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Florida's Gender-Bending Chemicals

Frogs living in agricultural areas of Florida are more likely to be feminized than their suburban counterparts. Along the shore of Florida's Lake Okeechobee, male toads seem more like females. Most have ovaries as well as testes, the mottled skin of a female and depleted testosterone. Nearby, in a Palm Beach suburb, the frogs are normal. The difference? The feminized ones live in areas with heavy agriculture while the normal males inhabit suburban areas.

Scientists at University of Florida have documented that proximity to farms increases the chances that amphibians are half-male, half female. The more intense the agriculture, the more feminized the male toads, and the more likely they can't reproduce.

The new findings intensify the already highly contentious debate over whether pesticides — particularly atrazine, one of the most widely used herbicides in the United States — are messing up the reproductive organs of wildlife.

Some scientists say that pesticide exposure is likely to be a big piece of a puzzle that they have tried to solve for decades: What is wiping out frogs and amphibians around the world?

The threat from agriculture "is part of a complex response that endangers frog and other wildlife populations," said Louis Guillette, senior author of the study and a University of Florida Distinguished Professor of Zoology.

You have stacked the deck against healthy populations," he said. "The reality is we are

stressing wildlife populations, killing them through habitat loss and disease, and then also modifying them so they cannot reproduce optimally."

The new research "adds to the support that agriculture causes these problems," said Tyrone Hayes, a professor of integrative biology at University of California at Berkeley.

Hayes in 2003 published data that showed frogs exposed in the laboratory to the herbicide atrazine became hermaphroditic.

However, other studies, many of them industry-funded, have found no such effects. The U.S. Environmental Protection Agency concluded last year after a review of existing data that there was insufficient data to suggest that atrazine feminizes amphibians. Its science advisory committee agreed.

Dr. Tim Pastoor, principal scientist at Syngenta, the manufacturer of atrazine, said "a growing body of research conducted by independent labs across the world is showing that atrazine does not affect the sexual development of amphibians."

Hormone Disruptors

University of Florida's research in the early 1990s, led by Guillette, was considered pivotal





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science that led to worldwide concern about chemicals that mimic or block hormones. The scientists linked the pesticide dicofol, which contains DDT, to feminized alligators in Florida's Lake Apopka. The phenomenon, called endocrine disruption, has now been replicated in research on various species and chemicals throughout the world.

In the new study, scientists collected toads from five sites in South Florida. At the two places, Belle Glade and Canal Point, where most land is farmed, about 60% of males had feminized sex organs, including 35% to 40% that were considered intersex, with both ovaries and testes. But at Lake Worth, which has no agriculture, there were no intersex toads and feminized traits were found in less than 10%.

Also, the male toads in the agricultural areas had fewer pads on their thumbs which grow on mating males. Their testosterone levels were low in the farmed areas, similar to those of female toads.

Andrew Blaustein, a zoology professor at Oregon State University who studies environmental threats to frogs, said the more-subtle, feminine changes found in the males—particularly the lack of thumb pads allowing them to hold on to a mate--could have dramatic effects on their ability to breed.

"The secondary sexual traits are really striking," he said.

Although the new study only looked at cane

toads, which are not native to Florida, "we have also studied green tree frogs and southern toads, and both show similar gonadal abnormalities at the agricultural sites," said Krista McCoy, lead author of the Florida study, which was published in an online edition of *Environmental Health Perspectives* in July.

"In general amphibian reproductive system development is very sensitive to hormones, natural and man-made," McCoy said. As a result, she said "what we find in cane toads is likely occurring in other species and might be contributing to their rarity."

"We know that many pollutants are distributed globally, and we know that amphibian populations are declining globally, faster than birds or mammals actually. But we do not have an understanding of the role that pollutants are playing in amphibian population declines," McCoy said.

Across all species, hormone systems are strikingly similar, regulating how the reproductive tract develops. Scientists suspect that the same chemicals that feminize toads might be feminizing human boys, too.

"In fact, there is general concern among scientists who study endocrine disrupting chemicals that some of the very chemicals used at the agricultural sites we studied are negatively affecting humans," McCoy said.

Atrazine-a major herbicide

About 888 million pounds of active pesticide ingredients were used in 2001, 76% for



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agriculture, according to EPA data. Of that, 550 million pounds were herbicides. Corn is the major crop using herbicides, accounting for more than one-third of the total. Illinois and Iowa lead the nation in herbicide use.

The Florida team did not implicate any particular chemical. But the primary pesticide used in that area is atrazine, applied to sugarcane fields.

"The big suspect is atrazine," Hayes said. "What makes atrazine particularly bad is that it is everywhere. It is the one pesticide that's always there, that's persistent. There is no other evidence at this point for other pesticides."

Hayes theorizes that atrazine feminizes animals by activating an enzyme that causes an imbalance between testosterone and estrogen.

"We have effects in fish, and similar effects in alligators and other species, and we have studies on human cell lines," Hayes said. "To me it's a no-brainer. That can't be a coincidence."

However, the EPA mounted a review of 19 laboratory and field studies exploring the effects on amphibians, and concluded last year that atrazine does not feminize them.

Some scientists, however, say there is ample evidence that pesticides are harming frogs and related animals. Hayes has criticized the EPA for relying too heavily on studies conducted by atrazine's manufacturer.

Said Blaustein, the Oregon State zoology professor: "Not only can these pesticides have

direct effects, they can have indirect effects. They can kill you, they can screw up your physiology and anatomy and they can put you under stress and hamper your immune systems, so they are nasty."

Throughout much of the world, urban development, introduced predators and diseases all play a role in the disappearance of native frogs, toads and other amphibians.