



## A Mini-review on *Shewanella* spp. Infection in Fish

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### Abstract

*Shewanella* spp. infection poses a significant threat to fish populations, impacting various species in both cultured and wild environments worldwide. The disease, known as shewanellosis, has gained substantial attention due to emerging outbreaks affecting piscine hosts. It has caused widespread epizootics in both wild fisheries and aquaculture settings, with some species even capable of infecting humans. The disease's impactful nature in aquaculture is well-documented, yet there is currently no widely accepted cure beyond resorting to disinfection and depopulation. This review aims to consolidate existing knowledge about *Shewanella* spp. infection in fish.

**Keywords:** *Shewanella* spp.; Fish Infection; Transmission; Human Infection

### Introduction

*Shewanella*-induced shewanellosis represents a chronic and progressive disease affecting various vertebrates, including humans (known for soft tissue infections and otitis), livestock, and fish. This disease, caused by multiple species within the genus *Shewanella*, poses significant and costly impacts across affected populations. It's frequently observed in aquaculture setups and the trade of fish for aquaria [1]. In wild fish, occurrences of this disease were infrequent until recent years. This review focuses on exploring the specific pathogens accountable for shewanellosis in fish.

### The species

The taxonomic portion of *Shewanella* has been reviewed [2]. Its name honors J.M. Shewan, acknowledging his significant contributions to the microbiology of fish and fishery products [3]. So far, there are 50 identified species of *Shewanella* have been reported [4]. Typically, *Shewanella* species are characterized as gram-negative, anaerobic, non-spore-forming, motile, and non-oxidative bacilli [1]. They are extensively distributed in both freshwater and marine environments [5], playing a crucial role in decomposing organic matter [6], also well-known as fish spoilage organisms under

different circumstances. *Shewanella putrefaciens* is recognized as a particular spoilage organism affecting various cold-water marine fish when stored on ice [7]. Authors have deliberated on *Shewanella* spp. infections in fish. Some, like Qin., *et al.* [8], highlight these infections as a substantial issue in aquaculture. Meanwhile, other studies indicate that these bacteria act as opportunistic pathogens, leading to diseases and mortalities in fish when certain conditions reduce their immunity [9]. So far, only *S. algae*, *S. baltica*, *S. oneidensis*, *S. putrefaciens*, *S. seohaensis*, and *S. xiamenensis* have been identified as pathogenic bacteria affecting fish [10-13]. *S. putrefaciens* is commonly found across a diverse range of saltwater and freshwater species. *S. baltica* has been identified in *Cyprinus carpio* and Goldfish (*Carassius auratus*). Although less frequently isolated in marine fish, *S. xiamenensis* has been reported in goldfish (*Carassius auratus*), brown trout (*Salmo trutta*), Cichlid (*Petrochromis* spp.), and gudgeon (*Gobio gobio*). Infections of *S. algae* have been observed in Leaf scorpion fish (*Taenianotus triacanthus*). Additionally, *S. putrefaciens* has been isolated from *Cyprinus carpio*, tilapia, and goldfish (*Carassius auratus*) [12].

In recent years worldwide, strains, novel species, and isolates have been recovered both from wild and freshwater fish (Table 1).

| Species                | Frequency | Potential for Human Infection | Reference                          |
|------------------------|-----------|-------------------------------|------------------------------------|
| <i>S. putrefaciens</i> | C         | Y <sup>a</sup>                | Chen., <i>et al.</i> 1997          |
| <i>S. baltica</i>      | I         | U                             | Jung-Schroers., <i>et al.</i> 2017 |
| <i>S. xiamenensis</i>  | I         | U                             | Jung-Schroers., <i>et al.</i> 2017 |
| <i>S. seohaensis</i>   | I         | U                             | Jung-Schroers., <i>et al.</i> 2017 |
| <i>S. algae</i>        | C         | U                             | Khashe, 1998                       |
| <i>S. oneidensis</i>   | I         | U                             | Jung-Schroers., <i>et al.</i> 2017 |

**Table 1:** Species of *Shewanella* reported from fish.

In many cases, specification was based on phenotypic characteristics. I, infrequent; C, common; U, unknown; Y, yes.

<sup>a</sup>Brink *et al.* 1995

### Pathology

Shewanellosis has affected more than 44 documented fish species, as noted by Paździor, *et al.* [14], impacting both cultured populations and wild fisheries worldwide. Interestingly, a study found that goldfish, when experimentally infected with *Shewanella* spp. through the intramuscular application, displayed no clinical signs whatsoever [15]. While another study, in fish farms *S. putrefaciens* was used as a probiotic against stress. Due to these different results, the pathogenicity of the bacteria might vary on a specific isolate [16].

