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Popular Article

Black Gills, Silent Killer: The Hidden Threat in Our Waters

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Abstract

In global shrimp aquaculture, black gill disease possess an emerging health threat that causes substantial economic damages and affecting the sustainability of farming processes. Firstly this disease was reported in *Penaeus japonicus* in Japan. This disease is recognized by darkening or blackening of the gills due to an innate immune response to various stressors. Different causative agents, such as *Photobacterium damselae*, *Fusarium* spp., *Aspergillus flavus*, and the ciliate *Hyalophysa chattoni*, have been found responsible for this disease. It has been extensively reported in Asia, North America, and the Middle East, affecting both wild and farmed shrimp populations. Reduced feeding, sluggishness, and respiratory distress are exhibited by infected shrimp that often results in high mortality. Sometimes disease outbreaks caused due to the contribution of environmental factors, pollutants, and poor pond management. Though it is not transmissible to humans, It possess a serious aquaculture challenge. The preventive measure depends on regular health monitoring, proper water quality management, biosecurity, and probiotic use. With no single causative agent identified, integrated management strategies are essential to controlling its spread and sustaining shrimp farming industries.

Introduction

Aquaculture serves as a vital source of nutrition and provides employment of millions people in worldwide. Shrimp farming has gained significant attention for its high nutritional value, but disease outbreaks during cultivation remain a major challenge (Pushparajan and Soundarapandian, 2010). Different environmental conditions, along with infectious agents like fungi, viruses, and protozoans, as well as chemical and biological pollutants, can causes mass mortalities in shrimp ponds. These factors are threaten to the sustainability of shrimp farming as well as directly hinder growth and survival rates in grow-out culture ponds (Burgents et al. 2004). Black gill disease was primarily recognized in the Japanese Kuruma prawn (*Penaeus japonicus*) by Ishikawa in 1968. The disease was caused by Fusarium species, which were later recognized as the most harmful pathogens affecting Kuruma prawns in Japan (Khoa et al. 2004). Severely darkened gills, a state known as black gill, black spot gill syndrome, brown gill, or black necrotic disease, has been observed in different crustaceans, with epidemics in some penaeid and pandalid shrimp populations. Black gill disease is linked to gill tissue darkening (melanization), which represents an innate immune reaction to various gill irritants, including pathogens, parasites,

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pollutants, and nutrient deficiencies in different crustacean species (Jiravanichpaisal et al., 2006). Different chemical pollutants such as oil, zinc, cadmium, ozone, copper, potassium permanganate, ammonia, nitrate, and even a lack of ascorbic acid have been related to black gill disease. Moreover, environmental factors such as heavy siltation and excessive organic waste from leftover feed, debris, and feces accumulating on the pond bottom also contribute to its occurrence (Lavilla et al. 2000). In diseased shrimp, At first the gills appear yellowish to brown, gradually turning black as the disease advances, especially if rearing conditions are not improved (Velmurugan & Ayyaru, 2014).

What is Black Gill Disease?

A pathological state identified as "black gill disease" affects crustaceans and is typified by a marked blackening (melanization) of the gills. The crustaceans' innate immune system's reaction to stress or infection causes this darkening (Karthikeyan et al., 2015). The phenoloxidase system, which produces oxidative and toxic intermediates that ultimately causes the production of melanin, is related to the innate immune response that turns black the gills of infected animals (Lightner and Redman, 1977). The thin carapace protecting the gill chamber makes the melanised, blackened gills easily observable (Landers et al., 2020).

Sign and symptoms

The most prominent sign is the darkening of the gills, which causes due to melanin deposition resulting from inflammation or tissue damage. Affected shrimp often shows sluggish behavior, moving less actively than healthy individuals, and may show a less appetite, leading to decreased feeding. As the disease progresses, respiratory distress becomes more ostensible, as the damaged gills impair the shrimp's ability to breathe efficiently. This may cause them to swim to the surface more frequently in an attempt to access more oxygen. Black gill disease is known as one of the most important diseases in shrimp aquaculture, causes high mortality (Souheil et al., 1999; Khoa et al., 2004). As the name suggests, the disease is identified by the gills turning black, a result of melanin buildup due to inflammation or tissue injury caused by the causative agent (Lightner & Redman, 1977; Bian & Egusa, 1981; Maestracci & Vey, 1988).

