

Kelley Brownell:

Hello, and welcome to Policy360. I'm Kelley Brownell, the Dean of the Sanford School of Public Policy at Duke University. My guest today is Tyrone Hayes, professor of integrative biology at the University of California, Berkeley. Professor Hayes is known for his research findings regarding the effects of the herbicide atrazine and endocrine disruptor on frogs. Atrazine is often used by corn farmers, but professor Hayes's research raise questions about its safety. Syngenta, the Swiss manufacturer of atrazine, took exception to professor Hayes's research and launched, in the eyes of some, a campaign to discredit both him and his research. The New Yorker wrote an in-depth article about the situation, and I suggest you read this because it's available online. It's extremely interesting.

Filmmaker Jonathan Demme, best known for the film The Silence of the Lambs, has made a documentary on this topic. Professor Hayes has presented 100 of papers, talks, and seminars worldwide on his conclusions that environmental chemical contaminants have played a role in global amphibian declines, and contribute to minority and low income population health disparities. Welcome.

Tyrone Hayes:

It's good to be here.

Kelley Brownell:

Delighted to have you here. First please give us some background on your relationship with the Syngenta company. How far back does this go and how have you been involved with them?

Tyrone Hayes:

Oh, I was originally contracted back when they were Novartis. So about 20 years ago I was a brand new assistant professor at University of California, Berkeley. And I was contracted to study atrazine, which at the time was their number one selling product, and still is for Syngenta. And originally it was just a literature review, and we sort of came to the conclusion that not that much was known with regards to atrazine's impact on amphibians, in terms of it being an endocrine disruptor. And then I was contracted to do research on amphibians to figure out if atrazine interfered with hormones and development in amphibians.

Kelley Brownell:

So I think you've just explained this a bit, but could you just describe what you mean by endocrine disruptor?

Tyrone Hayes:

So endocrine disruptor is a term that was sort of coined by sort of the key people, who were people like Pete Meyers and Lou [Julet 00:02:25], Theo Colborn, among others. And it's in reference to synthetic or human made chemicals that interfere with hormones, either with their synthesis or their circulation or their action, et cetera.

Kelley Brownell:

So can you describe the research you did on the impact of atrazine and what the results showed?

Tyrone Hayes:

So we examined the effects of atrazine on amphibians throughout development, and we used levels that were ecologically relevant, so levels that you could find even in your rain water and your drinking water, levels that were well below what the EPA thought was safe. And we found that atrazine inhibited growth of the voice box, so the larynx, in male frogs-

Kelley Brownell:

[crosstalk 00:03:07] frogs.

Tyrone Hayes:

... in frogs.

Kelley Brownell:

Yes.

Tyrone Hayes:

It inhibited growth of the voice box, or the larynx, which implied that the compound somehow was a chemical castrating agent, that it lowered testosterone. And then we subsequently found that it also caused feminization of genetically male frogs. So male frog would develop ovaries or eggs in their testes, et cetera.

Kelley Brownell:

Well these sound like pretty dramatic findings. What impact would this have on animals living out there in the real world?

Tyrone Hayes:

We subsequently went on to actually study whether or not we found hermaphroditic or feminized frogs in the wild, and if it was associated with atrazine. And that was the case. So we and other labs have subsequently shown that, in areas where you do have atrazine, you do have these feminized frogs, and the trouble is it's hard to find a place that doesn't have atrazine. It travels in rainwater. Half a million pounds of atrazine come down in the rain water every year. It can travel over 1000 kilometers or 600 miles. So it's a very ubiquitous contempt.

Kelley Brownell:

Would it travel that far in rivers and streams? Like for example, used in cornfields in Iowa and it would travel down the Mississippi?

Tyrone Hayes:

Absolutely it travels. 1.2 million pounds of atrazine flow into the Gulf of Mexico through the Mississippi river every year.

Kelley Brownell:

I know that people talk about dead zones in the Gulf of Mexico because of runoff, agricultural runoff. And mainly your people talk about fertilizers in that context, but do the herbicides contribute to that as well?

Tyrone Hayes:

In the Gulf of Mexico I'm not sure if anybody's actually really examined atrazine specifically. But you would think that it would have a big impact.

Kelley Brownell:

So the ecology of a city like New Orleans, let's just say that there's no corn production around there, could be very heavily affected because of the travel of these things through the water supply.

