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# Infectious Bacterial Diseases in Cold-Water Aquaculture

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Due to the rising demand for fish consumption as food, aquaculture is now the food industry with the fastest rate of growth worldwide. The frequent occurrence of diseases and epizoonosis, however, is thought to be one of the main production bottlenecks. The majority of the diseases are caused by bacteria and parasites. According to Sahoo et al., (2017), diseases contribute between 5-10 percent of the production cost. The development of a certain fish disease is greatly influenced by the climate that prevails in a given zone, region, or nation.

Keywords
Disease, aquaculture, fish, cold-water fisheries

## Introduction

One of the most effective and environmentally friendly ways to generate high-quality protein is aquaculture. The sector features a low feed conversion ratio (FCR), excellent protein retention, and minimal carbon footprint. The rapid growth of aquaculture technology over the past 30 years has directly contributed to the doubling of animal protein consumption per capita in developing nations. Increased food security and lower poverty rates in emerging countries are positively correlated with the nutritional advantages of fish eating. However, diseases are a serious hazard to aquaculture. According to Monir *et al.,* (2015), diseases result in the economic loss in between USD 1.05 to USD 9.58 billion annually in the global finfish aquaculture industry (Shinn *et al.,* 2015). It is now widely acknowledged that disease outbreaks pose a serious obstacle to the production of finfish. In addition to causing death, illnesses can impair fertility and negatively affect the efficiency of feed conversion, which can result in a reduction in the growth and general performance of farmed fish. The purpose of this article is to outline potential bacteriological agents that could be present in cold water environments.

## Bacterial Hemorrhagic Septicemia

Hemorrhagic septicaemia is one of the most prevalent diseases in the fish farming sector worldwide, generating considerable economic loss due to its high mortality rate, caused by *Aeromonas hydrophilla*. Red-mouth disease, infectious dropsy, rubella disease, red-pest, and freshwater eel disease are some of the different names for this disease (Parvez and Mudarris, 2014). In India, it is referred to as either bacterial hemorrhagic septicemia or infected dropsy (Gopalakrishnan, 2011). A fast deadly septicemia with few overt symptoms, such as exophthalmia, skin redness, and accumulation of fluid in the scale pockets and abdominal cavity, is typical of the acute type. While in the chronic form, skin ulceration with focal haemorrhages and inflammation are the main clinical symptoms. The underlying musculature becomes highly necrotic, and the dermis and epidermis are both undermined.

## Bacterial kidney disease

The bacterium *Renibacterium salmoninarum* is the source of the chronic condition known as bacterial kidney disease. It happens whenever salmonid fish are present (Bayliss *et al.,* 2018). The mortality rate for Pacific salmon can reach 80%, whereas that of Atlantic salmon can reach 40%. The infectious agent can spread horizontally as well as vertically (Boerlage *et al.,* 2018). There are many different clinical indicators that infected fish exhibit, yet other fish show no symptoms at all. Lethargy, skin darkening, bulging eyes, anaemia, swollen abdomens, blisters on the flanks filled with blood, and bleeding around the vent are the important clinical symptoms. Internal symptoms include fluid buildup in the abdomen, enlarged kidneys that can have white or grey lesions, and diffuse white membranes covering the internal organs. More uncommon signs of the disease, particularly in fish kept at low temperatures, may include bleeding in the internal organs and fluid accumulation in the abdominal cavity (Fryer and Sanders, 1981).

## Bacterial cold-water disease

According to Wood and Yasutake (1956), the gram-negative bacterium *Flavobacterium psychrophilum* is the cause of an acute septicemic disease in salmonids. Due to the serious fatalities brought on by infection with this disease and the subsequent financial impact on commercial aquaculture producers and conservation hatcheries, *Flavobacterium psychrophilum* is regarded as one of the most significant salmonid infections globally (Michel *et al.,* 1999). Temperatures between 4$^{o}$C and 10°C are often when outbreaks happen. However, at consistent temperatures of 15°C during the past ten years, the commercial trout business in the United States has seen significant disease. When feeding first begins, lesions with yellow-coloured margins may appear on the caudal peduncle region because *F. psychrophilum* has a preference for skin and muscle tissue (Lumsden et al., 1996). The caudal peduncle develops a grey, patchy, discoloured region as the first sign of coldwater illness. The peduncle of diseased fish darkens, and as the illness worsens, the caudal fin erodes and becomes ragged. Clinical symptoms of coldwater illness in its advanced stages can include loss of the caudal tin, open sores and skin erosion on the caudal peduncle, as well as total erosion of the peduncle's musculature.

