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Streptococcal Infections of Fish[1]

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Introduction

Streptococcus is a genus of bacteria that includes some species that cause serious diseases in a number of different hosts. A major identifying feature of *Streptococcus* is that they are Gram-positive (they appear purple/blue when stained using a procedure called a Gram stain). By contrast, most of the common disease-causing bacteria of fish are Gram-negative (appear pink with a Gram stain). This is important when considering treatment options, and will be discussed in greater detail below.

Streptococcal (Strep) diseases of fish are not common; however, when they do occur, significant mortality can result. Some aquatic Strep species may cause disease in humans in unusual circumstances. However, these latter species do not usually affect healthy people. In addition to bacteria in the genus *Streptococcus*, there are several other closely related groups of bacteria that can cause similar disease, including *Lactococcus*, *Enterococcus*, and *Vagococcus*. For purposes of this fact sheet, all of these bacteria and the disease itself will be referred to as Strep.

Streptococcal disease in fish was first reported in 1957, affecting cultured rainbow trout in Japan (Hoshina et al. 1958). Since then, numerous other species of fish have been found susceptible to infection, including salmon, mullet, golden shiner, pinfish, eel, sea trout, tilapia, sturgeon, and striped bass (Inglis et al. 1993). Strep has also been isolated from a variety of ornamental fish, including rainbow sharks, red-tailed black sharks (Russo, Mitchell, Yanong 2006), rosey barbs, danios, some cichlids including Venustus (*Nimbochromis* ("Haplochromis") *venustus*) and *Pelvicachromis* sp., and several species of tetras.

Strep infections in fish can cause high mortality rates (> 50%) over a period of 3 to 7 days. Some outbreaks, however, are more chronic in nature and mortalities may extend over a period of several weeks, with only a few fish dying each day. A typical history suggesting that Strep may be the cause of disease in a group of fish might include reports of abnormal swimming behavior, often described as spiraling or spinning. Anytime fish are observed behaving in an unusual manner, Strep should be considered as one of the possible causes. However, not all infected fish show abnormal behavior.

Keep in mind that the keys to disease prevention in fish include: a) maintaining good water quality; b) providing proper nutrition; c) keeping the environment clean; and d) quarantining new fish before adding them to an existing collection. Knowing which species are susceptible to Strep and seeking assistance for rapid diagnosis and proper therapy if a disease outbreak should occur are important ways to decrease losses.

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Streptococcal Disease in Fish

Factors Contributing to Disease

Most infectious diseases of fish are opportunistic. This means that the simple presence of the pathogen in the environment of the fish is inadequate to cause a disease outbreak. Other factors usually come into play such that either the pathogen has an advantage over the host or the immune system of the host is compromised in some way, increasing its susceptibility to the pathogen. This phenomenon is often precipitated by "stress," and it is discussed in greater detail in IFAS Circular 919, Stress - Its Role in Fish Diseases. Stress often plays a significant role in outbreaks of infectious disease in fish populations. Some stressors that have been associated with Strep outbreaks include high water temperatures (e.g., during the summer), high stocking densities, harvesting or handling, and poor water quality, such as high ammonia or nitrite concentrations.

Bacteria that cause disease in fish are often categorized based upon their perceived or documented virulence (ability to cause disease); however, these are inexact characterizations. In reality, individual bacterial strains often differ in their virulence, and many bacteria fall somewhere within a wide spectrum of virulence, with true opportunists being the least virulent and primary pathogens being considered the most virulent. For example, the most common bacterial pathogen in freshwater fish, *Aeromonas hydrophila*, is considered a truly opportunistic pathogen, because it is relatively common in the aquaculture environment (hence, the term "environmental bacteria") and typically does not cause disease in healthy, well-maintained fish populations.

Strep, on the other hand, does not seem to be a truly opportunistic pathogen, as it can be more aggressive than many other environmental bacteria. In one experimental study (Ferguson et al. 1994), populations of zebra danios and white cloud mountain minnows exposed to high concentrations of Strep in the water experienced 100% mortality within 2-4 days of exposure. Consequently, it is important that infections be quickly identified and managed to prevent major losses.

Clinical (Observable) Signs

Affected fish may exhibit one or more of the following clinical signs, depending upon the species: erratic swimming (such as spiraling or spinning); loss of buoyancy control; lethargy; darkening; uni- or bilateral exophthalmia ("pop-eye" in one or both eyes); corneal opacity (whitish eyes); hemorrhages (Figure 1) in or around the eye, the gill plate, base of the fins, vent/anus, or elsewhere on the body; ascites

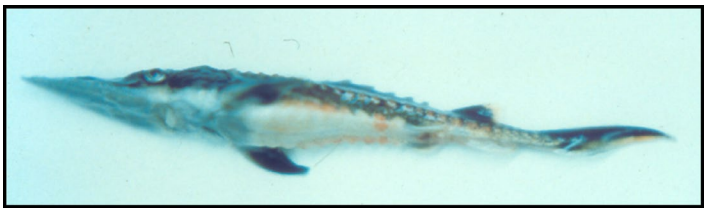

Figure 1. Bloody areas caused by a Strep infection are visible on the underside, along the side, and at the edge of the tail fin of this juvenile sturgeon.

