frontiers in Marine Science

EDITORIAL
published: 01 February 2022
doi: 10.3389/fmars.2022.812660

Editorial: Harmful Algal Blooms in Marine Environments: From Biologically Active Compounds to Species Diversity

*Cristiana Moreira**

CIIMAR/CIMAR, Interdisciplinary Centre of Marine and Environmental Research, University of Porto, Matosinhos, Portugal

Keywords: HAB (harmful algal blooms), climate change, risk assessment, toxins, water quality, natural products

Editorial on the Research Topic

Harmful Algal Blooms in Marine Environments: From Biologically Active Compounds to Species Diversity

Constant and urging human costal pressures demand the continuous vigilance of toxic pollutants such as those that are produced under Harmful Algal Blooms or HAB's. Economic losses or lockdown of human activities are problems frequently associated with HAB's report globally. Contact routes or exposure to these toxicants can endanger health if ingested, inhaled or enter in contact with the skin resulting in epidemiological data that in many areas of the globe is poorly followed. Studying this phenomenon requires the application of reliable methodologies that in summary characterize, evaluate and identify possible hazards and risks underlined with HAB's occurrence, namely in coastal ecosystems (Anderson et al., 2012). Characterizing the toxicity (toxins amount and content) along with species description most commonly associated with HAB's can improve knowledge and contribute to the implementation of control measures toward its crucial mitigation. With five articles compositing this Research Topic authors contributions highlight once more on the problematics of HABs and provide additional answers either with monitoring or HAB's species studies. The contributions of Bucci et al. illustrates the phenology of blooms of the toxic dinoflagellate *Alexandrium catenella*, an annually recurrent phenomena in the Bay of Fundy (US), predicting that these may increase in the region by the middle of this century. Carrying a 27-year data of bloom metrics and phenology Bucci et al. revealed that warmer years are linked to earlier arrival of thermal habitats and earlier detection and bloom initiation. The study of to Bucci et al. will be relevant in future monitoring campaigns contributing to climate change prediction models and in the anticipation of possible outbreaks of toxins associated with shellfish consumption in the region. In another study, Cembella et al. assessed a marine dinoflagellate of the genus *Prorocentrum* to infer the inter- and intraspecific relationships of members of *Prorocentrum lima* and *Prorocentrum hoffmannianum* species complexes. In Cembella et al. a total of 67 toxigenic isolates were analyzed representing a first survey on the chemodiversity of polyketide-derived toxins associated with diarrheic shellfish poisoning (DSP) on a benthic dinoflagellate genus. Results of Cembella et al. highlight that clonal chemodiversity in toxin composition is unable at present to confirm clear distinctions among substrates or geographical origins to define populations within a species. The authors further claim the application of a multidisciplinary approach in

Edited and reviewed by:
Yuanyuan Feng,
Shanghai Jiao Tong University, China

***Correspondence:**
Cristiana Moreira
cmoreira@ciimar.up.pt

Specialty section:
This article was submitted to Global Change and the Future Ocean, a section of the journal Frontiers in Marine Science

Received: *10 November 2021*
Accepted: *10 January 2022*
Published: *01 February 2022*

Citation:
Moreira C (2022) Editorial: Harmful Algal Blooms in Marine Environments: From Biologically Active Compounds to Species Diversity. Front. Mar. Sci. 9:812660. doi: 10.3389/fmars.2022.812660

