Study sheds new light on how some fish adapt to saltwater

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(Phys.org) —Tilapia fish readily adapt to fresh or salty water, making them both good candidates for aquaculture and potential invasive pests. New work at the University of California, Davis, shows how tilapia can change the protein makeup of their gills, allowing them to nimbly adjust to widely varying levels of water salinity.

Salinization and salinity stress are of particular concern for fish and other organisms, as global climate change is predicted to cause rises in sea level and more frequent droughts. Results from the study are reported in the Sept. 24 issue of the journal *Molecular & Cellular Proteomics*.

"This study provides us with a better understanding of the strategies that different fish species have for coping with salinity stress, as well as the limitations of those strategies," said Dietmar Kueltz, a professor of animal science. "That in turn will provide insight into future impacts of climate change on the composition of species in habitats affected by salinization."

He added that such studies also reveal which protein-coding genes will be under the strongest selection pressure in future climate-change scenarios.

For this study, the researchers worked with Mozambique tilapia (Oreochromis mossambicus), one of four tilapia species that readily interbreed, producing hybrids that are used worldwide in aquaculture

operations. These hybrids grow rapidly and are easy to raise. They also have a high tolerance for many environmental stresses, including salinity stress.

Their adaptability to different environments has, however, also given them the capacity to invade and thrive in non-native habitats. Although tilapias are originally native to African freshwater ecosystems, they have spread throughout the world, including to marine reef ecosystems in Hawaii and Florida.

"Understanding the molecular, or proteomic, basis of tilapia's high environmental stress tolerance will also offer insight into potential strategies for managing these fish in aquaculture operations and controlling their invasiveness," Kueltz said.

In this study, the researchers focused on the molecular changes that occurred in the lining, or epithelium, of the tilapias' gills. The adaptability of the gill epithelium plays an important role in enabling tilapia and other related fish to live in a wide range of water salinity.

The fish are able to alter the proteins in the gill epithelium to adjust the amount of salt that can enter the body. The researchers analyzed the entire collection of proteins, or proteome, present in the gill tissue as the tilapia adjusted from a freshwater habitat to sudden or gradual exposure to water with varying levels of salinity, ranging from 34 parts per thousand (regular ocean salinity) to 70 ppt to 90 ppt.

Their data revealed strong effects of environmental salinity on the molecular characteristics of the tilapias' gills, including large changes in proteins that protect organisms and their cells from stress-related damage.

"The study also revealed specific proteins and mechanisms that are key

to the tilapias' ability to tolerate an extremely wide range of salinity," Kueltz said. "Furthermore, it confirmed the reliability of this analytical process in studying stress-related changes in the molecular makeup of fish tissues," he said.

Kueltz and his team plan to conduct additional related research on the functions of proteins altered by salinity in gills as well as other tissues such as those in the kidney and brain, which serve to alleviate the effects of environmental stress on fish.

Provided by UC Davis

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