



## Discovery

# Against the tide: Fish quickly adapt to lethal levels of pollution

## What's its secret?



New Bedford Harbor in Massachusetts is contaminated with PCBs from decades of industrial pollution.

[Credit and Larger Version \(/discoveries/disc\\_images.jsp?cntn\\_id=190457&org=NSF\)](https://www.nsf.gov/discoveries/disc_images.jsp?cntn_id=190457&org=NSF)

[View Additional Multimedia](#)

## December 12, 2016

Evolution is allowing some urban fish to survive in a lethal, human-altered environment, according to new results published in the journal *Science*.

While environmental change is outpacing the rate of evolution for many other species, Atlantic killifish living in four polluted East Coast estuaries turn out to be remarkably resilient. These fish have adapted to levels of highly toxic industrial pollutants that would normally kill them.

The killifish is up to 8,000 times more resistant to this level of pollution than other fish, scientists found. While the fish is not commercially valuable, it is an important food for other species and an indicator of environmental health.

"This study shows that different populations of Atlantic killifish exposed to toxic pollution evolve tolerance to that pollution through changes in one molecular pathway," said George Gilchrist, program director in the National Science Foundation (NSF)'s Division of

Environmental Biology, which funded the study. "This pathway may play a similar role in many animals exposed to pollutants, with slightly different adaptations in response to different toxins."

### **Genetic diversity speeds evolution**

What makes Atlantic killifish so special? Extremely high levels of genetic variation, higher than any other vertebrate -- humans included -- measured so far. The more genetic diversity, the faster evolution works. That's one reason insects and weeds can quickly adapt and evolve to resist pesticides, and pathogens can evolve quickly to resist drugs created to destroy them.

Not all species are so lucky, however.

"Some people will see this as a positive and think, 'Hey, species can evolve in response to what we're doing to the environment!'" said lead author Andrew Whitehead of the University of California-Davis. "Unfortunately, most species we care about preserving probably can't adapt to these rapid changes because they don't have the high levels of genetic variation that allow them to evolve quickly."

### **Killifish genomes**

The scientists sequenced complete genomes of nearly 400 Atlantic killifish from polluted and non-polluted sites at New Bedford Harbor in Massachusetts; Newark Bay in New Jersey; Connecticut's Bridgeport area; and Virginia's Elizabeth River.

The sites have been polluted since the 1950s and 1960s by a complex mixture of industrial pollutants including dioxin, heavy metals, hydrocarbons and other chemicals.

At the genetic level, the tolerant Atlantic killifish populations evolved in very similar ways. This adaptation suggests that these fish already carried the genetic variation before the sites were polluted, and that there may only be a few evolutionary solutions to pollution.

The study lays the groundwork for future research that could explore which genes confer tolerance of specific chemicals. Such work could help better explain how genetic differences between humans and other species may contribute to differences in sensitivity to environmental chemicals.

"If we know the kinds of genes that can confer sensitivity in another vertebrate animal like us, perhaps we can understand how humans, with their own mutations in these important genes, might react to these chemicals," Whitehead said.

The National Institute of Environmental Health Sciences also funded the research. The study's co-authors are affiliated with the U.S. Department of Agriculture, Environmental Protection Agency, Washington University School of Medicine, University of Birmingham, Indiana University, Woods Hole Oceanographic Institution, and University of Miami.

-- Cheryl Dybas, NSF (703) 292-7734 [cdybas@nsf.gov](mailto:cdybas@nsf.gov) (<mailto:cdybas@nsf.gov>)

-- Kat Kerlin, UC-Davis (530) 752-7704 [kekerlin@ucdavis.edu](mailto:kekerlin@ucdavis.edu) (<mailto:kekerlin@ucdavis.edu>)



This good killifish habitat near New Bedford Harbor is relatively devoid of chemical pollution.  
[Credit and Larger Version \(/discoveries/disc\\_images.jsp?cntn\\_id=190457&org=NSF\)](#)



The Atlantic killifish, subject of the researchers' study.

[Credit and Larger Version \(/discoveries/disc\\_images.jsp?cntn\\_id=190457&org=NSF\)](#)



Virginia's Elizabeth River is contaminated with creosote, which contains toxic PAHs.

[Credit and Larger Version \(/discoveries/disc\\_images.jsp?cntn\\_id=190457&org=NSF\)](#)



The scientists collected fish in a minnow trap. A sheen from creosote contamination is visible.

[Credit and Larger Version \(/discoveries/disc\\_images.jsp?cntn\\_id=190457&org=NSF\)](#)



Killifish are raised in the lab for multiple generations and tested for tolerance to pollutants.

[Credit and Larger Version \(/discoveries/disc\\_images.jsp?cntn\\_id=190457&org=NSF\)](#)

---

### Investigators

Andrew Whitehead

### Related Institutions/Organizations

University of California-Davis

### Related Awards

[#1265282 Collaborative Research: The genomic basis of dramatic, rapid, convergent evolution in the killifish \*Fundulus heteroclitus\* \(/awardsearch/showAward.do?AwardNumber=1265282\)](#)

**Total Grants**

\$159,459

National Science Foundation, 2415 Eisenhower Avenue, Alexandria, Virginia 22314, USA Tel: (703) 292-5111, FIRS: (800) 877-8339 | TDD: (800) 281-8749