resolving *Prorocentrum* genus. In another study of Esenkulova et al. attempts were performed to uncover HAB's variability and its link to environmental drivers in a bloom forming region (British Columbia) and where HAB's are frequently monitored. In their study 4-year data on harmful algae concentrations and physical and chemical properties of seawater were analyzed. Data retrieved from this analysis confirmed the presence of the most common harmful algae in the Strait of Georgia (British Columbia) (*Rhizosolenia setigera*, *Dictyocha* spp., *Alexandrium* spp., *Heterosigma akashiwo*, *Chaetoceros convolutus*, and *C. concavicornis*). These HAB's species had a significant interannual variability in the studied region and its prevalence resulted in high toxin concentrations (Paralytic and Diarrhetic Shellfish Poisonings) in the local shellfish aquacultures correlating with the higher increase of harmful algae in the study area. Similarly fish deaths were registered in salmon farming and these also correlated with the high prevalence of harmful algae concentrations in the water. A statistical positive correlation of harmful algae and environmental parameters was achieved resulting in an improved understanding of the climatic conditions in the region. Main findings of Esenkulova et al. were that long-term data may provide more insights on harmful algae as a stressor in the Strait of Georgia and that tools such as citizen science monitoring programs are valuable. In Cho et al. a transcriptome analysis was conducted elucidating the algicidal mechanism of a marine bacterium *Pseudoruegeria* sp. M32A2M against the bloom-forming dinoflagellate *Alexandrium catenella*. Data show that *Pseudoruegeria* sp. M32A2M inhibits *A. catenella* motility and induces cell disruption after 24 h of co-culture. The analysis of distinct expressed genes revealed that the photosystem in *A. catenella* was inhibited within 2 h, and that pathways related to oxidative phosphorylation and carbon fixation were also affected. *Pseudoruegeria* sp. transcriptome further revealed the upregulation of glycolysis, tricarboxylic acid cycle, and oxidative phosphorylation pathways in *A. catenella*. Also the secondary metabolite biosynthesis gene clusters of *Pseudoruegeria* were suggested to be involved in algicidal activity with the transcriptomes of bacteriocin- and lasso peptide-synthesizing related genes being specifically upregulated according to Cho et al.. Their study provides new insights based in metatranscriptome analysis on the application of bacteria with algicidal activity and in the control of HABs. Finally, in Song et al. a search for the ecological role of the dinoflagellate *Alexandrium insuetum* was performed. *A. insuetum* is a species reported as toxic (Paralytic Shellfish Poisoning) and bloom-forming in several countries of Asia and Europe but carries until now no known mortality among marine animals. This study, the first to characterize *A. insuetum*, englobes the first observation under light and scanning microscopy of isolates of *A. insuetum* from China. According to Song et al. these isolates further confirmed to be toxic to finfish, brine shrimp and rotifer eggs after laboratory bioassays. Chemical analysis of toxicity revealed the absence of PSTs and spiroimines (13-desmethyl spirolide C and gymnodimine) showing a novel toxicity, heat unstable, that can affect the health of finfish and zooplankton, according to Song et al.. Data collected from their study is particularly relevant in a HAB's risk assessment and in the monitoring of blooms of *A. insuetum* in China and across the globe.

Though frequent in the more developed areas of the world and under public health and water quality perspectives HAB's are a relevant source of pollution that demands a full understanding for Ocean and Human health interest. Therefore, and in the lack of many national regulations, science has paved the knowledge on the topic of HAB's occurrence, species description and associated toxicity. Application of sciences such as those undertaken in this Research Topic have permitted to contribute to a wider comprehension on HAB's, establish ecosystems risk levels, as well as assist in the protection of citizens and animal life. Currently, global changes such as heavy rainfall or heat waves have been attributed as a probable cause of HAB's occurrence with extensive impacts on species composition and variation and consequently on toxins profile. Therefore, under our current climate conditions, HAB's vigilance is a critical requisite to assess possible alterations on HAB's occurrence and distribution along with species variation to improve knowledge on HAB's prediction locally and globally. Given these reasons, discussions on HAB's should be considered a primary issue by national governments, international agencies and scientists. Its understanding and risk evaluation can permit to achieve safer ecosystems, minimize economic losses and improve water management strategies without overlooking water quality. With the scientific studies published in this Research Topic, scientists have once more expressed their concerns to the problems of HAB's foreseeing its conception, mitigation and prevention.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

FUNDING

This research was supported by national funds through FCT – Foundation for Science and Technology within the scope of UIDB/04423/2020 and UIDP/04423/2020 and by the Postdoctoral fellowship to Cristiana Moreira (Ref. SFRH/BPD/122909/2016) from FCT.

REFERENCES

Anderson, D. M., Cembella, A. D., and Hallegraeff, G. M. (2012). Progress in understanding harmful algal blooms: paradigm shifts and new technologies for research, monitoring, and management. *Annu. Rev. Mar. Sci.* 4, 143–176. doi: 10.1146/annurev-marine-120308-081121

Conflict of Interest: The author declares that the research was conducted in the absence of any commercial or financial

relationships that could be construed as a potential conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.