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Decoding Soil Intelligence: Biological, Chemical and Physical Drivers of Crop Productivity

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Abstract

Translucent post-larvae disease (TPD), also known as glass post-larvae disease, is an emerging bacterial disease affecting early post-larval stages of *Penaeus vannamei*. The disease is characterized by rapid onset, severe damage to the hepatopancreas and digestive tract, and mortality reaching up to 100% within a few days. It is caused by a hypervirulent strain of *Vibrio parahaemolyticus* carrying novel virulence genes, particularly vhvp-2. Unlike AHPND-associated strains, this pathogen exhibits a distinct toxin-mediated mechanism of pathogenicity. Initially reported in China, TPD has now been detected in other regions, raising concerns about its global spread. Early diagnosis, strict biosecurity, and improved management strategies are essential to control this disease in shrimp hatcheries.

Keywords: TPD, *Vibrio parahaemolyticus*, shrimp disease, VHVP toxins

Introduction

Shrimp aquaculture, particularly the culture of *P. vannamei*, plays a major role in global seafood production. However, disease outbreaks continue to limit productivity and sustainability in this sector. In recent years, a new disease known as translucent post-larvae disease (TPD) has emerged as a serious concern in shrimp hatcheries. The disease was first reported in China and rapidly spread across major shrimp-producing regions, causing significant economic losses. TPD primarily affects early post-larval stages and is notable for its rapid progression and high mortality. In many cases, hatchery operators observe sudden collapse of larval populations within a few days. The disease has drawn attention due to its unique clinical presentation and its difference from previously known shrimp diseases (Zou et al., 2020).

Etiology

Investigations into the cause of TPD initially focused on viral pathogens, but common shrimp viruses were not detected in affected samples. This led researchers to explore bacterial causes. Subsequent studies identified a highly virulent strain of *V. parahaemolyticus* as the etiological agent. This strain, often referred to as VpTPD, was isolated from diseased shrimp and confirmed through experimental infection studies. Unlike the strains associated with acute hepatopancreatic necrosis disease (AHPND), VpTPD does not carry the pirA and pirB toxin genes but instead possesses a distinct set of virulence genes, indicating a different pathogenic mechanism (Dinh-Hung et al., 2025).

Geographical Distribution and Status in India

TPD was first documented in southern China and quickly spread to other regions within the country. More recently, reports have confirmed the presence of TPD-associated *V. parahaemolyticus* strains outside China, indicating that the disease is no longer geographically restricted (Dinh-Hung et al., 2025). The movement of infected post-larvae and the global nature of shrimp trade are likely contributing factors to its spread. At present, there are no confirmed reports of large-scale TPD outbreaks in India.

Clinical Signs

The clinical signs of TPD are distinct and mainly related to the digestive system. Affected post-larvae exhibit a transparent or glass-like appearance due to the loss of pigmentation in the hepatopancreas and the presence of an empty digestive tract. The hepatopancreas appears pale or colorless, and the larvae show reduced activity and weak swimming behavior. Many individuals tend to sink to the bottom of the rearing tanks. These symptoms reflect severe impairment of digestion and nutrient absorption, which ultimately leads to mortality (Zou et al., 2020).

Pathology

The primary organs affected in TPD are the hepatopancreas and midgut. Histopathological examination reveals extensive damage to these tissues. The epithelial cells of the hepatopancreas undergo necrosis and detach from the tubules, while similar degeneration occurs in the midgut. Bacterial colonization is commonly observed in these tissues, along with inflammatory responses such as hemocytic enteritis in advanced stages. These pathological changes disrupt normal digestive functions, resulting in starvation and rapid deterioration of the larvae. The severity of tissue damage explains the high mortality rates associated with the disease (Dinh-Hung et al., 2025).

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Virulence and Molecular Pathogenesis

VpTPD virulence is driven by plasmid-encoded Vibrio high virulent proteins (VHVPs), especially VHVP-2, the key pathogenic factor. Deletion of *vhvp-2* reduces virulence, while its restoration reinstates pathogenicity (Liu et al., 2023). These toxins disrupt epithelial integrity, cytoskeletal structure, and induce oxidative stress, causing hepatopancreatic and midgut damage (Stef et al., 2025). Their plasmid location also enables horizontal gene transfer, facilitating the spread of virulence.

Epidemiology

TPD spreads rapidly in hatchery environments due to multiple transmission pathways. The pathogen can be introduced through infected broodstock, contaminated water, live feeds, and equipment. Environmental factors such as poor water quality, high stocking density, and microbial imbalance can further increase susceptibility to infection. The ability of Vibrio species to persist in biofilms and sediments also plays a role in maintaining the pathogen within hatchery systems (Shinn et al., 2024).

Management Strategies

Control of TPD is mainly preventive, focusing on strict biosecurity, including pathogen-free broodstock, water and equipment disinfection, and prevention of cross-contamination. Early molecular detection aids timely intervention, while antibiotic use is discouraged due to resistance concerns. Natural antimicrobial compounds show promise by reducing virulence through suppression of gene expression and bacterial adhesion rather than direct killing.

Conclusion

Translucent post-larvae disease represents a significant emerging threat to shrimp hatchery production. Its rapid onset, high mortality, and unique pathogenic mechanism distinguish it from other known shrimp diseases. The identification of novel virulence factors, particularly VHVP-2, has improved our understanding of the disease, but challenges remain in its management. Although the disease has not yet been widely reported in India, the risk of introduction is real, and proactive measures are necessary. Strengthening biosecurity, improving diagnostic capabilities, and adopting sustainable control strategies will be key to managing TPD and ensuring the long-term sustainability of shrimp aquaculture.

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