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Pill to Gill: Antianxiety Drugs Flushed into Water May Be Making Fishes Fearless

Levels of human drugs commonly found in the world's waterways may be altering the way fishes behave By David Biello | Friday, February 15, 2013 | 6 comments

Antianxiety drugs may be making fish more aggressive. New laboratory tests reveal that even extremely low concentrations of the calming drugs benzodiazepines more commonly known as Valium and Xanax, among others—cause fish to become less timid and to feed faster, among other effects.

"This is an essential drug that is used around the world," said chemist Jerker Fick of Umea University in Sweden at a press conference preceding publication of the research in *Science*. Benzodiazepines calm people with anxiety by stimulating the GABA receptor, enhancing the sedative effect of that neurotransmitter. The drugs are then excreted in urine, often as the compound oxazepam—a compound that is produced when the body breaks down some benzodiazepines as well as a drug in its own right. Then there are all the compounds are flushed down the toilet.

But humans are not the only animals with GABA receptors. "It is present in almost all vertebrates. All fish have these," Fick added.

A previous survey revealed that low levels of such antianxiety drugs contaminated Sweden's waterways, reaching levels as high as 0.58 microgram per liter. Oxazepam in particular proved long-lasting because even sunlight failed to break it down. As a result, the compound built up in the tissue of wild-caught perch, reaching levels of 3.6 micrograms per kilogram—or more than six times higher than in the surrounding waters. So the Swedish researchers decided to run some experiments to see how these low levels of drugs might be affecting fishes.

The researchers used 90 juvenile European perch, *Perca fluviatilis*—the same fish whose levels in the wild had been measured. They tested their behavior in clean water: recording how active they were; their risk-taking behaviors such as entering an unknown and open stretch of water; how they interacted with their fellow perch; and even how quickly they fed on prey.



Levels of human drugs commonly found in the world's waterways may be altering the way fishes behave. Image: Flickr/Saspotato

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The researchers then either kept some of the fish in clean water for a week, exposed them to low levels of oxazepam (1.8 micrograms per liter, or three-times environmental levels) or high levels of the drugs, 910 micrograms per liter. The effect was obvious, says ecologist Tomas Brodin of Umea University, who led the research. "They became more active, they became asocial and they became risk-taking," Brodin explained at the press conference. "We do daily care on these fish. On day three, without knowing [which fish was in which group], I could tell which fish were exposed." That's because the unexposed fish would cower in dark corners or swim around nervously whereas exposed fish quickly explored new, but possibly dangerous aquatic territory. The exposed fish also ate prey faster—it took 75 seconds for unexposed fish to decide the coast was clear enough to eat zooplankton, as compared with 25 seconds for fish exposed to low levels of the drug and just two seconds for fish with the highest levels.

Drugged fish are not likely to impact humans: "You'd have to eat four [metric] tons of perch from the river to get one tablet of the drug," Fick explained at the press conference. "It's not a human health issue, it's an aquatic issue."

And it may be that the levels actually found in water—about one third of the exposure levels in the lab—are low enough that no impact is seen. "We need to reduce the exposure concentration to see where we don't have any effect," Fick admitted. But "we can see profound effects at low levels, at levels that correspond to levels we actually find in surface waters."

For an individual perch, a little less anxiety may be good if it leads to faster feeding. But such alacrity may also have unintended consequences, either by setting off a cascade of faster consumption of algae-eating zooplankton throughout the food web, thereby allowing more algal blooms in the ecosystem or simply by exposing individual perch to more predation. Fish without fear are fish that quickly get eaten by larger predators, such as pike.

It remains to be seen what the overall effect of the pharmaceutical contamination may be, although it has been going on for decades since benzodiazepines were first prescribed in the 1960s. But instead of flushing old drugs, the better bet is to return them to pharmacies for proper disposal as well as, potentially, develop new treatments for sewage facilities that can filter out the drugs coming into the water via human urine. "There are several ongoing research projects that try to develop more efficient removal techniques, such as using ozone," Fick told *Scientific American* in an e-mail. Otherwise, human antianxiety drugs may provoke yet more anxiety about the environment.

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