Urban fish masculinized by hormone-mimicking chemicals

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Endocrine disrupting chemicals are known to cause physiological and behavioral abnormalities in fish. Credit: Susanne M. Brander

(Phys.org) —It's a man's world for fish in a San Francisco Bay-Delta estuary. Silverside fish collected from an urban beach in Suisun Marsh were more masculinized, but with smaller and less healthy gonads, than were neighboring silversides swimming near a cattle ranch in the marsh, according to a new study led by the University of California, Davis.

The study, published Sept. 25 in the journal *PLOS ONE*, measured the effects of endocrine disrupting chemicals, which mimic hormones, on Mississippi silversides (Menidia audens) at the two beaches.

Endocrine disrupting chemicals are known to cause physiological and behavioral abnormalities in fish. They come from a variety of sources, such as agricultural, urban and residential run-off. They're also found in wastewater effluent, which includes pharmaceuticals such as birth

control, hormone replacement therapy and some anti-inflammatory medications known to contain endocrine disruptors.

"The DNA sequence for a hormone receptor in a fish isn't that different from the DNA sequence for a hormone receptor in a human," said lead author Susanne Brander, who was a doctoral student at the UC Davis Bodega Marine Laboratory when the study was conducted. She is currently an assistant professor at the University of North Carolina, Wilmington. "Exposure pathways are different, of course, but what we see happening with fish is indicative of potential issues that could cause problems with human health. We're not swimming around in a soup of hormones and pesticides, but we're exposed to those things through food or in the air."

The researchers analyzed the fishes' response to endocrine disruptors at the molecular, cellular, organism and population levels to better predict the ecological impacts of such exposure. For example, would an abnormality at the cellular level indicate abnormalities for the whole population?

The ranch beach was less polluted than the urban beach, with ranch run-off being the primary source of pollution. The study found that male fish at the ranch beach had a higher expression of genes normally only expressed in females, compared to their male counterparts at the urban site. Yet, this did not appear to affect the sex ratio or gonadal health of fish at the ranch site, which was roughly 50-50 male and female.

However, males dominated at the urban beach, which was exposed to several sources of pollution—a nearby wastewater treatment plant, the surrounding urban community, as well as ranch lands. The males had smaller, less healthy gonads relative to their size, indicating that they might produce less sperm than male fish at the ranch site. Fish at the urban site also grew more slowly than the ranch fish. And while female

silverside fish are typically larger than males, males at the urban beach were larger than both the urban females and the ranch males.

A potential explanation, the researchers hypothesize, is that exposure to androgens—hormones like testosterone that control the development of male characteristics—reduced the expression of estrogen-dependent genes, which the females need to develop and reproduce successfully. Androgen exposure from endocrine disruptors may also be causing some of the fish that would have been female to become male, Branden said, adding that ongoing research is working toward investigating that hypothesis.

The study also found that the Mississippi silverside appears to be a good indicator species for studying the effects of endocrine disruptors. Researching the impacts of these chemicals in the San Francisco Bay estuary has been challenging for scientists because many of the region's highly impacted native species cannot be collected in large enough numbers to study. However, the Mississippi silverside, introduced in the early 1970s to the estuary, shares similar habitat, diet and lifespans with some endangered fishes.

"A lot of endocrine disruptor work has been done with fish such as Japanese medaka and zebrafish, but you can't go out and catch those in the San Francisco Bay," Brander said. "The Mississippi silverside is a fish that can be used both for studying ecotoxicity in the wild and translating that to what's happening in the lab."

More information: dx.plos.org/10.1371/journal.pone.0074251

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