

## “Fiend Angelical”

### The “Honorable Villain,” Atrazine

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For many years, agricultural institutions have relied on atrazine as a powerful herbicide primarily used for corn, but also on a large number of less prolific crops. It is so widely used as a pesticide that traces of atrazine have been found in over two thirds of the bodies of water in the United States (*PANNA*) due to significant runoff from irrigation. Atrazine is produced by a champion of the agribusiness industry known as Syngenta. Dr. Tyrone B. Hayes, a researcher from the University of California at Berkeley, has presented evidence that atrazine is a carcinogen in the reproductive system and a hormonally active agent due to its chemical property to interrupt the endocrine system. Hayes's research focuses primarily on atrazine's effects on amphibians, specifically hermaphroditism in frogs. However, Syngenta's head researcher, Dr. Peter Hertl, has contested Dr. Hayes's findings and questioned the validity of his research (Hertl). Despite Dr. Hertl's rejection of Dr. Hayes's research and the doubts of its scientific merit, there is significant evidence that suggests that atrazine is a dangerous endocrine disruptor and is a significant environmental hazard. While Hertl challenges Hayes's results, there is greater reason to question Hertl's motives.

Recently, the significant decline in the African frog (*Xenopus laevis*) population in southern California prompted Dr. Tyrone B. Hayes to conduct a study to clarify the effects of atrazine in the hormones and reproductive organs of maturing male frogs. He hypothesized that the rapid decline was linked to the increasing presence of atrazine in their environment. Hayes began conducting experiments by introducing atrazine in 2.5 parts per billion to forty male frogs. Out of the total raised, 90% of the testing population experienced decreased hormone levels of testosterone and decreased fertility,

meaning that they are less likely to reproduce in nature. The remaining four frogs, or 10% of the testing population, did not possess nuptial pads on the lower arms, but had cloacal labia, meaning they were now effectively female. Hayes observed that the hermaphroditic frogs also had an increased amount of aromatase, the enzyme which is responsible for changing testosterone to estrogen. Of these hermaphrodites, two were mated with other atrazine-exposed males and bore offspring while the other two were dissected and examined. While surveying the frogs' anatomy, Hayes discovered that even though they were chromosomal males, after being exposed to atrazine, the frogs had been physically and chemically converted into females. In addition, all of the offspring from “atrazine-induced females” were males (Hayes, et al. 4612). If atrazine is already affecting frogs at low concentrations, because concentrations are occurring in greater numbers in the wild, it is likely that Hayes's results would prove correct for other species over time.

Hayes's most recent experiment on atrazine titled “Atrazine Induces Complete Feminization and Chemical Castration in Male African Clawed Frogs (*Xenopus Laevis*),” which was published in the Proceedings of the National Academy of the Sciences, is under scrutiny. Syngenta's head of Global Product Safety, Dr. Peter Hertl, wrote a letter critical of Hayes to the University of California at Berkeley and to the president of the National Academy of Sciences stating the inadequacies of Hayes's report. Hertl made few correct accusations. First, he argues that there was no control population to compare outcomes of similar sexual growth. Yet Hayes's study includes a control group of forty male African clawed frogs (Hayes, et al. 4612). Secondly, he claims that not all the methods and procedures of the experiment were included (Hertl), which also means that Hayes did not follow the standard Good Laboratory Practices (*Nebraska Corn Kernels*). When examining Hayes's methods and results, the reader will find a complete demonstration of the experiments and a supported conclusion. Finally, Hertl claims that experiment tested only one dosage of atrazine on frogs that were constantly handled by scientists. It is true that only one dosage of 2.5 ppb (parts per billion) of atrazine were applied to the

test population, which might jeopardize the accuracy of the experiment. However, Hayes uses 2.5 ppb as the current testing environment's saturation of atrazine because it is a relatively small concentration compared to the EPA's allowed maximum concentration of 3.0 ppb. It is even possible that the actual presence in certain areas in nature could be much larger. Because the test produces such adverse effects at such a small dosage there is concern for the possibility that more severe and human-related consequences could occur. Therefore, the test only needs one dosage to determine atrazine's potential toxicity because Hayes is determining the minimal effects of atrazine. If this miniscule dosage of 2.5 ppb is enough to endanger a population of frogs, then there's no way of measuring the imminent, mass infliction atrazine can cause in larger dosages to wild populations.

