Last lecture:
Evolutionary processes
• Selection – disruptive, stabilizing
  – Directional selection -? genome signatures

Today
• Coevolution - mutualistic
  – antagonistic => freq dependent selection

SEX...
• Why have sex? - cost of sex, alternatives (pathenogenesis), proposed advantages

Sexual selection (pp 295-297)
• Mating systems
• Intra vs intersexual selection
• Female preference: Direct benefits (resources) vs indirect (good genes)
Coevolution (pp 428-9)

species 1 \(\xrightarrow{\text{selection}}\) species 2

**Mutualistic**
- Symbioses, mutualisms; eg.
  - Yucca moths \(\leftrightarrow\) Yucca

**Antagonistic**
- Host \(\leftrightarrow\) pathogen
- Predator \(\leftrightarrow\) prey

Yucca moth

Garter snake and poisonous pacific newt
Why have sex?

Alternatives - asexual:
- parthenogenesis in animals (pp. 639);
- apomixis in plants (pp. 568-569)

Why not sex?
Inefficient, risky, breaks up good gene combinations

Daphnia - asexual in good times, sexual in harsh conditions

Apomictic dandelion

Parthenogenetic whiptail lizards
Hypotheses for advantages of sex

1. Reduces accumulation of disadvantageous mutations ("Mueller’s ratchet")
2. Brings together independent mutations that together increase fitness
3. Generates genetically diverse offspring
   - Advantage in variable environment
   - Increases ability to resist pathogens & parasites (coevol “arms race” => Red Queen hypothesis

Long-term and only if sexual populations are large (weak drift)
Sex and genetic variation

Sexual reproduction produces genetically variable offspring through:

- Random mating
- Independent assortment across loci
- Recombination between loci
- See pp. 138-139
Evolution & consequences of parthenogenesis in an Australian gecko (*Heteronotia binoei*)

Rapid spread, but more parasites

Sexual population

Parthenogenetic population

Mite load
The things males do....

And youtube: moonwalk bird” and “dancing bird of paradise”....
Intra v inter sexual selection

Competition and mating success in male elephant seals

Female choice: manipulation of tail-length in male widowbirds

A few males dominate reproduction

Futuyma, Evolution, 1st Ed.

See also Fig. 15.9
Sperm competition & cooperation in *Peromyscus* mice (Fisher & Hoekstra 2010 Nature 463:801)

- Sperm in groups swim faster => fertilization advantage
- In species with multiple mating (*P. maniculatus*) sperm aggregate with themselves vs sperm from relatives
- This is not seen in monogamous species (*P. polionotus*)
Benefits of multiple mating:
sperm-competition winner =>
increased survival of offspring
(Fisher et al. 2006 Nature 444: 89-92)

Antechinus -
marsupial “mouse”

Survival in the wild is estimated from the number of offspring that were captured at weaning. We released 100 offspring from 17 monandrous females and 139 offspring from 19 polyandrous females into the wild. Survival in captivity is calculated from the number of offspring that survived until weaning. There were 121 offspring from 18 monandrous females and 116 offspring from 18 polyandrous females in the captive experiment. Red bars indicate monandry; blue bars indicate polyandry. Data are the mean ± s.e.m.

Mean survival curves are presented for monandrous females mated to more competitive males (n = 41 offspring from five litters; unbroken black line) or less competitive males (n = 80 offspring from 13 litters; dotted black line) and polyandrous females (n = 116 offspring from 18 litters; blue line). The pooled curve for all 18 monandrous females that gave birth is also shown (red line).
Female choice - good gene hypothesis

Do females select males based on signals that indicate high fitness of offspring?

Females prefer males with long calls (LC)

**RESULTS**

<table>
<thead>
<tr>
<th>Fitness Measure</th>
<th>1995</th>
<th>1996</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larval growth</td>
<td>NSD</td>
<td>LC better</td>
</tr>
<tr>
<td>Larval survival</td>
<td>LC better</td>
<td>NSD</td>
</tr>
<tr>
<td>Time to metamorphosis</td>
<td>LC better (shorter)</td>
<td>LC better (shorter)</td>
</tr>
</tbody>
</table>

NSD = no significant difference; LC better = offspring of LC males superior to offspring of SC males.

Offspring of LC males have higher fitness
Intersexual selection: female choice =>
dimorphism, displays, ornamentation
Sensory bias - males exploiting pre-existing preferences of females

Evidence from phylogeny - $P = F$ preference, $T = M$ trait

*EVOLUTION* 2e, Figure 15.22

Futuyma