Lect. 19: Life-history evolution, Phylogenetics

- Life history, trade-offs
  - Senescence
  - Optimal clutch
  - Optimal offspring size
- Phylogenetics
  - Similarity, synapomorphy, homoplasy
  - Which tree: Parsimony
  - Timing: Molecular clocks

Evolutionary hypothesis

Prediction 2: senescence delayed with lower extrinsic levels of mortality (predation, disease, etc.)

Test: Compare mainland and island population (Fewer predators, etc.)

Austad (1993)

Island population:
- Lower mortality rates
- Little decline in reproductive performance with age

Hypothesis?

Island population:
- Lower mortality rates
- Little decline in reproductive performance with age

See figure 12.14

Why?

- Intra-generational trade-off
  - Clutch size vs. parent survival and reproduction
  - Collared flycatcher: Enlarged brood, smaller clutches later

Observed smaller than optimal clutch size

- Why?
- Trade-offs!

Fig 12.17

How many young to produce?

- David Lack 1947
- Clutch size that produces the most surviving offspring

Lack clutch size optimum

<table>
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<tr>
<th>Clutch size</th>
<th>Survival probability</th>
<th>Maternal fitness</th>
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Why?

- Inter-generational trade-offs
  - Mother’s clutch size negatively correlated with clutch size in offspring

Inter-generational trade-offs

- Mother’s clutch size negatively correlated with another factor

Fig 12.13b

Graphical summary of evolutionary history

Nodes: branch points (speciation) from common ancestors

Phylogenetics

- Closely related taxa: similarity in traits they share

Fig 12.18
Causes of Similarity

1. Descent from common ancestor
   - Synapomorphy: Homologous traits modified in a common ancestor

2. Homoplasy:
   - Similarity NOT by descent from common ancestor
   - Selection (convergence)
   - Evolutionary reversals

Phylogenetics & Parsimony

4 chamber heart

Methods:
- Parsimony
- Genetic distance
- Maximum likelihood
- Bayesian

Assumes evolutionary transitions are uncommon
- Synapomorphy more common than homoplasy

Determine polarity by comparison to outgroup

Assess all possible trees, choose tree that has the fewest evolutionary transitions

This tree more parsimonious

Monophyletic group: an ancestral species and all of its descendents
Paraphyletic group: an ancestral species and some (but not all) of its descendents

Parsimony: DNA sequence

Human: CACAATA...TGAGC...G
Chimp: CACAATA...GGAGC...G
Gorilla: CACAATA...TGAGT...T
Orang: CACAATA...TGAGA...T

Parsimony analysis of COII gene (mtDNA)

Gibbons Orangutans Gorillas Pygmies Common Humans
98% 98% 100% 98% 100%

Bootstrap values

Evolutionary Timing

When did these evolutionary splits occur?

Senescence

- Rate of life hypothesis: repair & maintenance fail with age
  - But selection can produce longer lifespan
- Evolutionary hypotheses: mutation accumulation, antagonistic pleiotropy
  - Selection is weak on alleles that affect traits expressed late in life.
  - Embryonic depression increases with age
  - Extrinsinc mortality (weaker selection on deleterious alleles) associated with senescence

Optimal clutch size

- Trade-offs within and between generations influence optimal clutch size
  - Parents maximize no. young per nest
  - Trade-off between no. eggs & future reproduction
  - Trade-off between no. of eggs & quality of young
- Clutch size is a compromise among trade-offs

Molecular clocks

- Molecular change proportional to time
- Assumes:
  - Steady rates of molecular change
  - Changes are neutral

Problem: Clocks can be gene or taxon specific