Tyrone Hayes:

Absolutely. Yeah. Absolutely.

Kelley Brownell:

Yeah. So that's so interesting. So the main problem, it sounds like on frogs in particular, was the endocrine problems and the feminization of these male animals. Does it have an impact on female animals?

Tyrone Hayes:

I had a student who was really interested in impact on females, and we've just started doing those kinds of studies. And you might expect, at least for frogs, that the effect would be less recognizable because females already have estrogen. What atrazine does is it causes you to make too much estrogen, and females frogs already have the estrogen. And so we haven't detected effects yet on females. That doesn't mean that they don't exist, but they're harder to detect.

Kelley Brownell:

If you went into the wild and you found frogs, the male frogs, that had been exposed to the atrazine, is there a way of knowing what percentage of them would have significant impacts? Is it a few? Is it a lot? What's the magnitude of the impact?

Tyrone Hayes:

That's a harder question to answer. And it's hard to answer because, one, you don't know the full history of exposure to that individual. Two, there could be other compounds in the environment that maybe even do the same thing, or there maybe act synergistically or maybe antagonize the effects of atrazine. Three, it's hard to find a place that doesn't have atrazine exposure. So it's hard to find a control. And even if you do, it's hard to find a place where would know the history of exposure, because exposure across multiple generations could mean that you've evolved resistance or you've evolved increased sensitivity. So it's really hard to pinpoint what's normal. We can more easily do that in a laboratory, where we have control studies and we have animals and we know the history of not only the animals that we're testing, but the history of four or five generations back.

Kelley Brownell:

So in your lab studies, when you're exposing the animals to ecologically relevant levels of atrazine, what percentage of the frogs would develop significant problems?

Tyrone Hayes:

It depends on the population. So we have populations that differ 10,000 fold in their sensitivity. So even with estrogen we have populations where we can treat with a dose or expose with a dose of estrogen or atrazine and get 90% of the animals feminized. We have other populations that don't even see that, where we get zero effects. And we're pretty clear in the laboratory that that involves a history of selecting for animals that are resistant versus animals that are more sensitive.

Kelley Brownell:

So when you began publishing these results in the scientific literature, how did the scientific community respond?

Tyrone Hayes:

I've always had very strong support from the scientific community. In addition to my work, there's a few dozen laboratories that have shown similar effects of atrazine, independent of my laboratory. My papers have been in the top most difficult journals to be published in. We've always received very good reviews and very good support from the scientific community.

Kelley Brownell:

Now I gather that the response from Syngenta wasn't as friendly.

Tyrone Hayes:

No.

Kelley Brownell:

So can you describe how the history of the company responding to your findings and how that played out?

Tyrone Hayes:

Well, initially the company's response, when I initially reported the data, their response was to attempt to get me to manipulate the data and essentially hide it. So for example, they requested that when we studied the voice box or laryngeal size, they tried to get me to divide the larynx size by its body weight, which essentially hides the data. And I demonstrated that to them. Their next attempt was to hire statisticians to try to show that we had done something statistically or that there was a flaw in our design, even though the design was approved by the company itself. And then when I became aware that they weren't being forthright and left the contract, they then hired other scientists to try to prove that there was something wrong in our experimental design, or that the data weren't repeatable, or that the studies weren't repeatable.

And then it really sank into unsavory things, and I mean including threats of violence and threats against my family, and a marketed attempt to discredit me, to have my papers retracted, even trying to have me fired. And as you may know, during that time I also had a job offer at Duke that they reportedly had taken away, taken off the table.

Kelley Brownell:

So this sounds like very serious things that were going on. And I can imagine what this felt like to be the recipient of these. So you mentioned physical violence. I mean, did you receive overt threats of things like this?

Tyrone Hayes:

Oh yeah. Absolutely. There was an employee, who still is at Syngenta, who would openly say things like, "Your wife and daughter alone at home right now. How do you know I don't have somebody going to your house?" Or who would say things like, "If you go for a run tonight, maybe I'll have some good old boys come show you what it's like to be gay." I mean, he openly made threats of sexual violence and other things.

Kelley Brownell:

And some of the reports I read said that they sent company representatives to your talks.

Tyrone Hayes:

Constantly.

Kelley Brownell:

And when you said that they tried to affect your employment at Berkeley, what form did that take? How did that play out?

