved oxygen (DO) (mg L<sup>-1</sup>), salinity (ppt), and temperature (°C) were measured using a YSI Pro 2030 (Xylem, USA), while pH was measured using a pH 600 (Milwaukee, USA). Water transparency (m) and depth (m) were measured using a 20 cm diameter Secchi Disk and a portable F12 Echo Sounder (Erchang, China), respectively. *P. bahamense* samples were collected using a plankton net with a 30 cm mouth diameter and 20 µm mesh size. The net was lowered to a depth of 5 m, hauled vertically, and then the collected samples were concentrated to the cod-end using a sprayer. The collected samples were transferred to a pre-labeled plastic bottle and preserved with 5% formaldehyde solution.



**Figure 1.** Location of sampling stations in Shark Fin Bay, Taytay, Palawan.

In the laboratory, *P. bahamense* was identified and counted using conventional microscopy techniques. Identifying *P. bahamense* followed references from Tomas (1997) and Omura et al. (2012). Cell counting was performed using a sedgewick rafter counting chamber and viewed under a BA210 light microscope (Motic, Germany). A 1-mL aliquot of the sample was transferred to a sedgewick rafter counting chamber (50 mm x 20 mm grids) in triplicate. Density was computed using the formula used by Relox (2002):

$$\text{Density (expressed in cells L}^{-1}\text{)} = \frac{(N \times V_1)}{V_s}$$

Where: N = number of cells in a 1-ml aliquot; V<sub>1</sub> = total plankton sample volume; V<sub>s</sub> = volume of the seawater filtered by the plankton net within hauling depth.

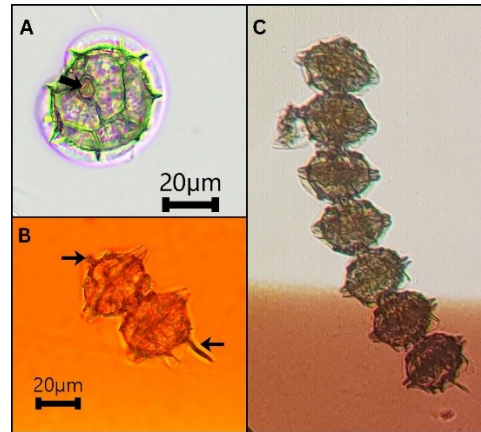
To map the spatial distribution, mean density data of *P. bahamense* were plotted using QGIS software version 3.28.14. Moreover, data for correlation analysis were subjected to a normality test using the Shapiro–Wilk test. Since the data did not satisfy the assumption of normality, a non-parametric analysis was performed using Spearman's correlation. The correlation coefficient was calculated using the

‘corr’ function in R statistics, with the level of significance set at  $\alpha = 0.05$ , and a correlation matrix was created to visualize the relationships between the data.

The water parameters at Shark Fin Bay showed minimal variations among the sampling stations (Table 2). The water temperature ranged from 29.0 to 29.80°C. The mean salinity was 35.4 ppt, with the lowest recorded in Macuao (34.6 ppt) and the highest in Depla (35.9 ppt). Dissolved oxygen values varied from 4.3 to 5.3 mg L<sup>-1</sup>, while pH had a mean of 8.5. The highest values for water transparency and depth were recorded in Macuao, measuring 9 m and 23.9 m, respectively.

*Pyrodinium bahamense* (Figure 2) was observed in water samples collected from Shark Fin Bay only in December 2023, with most cells in chains. At this time, *P. bahamense* was found in all six stations. The cell count ranged from 15 to 442 cells L<sup>-1</sup>, with the highest density recorded at Garden Station near Pangatalan Island (Figure 3). Lower densities were

