Lecture 14: Adaptation

- Adaptation
  - Design, Observations, Experiments, Comparisons
- Are traits adaptive?
- Are differences among populations or species adaptive?

Adaptation

- A trait that
  - increases an individual's survival or reproduction (fitness) compared to individuals without it.
  - results from the force of N.S.

Adaptation as a hypothesis

H: flower tube length increases pollen transfer and pollination?

Adaptationist hypotheses should be tested rigorously

- phenotypic traits influenced by
  - Mutation, drift, migration also
  - Genetic constraints
  - Genetic correlation antagonistic to selection

Darwin (1859)

'how the innumerable species inhabiting this world have been modified, so as to acquire that perfection of structure and coadaptation that most justly excites our admiration.'
Historical phylogenetic constraint

Termites bite
• termite ancestors lacked precursor to stinger (hardened ovipositer)

History: natural selection works with what it is given

Wasps sting

Natural selection:
- uses the variation available
- like building with stones that fall from a cliff

Historical phylogenetic constraint

Studying adaptationist hypotheses?

hypotheses ➔ predictions ➔ tests

1. Design
2. Observational
3. Experimental
4. Comparative

Adaptation: 2 Questions

1. Are various traits adaptive?
2. Are differences among populations or species adaptive?

Mirror orchid flower adaptive?
Hypothesis: Flowers mimic female bees to attract male bee pollinators

Design test: match the adaptive function?
Hypothesis: Flowers mimic female bees to attract male bees
Predictions:
1. Flowers attract males
2. Males receive pollen

Exquisite Design!

Study of design: pitfalls!
• Alternative hypotheses?
• $H_1$: giraffe’s neck adaptive for feeding
• Prediction: spend most time foraging high

Observational study: giraffes
• Feed at shoulder height (Fig 9.2)
Observational study

- H₂: giraffe's neck adaptive for competition for mates
- Prediction: larger-necked males beat smaller males

Competitive hierarchy among males (transitive)

Long necks
- evolved for male-male competition for mates
- used incidentally for feeding high

Floral spur length adaptive?

Hypothesis: floral spur length evolves to match pollinator tongue length

Experimental tests

Prediction: shortening spur decreases pollination success

Constrict spur to shorten


Comparative method: testes size as an adaptation

- Flying foxes, fruit bats
- Males compete to fertilize females
- Larger testes, more sperm
- H₁: testes size adaptive for sperm competition

Comparative method

- Prediction: more sperm competition, larger testes in bats that roost in large groups (Fig. 9.11)
- Fig. 9.12
- 2 species
- Shortening spur to different lengths
- Reduces reproduction (pollen removal, ovule fertilization)

Fig 9.12

Small group, small testes
Large group, large testes

Only one evolutionary event!

Do the two species that evolve larger groups from a common ancestor also evolve larger testes?

- 4 events (S, T, U, R)
- Fig 9.13, 14
- YES!

Small group, small testes
Large group, large testes
Adaptation: 2 Questions

1. Are various traits adaptive?
2. Are differences among populations or species adaptive?

Local adaptation: adaptive differences among populations

- Arctic char introduced into three lakes
  - Aur: coldest
  - Las: medium
  - Har: warm
- Populations differ in growth, reproduction
- H: population differences are adaptive

Experimental test

- Prediction: each population survives best in the temperature conditions of home lake