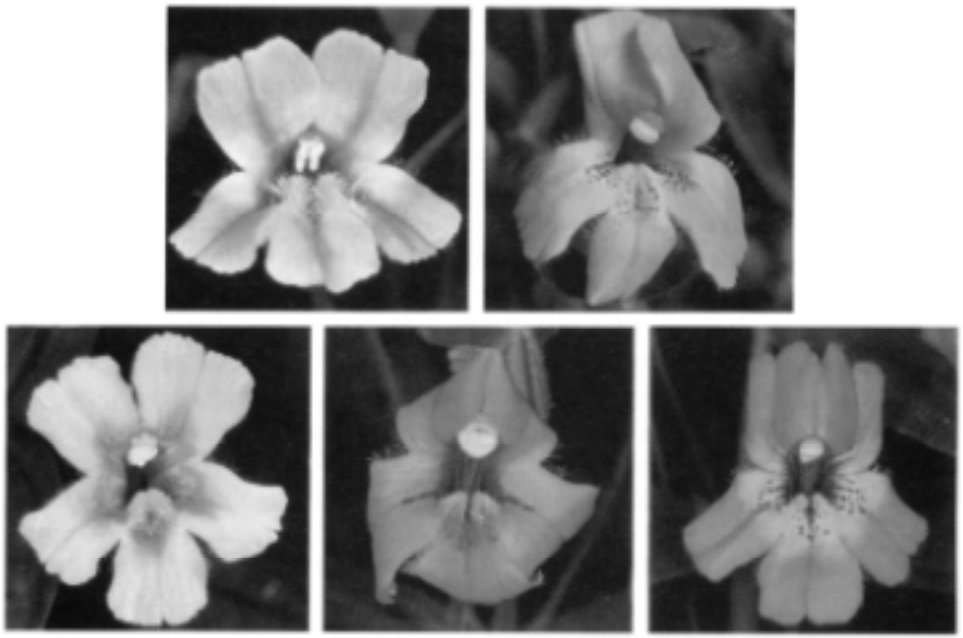
Mechanisms of Speciation



Speciation

- Species concepts
- Mechanisms of Isolation
- Mechanisms of Divergence
- Secondary contact

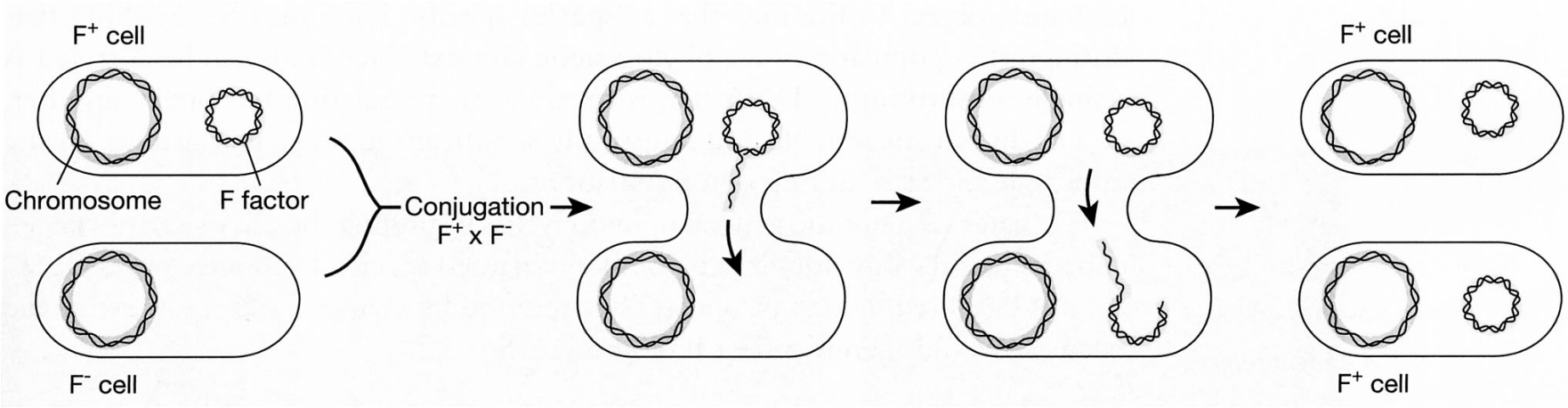
Speciation

- All species on earth thought to share single common ancestor
  - That is life arose once, ca. 3.8 bya
- Speciation is the generation of species level diversity
- What processes lead to genetic differences sufficient to create a new species?

