Pesticides and Pseudoestrogens

Fertility today, gone tomorrow

(Word Slide Text: Thanks to Jessie Cable, EEB, 2004)

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

Atrazine, a top selling weed killer in the United States and the world, has been found to dramatically affect the sexual development of male frogs, turning them into hermaphrodites; creatures with both male and female organs at concentrations 30 times lower than those deemed safe by the U.S. Environmental Protection Agency (EPA).

“What struck us as unbelievable was that atrazine could cause such dramatic effects at such low levels,” says Tyrone Hayes, an associate professor of integrative biology at the University of California, Berkeley, who led the frog study.

Leopard frogs, native to the United States, living near atrazine-contaminated ponds in the Midwest show the same abnormalities as the atrazine-exposed animals in Tyrone Hayes’ lab.

Atrazine can be as high as 21 ppb in groundwater, 102 ppb in river basins in agricultural areas, and 224 ppb in streams in the Midwest. There is virtually no atrazine-free environment, says Hayes, who adds that the herbicide has been used for 40 years in over 80 countries.

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

Pesticides

• Alternatives
  – Insect birth control
    • Sterilize males
  – Pheromones
    • Luring into traps
  – Irradiation

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

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

Pseudoestrogens: Endocrine Disruptors

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

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.

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.

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

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

What to do about it?