## Furunculosis

*Aeromonas salmonicida*, a Gram-negative bacteria first identified by Griftin *et al.* in 1953, is the disease-causing agent. It is an infectious disease with a

significant mortality and morbidity rate that affects the aquaculture sector globally (Lewbart, 2001). Salmon and carps are just a few of the many species of fish that are affected by this lethal and crippling disease (Lim and Hong, 2020). Fingerlings that are clinically infected typically have erosion of the pectoral fins and haemorrhages at the base of the fins. On the ventral surface, petechial haemorrhages and bloody or hemorrhagic vents are frequently seen. Adults with a persistent infection may have the usual "furuncules" or blisters on the skin that contain blood and an amorphous yellow substance. Even though a preliminary diagnosis of furunculosis can be made from clinical trials, the pathogens should be isolated and identified in order to confirm the diagnosis and differentiate it from other bacterial diseases of the fish. This is so because other diseases of the fish caused by gram-negative bacteria have a pathogenesis with furunculosis (and its clinical symptoms) (Bernoth, 1997).

## Enteric red mouth disease

One of the most serious bacterial illnesses in coldwater fish farms, enteric red mouth disease or Yersiniosis, is responsible for large economic losses and mortalities in salmonid fish farms, particularly in rainbow trout (*Oncorhynchus mykiss*). *Yersinia ruckeri* is a gram-negative rod with rounded ends that ranges in size from 0.5 - 0.8 × 1.0 to 3.0 μm (Wiens and Vallejo, 2010). The initial mortality rates of disease outbreaks are low, but they are sustained over time, leading to significant cumulative stock losses (Horne and Barnes, 1999). Lethargic behaviour, inactivity, swimming close to the surface, anorexia, and skin discoloration are all visible symptoms of the disease. Prolapse and haemorrhages in the anus have been seen frequently and may be a particular symptom. Fish with Y. ruckeri infections are frequently jadish and are located in low-flow places (Zorriehzahra *et al.*, 2017). According to the scientists, *Y. ruckeri* can move to the circulatory system as quickly as 1 minute after infection (mpi), infecting the secondary gill lamellae first. At 30 mpi, it could be found in the gut lumen, at 3 days post infection (dpi) in the kidney, and at 7 dpi in the liver, spleen, brain, and heart (Ohtani *et al.*, 2014).

## Bacterial gill disease

The bacterium, *Flavobacterium branchiophilum* is highly contagious to fish and is the causative agent of bacterial gill disease. After being exposed to live *F. branchiophilum*, cells for less than an hour and after living with infected fish for a short period of time, trout gill tissues become attached and colonised (Ostland *et al.*, 1995). Fish that are impacted typically become lethargic and lose their appetite. Near the pond's screen or exit, a great number of sick fish congregate. Acute epizootics can cause a mortality rate of 20 to 50% within 24 hours. The dorsal ends of the opercula flare out to varied degrees depending on the degree of swelling, and the gill filaments become so pale and bloated that they are unable to lay down flat. Rohu and Catla were found to have necrotic gills, congested eyes, and dark body colours, according to Swain *et al.*, (2007).

## Conclusion

Although aquaculture is a rapidly expanding food industry, bacterial infections are a major problem. Fish raised in aquaculture facilities at high densities are extremely vulnerable to disease outbreaks. Several bacterial infections are opportunistic and exist in the environment as asymptomatic carriers on some fish. To minimise antibiotic resistance in aquaculture, prevention is extremely crucial. Three main principles can be used to control bacterial infections: removal of the disease source, breaking the chain of transmission, and shield the host from disease or infection.

## Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

## Conflict of interest

The authors declare that the manuscript was formulated in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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