Shewanellosis manifests primarily through symptoms such as fatigue, bleeding, abnormal tissue formations, protruding eyeballs, ulcers, deterioration of tubular epithelial cells, reduced functionality of liver cells with expanded blood vessels, fluid buildup leading to swelling in the liver, and unexpected fatalities [11,17,18]. Initially, the disease causes congestion in the internal organs like the spleen, liver, and kidneys. However, in advanced stages, it can extend its effects to all organs throughout the body [10,11,13,14], however, this statement may be highly relying on the *Shewanella* species and piscine host. Studies involving challenge trials have clarified the advancement of shewanellosis infection across multiple aquatic species. These studies provide comprehensive insights into the varying levels of pathogenicity among different *Shewanella* isolates and highlight specific differences in how they affect their hosts.

### Transmission

The transmission of the disease in fish isn't definitively understood. It's been proposed that in water, transmission might occur through direct contact. Disease infection is predominantly

reported as secondary infections following contact with polluted water, occasionally after consuming raw fish, and injuries caused by animals residing in contaminated water [19,20]. The significant increase in infection rates among cultured rainbow trout, *Cyprinus carpio*, and Tilapia was directly linked to feeding them infected fish carcasses. This issue can be resolved by discontinuing this practice and instead using pasteurized fish meal [9,10,13].

### Diagnosis

Diagnostic methods for detecting Shewanellosis in fish are evolving, relying on clinical signs and visible abnormalities as initial indicators of *Shewanella* species infection. However, the clinical symptoms of Shewanellosis lack specificity for the disease, exhibiting variable occurrence and severity. Symptoms of the disease might encompass reduced activity, lethargy, diminished responsiveness to stimuli, protruding eyes, abdominal swelling, weight loss, skin darkening, enlarged anus, bleeding, changes in skin coloration, nervousness, shallow ulcers on the skin with tissue death, fin erosion, and protruding eyes [10]. In numerous cases, there are no evident external indications. Examination of affected organs shows an elevation in Kupffer cells within the liver and an increase in ellipsoid macrophages in the gills, involving the proliferation of the free ends of gill filaments, cell death in the epithelial cells, and bleeding in the spleen. However, similar responses can be triggered by other bacteria, fungi, and parasites, which can frequently lead to an inaccurate diagnosis solely based on observable features.

Traditionally, scientists have depended on biochemical, molecular techniques, and culturing to detect *Shewanella*. Yet, the presence of *Shewanella* in tissue sections isn't consistently detectable, potentially influenced by the species, abundance, or growth stage

of the pathogen. Culturing remains a crucial diagnostic method for *Shewanella* infections. While standard biochemical profiling can be quick, it may also incur significant costs [11]. MALDI-TOF MS method (Matrix-Assisted Laser Desorption/Ionization-Time of Flight mass spectrometry), Sherlock microbial identification system (MIS), gene sequencing, and DNA probes have been extensively assessed for species of clinical significance in the human medical field allowing for rapid recognition to the species level in many cases. Efforts to differentiate the more common fish isolates have concentrated on the PCR amplification of the 16S ribosomal gene [21]. Other techniques such as Random amplified polymorphic DNA (RAPD) analysis have also been employed with varying success [22].

### Impact on food fish and marine ornamental culture

Pathogenic *Shewanella* are most commonly reported in aquaculture/ornamental fish. Freshwater ornamental fish are susceptible to *Shewanella* infections [23]. Reported cases in aquaculture identify stress because of poor water quality, and overcrowding as factors predisposing to infection [22]. Commercial fish species sea bass (*Dicentrarchus labrax*), production in Turkey has been severely hindered by *S. putrefaciens* infection [18]. *Shewanella* spp. infections have also been found in farmed Tilapia, *Cyprinus carpio* [10,22] and cultured Nile tilapia [13].

Whether the disease is an independent process or a reflection of ecosystem change remains to be seen. Determining the environmental stressors' impact on disease state is inherently hard owing to the complexities of the interactions that may occur.

### Impact on human health

Many reports have concerned *S. putrefaciens* causes various human infections such as cellulitis [24], bacteremia [25] ear infections [26,27], peritonitis and abscesses [25,28]. Bacteremia was noticed to have an inherent unwellness such as diabetes mellitus in patients [29], failure of renal or long-term catheterization, liver or biliary disease [29], burns [30]. Numerous reports indicate infection due to *S. putrefaciens* following exposure to marine environments such as shellfish contact and marine life [31] and traumatic spike injury from a fish [24].

### Summary

As yet, FDA-approved drugs are not available for the treatment of Shewanellosis in fish. Effective disinfection procedures and leaving depopulation have been suggested for disease control. She-

wanellosis infection is a serious issue in the propagation of many wild and culture fish species. Future progress in treatment options is warranted.

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### Statement of Competing Interest

The authors assert that there are no conflicts of interest to disclose.

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