**Predator-prey arms races**

- Selection for efficient foraging
- Improvement in prey defences
- Adaptation in a predator
- Adaptation in prey

**Why is prey ahead in the arms race?**

1. Life vs. dinner principle
2. Generation time
3. Predators often have several prey

**Ladybird Beetles**

Predaceous adults and larvae

**Cottony Cushion Scale,**
*Icerya purchasi Maskell* (Homoptera: Margarodidae)

- Edge of female scale
- Scale "crawler"

**Biological Control with Ladybird Beetles**

- CCS accidentally imported into CA
- Major pest on citrus
- Vedalia beetle, *Rodolia cardinalis,* imported from Australia by USDA in late-1800’s
- Predation has kept pest in check

**Multicolored Asian Lady Beetle,**
*Harmonia axyridis*

- Released as a biological control agent
- Established in Louisiana in 1988
- Spread into eastern and northern US
- Predator on soybean aphid
Insect Defenses

- What are they?

Crypsis

- Very common form of insect concealment
- Tropics and nocturnally active insects
- Low energy cost to the insect

Behavioral defenses

- Crypsis
  - Behaviors and habitat selection match defense strategy
- Thanatosis
  - Feigning death
  - Used by beetles
- Flash of color or startle display

Warning Colors

- Yellowjacket and other Hymenoptera
- Many Lepidoptera
- What others?

Chemical Defenses

- Energetically expensive
- High apparency
- Aposematic coloration
- Palatable, with active chemical defense

Mimicry

- Evolutionary deception
- Mimic needs a Model
Warning Colors

- What flies mimic bees?
- What butterflies mimic others?

Unpalatable model
- Danaus chrysippus
  F. Nymphalidae
  sF. Danainae

Batesian mimic - mimic is palatable
- Hypolimnas misippus
  F. Nymphalidae
  sF. Danainae

Müllerian mimicry - mimic is unpalatable
- Hypolimnas deceptor
  F. Nymphalidae
- Acraea encedon
  F. Nymphalidae
  sF. Acraeinae

Monarch butterfly Batesian mimic

Mechanical Defenses
- Morphological structures
- Construction of retreats
- Secretion of waxes, powders
- Autotomy
  - Shedding of limbs

O. Diptera, F. Syrphidae (hover flies)

Escape in space or time
- Soil arthropods
- Borers, miners
- Dispersal