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Editorial: Endocrine regulation and physiological adaptation of stress response in aquatic organisms, volume II

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Editorial on the Research Topic
Endocrine regulation and physiological adaptation of stress response in aquatic organisms, volume II

At the individual level, organisms develop many complex morphological and physiological adaptations to maintain homeostasis, of which endocrine regulation is the key. By adjusting physiological mechanisms, organisms adapt their response to the external environment, enabling the acquisition of new homeostatic equilibrium that allows survival.

The physiological adaptative mechanism plays an important role in maintaining homeostasis and adapting to changes in the external environment. Well-known environmental factors such as ambient temperature, pH, ammonia nitrogen, salinity, and exposure to new pollutants can disrupt homeostasis, resulting in growth and physiological and endocrine disorders. Thus, in a rapidly changing climate, it is important to explore the biological adaptive regulation mechanism and endocrine regulation strategy under stress, which has an important impact on the protection of aquatic ecology. The main purpose of the Research Topic is to explore and discuss these potential physiological and molecular mechanisms to provide new insights for developing new green ecological activities.

Lopes et al. explored the impact of chronic stress on the physiological and immune responses of lumpfish (*Cyclopterus lumpus*), revealing that increased stress exposure led to significant alterations in immunity and elevated nutritional demands, particularly for branched-chain amino acids and lysine. Notably, while initial stress exposure enhanced immune parameters, such as plasma nitric oxide and peroxidase levels, these effects diminished by the end of the experiment, coinciding with the worst health conditions observed in the most frequently stressed group. The findings emphasize the complex

relationship between stress, immunity, and nutrition, suggesting a need for tailored dietary strategies and improved rearing practices.

Duan et al. elucidated the detrimental effects of acute heat stress on the intestinal health of a cold water schizothoracine fish *Gymnocypris eckloni*, revealing significant morphological damage, increased oxidative stress, and elevated inflammatory markers, indicating compromised intestinal barrier function. Transcriptomic analyses highlighted the HIF-1 signaling pathway's critical role under heat stress, with downregulation of adaptive immunity-related genes suggesting impaired immune function. Additionally, notable shifts in the intestinal microbiota composition were observed, correlating with stress-related gene expression changes, enhancing our understanding of the adaptive mechanisms in response to high temperatures and informing future aquaculture practices for cold-water fish.

Mao et al. demonstrated that moderate high-temperature stress (32°C–34°C) significantly improves growth performance and enhances immune responses in the rice field eel *Monopterus albus*, as indicated by improved feed conversion ratio, body weight gain, and increased expression of immune-related genes. However, elevated temperatures (36°C and 38°C) negatively impacted liver cell integrity and digestive enzyme activities. Additionally, the study found that the α diversity of intestinal microbiota peaked at 34°C, highlighting the beneficial effects of appropriate thermal conditions on the adaptability and health of *M. albus* in aquaculture settings.

Sun et al. utilized an integrated multi-omics approach to elucidate the physiological responses of the razor clam (*Sinonovacula constricta*) to ammonia nitrogen exposure, revealing significant increases in free amino acids, immune-related enzyme activities, and antioxidant enzyme levels only after long-term exposure. Additionally, transcriptomic and metabolomic analyses indicated alterations in metabolic pathways, particularly in amino acid, lipid, and carbohydrate metabolism, alongside significant changes in gene expression related to detoxification and ammonia excretion. These findings suggest that mechanisms such as the conversion of endogenous ammonia to alanine and urea synthesis may serve as adaptive strategies to ammonia stress in benthic mollusks.

Liu et al. characterized the cytochrome P450 enzyme CYP26B1 gene in the black-spotted frog (*Pelophylax nigromaculatus*). Chronic exposure to the antibiotic sulfamethoxazole (SMX) significantly upregulated CYP26B1 expression in liver tissues at 1 and 10 μg/L concentrations, with SMX displaying an affinity of −7.6 kcal/mol for the enzyme. These results highlight the role of CYP enzymes in detoxification and the potential ecological impacts of antibiotic exposure on amphibian species.

Li et al. assessed the effects of ammonia and heat stress on the growth performance, antioxidant activity, and immunity of wild and breeding strains of the juvenile rice field eels (*Monopterus albus*). Results indicated that both strains experienced significant growth inhibition, with breeding strains exhibiting superior growth and survival rates attributed to enhanced growth-related gene expression (*gh*). Furthermore, breeding strains showed increased enzyme activity and immune gene expression in response to oxidative stress. However, evidence of oxidative damage and inflammatory responses was observed in both strains, highlighting their differing adaptability to environmental stressors.

