

Pseudoestrogens

09 April 2007
35th class meeting

READINGS

Monday 09 April:
Pesticides and Pseudoestrogens:
Colborn 1997; Gore 1994
Wednesday 11 April: Rob Robichaux
Monday 16 April:
Water:
Postel 2001; EPA website; 3Gorges:
<http://news.bbc.co.uk/2/hi/asia-pacific/5000092.stm>



Lab 11/13 April: meet at van s-side BSE
Exam Friday 13 April (→ pseudoestrogens)

Environmental Biology (ECOL 206)
University of Arizona, spring 2007

Kevin Bonine, Ph.D.
Anna Tyler, Graduate TA

http://eebweb.arizona.edu/courses/Ecol206/206_Page2007.html

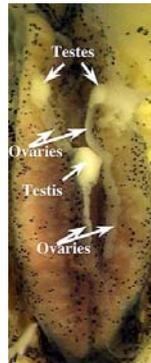
Pesticides and Pseudoestrogens

Fertility today, gone tomorrow

(Most Slide Text Thanks to Jessie Cable, EEB, 2004)



Atrazine, a top selling weed killer in the United States and the world, has been found to dramatically affect the sexual development of male and female frogs. In a study by Tyrone Hayes, an environmental biologist at the University of California, Berkeley, he found that atrazine could cause such effects in frogs. Hayes, who adds that the pesticide has been used for 40 years in over 80 countries.



Abnormal gonads in a male *Xenopus* frog, the result of exposure to the herbicide atrazine. The frog has become a hermaphrodite, that is, it has both male (testes) and female (ovaries) sex organs. Credit: Tyrone Hayes/UC Berkeley, courtesy PNAS

308 PART TWO Environmental Problems and the Search for Solutions

Science Behind the Story

Pesticides and Child Development in Mexico's Yaqui Valley

With spindly arms and big round eyes, one set of pictures shows the same of stick figures drawn by young children everywhere. Next to them is another group of drawings, neatly disconnected squiggles and lines, resembling nothing. Both sets of pictures are intended to depict people. The main difference identified between the two groups of young artists long before pesticide exposure.

Children's drawings are not a typical tool of toxicology, but Elizabeth Guilleter, an anthropologist, wanted to try new methods. Guilleter was interested in the effects of pesticides on children. She devised tests to measure childhood development based on techniques from anthropology and medicine. Searching for a study site, Guilleter found the Yaqui Valley region of northwestern Mexico.

The Yaqui Valley is farming country, worked for generations by the indigenous group that grows the region's main crop. Synthetic pesticides arrived in the area in the 1940s. Some Yaqui embraced the agricultural innovations, spraying their farms in the valley to increase their yields. Yaqui farmers in the surrounding foothills, however, generally chose to bypass the chemicals and to continue following more traditional farming practices. Although differing in farming techniques, Yaqui in the valley and foothills continued to share the same culture, diet, education system, income levels, and family structure.

At the time of the study, in 1984, valley farmers planted crops twice a year, applying pesticides up to 43 times from planting to harvest. A previous study conducted in the valley in 1996, focusing on areas with the largest farms, had indicated high levels of multiple pesticides.

Elizabeth Guilleter's study in Mexico's Yaqui Valley offers a startling example of exposure to pesticides and child development. Young children from foothill areas where pesticides were not commonly used drew recognizable figures of people. Children the same age from valley areas where pesticides were used heavily in industrial agriculture could draw only scribbles when asked to draw people. Adapted from Elizabeth A. Guilleter, et al., *Environmental Health Perspectives*, 1996.