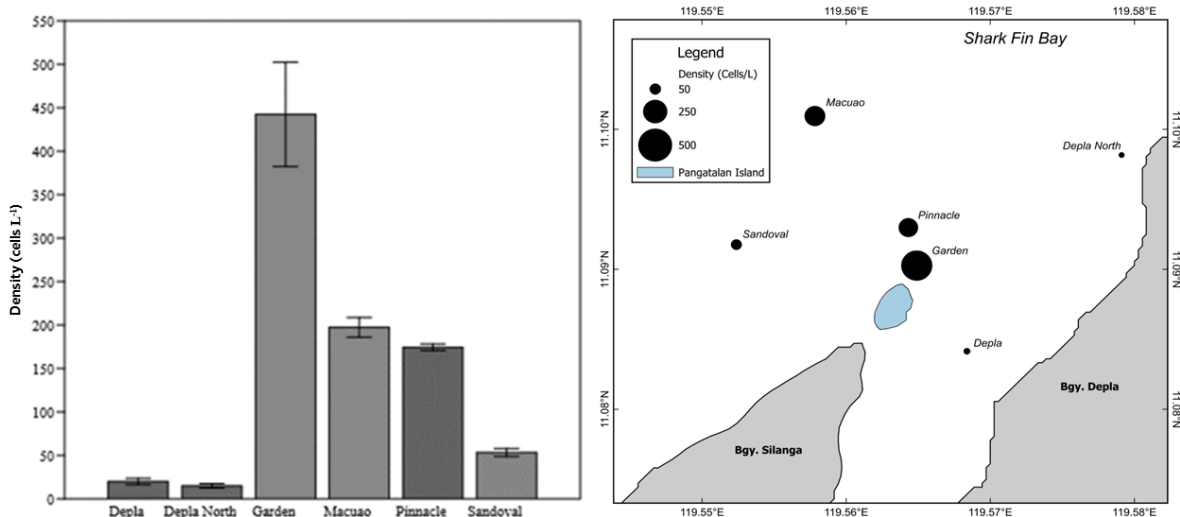
observed in the eastern stations (Depla and Depla North).



**Figure 2.** Light microscopy images of *Pyrodinium bahamense* at 100x magnification. (A) Apical view showing the plates and the apical attachment pore (arrow); (B) cells showing an apical spine (upper arrow) and an antapical spine (lower arrow); (C) cells in chains.

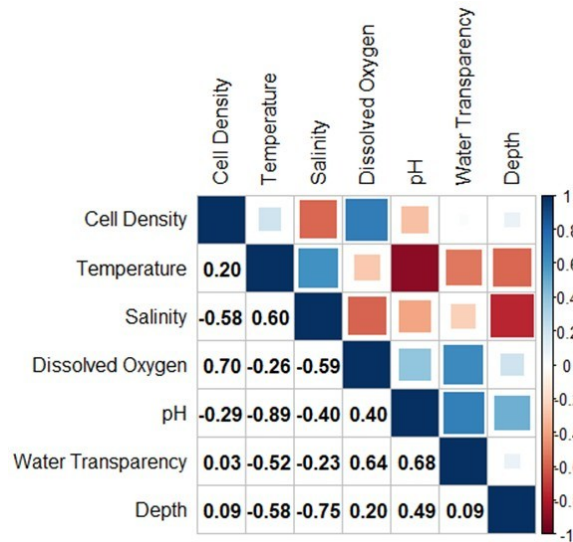
**Table 2.** Mean physicochemical parameters at sampling stations in Shark Fin Bay.

Station	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)	pH	Water Transparency (m)	Depth (m)
Depla	29.8	35.9	4.3	8.4	4.6	9.5
Depla North	29	35.2	4.3	8.5	5.2	20.7
Garden	29.7	34.9	5	8.4	4.3	10.6
Macuao	29.2	34.6	5.3	8.5	9	23.9
Pinnacle	29.7	35.8	4.4	8.4	5.3	5.3
Sandoval	29.5	35.8	5.1	8.5	6.5	6.6
Mean	29.5	35.4	4.7	8.5	5.8	12.8



**Figure 3.** Density and spatial distribution of *Pyrodinium bahamense* in Shark Fin Bay during December 16–17, 2023.

Preliminary analysis of the correlation between *P. bahamense* density and water physicochemical parameters showed a positive correlation for temperature (0.20), DO (0.70), water transparency (0.03), and depth (0.09), while a negative correlation was found for salinity (-0.58) and pH (-0.29), as shown in Figure 4. However, all water parameters showed no significant linear relationship ( $P > 0.05$ ) with cell density due to the limited data. Therefore, a study involving long-term monitoring is needed to address these limitations.