Credits: Ruth Francis-Floyd; University of Florida

(i.e., distended abdomen/dropsy/bloating); and ulcerations. In some cases, the fish may show no obvious signs before death.

Of the signs listed above, hemorrhage, pop-eye, spinning, and rapidly progressing mortalities are among the most frequent observations.

Necropsy (Internal) Findings

Internal examination may reveal the presence of blood-tinged fluid in the body cavity, an enlarged reddened spleen, pale liver, as well as inflammation around the heart and kidney. Many Streps infect the brain and nervous system of fish, explaining the erratic swimming frequently observed in infected fish.

Diagnosis and Treatment

Most common opportunistic fish bacteria, when viewed with a microscope at high power, appear pink after a procedure known as Gram staining. These pink-staining bacteria as a group are called Gram-negative. Most of these are also rod-shaped. By contrast, Streps appear purple/blue after Gram staining; purple/blue-staining bacteria as a group are considered Gram-positive. Streps are also typically more spherical or oval in shape (coccus meaning ball- or sphere-shaped).

A tentative diagnosis of Strep can be made from the history and clinical signs, necropsy findings, and identification of Gram-positive bacteria from stains of impressions (produced by blotting sections of fresh tissues onto a glass slide) from the brain, spleen, kidney, or liver. Strep should be highly suspected if fish exhibit abnormal swimming behavior, pop-eye, hemorrhages, and rapid and severe mortalities, and Gram-positive cocci are found in brain, kidney, and/or other organs.

A confirmed diagnosis requires culture of internal organs, especially the brain and kidney, followed by identification of the bacterium. Blood agar is the medium of choice for growing Strep. Identification is important for determining

treatment options. There are a variety of commonly used antibiotics that generally work best against Gram-negative bacteria, and others that work best against Gram-positive bacteria, including Strep.

Ideally, after the bacterium has been identified from a sick fish, a sensitivity test should be conducted to select the most effective antibiotic to use. Typically, Gram-positive bacteria, including Strep, are susceptible to erythromycin. One oral dosage rate that has proven effective in the field is 1.5 grams of erythromycin per pound of food, fed for 10 to 14 days. Amoxicillin has also been shown to be effective against Strep in experimentally infected tilapia and sunshine bass at an oral dosage rate of 80 mg/kg body weight (= 3.6 grams per pound of food) fed for 8 to 12 days (Darwish and Ismaiel 2003; Darwish and Hobbs 2005). However, sensitivity testing will confirm whether or not one of these is the antibiotic of choice when an outbreak is in progress. Consequently, the assistance of a fish health specialist or diagnostic laboratory is highly recommended. If you raise food or game fish, there are restrictions on which antibiotics can be used legally to treat these animals. Consult with a fish health specialist before attempting to treat fish with a potentially illegal drug that could result in tissue residues. A fish health specialist can also recommend the proper dosage regime for a particular antibiotic and situation.

Prevention

Prevention of disease is always preferable and more profitable than treatment of disease outbreaks. Preventive medicine programs should be designed to minimize stress (see IFAS Extension Circular 919, Stress - Its Role in Fish Diseases); maintain the best water quality possible (see IFAS Extension Circular 715, Management of Water Quality for Fish); and minimize exposure to infectious agents by following appropriate disinfection and sanitation protocols (see IFAS Extension fact sheet VM-87, Sanitation Practices for Aquaculture Facilities). Although Strep does seem to occur more frequently at warmer temperatures, it can occur at any time of the year.

Studies in marine systems in Japan (Kitao et al. 1979) indicate that Strep may be present in salt water and mud, with higher incidences in the water during summer months. This implies that, in aquaculture systems some Streps that occur naturally in the environment may become endemic (established within the farm) and cause disease on a periodic basis. As a result, Strep infections may be a cyclic, recurring problem especially during periods of high stress.

If you suspect that you have a group of fish with a Strep infection, the affected population should be isolated from all others. If possible, have dedicated equipment (nets, siphon hoses) for these fish, and be sure to follow each use with an antibacterial dip such as benzalkonium chloride or Virkon® (follow manufacturer's instructions). Strep infection can spread rapidly in a group of fish exposed to water contaminated with the bacteria. In addition, Strep can spread in a group of fish through oral routes, including cannibalism of infected fish, or through feeding of infected fish food. Remove dead fish as soon as possible to minimize oral transmission. Live or unprocessed (fresh or frozen) foods should be considered a possible source of exposure, and they should be submitted to a microbiology lab for bacterial culture when an outbreak is being investigated.

