Introduction to Ecology

- What ecology is
- Levels of biological hierarchy
- Types of ecological study
- What ecologists do
  - Detecting Patterns
  - Developing and testing hypotheses

What is ecology?

- Popular usage:
- Scientific meaning:

Levels of biological hierarchy

1. Individual organisms
2. Populations
3. Communities

How to be an ecological scientist

1. Detect interesting patterns in nature
   - Pattern: non-random outcome/event that demands an explanation

2. Develop hypotheses about processes
   - Process: the mechanism causing a natural pattern

How to be an ecological scientist

Examples of hypothetical ecological processes:

- Moss: microclimate is cooler on north side of trees and more favorable to moss
- Deer: live in groups because this reduces their susceptibility to predators
- Artic voles: populations grow each summer when resources are plentiful and then crash in harsh winters
- Species diversity in poles vs. tropics: more stable climate in tropics allows more species to persist
How to be an ecological scientist

3. Determine which processes actually produce such natural patterns
   - For each pattern there are several possibilities

How to be an ecological scientist

Examples of alternative hypotheses for moss pattern:
- Hypothesis 1: microclimate is cooler on north side of trees and more favorable to moss growth
- Hypothesis 2: texture of trees is different on north vs. south sides, and is more favorable to moss establishment on north sides

We need to investigate alternative hypotheses and experimentally determine which processes are actually responsible for pattern

Types of ecological studies

1. Observational: just observing patterns in nature, not manipulating system

2. Experimental: we manipulate the system

Types of ecological studies

3. Comparative or literature: based on previously collected data

4. Pure theory: can be based on data or purely hypothetical

Types of ecological studies

Why are experiments such a powerful way to conduct ecological studies?

Ecological study example

- Pattern: duckling survival increases with initial brood size

![Individual duckling survival rate](image)
Ecological study example

- Hypothesized mechanism: Bigger groups provide increased protection from predators
- Prediction: the predation rate on ducklings should decrease with group size

**Predation rate on ducklings**

# Ducklings in brood

Ecological study example

- Hypothesized mechanism #2: Quality of mom hypothesis
- Prediction: the survival rate of individual ducklings is directly related to mom quality

**Survival rate of individual ducklings**

# Ducklings initially in brood

Ecological study example

- Both Hypotheses could explain original pattern:
- Experimentation facilitates distinguishing between these alternative mechanisms!

Biodiversity and Evolution

- What is biological diversity?
- Natural selection - the fundamental driving force behind evolution
- Adaptive radiations and convergent evolution

Biodiversity and Distributions

- Two types of biological diversity:
  - Ecological diversity:
  - Taxonomic diversity:

- Fundamental question:
Biodiversity and Distributions

What determines the distributions of individual species?
1. Historical factors
2. Ecological factors

The process of natural selection

What is natural selection?

How does natural selection work?

The process of natural selection

When the following 3 conditions are met in a population of organisms:
1. There is
2. This
3. There is

Then two results will occur:
1.
2.
⇒ THIS IS NATURAL SELECTION

Natural selection: A case study

Grants’ studies on the Galapagos finches
Example: medium ground finch (G. fortis)
– Entire population found on Daphne island
– Finches use their beaks to open seed cases and eat seeds inside
– They measured the beak sizes of individuals and monitored reproduction and survival over many years

Results:
1. Lots of individual variation in beak size

Number of individuals (frequency)

<table>
<thead>
<tr>
<th>Beak depth/size</th>
<th>7 mm</th>
<th>12 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td></td>
<td></td>
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</tbody>
</table>
Natural selection: A case study

Results:
2. Beak size is heritable

3. Beak variation has ecological consequences

4. Beak variation had survival consequences

Case studies of natural selection

Summary:
- The study of natural selection in progress requires these critical factors:

Natural selection: Important points

1. NS operates on individuals!

2. There is a lot of potential for NS because most traits are heritable

3. NS is an evolutionary process

4. NS can be very strong and rapid

5. NS is variable and can rapidly reverse directions
Adaptive radiations

= Definition of adaptive radiation:

Adaptive radiations

Classic example: Darwin's finches (again!)
• Speciation: 14 species total
  – 13 in archipelago of Galapagos islands
  – 1 on Cocos island in Costa Rica
  – Molecular work confirms common ancestor and that speciation occurred within past 1 million years

Adaptive radiations

Necessary factors for adaptive radiations to occur:
1. 
2. 
3. 
Prediction:

Adaptive radiations

• Other cool examples:
  – 
  – 
• The process leads to
  • However, because species all shared common ancestor

Convergent evolution

• Different taxonomic lineages converge in ecological roles
• Evolutionary convergence is presumed to be result from adaptation to similar environments
• Classic example: marsupial and placental mammals have both given rise to similar forms:
  – Carnivores
  – Flying mammals
  – Terrestrial herbivores
  – Subterranean forms such as moles