**Figure 4.** Correlation matrix between water physicochemical parameters and *Pyrodinium bahamense* cell density.

The measured physicochemical parameters were consistent with the optimal environmental conditions for the Philippine *P. bahamense* population, characterized by lower temperature and higher salinity (Gedaria et al. 2007). Notably, the species has also been reported in Eastern Samar, where the temperature ranged from 29 to 32°C and the salinity varied between 27 and 35 ppt (Ravelo et al. 2022). Further, a bloom of the species occurred in the coastal waters off Yemen in the Red Sea, where the water temperature reached 32°C, and the salinity was as high as 37 ppt (Alkawri et al. 2016). Generally, *P. bahamense* blooms occur only in waters with a temperature of more than 20°C and a salinity of 20 ppt or higher (Usup et al. 2012).

To our knowledge, the presence of *P. bahamense* in Shark Fin Bay was the first report of this species in the area. In Palawan, the first report of PSP occurred in 1998 at Malampaya Sound within the municipality of Taytay (Furio and Gonzales 2002). This incident was potentially linked to *P. bahamense*, as resting cysts of this species were documented in the area (Botja et al. 2000). In fact, Sombrito et al. (2004) suggested that *Pyrodinium* cysts may have been

present in the sediment before the first recorded toxic algal bloom in the province. In Puerto Princesa Bay, Garcellano et al. (2022) noted the presence of *P. bahamense* in coastal areas inhabited by informal settlers. Furthermore, live cells of *P. bahamense* have been previously isolated, cultured, and characterized from Honda Bay (Onda et al. 2013). Moreover, the Malampaya Sound, Puerto Princesa Bay, and Honda Bay have been listed in the Shellfish Bulletin of the Bureau of Fisheries and Aquatic Resources (BFAR 2024) for PSP monitoring (Figure 5).

The cell density observed in this study was higher than that reported in Puerto Princesa Bay (Garcellano et al. 2022) but did not reach a level indicative of a bloom since there is currently no standardized density threshold for its classification. In contrast, in Sabah, Malaysia, red tide attention is directed to the public when the *P. bahamense* cell density is more than 1,000 cells L<sup>-1</sup>, while red tide alert is issued when it exceeds 7,000 cells L<sup>-1</sup> (Jipanin et al. 2019). In the Philippines, PSP monitoring has primarily relied on toxin levels in shellfish rather than phytoplankton cell counts (Arcamo et al. 2014).

The preliminary results from the correlation analysis suggest that other significant environmental factors may be the main contributors to the abundance and distribution of *P. bahamense* in the area. Water dynamics influenced by monsoons and nutrient availability have been vital factors in the blooms of *P. bahamense* in several regions. In Florida, USA, blooms mainly occurred in shallow areas with long water residence times, where abundance was linked to nutrient concentrations (Phlips et al. 2006). In contrast, blooms in Matarinao and Murcielagos Bays in the Philippines did not consistently correlate with the simulated residence time patterns (Lumayno et al. 2021). In Manila Bay, Villanoy et al. (2006) noted higher nutrient concentrations and phytoplankton biomass at depths shallower than 10 m, influenced by the strong vertical mixing of the water column. In addition, they also observed that wind forcing caused the resuspension of *Pyrodinium* cysts, accompanied by an increase in bottom current velocity. Notably, the sampling period in December coincided with the Northeast Monsoon (NEM) in the Philippines, which significantly affects the eastern portion of Palawan. Additionally, there was a tropical depression during the sample collection that strengthened the NEM, contributing to strong water currents in the area. These environmental factors could have contributed to the presence of *Pyrodinium* in Shark Fin Bay during the sampling period.