What is a species?

- Biological species concept
  - Reproductive isolation, no genetic exchange
  - Textbook definition, Mayr 1942
  - Widely used by zoologist, and by legal acts
- But what about:
  - forms that do not meet
  - Asexual organisms like bacteria
  - Many plants with extensive hybridization

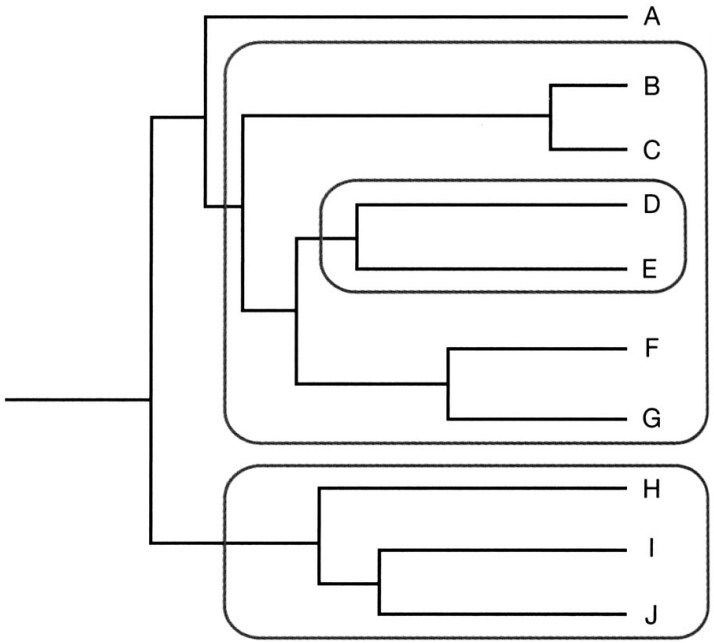
Asexual bacteria: what is a species?



Genetic traits can be passed across very distantly related bacteria. E.g., antibiotic resistance genes spread widely.

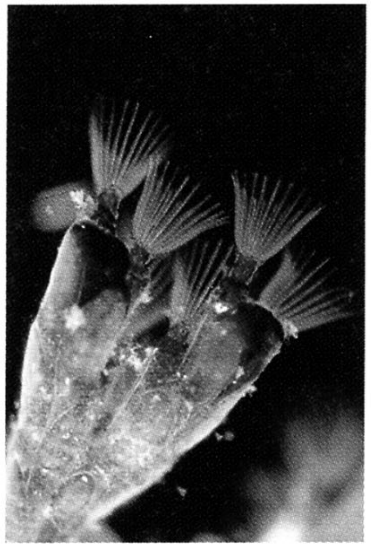
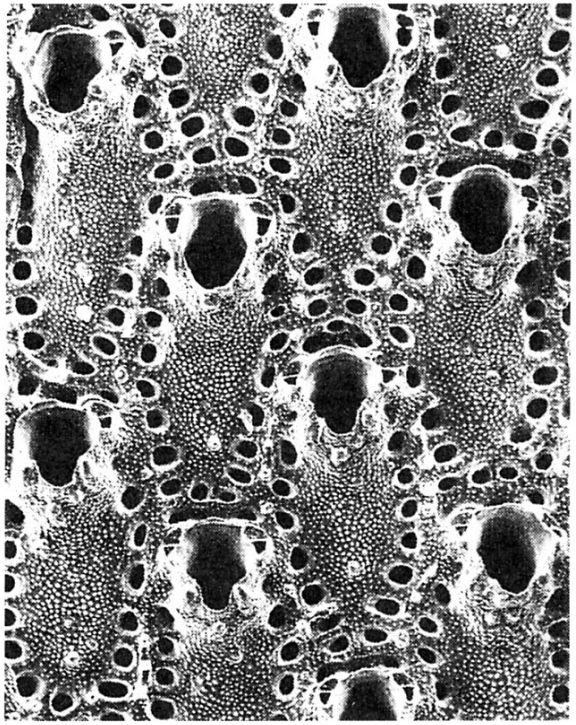
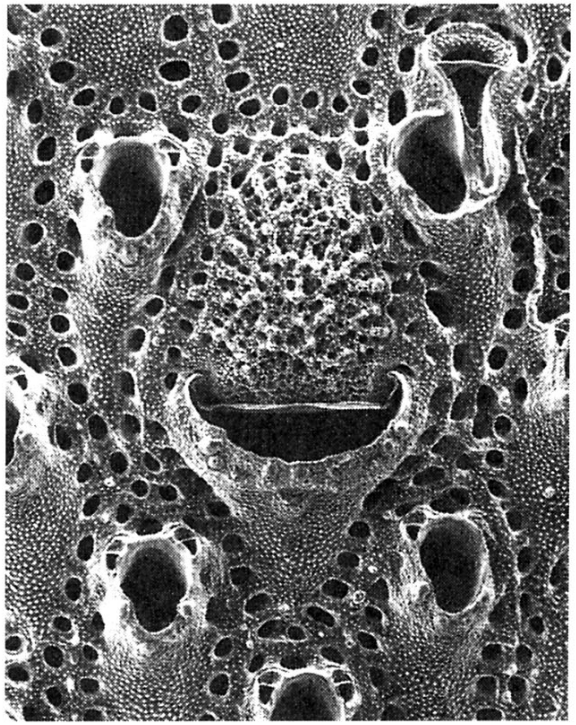
Phylogenetic species concept

