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Editorial

Physiological Adaptations, Nutritional Strategies, and Health Management in Aquatic Organisms

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Aquatic organisms are continuously challenged by dynamic environmental factors, including temperature, salinity fluctuations, and dissolved oxygen levels [1–8]. In this Special Issue, Zhai et al. [9] delve into thermal sensitivity by integrating oxygen consumption rates and transcriptome analysis to reveal the energy metabolism mechanisms in wild Amur grayling (*Thymallus grubii*) under acute warming. Similarly, Wang et al. [10] explore the adaptation process of *Huso dauricus* to high temperatures through the lens of intestinal microbiota succession, while Dao et al. [11] investigate the metabolic adaptation strategies of fish on the Yun-Gui Plateau following temperature acclimation. Beyond thermal stress, aquatic animals must also cope with hypoxic conditions and salinity variations. Yan et al. [12] focus on the acute effects of hypoxia and reoxygenation on physiological indices in hybrid catfish. Furthermore, building on the broader understanding of osmoregulation in aquatic animals [13], Zhang et al. [14] demonstrate the molecular adaptation mechanisms of the hybrid Erythroculter in saline–alkali water, highlighting the potential for aquaculture expansion in non-conventional waters.

Nutritional regulation is pivotal for optimizing growth and bolstering health, particularly through the modulation of intestinal barrier function and immunity by functional nutrients such as amino acids [15–17] and vitamins [18]. Addressing the industry's need for sustainable protein sources—and the associated challenges regarding intestinal integrity [19]—Cao et al. [20] report that substituting fish meal with cottonseed protein induces hepatic ferroptosis in largemouth bass (*Micropterus salmoides*) via the SIRT1-YAP-TRFC axis. To mitigate metabolic disturbances, functional additives play a crucial role. Contributing to this field, Zhao et al. [21] reveal that dietary methionine hydroxy analog regulates hepatic lipid metabolism via SIRT1/AMPK signaling pathways. Additionally, Meng et al. [22] demonstrate the benefits of dietary *Rhodotorula mucilaginosa* on muscle composition in red claw crayfish, and Zhang et al. [23] evaluate the antioxidant-enhancing effects of vitamin K3 in coho salmon (*Oncorhynchus kisutch*) alevins. Notably, Cao et al. [24] underscore the synergistic power of nutrition and environment by examining the beneficial effects of arginine supplementation on yellow catfish specifically under low-temperature farming conditions.

Finally, sustainable aquaculture requires a holistic perspective that spans from genomic insights for disease resistance [25] to macroscopic ecological management. The current issue expands on this scope through three ecological studies. Cai et al. [26] analyze the guild interactions hindering the population recovery of large yellow croakers. Rusco et al. [27] explore the productivity and quality benefits of Integrated Multi-Trophic Aquaculture (IMTA) systems. On a broader biogeographical scale, Nhat et al. [28] reveal the impact of submarine groundwater discharge on the spatial variability of coastal fish diversity using environmental DNA (eDNA) technology.

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Taken together, the studies presented in this Special Issue highlight the complex interconnections between biodiversity, physiological adaptation, nutritional regulation, and environmental variability.

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