Given the vast coastal waters of Palawan, the detection of *P. bahamense* in Shark Fin Bay underscores the importance of monitoring, particularly in areas with no prior records of HABs. This study also contributes to the growing knowledge of the species' spatial distribution in Palawan, which is essential for

the effective monitoring and management of PSP during bloom events. Therefore, continued and expanded monitoring is recommended, with the inclusion of other necessary environmental parameters, to generate more substantial evidence on the contributing factors and bloom dynamics in the area. Moreover, the findings of this study may serve as baseline information to support the possible inclusion of Shark Fin Bay as a regular PSP monitoring site by relevant local and national agencies.

## FUNDING

This study is part of the Sea Academy Project led by Sulubaaï Environmental Foundation, with support from the French Facility for Global Environment, the Prince Albert II of Monaco Foundation, and Blancpain Ocean Commitment. This study is also supported by the HABs Watch Project funded by the CHED-LAKAS program.

## GENERATIVE AI STATEMENT

The OpenAI's ChatGPT was used only to improve grammar, clarity, and formatting references. The authors reviewed and verified all AI-generated content to ensure accuracy and compliance with academic standards.

## ETHICAL CONSIDERATIONS

No animals were harmed, and no human subjects were involved during this study.

## DECLARATION OF COMPETING INTEREST

The authors declare no competing interests.

## ACKNOWLEDGMENTS

The authors would like to thank the Microbial Oceanography Laboratory of the University of the Philippines - Marine Science Institute for allowing their microscope to capture better images of the specimen. Additionally, we thank Mr. Robert Jay Ramos for his assistance during the microscopy. Finally, we thank the anonymous reviewers for their valuable insights, which significantly contributed to the improvement of this paper.

## REFERENCES

Alkawri A, Abker M, Qutaei E, Alhag M, Qutaei N, Mahdy S. 2016. The first recorded bloom of *Pyrodinium bahamense* var.

*bahamense* plate in Yemeni coastal waters off Red Sea, near Al Hodeida city. Turkish Journal of Fisheries and Aquatic Sciences. 16(2):275-282. [https://doi.org/10.4194/1303-2712-v16\\_2\\_07](https://doi.org/10.4194/1303-2712-v16_2_07)