Causative agents

Black gill disease does not have a single cause. Numerous studies have connected the disease to Fusarium species (Bian & Egusa 1981, Khoa et al. 2004). However, other studies have found other causes, such as Photobacterium damselae (Wang et al. 2020), Aspergillus flavus (Dewangan et al. 2015), and the ciliate Hyalophysa chattoni (Frischer et al. 2018). Only Maestracci & Vey (1988) have discovered that F. oxysporum is the cause of crayfish black gill disease thus far. According to Zhang et al. (2022), this fungus, which is typically benign but can infect various animals, caused gill damage, altered bodily fluids, and ultimately resulted in

the crayfish's demise.

Geographical distribution

Shrimp black gill disease, which affects different shrimp species in different regions, is a serious threat to aquaculture worldwide. The disease has been documented in both wild and farmed prawn populations in Asia, including Taiwan, China, India, Indonesia, Malaysia, and Japan. According to genetic testing, Fusarium solani is the cause in China, where infected prawns have a high mortality rate of 88.66% (Yao et al. 2022). Black gill disease has also afflicted wild and farmed prawns in North America, especially along the Gulf Coast and in southeastern states like Georgia, South Carolina and North Carolina. Hyalophysa chattoni has been connected to the disease, according to research from the University of Georgia, and environmental factors like warming seas have been implicated in its spread. In the Middle East, particularly along the coast of Bushehr in Iran, histopathological studies have shown a prevalence of black gill disease in marine shrimp populations, with Fusarium infections causing gill damage and melanization.

Impact on Aquaculture

Black gill disease has a substantial impact on aquaculture, principally in shrimp farming, where it can cause considerable economic losses. The disease leads to high mortality rates in infected shrimp, which directly reduces production and yield. As the disease progresses, shrimp show symptoms like darkened gills, reduced feeding, and slower growth, making them less valuable in the market. In severe cases, entire batches of shrimp can be lost, leading to financial strain for farmers. The disease also affects the quality of the shrimp, rendering them less appealing for consumption, which can further diminish their market value. Besides, outbreaks of black gill disease can generate troubles in the international trade of shrimp, as countries with infected populations may face export restrictions. Overall, the disease poses a serious threat to the sustainability of shrimp farming operations worldwide.

Prevention and Management

For the effective prevention of this disease in shrimp there is needed to monitor water quality such as pH, salinity, temperature, DO, and ammonia levels regularly (Pazir et al. 2024). Also there is should be careful about proper pond preparation and stocking densities. The use of probiotics in shrimp aquaculture increases shrimp immunity, while regular health checks help detect symptoms early for prompt action. Managing environmental stressors, such as temperature and salinity fluctuations, is crucial to reducing vulnerability. Infected shrimp may require antifungal or antibacterial treatments, but these should be used cautiously. Strict biosecurity measures, including controlling the movement of stock and ensuring new shrimp are disease-free, help prevent pathogen introduction. By integrating these strategies, shrimp farmers can reduce the impact of black gill disease and sustain their operations.

Can It Spread to Humans?

Black gill disease in shrimp does not spread to humans and is not considered a zoonotic disease. The primary pathogens associated with black gill disease such as *Fusarium solani*, *Aspergillus flavus*, and *Hyalophysa chattoni* affect shrimp and other aquatic organisms but do not pose a risk to human health through consumption or handling of infected shrimp. However, immunocompromised individuals should still practice good hygiene when handling raw seafood, as some fungi like *Fusarium* and *Aspergillus* can, in rare cases, cause opportunistic infections but this is unrelated to black gill disease itself and extremely uncommon.

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