Drawings by children in the foothills

Drawings by children in the valley

8-year-olds

5-year-olds

8-year-olds

5-year-olds

Brennan and Withgott 2005

Pesticides



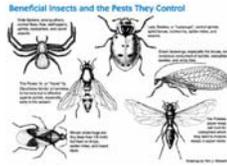
- What are they?
 - “pest” = competes with us, destroys what we have/need, spreads disease
 - “-icide” = kill
- What is the ideal pesticide?
 - Target specific
 - Breaks down into harmless compounds
 - Genetic resistance doesn't occur



Pesticides – the good, the bad, the ugly

- GOOD
 - Save human life against malaria, plague, typhus
 - Increase food supply, lower costs
 - Increase farmer profit
 - Fast acting, long shelf life, easily shipped
 - Newer pesticides are safer
 - Used at lower rates than before
- BAD
 - Accelerate genetic resistance of pests
 - Broad spectrum – kills predators of pests
 - Do not stay put – little of what is applied reaches the target
 - Harm wildlife and human health

Pesticides



- Alternatives
 - Change cultivation practices
 - Crop rotation, change planting time, polyculture
 - Genetic engineering
 - Pest-proof the plants
 - Biological pest control
 - Bacteria, viruses, parasites, natural predators

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Pesticides

- Alternatives
 - Insect birth control
 - Sterilize males
 - Pheromones
 - Luring into traps
 - Irradiation



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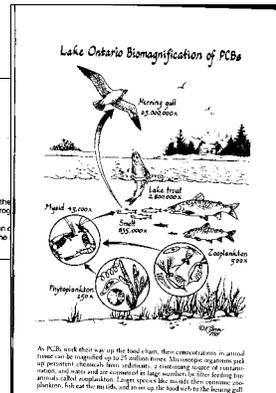
Pesticides

- Alternatives
 - INTEGRATED PEST MANAGEMENT
 - Evaluation of pests and crops on an individual basis (NOT a band aid for every situation)
 - Includes combination of methods (cultivation, biological, chemical)
 - Specifically timed
 - Pollution prevention
 - Successful in many countries



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Pesticides: the ugly



http://en.wikipedia.org/wiki/Polychlorinated_biphenyl

Pseudoestrogens



- Endocrine disruptors
- Synthetic compounds that interfere with endocrine function
- Mimic hormones
- Can block receptors, attach to receptors to induce response
- Ultimately: feminization of males

Dr. Shane Snyder
R&D Project Manager
Southern Nevada Water
Authority

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Pseudoestrogens: Endocrine Disruptors

- Where are they found?
 - Pesticides
 - Natural and synthetic hormones
 - Plant constituents
 - Plastics
 - Detergents
 - Environmental pollutants
 - Sewage effluent



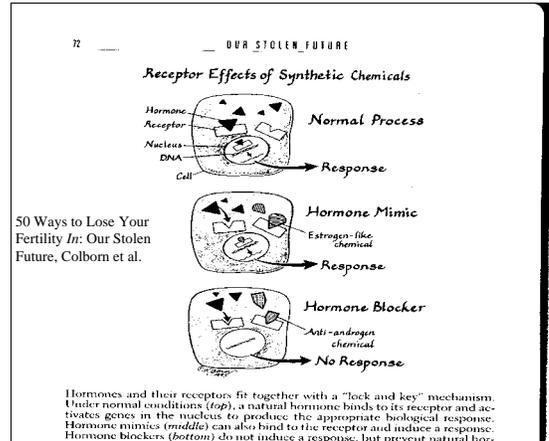
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Some scientists say estrogen mimics could also explain the growing incidence of **breast cancer** and **perhaps prostate cancer** as well. The putative endocrine disrupters have **structures akin to real hormones**, and seem to include:



- breakdown products of several **pesticides** that are now banned, such as DDT
- **dioxins**, a group of toxic chemical byproducts from paper production and incineration, and
- **PCBs**, a persistent group of chemicals still found in electrical equipment that pollutes lake and stream sediments in many industrial regions http://en.wikipedia.org/wiki/Polychlorinated_biphenyl
- chemicals found in the epoxy lining of "tin" cans, plastics used for storing food, dental sealants, and Vinclozolin, a fungicide used on fruit.

