Ch. 17 Notes: Pests and Pest Control

I. The Need for Pest Control

A. Defining **pest**

1) various definitions

a) an organism that is *noxious, destructive, or tiresome*

b) an annoying thing; a nuisance

c) a pestilence

d) any organism detrimental to humans

e) an *injurious plant or animal*, especially one harmful to humans

2) categories

a) **agricultural pests** *(plant pests)—organisms which feed on crops or ornamental plants*

- *vertebrate pests* such as **scale insects,** *which extract liquids from plants*
- *weed pests:* annual grasses, perennial grasses, annual broadleaf, perennial broadleaf
- **weeds** compete with other plants for resources
- *invertebrate or insect/arthropod pests*: aphid, beetle, weevil, wireworm, cutworm, armyworm, moth, caterpillar, white fly, mealy bug, whitehopper, grasshopper, cricket, mite, maggot, thrip
- *microbial pests or pathogens*: nematode, fungi, viruses

b) *arachnids*: spiders, ticks, flour/grain/cheese mites

c) *crustaceans*: woodlice / pill bugs, flour / grain / cheese mites

d) *pathogens*: bacteria, viruses, fungi

e) *rodents*: house mouse, common rat, black rat

f) insects

Hide Beetles
Cluster Flies
American Cockroach
Angoumois Grain Moth
Black Ant
Australian Cockroach
Australian Spider Beetle
Biscuit / Drugstore Beetle
Bluebottle
Booklice
Brown House Moth
Brown Tail Moth
Bed Bugs
Carpenter Ants
Tropical Warehouse Moth
Common Clothes Moth
Common Cricket
Dermestid Beetles
Earwigs
Warehouse / Cocoa / Tobacco Moth
Filter Flies
Human Flea
Cat Flea
Dog Flea
Tropical Rat Flea
Bird Flea
Flour Beetles
Fruit Flies
German Cockroach
Horse Flies
Common House Fly
Lesser House Fly
Indian Meal Moth
Mill Moth
Mosquitoes
Oriental Cockroach
Pharaohs Ants
Sawtooth Grain Beetle
Silverfish
Small Ermine Moth
Brown Banded Cockroach
Mealworm Beetle
Termites
Tobacco / Cigarette Beetle
Wasps
White Shouldered House Moth
Woodworm / Furniture Beetle
Smoky Brown Cockroach
Carpet Beetle
Grain Weevil
Rice Weevil
Rust Red Grain Beetle
Khapra Beetle
Dried Bean Beetle
Lesser Grain Borer
Larger Grain Borer

B. Importance of pest control

1) general types

a) **herbicide**—chemical that kills *weeds*

b) *insecticide*—chemical that kills *insect pests*

c) **pesticide**—chemical that kills *pests in general (insects/animals)*

d) *fungicide*—chemical that kills *pathogens*

e) *rodenticide*—chemical that kills *rodents*

2) two parts to these chemicals

a) *active ingredients*—chemicals that kill the targeted pests

b) *formulants*—chemicals acting as emulsifiers, dilutants, or solvents (sometimes more dangerous than the active ingredients)

3) other characteristics
    a) **broad spectrum**—effective against a *wide variety* of pests
    b) **persistence—**the ability of a chemical to last; to not break down

C. Different philosophies of pest control
1) **chemical treatment—***use of various chemicals to eliminate or reduce pest presence and effects*
    a) short-term
    b) risk of environmental damage
    c) risk of damage to beneficial organisms
2) **ecological control**

focuses on protection from damage, not elimination of the pest

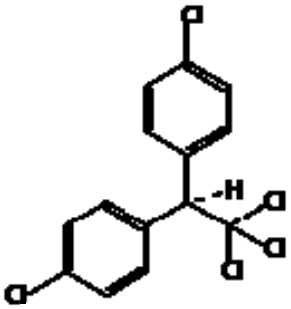
3) **IPM—Integrated Pest Management**
    a) *combination of chemical and ecological approaches*
    b) uses sustainable methods
    c) long-term solutions
    d) minimal environmental impact