- Arcamo SV, Relox J Jr, Romero MLJ, Cabella LMT, Carolino LC. 2014. Paralytic shellfish monitoring in the Philippines – a management review. In: MacKenzie L, editor. Proceedings of the 16<sup>th</sup> International Conference on Harmful Algae; 2014; Nelson, New Zealand. Nelson (NZ): Cawthron Institute. p. 274-277.
- BFAR (Bureau of Fisheries and Aquatic Resources). 2021. Shellfish Bulletin No. 15, Series of 2021; 2021 May 12 [accessed 2024 Mar 22]. <https://www.bfar.da.gov.ph/wp-content/uploads/2022/01/Shellfish-Bulletin-Archive-2021.pdf>
- BFAR (Bureau of Fisheries and Aquatic Resources). 2024. Shellfish Bulletin No. 01, Series of 2024; 2024 Jan 11 [accessed 2024 Mar 22]. <https://www.bfar.da.gov.ph/shellfish-bulletin-no-02-2022>
- Borja VM, Furio EF, Rodriguez AK. 2000. Horizontal and vertical distribution of *Pyrodinium bahamense* cysts in sediments of Malampaya Sound, Palawan, Philippines. In: HAB 2000 Conference; 2000; Tasmania, Australia. [cited 2024 Mar 22]. Available from: [http://www.utas.edu.au/docs/plantscience/HAB2000/poster-abstracts/docs/Borja\\_VM.html](http://www.utas.edu.au/docs/plantscience/HAB2000/poster-abstracts/docs/Borja_VM.html)
- Estudillo RA, Gonzales CL. 1984. Red tides and paralytic shellfish poisoning in the Philippines. In: White AW, Anraku M, Hooi KK, editors. Toxic red tides and shellfish toxicity in Southeast Asia: proceedings of a consultative meeting; 1984 Sep 11–14; Singapore. Singapore: Marine Fisheries Research Department, Southeast Asian Fisheries Development Center. p. 52-79.
- Furio EF, Gonzales CL. 2002. Toxic red tide and paralytic shellfish poisoning profiles in the Philippines. In: Gonzales CL, Sakamoto S, Furio EF, Ogata T, Kodama M, Fukuyo Y, editors. Practical guide in paralytic shellfish monitoring in the Philippines. Manila (PH): Bureau of Fisheries and Aquatic Resources, Japan International Cooperation Agency. p. 3-27.
- Gacutan RQ, Tabbu MY, Aujero EJ, Icatlo F. 1985. Paralytic shellfish poisoning due to *Pyrodinium bahamense* var. *compressum* in Mati, Davao Oriental, Philippines. Marine Biology. 87(3):223-227. <https://doi.org/10.1007/BF00397798>
- Garcellano RC, Japson LS, Wy SI. 2022. Water quality of Puerto Princesa Bay in relation to the presence of informal settlers in its coastal areas. The Palawan Scientist. 14(1):84-99. <https://doi.org/10.69721/TPS.J.2022.14.1.10>
- Gedaria AI, Luckas B, Reinhardt K, Azanza RV. 2007. Growth response and toxin concentration of cultured *Pyrodinium bahamense* var. *compressum* to varying salinity and temperature conditions. Toxicon. 50(4):518-529. <https://doi.org/10.1016/j.toxicon.2007.04.021>
- Gobler CJ. 2020. Climate change and harmful algal blooms: insights and perspective. Harmful Algae. 91:101731. <https://doi.org/10.1016/j.hal.2019.101731>
- Jipanin SJ, Shaleh SM, Lim PT, Leaw CP, Mustapha S. 2019. The monitoring of harmful algae blooms in Sabah, Malaysia. In: J Phys Conf Ser. 1358:012014. Bristol (UK): IOP Publishing. <https://doi.org/10.1088/1742-6596/1358/1/012014>
- Lumayno SDP, Benico GA, Yñiguez AT, Alabia ID, Fernandez IQD, Dianala RDB, Azanza RV, Villanoy C. 2021. Residence time models and *Pyrodinium* blooms in Matarinao and Murcielagos Bays, Philippines. Philippine Journal of Science. 151(S1):79-90. <https://doi.org/10.56899/151.S1.06>
- Lundholm N, Churro C, Fraga S, Hoppenrath M, Iwataki M, Larsen J, Mertens K, Moestrup Ø, Zingone A. 2009 onwards. IOC-UNESCO taxonomic reference list of harmful microalgae. Paris (FR): Intergovernmental Oceanographic Commission of UNESCO. [accessed 2024 Mar 22]. <https://doi.org/10.14284/362>

