



From the Titanic to Fish Farms: The Journey of *Halomonas titanicae*

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ABSTRACT

The marine halophilic bacterium *Halomonas titanicae* was isolated from rusticles over the remains of the R.M.S. Titanic in 2010. This species has been extensively studied in the context of deep-sea iron biocorrosion and extreme environment adaptation. However recent research has uncovered the potential of this bacterium as a probiotic in aquaculture. Whole-genome analyses reveal that *H. Titanicae* possesses a range of osmoadaptation mechanisms oxidative stress response pathways, extracellular enzyme systems and biofilm-forming capabilities. The study also demonstrates that the gut-isolated strain *H. Titanicae* HT-Tc3 can improve the growth performance, digestive enzyme activity, antioxidant status, nonspecific immunity and resistance to *Aeromonassalmonicida* infection in turbot. These findings highlight the advantages of using marine probiotics over traditional terrestrial counterparts. Further research is needed to evaluate the safety, regulatory approval and commercial production of this promising aquafeed additive.

KEYWORDS

Halomonas titanicae; Probiotics; Aquaculture; Turbot

Introduction

Discovery of *Halomonas titanicae* from the RMS Titanic In 1912 the R.M.S. Titanic sank to the bottom of the Atlantic Ocean coming to rest 3,800 m below the surface. In 2010 while attempting to isolate bacteria from icicle-shaped rust formations ("rusticles") that had formed on the ships hull scientists were surprised to find a bacterium that they later named *Halomonas titanicae* (strain BH1).

Why Scientists Were Studying Shipwreck Bacteria

The scientists were interested in this bacteria because they wanted to know:

- How these bacteria could contribute to deep-sea bio-corrosion of submerged metals?
- What cellular mechanisms enable them to withstand the pressures and low temperatures of the deep sea?
- Could these organisms be harnessed to



recycle or recover metals from vessels?

Taxonomy & Characteristics

- *Domain: Bacteria*

- *Phylum: Pseudomonadota (Proteobacteria)*
- *Class: Gammaproteobacteria*
- *Order: Oceanospirillales*
- *Family: Halomonadaceae*
- *Genus: Halomonas*
- *Species: H. Titanicae*

General morphology:

It is a Gram negative, rod shaped and motile bacterium that commonly inhabits marine environments.

Salt Tolerance & Biofilm Formation

As a halophile *H. Titanicae* can tolerate and grow in a wide range of NaCl concentrations (0.5-25%). The bacterium produces amounts of Extracellular Polymeric Substances (EPS) enabling it to colonize marine surfaces and mucosal membranes by forming dense biofilms.

Role in Rusticle Formation

By catalyzing the oxidation of iron to insoluble ferric oxides (Fe_2O_3 , Fe_3O_4) *H. Titanicae* plays a prominent role in promoting deep-sea iron biocorrosion.

More Than a Corrosion Bacterium

Genomic Discoveries & Stress Tolerance

Genomic analysis of *H. Titanicae* reveals an abundance of genes that aid in regulation, heavy metal detoxification and ROS (Reactive Oxygen Species) scavenging.

Production of Beneficial Metabolites & Environmental Adaptability

In addition to metal-reducing capabilities *H. Titanicae* can synthesize bioactive molecules, including ectoine and extracellular enzymes. The strain also possesses bioremediation potential by degrading pollutants and hydrocarbons in marine environments.

The Shift Toward Aquaculture

Why Researchers Became Interested

The researchers became interested in this bacteria because it could potentially be used as a probiotic for fish and shrimp. Compared to terrestrial probiotics (e.g., *Lactobacillus*, *Bacillus*) endogenous marine bacteria are better adapted to the saline environment of aquatic animals and provide colonization advantages in the gut.

Probiotic Studies in Marine Species

The following study highlight the potential of various *Halomonas* spp. In aquaculture:

1. Turbot (*Scophthalmus maximus*): According to an article published in the Journal of Aquaculture. Bamidgeh (Xu et al. 2026) the endogenous strain of *H. Titanicae* isolated from healthy turbot gut (HT-Tc3) can improve fish growth performance, digestive enzyme activity and disease resistance.

That studies demonstrate that host-derived strains of *H. Titanicae* can be utilized as probiotics for a variety of marine species.

Key Experimental. Performance Profile

Summary of probiotics efficacy
(*Halomonas titanicae* HT-Tc3 in Turbot)

- Final Body Weight (Day 60): Increased by 34.8% (8.51 gm 0.15 g vs. 6.31 gm 0.13g in control $P < 0.05$).
- Final Body Length (Day 60): Increased by 10.2% (7.95 cm 0.56cm vs. 7.21 cm 0.54cm in control $P < 0.05$).
- Trypsin Activity (TPS): +35.0% higher in treatment group ($P < 0.05$) improving protein digestion.
- Amylase Activity (AMS): +33.3% in treatment group ($P < 0.05$) enhancing carbohydrate digestion.
- Superoxide Dismutase (SOD): +53.4% higher ($P < 0.05$) indicating improved defense.
- Alkaline Phosphatase (AKP): +82.2% higher ($P < 0.05$) suggesting enhanced immunity.
- Pathogen Resistance (*A. Salmonicida*): Survival rate was 28% in treated fish vs. 12% In control (a 16-percentage-point survival advantage) demonstrating the lasting protective effects of the probiotic.

How Does It Benefit Fish and Shrimp?

1. Gut Microbiome Modulation

The probiotic strain modulates the gut microbiota by increasing the abundance of bacterial taxa while reducing the prevalence of potential pathogens.

2. Enzyme Production & Improved Feed Utilization

By producing digestive enzymes the probiotic enhances nutrient breakdown and utilization leading to improved growth performance.

3. Competitive Exclusion of Pathogens

The mucosal adhesion properties of *H. Titanicae* HT-Tc3 allow it to colonize the intestinal epithelium displacing potential pathogens and reducing the risk of disease outbreaks.

Future Perspectives

- Precision Probiotics: Developing tailored formulations for different host species and life stages.
- Synbiotic Approaches: Exploring the use of prebiotics to enhance the colonization and efficacy of *H. Titanicae* in aquaculture.
- Microencapsulation: Encapsulating live cells to improve their survival and efficacy in commercial fish feeds.
- Sustainable Aquaculture: Advancing the use of marine probiotics as a sustainable alternative to antibiotics in aquaculture.

Conclusion

The journey of the bacterium from the wreck of the Titanic to its applications as a probiotic in aquaculture is truly remarkable. This unique microbe can be used to improve fish growth, digestion and disease resistance making it a valuable asset in aquaculture.

References

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