Li et al. conducted a transcriptomic analysis of pearl oysters (*Pinctada fucata martensii*) exposed to titanium dioxide nanoparticles (TiO_2-NPs) for 14 days, identifying 911 differentially expressed genes related to oxidative stress, apoptosis and disrupted protein homeostasis. Gene ontology and KEGG pathway analyses revealed enrichments in pathways associated with hydrolase activity, immune response, and metabolic processes, indicating significant negative impacts on biomineralization and cellular metabolism. Despite a brief recovery period of 7 days, the oysters continued to exhibit adverse effects from TiO_2-NP exposure, highlighting the complexity of their stress responses.

Zhou et al. characterized the fad6 gene in yellow catfish (*Pelteobagrus fulvidraco*), revealing its conserved sequence and significant expression in the heart and liver. Transcription levels are influenced by dietary composition and nutritional status, suggesting a regulatory role of Fad6 in HUFA biosynthesis.

Lin et al. identified three carnitine palmitoyltransferase isoforms (*cpt-1a*, *cpt-1b*, and *cpt-2*) in the mud crab *Scylla paramamosain*. The expression of all isoforms was markedly upregulated in response to fasting and low salinity stress, particularly *cpt-1a* in the hepatopancreas, highlighting their crucial roles in energy metabolism under these conditions. These findings contribute to understanding CPT phylogenetic evolution and the metabolic adaptations of crustaceans.

Li et al. investigated the effects of flowing water stimulation on hormonal regulation during the artificial reproduction of the conger eel (*Conger myriaster*). Results indicated that flowing water significantly enhanced follicle-stimulating hormone (FSH) synthesis in early ovarian development and luteinizing hormone (LH) synthesis in late stages while reducing estradiol levels. The findings provide insights into optimizing artificial reproduction techniques for this economically important species.

Shu et al. examined the effects of water velocity stimulation on ovarian maturation and antioxidant capacity in adult grass carp (*Ctenopharyngodon idellus*). While water velocity did not significantly alter ovarian development, it elevated concentrations of key hormones (estradiol, testosterone, progesterone, 17a,20b-DHP, and vitellogenin) and enhanced gene expression in the hypothalamus-pituitary-gonad (HPG) axis. This study indicates that appropriate water velocity improved antioxidant enzyme activities in the ovary and liver, supporting the physiological health of the fish.

Zhu et al. revealed that ocean warming significantly alters the microbiome of hard-shelled mussel (*Mytilus coruscus*) larvae, with a notable decrease in the abundance of beneficial genera such as *Delftia* and *Neptunomonas* under prolonged temperature exposure. At the same time, *Tenacibaculum*, an opportunistic pathogen, increased. Although overall microbiota diversity remained stable, species abundance rose at elevated temperatures. This suggests that climate-induced marine heat waves may impair the larvae's ability to degrade environmental toxins and enhance disease risk. These findings highlight the potential negative impacts of climate change on mussel larval health and survival. This study explores the physiological response mechanism of aquatic organisms under different environmental stimuli based on different technical means and analytical methods. Molecular and comparative biology methods have been applied to provide a new

understanding of growth, metabolism, and endocrine adaptation regulation in shellfish, fish, and other aquatic organisms. The results provide a theoretical basis for analyzing the complex interaction between species, environment, and physiology.

Understanding the molecular response and regulatory mechanism of endocrine regulation and physiological adaptation under environmental stimulation is important for developing early warning and protection systems related to aquatic organisms. Further research should focus on mechanisms, target analysis, and developing environmental early warning and monitoring systems to improve our understanding of how aquatic organisms respond to different environmental changes. By systematically revealing the adaptation mechanism of aquatic organisms to the environment, it can provide information for the subsequent development of sustainable aquaculture and environmental and ecological protection strategies.

Author contributions

YL: Conceptualization, Data curation, Methodology, Writing – original draft. Y-FL: Conceptualization, Methodology, Resources, Writing – original draft. MC: Investigation, Methodology, Writing – original draft. JF: Investigation, Methodology, Writing – original draft.

Conflict of interest

The authors declare that the research was conducted without any commercial or financial relationships that could potentially create a conflict of interest.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

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