



OPEN ACCESS

EDITED AND REVIEWED BY
Pung Pung Hwang,
Academia Sinica, Taiwan

*CORRESPONDENCE
José Ricardo Paula,
✉ jrpaula@ciencias.ulisboa.pt

RECEIVED 29 May 2023
ACCEPTED 01 June 2023
PUBLISHED 08 June 2023

CITATION

Paula JR, Wang X, Xu C and Moreira DC
(2023), Editorial: The defense responses
of aquatic animals to the environment.
Front. Physiol. 14:1231014.
doi: 10.3389/fphys.2023.1231014

COPYRIGHT

© 2023 Paula, Wang, Xu and Moreira. This
is an open-access article distributed
under the terms of the [Creative
Commons Attribution License \(CC BY\)](#).
The use, distribution or reproduction in
other forums is permitted, provided the
original author(s) and the copyright
owner(s) are credited and that the original
publication in this journal is cited, in
accordance with accepted academic
practice. No use, distribution or
reproduction is permitted which does not
comply with these terms.

Editorial: The defense responses of aquatic animals to the environment

José Ricardo Paula^{1,2,3*}, Xiaodan Wang⁴, Chang Xu⁵ and
Daniel C. Moreira⁶

¹MARE—Marine and Environmental Sciences Centre and ARNET—Aquatic Research Network, Laboratório Marítimo da Guia, Faculdade de Ciências, Universidade de Lisboa, Cascais, Portugal, ²Departamento de Biologia Animal, Faculdade de Ciências, Universidade de Lisboa, Lisboa, Portugal, ³Hawai'i Institute of Marine Biology, University of Hawai'i at Mānoa, Kaneohe, HI, United States, ⁴Laboratory of Aquaculture Nutrition and Environmental Health, School of Life Sciences, East China Normal University, Shanghai, China, ⁵Department of Aquaculture, College of Marine Sciences, Hainan University, Haikou, Hainan, China, ⁶Research Center in Morphology and Applied Immunology, Faculty of Medicine, University of Brasília, Brasília, Brazil

KEYWORDS

environmental stressor, hydrogen sulfide, osmoregulation, non-essential element, pH variation, ultraviolet radiation

Editorial on the Research Topic

The defense responses of aquatic animals to the environment

Aquatic animals use different physiological processes to maintain balance in response to environmental stressors. This Research Topic gathers innovative research studies that examine animal strategies for coping with various stressors. The studies focus on stressors like ultraviolet radiation (Gu et al.), hydrogen sulfide contamination (Alipio et al.), exposure to non-essential elements (Campoy-Diaz et al.), pH and ion variations (Lin et al.), and low-salinity stress (Li et al.). Additionally, a sixth manuscript published in this Research Topic explores the role of histone acetylation in the inflammatory response during foreign material implantation in pearl production (Yang et al.).

A study conducted by Gu et al. explored the differences in ultraviolet radiation (UVR) tolerance between low- and high-altitude fish species. The researchers analyzed the skin histology of 22 species and observed histological changes after UVR exposure. The study revealed that fish living in high-altitude and cold-water environments have stronger UVR tolerance, suggesting that adapting to such environments may be essential for UVR resistance. This research enriches our knowledge of the influence of environmental factors on UVR tolerance in aquatic animals.

Alipio et al. investigated the impact of hydrogen sulfide (H₂S) gas on the mucosa of Atlantic salmon (*Salmo salar*), which is known to affect mucosal functions in mammals. Using explant models, the authors focused on genes responsible for mucins and sulfide detoxification. The study results showed that exposure to a sulfide donor impacted the expression of these genes, emphasizing the role of mucins in protecting mucosa against H₂S toxicity. This research provides valuable insights into the unclear interactions between H₂S and fish at the mucosal level.

Campoy-Diaz et al. studied the balance between free radical production, antioxidant defenses, and oxidative damage in the digestive gland of the freshwater gastropod *Pomacea canaliculata* after exposure to non-essential elements (mercury, arsenic, and uranium). The

authors found that snails exhibited increased levels of reactive species and oxidative damage, which were partially compensated by non-enzymatic antioxidant defenses. This work sheds light on the cellular mechanisms underlying this gastropod's tolerance to non-essential elements and supports its use as a bioindicator species for metal pollution in freshwater bodies.

Using a transcriptomic approach, Li et al. investigated the molecular mechanisms underlying the tolerance of the black tiger shrimp, *Penaeus monodon*, to low-salinity stress. Chronic exposure to low salinity triggered adjustments in several cellular processes in the gills of these commercially relevant shrimps. There was a salinity-dependent response of differentially expressed genes, in which the major affected pathways were metabolic, immune and signaling pathways. Overall, the study revealed key molecular events associated with the survival of *P. monodon* to long-term low salinity stress. These insights are useful in understanding animal adaptation to environmental changes in salinity in nature or in aquaculture settings.

Lin et al. investigated the role of vitamin D in the regulation of ionocyte differentiation in zebrafish (*Danio rerio*) larvae. $1\alpha,25$ -dihydroxyvitamin D₃ ($1\alpha,25$ (OH)₂D₃), the bioactive form of vitamin D, is a steroid hormone that is involved in the regulation of Ca²⁺ uptake and acid secretion in teleosts. The present study indicated that $1\alpha,25$ (OH)₂D₃ treatment increased the number of foxi3a-positive cells, ionocyte progenitors, and mature ionocytes. However, the number of P63-positive cells and epidermal stem cells did not change in the zebrafish larvae treated with $1\alpha,25$ (OH)₂D₃. This study indicated that vitamin might play a positive effect on the ionocyte differentiation, which would increase the ion regulation ability of freshwater teleosts. The findings in this paper would provide some new insights into the mechanisms of how fish cope with environmental stress.

Finally, Yang et al. also used a transcriptomic approach to understand the role of histone acetylation in the modulation of the inflammatory response of the pearl oyster *Pinctada fucata*. The immune response of oysters is a decisive factor for the success of xenograft mantle transplantation, a technique used for pearl production. After successfully inducing H3 acetylation (butyrate treatment), the authors identified differentially expressed genes involved in the lysosomal pathway (upregulated) and cell migration and cell proliferation (downregulated). This effect was coupled with increased levels of lipid peroxidation and activity of antioxidant enzymes. In sum, the study revealed that histone H3 acetylation effectively alters the immune response of oysters to transplantation and identified the underlying molecular mechanisms. This information might support the improvement of the health and immunity of pearl oysters and ultimately optimize pearl production.

In conclusion, the studies in this Research Topic provide valuable insights into the defense mechanisms employed by aquatic animals in response to various environmental stressors. Understanding these defense responses is essential for predicting risks, determining future conservation strategies, and informing environmental protection programs.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Funding

JP acknowledges the support by FCT—Fundação para a Ciência e Tecnologia (2021.01030. CEECIND; PTDC/BIA-BMA/0080/2021—ChangingMoods; UIDB/04292/2020 and LA/P/0069/2020) and FLAD—Fundação Luso-Americana para o Desenvolvimento (Proj. 2022/0193).

Acknowledgments

As guest editors, we express our gratitude to Frontiers in Marine Science and Frontiers in Physiology for giving us the opportunity to edit this Research Topic. We are especially grateful to the reviewers who contributed to this exciting project.

Conflict of interest

The authors declare 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.