Tyrone Hayes:

They wrote letters to Berkeley. They filed an ethics complaint associated with some language that I used. They desperately tried to have my papers retracted. And I think actually part of their strategy was to do things so outrageous that if I talked about them, then I would look like I was crazy. But what happened prior to the New Yorker article was that during a court case, which they settled out of court, many of their documents from their meetings, explicit documents listing the things that they were trying to do to me, were made public. Including things like purchasing my name on the internet, investigating my wife, investigating my students, trying to involve me in some kind of scandal, hacking my emails, tapping my phone. I mean, all these things they actually wrote down. Exploiting my father's health problems. They're actually in their own handwriting.

So yeah, they generated a Wikipedia page. They had a blog pretending it was me. It was all kinds of things. They paid people to write papers. And even the canceled checks from these became public after this court case. And I knew these things were going on all along, but at the time I didn't have proof.

Kelley Brownell:

So when you said paying people to write papers, do you mean funding other scientists who would then find things-

Tyrone Hayes:

Or even just writing papers and then paying somebody to put their names on them, but op-ed pieces and things like that.

Kelley Brownell:

And the company would write them and then people would attach their names to them in exchange for a payment.

Tyrone Hayes:

Yeah.

Kelley Brownell:

Pretty remarkable. So what was the impact of the New Yorker article? And what did the New Yorker article talk about? I've read it, but it'd be interesting to see your account of it. And then what was the impact of that?

Tyrone Hayes:

So the funny thing is I agreed to do the New Yorker article. And it's one of those things where, if you do something like that, you really turn over your life. So I said, "Here's all my hard drives. Here's all my evidence." And I remember, just before the article came out, the fact checker called me. And the fact checker asked me questions that really made me sort of dubious about ... Questions like, "Did you really think somebody was following you around?" et cetera. And then I looked into the background of the author, Rachel Aviv. And then I learned that she's most well-known for writing stories about people with mental health problems.

Kelley Brownell:

Oh my God.

Tyrone Hayes:

And originally that's what she was commissioned to do, was to write some paper about this crazy paranoid guy who thought this company was pursuing him. But as she read through the documents and the things that were released in this court case, it became clear that ... Well, I may very well be crazy. Sorry, I didn't mean to be insensitive. But not in relation to this. And she says in the documentary, that it sounds like you've seen, that, "The most difficult thing in writing a story was convincing my editor that Tyrone wasn't crazy." But all the evidence was there, that they actually wrote these things down, that they were systematically doing to me, to try to discredit me, and to try to publicly ridicule me and get me out of their hair.

And I think once these things all became clear through the New Yorker article, which was a more popular piece, they really became kind of quiet. I haven't heard from them since the article came. Well, their lawyer sent me a couple of letters trying to scare me into not talking about these issues, but they've been much more quiet since the New Yorker article.

Kelley Brownell:

So since all that occurred, what's become of the state of science on this topic?

Tyrone Hayes:

My laboratory had a little bit of a difficult time with funding, but now we have essentially a lifetime endowment. So the funding in the lab has picked up and we have some long-term studies looking at multi-generational impacts of being exposed to atrazine and other estrogens. And some incredible data examining both impacts on behavior, so actually homosexuality in frogs, stuff that we're about to publish now. And an incredible data set looking at what happens if you're exposed for multiple generations, either because of selection, or because of what's now known as epigenetics. So even in generations when you're not exposed these animals have picked up a sensitivity and picked up effects that we think, across generations, alters gene expression. And we can produce genetic males that

spontaneously turn into females as a result of this exposure. I'm now raising funds to look more carefully at the impacts of chemicals like atrazine on breast cancer, for example, and whether or not the disparities you see in minority incidents of various cancers, as well as outcomes, is associated with history of exposure, rather than just genetics.

Kelley Brownell:

So you mentioned cancer as a potential outcome of exposure to atrazine. Is there any evidence that humans are responding with these kinds of problems?

Tyrone Hayes:

Well, so there've been several studies showing that atrazine is associated with prostate disease and mammary cancer, breast cancer, in rodents. So rodents are mammals and a lab model that we use to predict effects that would occur in humans. There's also several studies, not just mine, showing that atrazine has the same impact on human cells, that when human cells are exposed to atrazine they start producing estrogen. And estrogen is very important in prostate cancer. And the balance between androgens and estrogen is important in both breast cancer and prostate cancer. There's at least one epidemiological study, or study in human populations, that shows that females, women, whose well water's contaminated with atrazine are more likely to develop breast cancer. And there's a study out of their factory in Saint Gabriel, Louisiana showing that men who are exposed to atrazine in their own factory have an 8.4 fold higher incidents of prostate cancer.

