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Book review: "Epigenetics in aquaculture"

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Epigenetics is the science that studies the mechanisms that reversibly modify and transmit changes in gene expression without altering the nucleotide sequence. Epigenetics has long been neglected, but recently, it has emerged among all scientific communities in biology, especially due to its role in bridging genome expression and environmental conditions, even transgenerationally. Epigenetic regulation is indeed recognized as an essential factor in the development, acclimatization, and rapid adaptation of living organisms, which is crucial for coping with the major changes currently occurring in ecosystems. Aquaculture is no exception to this trend, and increasing research effort has been made in the last decade, an effort skillfully reviewed in the book "Epigenetics in Aquaculture" (1), edited by Francesc Piferrer and Hanping Wang, and published by Wiley.

This substantial book, the first on epigenetics in aquatic organisms, comprises three parts and 21 chapters authored by 48 contributors, including the most recognized experts in the field. The chapters cover the latest findings in the epigenetics of aquatic organisms and address sensitive questions related to aquaculture, such as epigenetic inheritance, response to stress and climate change, nutrition, sexual maturation, and biomarkers.

Significantly, many chapters include a focus on epigenetic inheritance, which is unsurprising given the emphasis on studying environmental epigenetics in aquatic species and the importance of heritability in aquaculture. The book delves into within-, inter-, and transgenerational studies, exploring a diverse range of aquatic species' responses to various stresses. It seeks to address questions which aim at better understanding the role of epigenetic modifications in adaptation and tolerance. Additionally, for numerous aquatic species, the epigenome of eggs, sperm, and developing embryos can be investigated without sacrificing the founder broods. This has resulted in a significant body of literature relating to intergenerational plasticity in aquatic organisms, primarily at the phenotypic level. However, detailed mechanistic information has also been thoroughly documented for specific aquatic model species. Furthermore, "Epigenetics in Aquaculture" includes chapters on aquatic model

invertebrates, such as water fleas, which are of particular interest in studying intergenerational plasticity due to their short generation time, asexual reproduction, and the availability of molecular tools, enabling experimental evolutionary settings that have advanced knowledge in the field. Algae serve as additional experimental evolution models where cutting-edge techniques have been applied to determine how epigenetic processes contribute to adaptation. *Chlamydomonas reinhardtii* and *Phaeodactylum tricornutum* are two models for which deep epigenome characterization has been carried out under a broad range of conditions. Notably, we convey the remarks that authors of "Epigenetics in Aquaculture" raise in several chapters concerning recurring weaknesses that need to be addressed for further advancements in the field. Specifically, questions related to the identification of specific epigenetic changes transmitted to offspring and their causative role in the emergence of phenotypes remain unanswered.

Additionally, the mechanistic understanding of epigenetics often tends to focus on the involvement of DNA methylation, the enigmatic role of which is occasionally discussed. While efforts have been made to describe the involvement of histones and non-coding RNA in model species, such endeavors remain infrequent, and there is a need for a more widespread expansion of these efforts. Another noteworthy limitation of the field highlighted in the book, and one that we also emphasize here, is the insufficient research on the role of epigenetics in the context of biotic interactions. Despite the substantial emergence of data emphasizing the crucial role of the microbiome in fish health, the interaction with epigenetics remains unaddressed. While the significance of utilizing epigenetic memory to maintain long-term beneficial effects of biotic stimulation has been acknowledged in invertebrate species, this aspect has not been thoroughly explored in the context of fish health and should be investigated as a potential sustainable strategy for disease prevention.

After a thorough review of the theoretical and practical bases of epigenetics in aquaculture (Part I) and the presentation of the knowledge acquired in major aquatic groups (Part II), "Epigenetics in Aquaculture" presents how epigenetics would be implemented in the actual farming of aquatic organisms (Part III). This part is highly innovative and proposes straightforward and integrative approaches to enhance this implementation. Based on up-to-date methods and experimental designs largely inspired by biomedicine, the perspectives opened in this part illustrate all the improvements that epigenetic biomarkers would bring to aquaculture. Among the classical objectives aiming to improve economically interesting phenotypes such as growth, others linked to animal well-being in a broad sense were particularly significant and convincing in the current context of social-ecosystem shifts induced by global changes.

Covering a broad spectrum of concepts, terminology, and providing extensive insights into the most farmed groups, "Epigenetics in Aquaculture" will be definitely

useful for students and advanced researchers. It is clearly a must-read for the community of epigenetics in marine biology and aquatic research.

Reference

1. Piferrer F., Wang, H.P., eds. 2023. *Epigenetics in Aquaculture*. John Wiley & Sons, Hoboken, New Jersey. 512 p. ISBN: 978-1-119-82191-5.