

RECENT ADVANCES IN FISH STRESS PHYSIOLOGY

N Dalai¹, S Shekhar², J Bagh³ and H K Barman^{4*}

¹*Department of Veterinary Physiology, C.V.Sc&A.H., OUAT, Bhubaneswar-751003, Odisha, India*

²*M.V.Sc, Animal Genetics and Breeding, C.V.Sc & A.H., O.U.A.T, Bhubaneswar-751003, Odisha, India*

³*Department of Livestock Production and Management, C.V.Sc & A.H., O.U.A.T, Bhubaneswar-751003, Odisha, India*

⁴*Fish Genetics and Biotechnology Division, ICAR-Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar 751002, Odisha, India*

**Corresponding author: hkbarmen68@hotmail.com*

Stress is defined as a physiological disorder that results from societal or environmental pressures and may affect how its recipient behaves or functions. When a physical factor has a detrimental impact on an ecosystem or its biotic components, that ecosystem or component is under stress. Living things may be at risk of dying as a result of this, or their ability to expand or reproduce may be hampered. When such perturbations take place, extremely complex ecosystems rapidly transform into stunningly simple systems with few or no symbiotic relationships and a scarcity of living organisms. Stresses in biotic communities can lead to a reduction in biomass, the extinction of species, or a decline in the ecosystem. Stress frequently leads to a decrease in biotic potential when it exceeds an organism's biological tolerance threshold.

The ecological study of rivers has become increasingly important in the Anthropocene era because numerous human interventions, such as deforestation in river catchments, the release of untreated industrial wastewater and effluents from urban areas, agricultural and residential runoff, etc are threatening freshwater ecosystems. Since all of the physicochemical properties in the water must be within the allowable range, good water is essential for the functional harmony of all autotrophs and heterotrophs. Fishery researchers frequently hold the idea that stresses itself is bad for fish. However, this isn't always the case. The fish's reaction to stress is thought of as an adaptive mechanism that enables it to deal with actual or imagined stimuli and keep its normal or homeostatic state. Quite simply, stress can be thought of as a condition of threatened homeostasis that is restored through a sophisticated array of adaptive reactions. However, if the stressor is too intense or persistent, physiological response mechanisms may be weakened and may become harmful to the fish's health and well-being, or maladaptive, a condition known as "distress" and a significant issue for fishery management.

Fish's physiological reactions to stimuli in their environment have been divided into three categories: primary, secondary, and tertiary responses. Corticosteroid hormone plays a significant as an early response consequent upon stimulating the hypothalamic-pituitary axis. With regard to fish reproduction, this circumstance generates both adverse and favourable effects. Generally speaking, the increase in cortisol impacts spawning, behaviour, and reproduction as well as sex hormone levels. Depending on the stage of the life cycle it occurs in, the degree and length of the stressor, and the

stressor itself, stress can have a variety of effects on reproduction. Stressors experienced in one developmental stage might have an impact on phases later in the process. By influencing the regulation of testicular steroidogenic capacity, a fish's social environment can also have an impact on reproduction. Since the amount of GnRH neurons in the hypothalamic-preoptic area and the size of the fish's testicles appear to be inversely connected to social status, the same social interaction also affects the fish's ability to reproduce. Crowding has an impact on reproductive hormones. Stressed fish have raised plasma levels of ACTH and cortisol and decreased levels of testosterone and 11-keto-testosterone. Haematological characteristics, changes in plasma and tissue ion and metabolite levels, and heat-shock or stress proteins (HSPs) are all secondary responses related to physiological changes in metabolism, respiration, acid-base status, hydro mineral balance, immune function, and cellular responses. Long-term hypoxic exposure may cause changes in gene expression patterns, which could be used as a molecular indication. Ion transporter genes such as glutathione S-transferase and transferrin were substantially expressed in hypoxic conditions. As a result, hypoxia stimulates ion transport by modifying cellular transport proteins. The tertiary reactions are those that affect an animal's overall performance, including its growth, condition, overall resistance to disease, metabolic range of motion, behaviour, and survival. Other than these, stress may have an impact on fish at all levels of the organisation, from the molecular and biochemical to the population and community, depending on its intensity and duration, genetic factors, environmental factors like acclimation temperature, salinity, time of day, the wavelength of light, and background colours of the tanks. The internal environment, including the fish's nutrition, illness status, poor water quality, or toxicants, has a significant impact on the stress response's intensity. Small non-coding RNAs (microRNAs) are essential for post-transcriptional gene regulation related to a variety of physiological activities, including metabolism, stress, and others. Understanding miRNA profiling and its prediction in response to ammonia toxicity help to better understand the fundamentals of the control of nitrogen metabolism and the critical function of miRNA in response to environmental stressors like ammonia toxicity.

The evidence presented above-provided clues regarding complex finely-tuned physiological regulatory roles of transcriptomes, miRNA and proteomics for adaptive stress management in fish and shellfishes.

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