"A weed is a plant whose virtues have not yet been discovered." - Ralph Waldo Emerson

II. Promises and Problems of the Chemical Approach

added info from from http://www.greenventure.ca/hcpi.asp?ID=83

A. development of chemical pesticides and their successes
2) **first-generation pesticides**
    a) (1400s +) *chemical*: contained *Hg, As, Pb*
    b) (1800s +) *botanical*: contained *natural plant extracts* such as nicotine (from tobacco leaves), pyrethrum (from chrysanthemum flowers) and rotenone (from the root of the derris plant)
    c) pests built up *resistance*
3) **second-generation pesticides**
    a) over 1600 different chemicals
    b) famous example: *DDT*



- $C_{14}H_9Cl_5$
- dichloro-diphenyl trichloroethane (1,1,1-trichloro-2,2-bis-(p-chlorophenyl) ethane)
- first prepared in 1873; rediscovered in 1938 by Paul Muller (he subsequently awarded the Nobel Prize for it in 1948!)
- water insoluble, lipid soluble (can't wash it away), so it stays in the environment and in organisms
- it is **broad spectrum** and **persistent**
- *accumulation*—the buildup of DDT in the body; continues until saturation is reached

from http://www.chem.ox.ac.uk/it_lectures/chemistry/mom/ddt/ddt.html

"The use of DDT increased enormously on a worldwide basis after World War II, primarily because of its effectiveness against the mosquito that spreads malaria and lice that carry typhus. The World Health Organization estimates that during the period of its use approximately 25 million lives were saved. DDT seemed to be the ideal insecticide—it is cheap and of relatively low toxicity to mammals… However, *problems related to extensive use of DDT began to appear in the late 1940s*. Many species of insects developed resistance to DDT, and DDT was also discovered to have a high toxicity toward fish.

The chemical stability of DDT and its fat solubility compounded the problem. DDT is not metabolized very rapidly by animals; instead, it is deposited and stored in the fatty tissues. *The biological half-life of DDT is about eight years; that is, it takes about eight years for an animal to metabolize half of the amount it assimilates. If ingestion continues at a steady rate, DDT builds up within the animal over time*."

The use of DDT was banned in the United States in 1973, although it is still in use in some other parts of the world. *The buildup of DDT in natural waters is a reverisble process:* the EPA reported a 90% reduction of DDT in Lake Michigan fish by 1978 as a result of the ban."
from http://www.ers.usda.gov/publications/ah717/ah717b.pdf

4) focusing on crops
   a) field crops: corn, cotton, soybeans, wheat, potatoes, sorghum, peanuts, rice
   b)other crops: fruit, non-potato vegetables

Herbicides: widely used for corn, soybeans, and other crops
Atrazine, Metolachlor, Cyanazine, Acetochlor, Trifuralin, Pendimethalin, Alachlor, Glyphosate, Dicamba, EPTC, 2,4-D

Insecticides (organophosphates): widely used for cotton and other crops
Chlorpyriphos, Terbufos, Methyl-parathion

Fungicides: widely used for potatoes and other crops

1) aliphatic nitrogen fungicides
2) amide fungicides
3) antibiotic fungicides
4) aromatic fungicides
5) benzimidazole fungicides
6) benzimidazole precursor fungicides
7) benzothiazole fungicides
8) bridged diphenyl fungicides
9) carbamate fungicides
10) conazole fungicides
11) copper fungicides
12) dicarboximide fungicides
13) dinitrophenol fungicides
14) dithiocarbamate fungicides
15) imidazole fungicides
16) inorganic fungicides
17) mercury fungicides
18) morpholine fungicides
19) organophosphorus fungicides
20) organotin fungicides
21) oxathiin fungicides
22) oxazole fungicides
23) polysulfide fungicides
24) pyrazole fungicides
25) pyridine fungicides
26) pyrimidine fungicides
27) pyrrole fungicides
28) quinoline fungicides
29) quinone fungicides
30) quinoxaline fungicides
31) thiazole fungicides
32) thiocarbamate fungicides
33) thiophene fungicides
34) triazine fungicides
35) triazole fungicides
36) urea fungicides
37) unclassified fungicides