- Maclean JL. 1989. Indo-Pacific red tides, 1985-1988. *Marine Pollution Bulletin*. 20(7):304-310. [https://doi.org/10.1016/0025-326X\(89\)90152-5](https://doi.org/10.1016/0025-326X(89)90152-5)
- Montejo UM, Sakamoto S, Cayme MF, Gatdula NC, Furio EF, Relox JR, Shigeru S, Fukuyo Y, Kodama M. 2006. Remarkable difference in accumulation of paralytic shellfish poisoning toxins among bivalve species exposed to *Pyrodinium bahamense* var. *compressum* bloom in Masinloc Bay, Philippines. *Toxicon*. 48(1):85-92. <https://doi.org/10.1016/j.toxicon.2006.04.014>
- Morquecho L. 2019. *Pyrodinium bahamense*, one of the most significant harmful dinoflagellates in Mexico. *Frontiers in Marine Science*. 6:1. <https://doi.org/10.3389/fmars.2019.00001>
- Omura T, Iwataki M, Borja VM, Takayama H, Fukuyo Y. 2012. Marine phytoplankton of the western Pacific. Tokyo (JP): Kouseisha Kouseikaku Co., Ltd. 160 p.
- Onda DF, Benico G, Sulit AF, Gaité PL, Azanza RV, Luisma AO. 2013. Morphological and molecular characterization of some HAB-forming dinoflagellates from Philippine waters. *Philippine Science Letters*. 6(1):97-106. <https://scienggi.org/2013/2013n1.11.pdf>
- Phlips EJ, Badylak S, Bledsoe E, Cichra M. 2006. Factors affecting the distribution of *Pyrodinium bahamense* var. *bahamense* in coastal waters of Florida. *Marine Ecology Progress Series*. 322:99-115. <https://doi.org/10.3354/meps322099>
- Plate L. 1906. *Pyrodinium bahamense* n.g., n. sp. die Leucht-Peridinee des "Feuersees" von Nassau, Bahamas. *Arch Protistenkd*. 7(3):411-429, plate 19.
- Ravelo SF, Yap-Dejeto LG, Silaras MLS, Amparado MLL, Ocampo JA, Abria EG, Albina MB. 2022. A snapshot on the distribution of coastal phytoplankton communities in five HAB-affected bays in Eastern Visayas, Philippines. *Frontiers in Marine Science*. 9:730518. <https://doi.org/10.3389/fmars.2022.730518>
- Relox EF. 2002. Plankton analysis. In: Gonzales CL, Sakamoto S, Furio EF, Ogata T, Kodama M, Fukuyo Y, editors. *Practical guide in paralytic shellfish monitoring in the Philippines*. Manila (PH): Bureau of Fisheries and Aquatic Resources, Japan International Cooperation Agency. p. 79-87.
- Siringan FP, Azanza RV, Macalalad NJH, Zamora PB, Sta. Maria MYY. 2008. Temporal changes in the cyst densities of *Pyrodinium bahamense* var. *compressum* and other dinoflagellates in Manila Bay, Philippines. *Harmful Algae*. 7(4):523-531. <https://doi.org/10.1016/j.hal.2007.11.003>
- Sombrito EZ, Bulos ADM, Sta Maria EJ, Honrado MCV, Azanza RV, Furio EF. 2004. Application of 210Pb-derived sedimentation rates and dinoflagellate cyst analyses in understanding *Pyrodinium bahamense* harmful algal blooms in Manila Bay and Malampaya Sound, Philippines. *Journal of Environmental Radioactivity*. 76(1-2):177-194. <https://doi.org/10.1016/j.jenvrad.2004.03.025>
- Tomas CR, editor. 1997. *Identifying marine phytoplankton*. San Diego (CA): Academic Press. 859 p.
- Usup G, Ahmad A, Matsuoka K, Lim PT, Leaw CP. 2012. Biology, ecology and bloom dynamics of the toxic marine dinoflagellate *Pyrodinium bahamense*. *Harmful Algae*. 14:301-312. <https://doi.org/10.1016/j.hal.2011.10.026>
- Villanoy CL, Azanza RV, Altemerano A, Casil AL. 2006. Attempts to model the bloom dynamics of *Pyrodinium*, a tropical toxic dinoflagellate. *Harmful Algae*. 5(2):156-183. <https://doi.org/10.1016/j.hal.2005.07.001>
- Yap-Dejeto L, Durante CY, Tan IL, Alonzo CO. 2018. *Pyrodinium bahamense* and other dinoflagellate cysts in surface sediments of Cancabato Bay, Leyte, Philippines. *Philippine Journal of Science*. 147(2):209-220.
- Yñiguez AT, Lim PT, Leaw CP, Jipanin SJ, Iwataki M, Benico G, Azanza RV. 2021. Over 30 years of HABs in the Philippines and Malaysia: what have we learned? *Harmful Algae*. 102:101776. <https://doi.org/10.1016/j.hal.2020.101776>

**ROLE OF AUTHORS:** EPP – *Conceptualization, Investigation, Formal Analysis, Writing – Original Draft*; AYMH – *Investigation, Writing – Original Draft*; NDR – *Investigation, Formal Analysis*; HPP – *Investigation, Writing – Review & Editing*; JAMO – *Conceptualization, Investigation, Supervision, Writing – Review & Editing, Fund Acquisition*.

**Responsible Editor: Dr. Roger G. Dolorosa**