So I'm very interested in the role of chemicals like atrazine, so-called endocrine disruptors, and how they may contribute to health disparities, particularly reproductive cancers. Minorities are more likely to live in and more likely to work in areas where they're exposed to chemicals that we already know are associated with these adverse health outcomes. And probably the most damning evidence is that atrazine, it's very clear now, in fish, amphibians, reptiles, birds, mammals, it's very clear that atrazine turns on an enzyme, the machinery if you will, aromatase, that converts testosterone into estrogen. And it's very clear that aromatase is important in breast cancer. And until year 2000, the same company, Novartis, sold atrazine, which induces aromatase, and associated with breast cancer, and they sold an aromatase blocker to treat breast cancer. So they know.

Kelley Brownell:

You mentioned that this is still Syngenta's leading product.

Tyrone Hayes:

It is.

Kelley Brownell:

So apparently the use of it's not going down. Are there any signs that farmers are concerned about this and they might change their practices? I mean, it could be that they're selling more of this chemical globally, and that's why their overall sales are still high, but there's less use in the United States. But I was wondering where that stood.

Tyrone Hayes:

The US is the biggest user. The European Union banned atrazine around the same time that my work came out. With regards to farmers, they're almost held hostage. Because a lot of people don't realize

this, but six chemical companies own 90% of the seeds that we grow, that we use to feed the world. Soon about to become four chemical companies, because two of them including Syngenta have been bought out. So the farmers are really hostages. I mean you're buying a seed from the same company that's selling you the chemical. And something like 90% of GMO products are crops that have been designed, that require chemical use.

Kelley Brownell:

So in your own research, what came first, the frogs or the atrazine? Were you mainly interested in studying the impact of these environmental contaminants? Or were you interested in the health of amphibians to begin?

Tyrone Hayes:

Neither one. Since I was a kid I've been interested in amphibians, biology in general, but especially amphibians, and how the environment affects development and physiology. So basic questions like how do birds know when to fly south? How do tadpoles know when to metamorphose? And by trying to understand the environmental factors that regulate development and physiology, it became clear to me that some of the most important environmental factors affecting growth, development, physiology, where these artificial chemicals that we've put into the environment. And right about that same time I was contracted by the companies, I'd never heard of atrazine specifically, to study atrazine. So I remember I asked them once, "I don't know what brings you the most regret, that you were the one who introduced me to this compound. I had never heard of it."

Kelley Brownell:

So you talk about this in a good natured way, and I admire you for that. I can only imagine what it must've felt like to go through all this. And it's hard enough being a young academic and trying to make your way, and there's lots of pressure to teach and publish and do all the things an academic needs to do, and that's hard enough. But then when you overlay that with all these kind of things that were happening to you, what sort of impact did that have?

Tyrone Hayes:

Well, in a way ... You know that old whole expression, "That which does not kill you makes you stronger." And in addition to ... Science is rigorous, getting things published and peer review. And here is a group who had an incentive, who spent, I would guess, millions of dollars, and the fact that they went personal says that my laboratory, my students, that we were so careful in terms of how we conducted our research, that they had to go there. They had to do things like investigate my father's health problems and purchase my name on the internet. And that it wouldn't even have to be a flaw. You can pick apart any experiment and go, "Well, you should have had a larger sample size," or, "You should have done it this time of year." That our science was so tight they had to go after me and my family personally. That's a test that maybe nobody should go through, but it's a test that we, and I say we, my students, that we survived. And so I appreciate that.

Kelley Brownell:

Well, you have one amazing story to tell. I mean, if all we were talking about were the science of this it would be fascinating, but then you add to that the complexity of the industry behavior and all the different things that went on. It's just a very remarkable story. So thank you very much for sharing this with us.

This transcript was exported on Jun 17, 2021 - view latest version [here](#).

Tyrone Hayes:

It's my pleasure.

Kelley Brownell:

My guest today has been Tyrone Hayes, professor of integrative biology at the University of California, Berkeley. He is on the Duke campus to give a talk entitled To Be Honest, When Scientific Integrity And Corporate Interests Clash. Until next time, I'm Kelley Brownell.