Fish reared in hard water are more susceptible to columnaris disease

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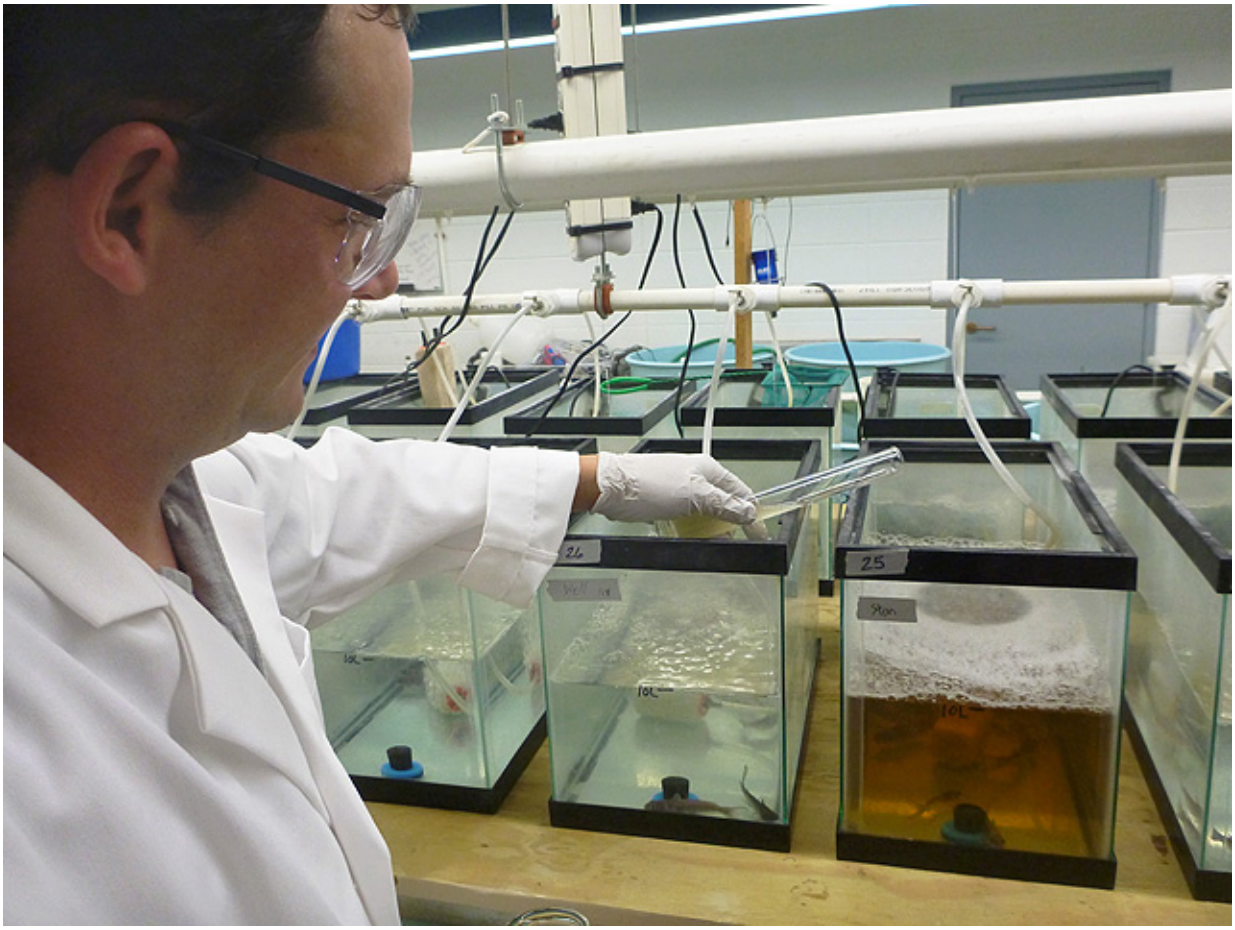

ARS support scientist Bradley Farmer pours a water solution containing columnaris bacteria into a catfish tank during a test on the effects of water hardness. Credit: Cindy Ledbetter

For most people, the choice between soft and hard water for everyday use is a matter of preference or geography. Both types have pros and cons. But for catfish, water hardness can make a difference in the development of columnaris disease, which is caused by the bacterium Flavobacterium columnare. Columnaris disease causes skin and gill lesions, can occur in any freshwater fish species, and costs the U.S. aquaculture industry $40-50 million each year.

Agricultural Research Service scientists observed that columnaris disease incidence varies with the type of water the fish are raised in. Specifically, after exposure to F. columnare, fish in well water from ARS's Harry K. Dupree Stuttgart National Aquaculture Research Center (SNARC) in Stuttgart, Arkansas, develop the disease, but fish in well water from ARS's Warmwater Aquaculture Research Unit (WARU) in Stoneville, Mississippi, do not develop the disease.

"Both waters come from the same aquifer but are very different," says SNARC toxicologist David Straus. "The water at SNARC is clear and contains significant amounts of calcium and magnesium, the two most common minerals that make water hard. The water at WARU is soft, because it contains very little dissolved calcium and magnesium. It contains substantial dissolved organic matter, such as tannins, that have leached from trees and other plant material into the aquifer and give the water a brownish tint."

The scientists challenged catfish in both types of water with the same concentration of F. columnare. All fish in the SNARC (hard) water died, while none of the fish in the WARU (soft) water died.

"We used a method called qPCR—quantitative polymerase chain reaction—to determine bacterial adhesion to gills, which was 1,900 times higher for SNARC-water fish than for WARU-water fish," Straus says. "In simple terms, fish in SNARC water had more than 800,000

bacteria attached to their gills, while fish in WARU water had less than 440—a dramatic difference."

A second experiment, using a lower dose of F. columnare to reduce mortality, was conducted to determine which factor—hardness or dissolved organic matter—caused the difference in fish mortality. Unfiltered SNARC and WARU water were used as above; in addition, dissolved organic matter was removed from the WARU water with a charcoal filter, and the SNARC water was filtered with a water softener to remove most of the dissolved calcium and magnesium.

The scientists found that filtering out the dissolved organic matter from the WARU water did not make a difference in fish mortality. However, eliminating most of the calcium and magnesium from the SNARC water caused a decrease in bacterial adhesion to gills, and all fish lived—in contrast to the unfiltered SNARC water.

Straus and his colleagues showed for the first time that water hardness influences the ability of F. columnare to attach to fish gills. Further studies will examine the effects of different levels of calcium and magnesium on bacterial attachment to fish gills.

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