Speciation
Macroevolution

Lecture outline
- Species definitions
- Keeping species separate
- Modes of speciation

What’s a species?
- **Species** is Latin for ‘kind’ or ‘appearance’
- Biologists have officially described MANY species
  - Roughly 1.8 million
  - Is there an official count?
    - The Catalogue of Life
    - Includes 1,837,565 species as of 2019

A brief detour on writing
- “Species” is both singular and plural
- Species names are written using binomial nomenclature of Latin or Latinized versions of words
- **Genus species**
  - The actual names are italicized
  - **Genus** is always capitalized
  - **species** is always lower case
- **Pycnopsyche gentilis**

Species concepts
- Our ideas about how best to define a species have changed over time
- A challenge:
  - If speciation is occurring, no species concept will “work” all the time - you should always be able to find debatable forms

How can you tell when something is a different ‘kind’ than something else?

![Meadowlarks](image)

Fig. 24.2a
Morphological species concept (1)

- Defined by...
- Type specimen
- Morphospecies?

Diatoms

Morphological species concept (2)

- Any problems?

Golden silk orb weaver
Nephila clavipes

Biological species concept

- Ernst Mayr (1904-2005)
  - German ornithologist
  - Modern Synthesis
- Population or group of populations that have the potential to interbreed in nature and produce viable, fertile offspring (1942)
- Gene flow?
- Problems?

Mayr on right in New Guinea

Reproductive isolation

- Two types of biological barriers to reproduction
  - Prezygotic vs. Postzygotic barriers

Fig. 24.3

Prezygotic barriers overview

- Habitat isolation
- Temporal isolation
- Behavioral isolation
- Mechanical isolation
- Gametic isolation

Notice anything in common?

Fig. 24.3

Prezygotic barriers (1)

- Habitat isolation

Three-spined stickleback species differ by lake habitat: benthic vs. pelagic zones

Peichel et al. (2001)
Prezygotic barriers (2)
- Temporal isolation

**Fig. 24.3 c & d**

Prezygotic barriers (3)
- Behavioral isolation

**Fig. 24.2a**

- Song
  - Eastern meadowlark
  - Western meadowlark

Prezygotic barriers (4)
- Mechanical isolation

**Fig. 24.3g**

- Gametic isolation

**Fig. 24.3**

Prezygotic barriers (5)

**Postzygotic barriers overview**
- Reduced hybrid viability
- Reduced hybrid fertility
- Hybrid breakdown

Notice anything in common?

**Postzygotic barriers (1)**
- Reduced hybrid viability: hybrid offspring dies during development

**Fig. 24.3**
Postzygotic barriers (2)

- **Reduced hybrid fertility**: hybrid offspring are sterile

![Horse + donkey = sterile mule](image)

Hybrid

Postzygotic barriers (3)

- **Hybrid breakdown**: hybrids are fertile, but their offspring either die or are sterile

![Hybrid cultivated rice plants with stunted offspring (center)](image)

Several other species concepts have been proposed

- **Phylogenetic species concept**
  - Minimum number of individuals that share a common ancestor forming a branch on an evolutionary tree

- **Ecological Species Concept**
  - Group of organisms adapted to a particular set of resources, called a *niche*, in the environment

- **Different species concepts agree most of the time**
  - They differ mostly when applied to borderline or poorly understood cases

Modes of speciation

- **2 species from 1**
  - = cladogenesis

- **Allopatric vs. sympatric speciation**

![Evidence for allopatric speciation](image)

Snapping shrimp vs. Isthmus of Panama

![Evidence for sympatric speciation](image)

- **Habitat differentiation**
- **Sexual selection**
- **Polyploidy**
  - 80%(!) of plants

![Evidence for autopolyplody](image)

Bread wheat

*Fig. 24.3i*

*Fig. 24.5*

*Fig. 24.8*

*Fig. 24.9*
Sympatric speciation (2)
- Polyploidy in tree frogs
  - Cope’s gray tree frog
    - *Hyla chrysocelis*
    - Call
  - Gray tree frog
    - *Hyla versicolor*
    - Call
  - 24 Diploid
  - 48 Tetraploid

Sympatric speciation (3)
- Sexual selection/Mate choice
  - Cichlids
  - EXPERIMENT
    - Normal light
    - Monochromatic orange light
  - *P. pundamilia*
  - *P. nyererei*
  - Fig. 24.12

What happens when allopatric populations meet?
- Hybrid zone formation
  - Fig. 24.14
  - Possible outcomes:
    - Isolated population diverges
    - Hybrid zone
    - Reinforcement
    - Fusion
    - Stability
  - Hybrid individual
  - Gene flow
  - Population
  - Barrier to gene flow

Hybrid zones: Reinforcement
- Phlox spp.
  - In Texas where *P. cuspidate* and *P. drummondii* occur together, the *P. drummondii* has evolved dark-red flowers. This newly evolved flower color causes pollinators to only visit the correct species.
  - Photo credit (A) David L. Des Marais and (B) Robin Hopkins.
  - Matute & Ortiz-Barrientos (2014) Current Biology

Hybrid zones: Fusion
- *Pundamilia nyererei* *Pundamilia pundamilia*
  - *Pundamilia “turbid water,”* hybrid offspring from a location with turbid water
  - Fig. 24.15