Immunostimulants added to the feed, such as beta-glucans and nucleotides, have been shown to increase survival for infected redtail black shark (ornamental fish) populations (Russo, Yanong, Mitchell 2006).

Vaccines may be useful for facilities that have continual or cyclic outbreaks of Streptococcosis. Autogenous vaccines (vaccines developed for a specific facility, targeting a specific bacteria isolated from a disease outbreak at that facility) have been shown to be effective under certain conditions. Commercial vaccines may also be available for use within the next few years.

Species ofthat May Cause Disease in Fish

There are many different species of Strep that cause disease in fish. Many of these have not been fully characterized. Identification features common to Strep species that cause disease in mammals are frequently not applicable to identification of those species that cause disease in fish.

Many of the *Streptococcus* species that are pathogenic (disease causing) to fish are found naturally in the environment and may become endemic to a farm. There is not enough information available for most to determine which species or strains of Strep are more pathogenic to fish.

Examples of Strep species that have been associated with disease in fish include *Streptococcus difficilis*, isolated from fish in Israel; *S. milleri*, isolated from the kidney samples of koi observed with external ulcerations; and *S. parauberis*, isolated from farmed turbot in northern Spain (Austin and Austin 1999). Streptococcus iniae is another species that has been isolated from diseased fish and mammals (Austin and Austin 1999). Other Gram-positive bacteria that are closely related to Strep and which have been associated with

disease in fish include, *Lactococcus garvieae*, isolated from diseased eels and yellowtail in Japan (Austin and Austin 1999); *L. piscium*; and *Vagococcus salmoninarum*, isolated from diseased rainbow trout.

Disease in Humans

Streptococcus iniae is known to cause disease in both fish and mammals, including humans (Austin and Austin 1999). *Streptococcus iniae* was first isolated from an Amazon River dolphin in the 1970s. In 1994, *S. iniae* was reported as the disease agent from an outbreak in tilapia hybrids. However, it was later determined that this Strep was identical to *S. shiloi*, first isolated from tilapia from Israel in 1984.

In 1991, the first recognized case of *S. iniae* in humans occurred in Texas (MMWR 1996). In 1994, a second case occurred in Ottawa, Canada. However, the source of infection for both cases was not determined (MMWR 1996).

In 1995, a group of Canadian doctors described Streptococcal disease in a group of older fish handlers, of whom at least four individuals had additional underlying ailments, including diabetes and/or rheumatic heart disease (Weinstein et al. 1997). They were known to have injured their hands while preparing whole raw fish, primarily tilapia, and subsequently became ill. The most common type of infection (8 of 11 patients) was cellulitis (infection of the connective tissue) of the hand, causing fever in these patients. One patient, who had other health risks (heart disease, kidney disease, diabetes, and arthritis), developed a more serious infection. All cases were treated with antibiotics and resolved.

Although humans did become ill from a Strep infection originating from the handling of diseased tilapia, it is important to note that the people in this group were older (median age 69 years). Several were in debilitated health, and thus, as a group, had compromised immune systems. Also, the majority of affected individuals became ill only following puncture wounds and/or cuts to their hands. These and other data and observations suggest that the risk of healthy humans getting Strep from diseased fish is apparently very low. Fish health experts working with tilapia producers in several states have not seen any problems resulting from farm workers handling diseased tilapia.

People who are immunocompromised are at a greater risk especially if they suffer cuts or puncture wounds, and thus these individual should follow appropriate precautions, such as wearing gloves and using antibacterial soap. Although it is important to be aware of the potential risk posed by *S. iniae* to immunocompromised workers, information to date suggests that the risk is minimal to healthy individuals (Shoemaker and Klesius 1997).

Summary

Although not as common as other bacterial diseases, Strep infections do occur in fish, and can result in significant financial loss to the fish farmer. Streps are Gram-positive bacteria. Fish populations with Strep infections typically experience moderate to heavy losses. Because Strep frequently infects the brain, abnormal behavior, such as spinning, is often noted. Other signs include lethargy, darkening, exophthalmia ("pop-eye"), hemorrhages, ascites (dropsy/bloating), and ulcerations, although these are not necessarily specific to Strep. However, in many cases, there may be no obvious signs other than rapid mortality. Other potential causes of disease should be ruled out as part of the diagnostic process. If you suspect you may have a Strep infection in your fish, consult a fish health specialist who can isolate the bacteria from the fish, properly identify the disease-causing organism, and recommend appropriate antibiotic therapy. Vaccines and immunostimulants may become more important preventive-medicine tools against Streptococcosis in the future.

Streptococcus iniae, known to infect certain fish species, has caused disease in humans, including one group of people in placecountry-regionCanada who handled live tilapia. However, these people were considered much more susceptible to disease than the general population because of their advanced age and underlying health problems. Additionally, puncture wounds or cuts were required to initiate infection in this group. Normal, healthy persons are at minimal risk of acquiring this disease from sick fish.

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