B. problems from chemical pesticide use
   1) development of *pest resistance*
      a) pesticides are made more potent
      b) *the most resilient individuals survive and reproduce*
      c) the pest population becomes more resistant
      d) *individuals may develop resistance to related chemicals even if they are not directly exposed to them*
      e) pesticides are made more potent again—the cycle continues…
   2) resurgences and secondary-pest outbreaks: the "**pesticide treadmill**"
      a) **resurgence**—*a population exploding after being nearly wiped out*
      b) **secondary post-outbreak**—*small populations of other organisms explode as well, creating new threats*
   3) examples of *human health effects* of pesticide external exposure or ingestion

lymphoma, breast cancer
dermatitis
neurological disorders
birth defects
male sterility (banned)
possible estrogen-like effects
headaches
dizziness
nausea
vomiting
mild irritations of skin and nose
loss of appetite
respiratory inflammations
organ dysfunction
diarrhea
swelling
nervousness
hallucinations
convulsions
blue or yellow skin color
tremors
shock
sweating
excessive thirst
skin rashes
lack of coordination
excessive salivation
eye irritant

from http://www.greenventure.ca/hcpi.asp?ID=83

SUMMARY OF DISADVANTAGES OF PESTICIDE USE

1) *"threatens human health through direct exposure and exposure to pesticide residues in food and water*
2) *creates insects and weeds that are genetically resistant to pesticides, leading to more spraying and more toxic formulations (pesticide treadmill)*
3) *destroys beneficial organisms, such as earthworms, bees and natural predators of the pests*
4) *harms wildlife, producing hormonal and genetic defects*
5) *contaminates groundwater, including drinking wells, streams and lakes*
6) *some pesticides accumulate and become amplified in the food chain (persistent organic pollutants)*
7) *economic costs: homeowners spend an average of $300 per year on pesticide products or services*

4) examples of *environmental effects* of pesticides

with additional info from http://extoxnet.orst.edu/tibs/ecologic.htm

- "*decline of forests*, due to air pollution and acid deposition
- *loss of fish production in a stream*, due to death of invertebrates from copper pollution
- *loss of timber growth*, due to nutrient losses caused by mercury poisoning of microbes and soil insects
- *decline and shift in age* of eagle and hawk (and other top *predator) populations*, due to the effects of DDT in their food supply on egg survival
- *losses of numbers of species (diversity)*
- *loss of commercially valuable salmon and endangered species* (bald eagle, osprey) from forest applications of DDT"
- water contamination
- cancer in animals
- death of pollinating insects and other beneficial insects
- thinning of egg shells, decreasing healthy hatching rate
  * DDE, a product of the partial breakdown of DDT, causes this
- **bioaccumulation**—*increase in concentration of a pollutant from the environment to the first organism in a food chain*
- **biomagnification**—*increase in concentration of a pollutant from one link in a food chain to another*
  ** pollutant must be long-lived, mobile, soluble in fats, and biologically active*

from http://www.nrdc.org/health/pesticides/hcarson.asp *Silent Spring* by Rachel Carson 1962

"*Silent Spring*… meticulously described how DDT entered the food chain and accumulated in the fatty tissues of animals, including human beings, and caused cancer and genetic damage. A single application on a crop, [Carson] wrote, killed insects for weeks and months, and not only the targeted insects but countless more, and remained toxic in the environment even after it was diluted by rainwater. Carson concluded that DDT and other pesticides had irrevocably harmed birds and animals and had contaminated the entire world food supply."

C. *nonpersistent pesticides*—are they the answer?
   a) *they break down into nontoxic components* within weeks of application
   b) *pesticide impact is a function of persistence, toxicity, dosage, and application location*
   c) nonpersistent pesticides can still do damage to the environment
   d) all insects can be affected, beneficial as well as pests
   e) **resurgence** and **post-secondary outbreaks** are still possible