Wednesday 22 March 2006, 27th class meeting

Environmental Biology (ECOL 206)
U. Arizona, spring 2006
Kevin Bonine, Ph.D.
Alice Boyle, Kristen Potter, Graduate TAs

1. TODAY: Food Production, Pesticides, Pseudoestrogens

2. Lecture schedule updates on your website

3. 206 Lab Website for handouts and assignments
   Lab this week – van to Tumamoc Hill

   -next installment of Group Project due Mon 27 March

   -Lab Notebooks, Exams

Levidow 1999 (Regulating Bt Maize in the U.S. and Europe)

   Bt = Bacillus thuringiensis bacterium
   (contains gene that codes for protein toxic to some insects)
   Genetically Modified Crops (cotton, potatoes, maize)

   Costs and Benefits
   - Yields and Fewer Agrochemicals
   - Agriculture, Environment (Monarchs), Humans
   - Resistance, Arms Race, ‘Genetic Treadmill’
   - Herbicide and Ampicillin markers

   IRM = Insect Resistance Management
   “High-Dose/Refuge” Strategy
   3-5 year time window

   Solutions
   - Crop Rotation, IPM etc.

   EPA, EU
Monarch Butterfly
*Danaus plexippus*

-Lepidoptera (order)
-Papilionoidea
-Danaidae
Milkweed Butterflies

Migration - 2000 miles
Canada <-> Mexico
(Hawaii, Australia)
Millions
Multiple Generations!
Solomon et al. 1993

Mullerian Mimicry

Milkweed (foliage, flowers, buds, fluid)
Poisonous cardenolides

Bacillus thuringiensis
Bt corn pollen --> milkweed
Domesticated Cattle

- Soil Erosion (vs. soil formation)
- Desertification

-Tropical Rainforest Depletion
- Global Warming

- Nonnative grasses, weeds, grains
- Old --> New World
- Ecological Change
Figure 9-24 Components of more sustainable, low-throughput agriculture. Miller, 2003 (= figure 8-18 in 2005)

**Toward Solutions**

**Food Production**

- Monoculture
- Polyvarietal
- Interplanting/Intercropping
  - >1 crop
- Polyculture
  - diff't times
- Agroforestry
  - with trees

Figure 9-13 Locations of the world's principal types of food production. Excluding Antarctica and Greenland, agricultural systems cover almost one-third of the earth's land surface and account for an annual output of food worth more than $1.3 trillion. Miller, 2003 (= figure 8-1 in 2005)
Local Ideas:

Tucson CSA (community supported agriculture)
food from Organic farm in Glendale

Terra Cycle Farms (located near Rio Rico)?

Tucson COOP (4th Ave.)

17th Street Market

Farmers Markets

CONSUMER DRIVEN CHANGE!

Ending Hunger and Disease (Miller p. 155):

- Immunizations
- Breast Feeding
- Sugar+Salt+Water to fight dehydration from diarrhea
- Vitamin A 2x/year to prevent blindness
- Family planning services
- Educate women
  nutrition, sterilize drinking water, child care

Cost: $5-10/child/year
### What are humans dying from?

<table>
<thead>
<tr>
<th>Cause of Death</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco use</td>
<td>440,000</td>
</tr>
<tr>
<td>Alcohol use</td>
<td>150,000</td>
</tr>
<tr>
<td>Accidents</td>
<td>93,600 (41,800 auto)</td>
</tr>
<tr>
<td>Pneumonia and Influenza</td>
<td>67,000</td>
</tr>
<tr>
<td>Suicides</td>
<td>28,300</td>
</tr>
<tr>
<td>Homicides</td>
<td>16,100</td>
</tr>
<tr>
<td>Hard drug use</td>
<td>15,600</td>
</tr>
<tr>
<td>AIDS</td>
<td>14,400</td>
</tr>
</tbody>
</table>

Annual deaths in the United States from tobacco use and other causes. Smoking is by far the nation’s leading cause of preventable death, causing more premature deaths each year than all the other categories in this figure combined. (Data from National Center for Health Statistics)

**Chapter 11, Risk and Toxins**

Ch10p220 (see 11-2 in Miller 2005)
What are humans dying from?

Chapter 11, Risk and Toxins

Miller, 2003 (see figure 11-11 in Miller 2005)

Figure 10-9 Number of deaths per year in the world from various causes. Numbers in parentheses give these deaths in terms of the number of fully loaded jumbo (400-passenger) jets crashing accidentally every day of the year with no survivors.

Shortening Lifespan in the U.S.

Miller, 2003 (see figure 11-12 in Miller 2005)
Thalidomide is a drug that was introduced on to the market on October 1, 1957 in West Germany. Thalidomide soon became a drug prescribed to pregnant women to combat symptoms associated with morning sickness. When taken during the first trimester of pregnancy, Thalidomide prevented the proper growth of the foetus resulting in horrific birth defects in thousands of children around the world. These children were born in the late 1950’s and early 1960’s and became known as "Thalidomide babies".

Of the 10,000 babies with "seal-like" limbs, only seventeen were born in the United States. The number was low because Dr. Frances Kelsey blocked the sale of the drug in this country.

Precautionary Principle
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 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 and Pseudoestrogens

Fertility today, gone tomorrow

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

Pseudoestrogens: Endocrine Disruptors

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

Table 2 POSSIBLE EFFECTS OF EDCS

<table>
<thead>
<tr>
<th>Males</th>
<th>Female</th>
<th>Wildlife</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decreased sperm counts or quality</td>
<td>breast cancer effects</td>
<td>infertility</td>
</tr>
<tr>
<td>testicular cancer</td>
<td></td>
<td>sex-changes</td>
</tr>
<tr>
<td>undescended testes</td>
<td>cardiovascular effects</td>
<td>(imposex)</td>
</tr>
<tr>
<td>malformed penis</td>
<td></td>
<td>developmental abnormalities</td>
</tr>
<tr>
<td>intelligence deficit</td>
<td>intelligence deficit</td>
<td>thyroid dysfunction</td>
</tr>
<tr>
<td>neurological problems</td>
<td>neurological problems</td>
<td>behavioural abnormalities</td>
</tr>
<tr>
<td>Source: IEH, WWF</td>
<td></td>
<td>dysfunctional immune system</td>
</tr>
</tbody>
</table>

Hormones and their receptors fit together with a “lock and key” mechanism. Under normal conditions (top), a natural hormone binds to its receptor and activates genes in the nucleus to produce the appropriate biological response. Hormone mimics (middle) can also bind to the receptor and induce a response. Hormone blockers (bottom) do not induce a response, but prevent natural hor-
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 foetus 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

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
**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*