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Pseudoestrogens: Endocrine Disruptors

Males	Female	Wildlife
Decreased sperm counts or quality	breast cancer	infertility
testicular cancer	cardiovascular effects	sex-changes (imposex)
undescended testes		developmental abnormalities
malformed penis		thyroid dysfunction
intelligence deficit	intelligence deficit	behavioural abnormalities
neurological problems	neurological problems	dysfunctional immune system

Source: IEH, WWF

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Diethylstilbestrol (DES)

Between the 1940s and 1970s, doctors prescribed an artificial estrogen named diethylstilbestrol, or DES, to prevent miscarriages in millions of pregnant women.

Only long after the fact did doctors find that DES had **caused** a rare form of cervical **cancer** in some of their daughters.



Detail from an ad for Grant Chemical Company's DES product, circa 1955. Courtesy Independent Television Service (ITVS), 1997.

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Hypospadias occurs in about **4 of 1000 male** births. There is some family risk, about a 20% chance of finding it in another family member.



Hypospadias is most **commonly caused by failure of adequate or continuous hormone production during the development of a fetus** from about 10 weeks into gestation. It can be detected by ultrasound or specialist inspection as often the foreskin will be malformed.

<http://www.hypospadiashelp.fsnet.co.uk/What%20is%20hypospadias.html>

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Pseudoestrogens



- **The Omens: reproductive failure in wildlife**
- **Bald Eagles** - Florida 1952
 - Not interested in mating
- **Otters** - England late 1950's
 - Dieldrin pesticide suspected
- **Mink** - Lake Michigan mid-1960's
 - PCB contaminated food (fish)



From: Our Stolen Future
Colborn et al.

Pseudoestrogens



- Herring Gulls – Lake Ontario 1970
 - Deformed/dead chicks, possible Dioxin contamination
- Western Gulls – Channel Islands, CA 1970's
 - Females nesting together, thin shells
- Alligators – Lake Apopka, FL 1980's
 - Low hatching rate, feminization of males



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Pseudoestrogens



- Seals – Northern Europe 1988
 - 18,000 dead, pollution?, disease?
- Striped Dolphins – Mediterranean Sea 1990's
 - >1,100 dead, PCB
- Human sperm – Copenhagen 1992
 - Abnormalities, global drop in sperm count
 - Increase in testicular cancer
 - Genital abnormalities



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BioMagnification
BioAccumulation
PCBs

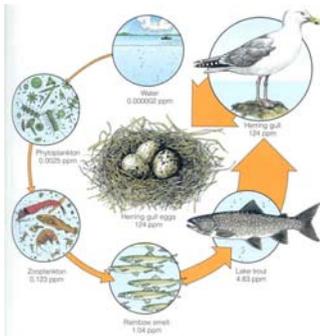


Figure 14-22 Biological magnification of PCBs (polychlorinated biphenyls) in an aquatic food chain in the Great Lakes. Most of the 209 different PCBs are (1) insoluble in water, (2) soluble in fat, and (3) resistant to biological and chemical degradation—properties that result in their accumulation in the tissues of organisms and their biological amplification in food chains and webs. Although the long-term health effects on animals exposed to low levels of PCBs are unclear, high doses of PCBs consistently animals produce (1) liver and kidney damage, (2) gastric disorders, (3) birth defects, (4) skin lesions, (5) hormonal changes, (6) smaller pups size, and (7) tumors. Birds in Taiwan exposed to PCBs while in their mothers' wombs developed abnormally sized penises. In the United States, manufacture and use of PCBs have been banned since 1979. Unlike them, millions of metric tons of these long-lived chemicals were released into the environment, and many of them are still found in bottom sediments of lakes, streams, and oceans.

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Miller, 2003 (other)

Pseudoestrogens

- Big Picture of Problems?
 - In each scenario
 - Defective sex organs
 - Loss of fertility
 - Abnormal mating behavior
 - Death of young
 - Huge die-offs



Rachel Carson, *Silent Spring*
Theo Colborn et al., *Our Stolen Future*

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What to do about it?

END

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