

Basic Toxicology

- ∞ Acute vs. chronic exposure
- ∞ lethal/ sublethal/ cumulative
- ∞ LD₅₀, EC₅₀
- ∞ Additive versus multiplicative effects
- ∞ Effects of other factors on toxins
- ∞ Bioconcentration- moving into organisms
- ∞ Bioaccumulation- accumulation from food (lipid solubility)
- ∞ Biomagnification- increases as you move up the food web

Lethal Doses of Pesticides

- ∞ Ecotoxicology Bioassay
- ∞ LD50
- ∞ <100% mortality leads to pesticide resistance
 - pesticide resistance is evolution in action!
 - As of 1993, 520 spp. of insects and mites, 150 plant diseases, and 113 weed spp. were tolerant of pesticides
- ∞ Pesticide treadmill
 - pesticide resistance leads to the use of different, and often more toxic, pesticides just to keep up with pest loads
 - analogous to farmer running hard just to maintain position on a treadmill
- ∞ what happens if the pest becomes resistant, but its predators do not?

evidence so far:

- ∞ declining populations occur in areas w/ granitic soils (Rocky Mountain National Park/St. Vrain)
- ∞ growing populations where there is access to road salts (Georgetown)
- ∞ lambs die before 1 yo of white muscle disease
 - a common cause of this is micronutrient deficiency, particularly selenium
- ∞ St. Vrain sheep had very low levels of copper and selenium, especially a radio-collared one found within 6 hours of death
- ∞ populations recovering after their diet was supplemented with a mineral block containing micronutrients

Bioassessment

- ∞ Use native assemblages to indicate chronic toxicity
- ∞ Useful because long term effects are difficult to document and acute episodes may be hard to sample
- ∞ EPT index is one common tool for assessment
- ∞ Index of Biotic Integrity (Karr) assesses habitats and fish species

Effects of Acid Rain

- ∞ Comes from the burning of coal and NO_x
- ∞ Acidified ground water leaches larger amounts of toxic metals
- ∞ Acidifies lakes, especially ones with low alkalinity
- ∞ Most fish stop reproducing successfully at pH 5
- ∞ Toxic metals are leached from rock and soil
- ∞ Bones dissolve; Gills destroyed
- ∞ CaCO₃ precipitation hindered
- ∞ Affects sensitive algae and invertebrates too
- ∞ Acid rain may be becoming more of a problem despite improved technology and cleaner fuels because the buffering capacity of the atmosphere has been depleted
- ∞ Half of the high altitude lakes in Adirondacks lack fish

Acid Mine Drainage

- Acid mine drainage, sometimes referred to as AMD, results when the mineral pyrite (FeS₂) is exposed to air and water, resulting in the formation of sulfuric acid and iron hydroxide
- $4\text{FeS}_2 + 15\text{O}_2 + 14\text{H}_2\text{O} \rightarrow 2\text{Fe}_2(\text{SO}_4)_3 + 28\text{H}^+ + 8\text{S}^{2-}$
- Mediated by *Thiobacillus ferrooxidans*
- Creates problems of low pH and dissolved metals
- kills aquatic organisms

Acid Mine Drainage

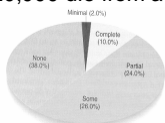
- When AMD enters the stream, pH is increased again, and dissolved metals ppt. out as metal (Fe and Al) hydroxides (yellow boy), causing plaques that physically disrupt insects

Organic Pollutants

- ✍ More than 10,000 created and used by humans, several hundred new each year
- ✍ Petroleum products. Urban runoff. A 20hp 2 stroke engine can make 11,000 m³ of water undrinkable in one hour
- ✍ Chlorinated hydrocarbons concentrate in sediments
- ✍ Atrazine common in agricultural areas. Poisons algae and macrophytes, may poison frogs

Pesticides and People

- ✍ Every year, more than 500,000 metric tons of active ingredients used in USA alone
- ✍ Homeowners take scorched earth approach
- ✍ 600 active ingredients used in USA
- ✍ 1,200 presumably inactive ingredients
- ✍ 1 million people (worldwide) receive acute exposure annually
- ✍ 20,000 die from acute exposure



Extent of AMD problem

- Although estimates of the amount of AMD vary, the scope of the problem is huge.
- According to the General Accounting Office, thousands of abandoned hard rock mines exist on Federal lands, a subset of which constitute physical safety or environmental degradation hazards. 50-billion tons of mine waste (enough to fill 2,400 football fields each one mile high) have been generated, 14,400 sites need extensive work to prevent surface-water contamination, and 5,000 miles of streams are affected by acid drainage.
- The Mineral Policy Center, an environmental research and advocacy group, estimates 557,650 AML sites in 32 states.
- The U.S. Environmental Protection Agency estimates over 200,000 sites (USEPA, 1996). According to the General Accounting Office (1996),

Biological Effects of Pesticides

- ✍ Lethal effects: the “purpose” of pesticides
- ✍ Sublethal effects
 - birth defects
 - disease
 - weakened immune systems
- ✍ Biological accumulation
 - repeated exposure to pollutant causes an increase with age
- ✍ Biological magnification
 - when pollutants meet food webs
 - lipophilic, persistent chemical pollutants increase as you move up the food web

Toxins in Food Webs: Case of DDT

- ✍ “Ideal” pesticide - properties discovered in 1939 by Paul Muller
 - cheap, stable, soluble in diesel fuel, highly toxic to insects, non-toxic to people
 - Nobel Prize in 1948
- ✍ Developed prior to WWII, saved 1,000,000’s lives
- ✍ WIDESPREAD use after war, sprayed everywhere! 50 million tons sprayed by 1950.
- ✍ banned in USA in 1972, but still manufactured here
- ✍ Found in Inuit breast milk.