While the dangers of atrazine are being debated, both men fail to mention a recurring phenomenon in frogs which could greatly alter atrazine research. It has been found that under extreme environmental pressure, various amphibians and most frogs are capable of changing sexes. Heterogamety is when two different sex chromosomes are formed in one gender. For instance, human females have two 'X' sex chromosomes while the males have an 'X' and a 'Y' chromosome, so the heterogametic sex is male. It is the heterogametic sex that is capable of disintegrating its current reproductive organs and growing functional reproductive organs of the opposite sex. In amphibians, heterogamety depends on the species, which neither Dr. Hayes nor Dr. Hertl addresses (Ogata, et al. 613). In Hayes's experiment, there are forty males in a single containment unit where members of the population are being exposed to a chemical and being handled by men with absolutely no women around. It seems as though this would be enough environmental stress to cause a male to change into a female to allow the population to survive, but because forty out of forty control frogs remained males during the testing, it shows that not even excessive handling and lab procedures will spark the transformation. Once again Dr. Hayes's evidence stands.

While Dr. Hayes is battling Dr. Hertl's proclamations to reinstate his integrity, the company

financially backing Dr. Hertl has larger things at stake. Syngenta's largest concern in regard to the situation is that atrazine was unjustly vilified by Hayes's data. Atrazine is Syngenta's highest source of revenue (Hayes). Syngenta is a mega-corporation that has millions invested in a hardy pesticide that brings loyal consumers and provides thousands of jobs. Atrazine is used in the majority of the United States and many farmers currently depend on it for the success of their crop yield ("Frogs"). Dr. Hertl's check is paid by Syngenta, while Hayes is funded by several organizations that reward education and merit; such as the California Toxic Substances Research and Teaching Program, the David foundation, and the National Science Foundation. The research that has been called into question by Syngenta was published in the Proceedings of the National Academy of the Sciences, which even the leading scientist against Hayes admitted "has a long history of publishing peer reviewed scientific papers of a high standard" (Hertl). Moreover, in 1997, Dr. Hayes was working in research for a company known as Novartis, where he discovered the possible hazards of atrazine. Instead of investigating the findings, the company restricted Hayes from spreading his research through conventions or by publishing the information. He then quit his position to research atrazine on his own terms. Hayes admits that the chemical company had greatly "hindered" his efforts to reenact the experiment (Hayes).

Three years later on November 13, 2000, Novartis joined AstraZeneca to form Syngenta (*Syngenta*). As a small company, Novartis prevented Hayes from not only finding the actual repercussions of the herbicide, but also from sharing his work with the scientific community. Now as a multi-billion dollar corporation, Syngenta is doing all in their power to keep their best product on the market.

#### Works Cited:

"Atrazine: Syngenta's Herbicide." *Pesticide Action Network North America (PANNA)*. Web. 31 Aug. 2010. <<http://www.panna.org/atrazine>>.

- "Company History." *Syngenta*. Web. 01 Aug. 2010.  
<[http://www2.syngenta.com/en/about\\_syngenta/companyhistory.html](http://www2.syngenta.com/en/about_syngenta/companyhistory.html)>.
- "Frogs, Atrazine and the Nutty Professor." *Nebraska Corn Kernels*. 12 Aug. 2010. Web. 23 Aug. 2010.  
<<http://nebraskacorn.blogspot.com/2010/08/frogs-atrazine-and-nutty-professor.html>>.
- Hayes, Tyrone B. "Our World...Our Future." *AtrazineLovers*. Web. 23 Aug. 2010.  
<<http://www.atrazinelovers.com/m0.html>>.
- Hayes, Tyrone B., V. Khoury, A. Narayan, M. Nazir, A. Park, T. Brown, L. Adame, E. Chan, D. Buchholz, T. Stueve, and S. Gallipeau. "Atrazine Induces Complete Feminization and Chemical Castration in Male African Clawed Frogs (*Xenopus Laevis*)." *Proceedings of the National Academy of the Sciences (PNAS)* 107 (2010): 4612-617. Web.
- Hertl, Peter. Letter to Dr. Ralph J. Cicerone and Dr. Randy Schekman. 1 June 2010. *Atrazine Herbicide*. Syngenta. Web. 26 Aug. 2010.  
<[http://www.atrazine.com/Amphibians/hayes\\_analysis.pdf](http://www.atrazine.com/Amphibians/hayes_analysis.pdf)>.
- Kaleita, Amy. "Environmentalism Turns to E-bullying." *Washington Times*. 11 Aug. 2010. Web. 23 Sept. 2010. <<http://www.washingtontimes.com/news/2010/aug/11/environmentalist-turns-to-e-bullying/>>.
- Ogata, M., H. Ohtani, T. Igarashi, Y. Hasegawa, Y. Ichikawa, and I. Muira. "Change of the Heterogametic Sex From Male to Female in the Frog." *Genetics* 164 (2003): 613-20. *The Genetics Society of America*. Web. 6 Dec. 2010. <<http://easybib.com/cite/form/website>>.