

# Shrimp White Feces Syndrome (WFS): Complex Interactions of Polymicrobes

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## ABSTRACT:

White feces syndrome (WFS) in shrimp cultivation ponds is characterized by the occurrence of shrimp with abnormal, white intestines (midguts) combined with large floating mats of white, shrimp fecal strings. The etiology for WFS is complex, but EHP-WFS is a type of WFS characterized by massive quantities of spores from the microsporidian parasite *Enterocytozoon hepatopenaei* (EHP) together with mixed, unidentified bacteria in the shrimp hepatopancreas, midgut and fecal strings. Severely impacting Asian shrimp productions, EHP-WFS in Thailand has significantly increased and economically threatens Thai shrimp production in recent years. In EHP-WFS outbreak ponds, some shrimp show white midguts (WG) while others in the same pond show grossly normal midguts (NG). Here, we examined a severe EHP-WFS outbreak in cultivated *Penaeus vannamei* with a combination of microscopic and microbial profiling analyses to compare WG and NG samples. By histology, EHP plasmodia and spores were confirmed in the hepatopancreas and midgut of WG and NG shrimp, but pathological severity and spore quantity was higher in the WG shrimp. In addition, intestinal microbiomes in WG shrimp were less diverse and had higher abundance of bacteria from the genera *Vibrio* and *Propionigenium*. These findings revealed candidate polymicrobes of two bacterial genera and EHP as a potential eukaryote-prokaryote pathobiome that causes EHP-WFS in *P. vannamei*.

## KEYWORDS:

White feces syndrome (WFS), *Penaeus vannamei*, *Enterocytozoon hepatopenaei* (EHP), EHP-WFS, *Propionigenium*, *Vibrio*