- Emphasis is on evolutionary monophyly
- Monophyletic groups
  - Group of taxa that contain all descendents of a common ancestor
- Here D and E could be same species
  - But E and J cannot
  - Unless A through J are

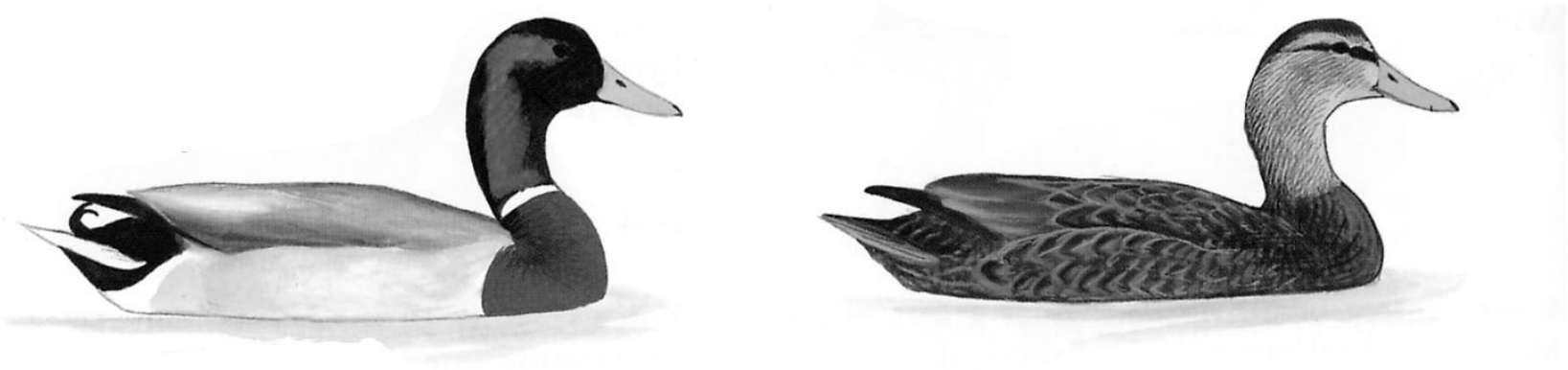


Morphological species concept

- If it looks like one….then it is one
- Usually only concept available for fossils

Morphological species or not?



Does this really matter?

- The United States legal definition of species comes from the Biological species concept
  - Reproductive isolation
  - No gene flow

Groups do not usually qualify for federal protection unless they are considered valid species or subspecies

All species concepts

- Genetic isolation important to all concepts
  - Heart of Biological Species Concept
  - If isolation were not there, at least mostly, then
    - Phylogenetic concept becomes difficult to apply
      - Gene flow would make monophyly gene dependent
    - Morphospecies no longer morphologically distinct
      - Hybrid gene flow could swamp out morphological differences

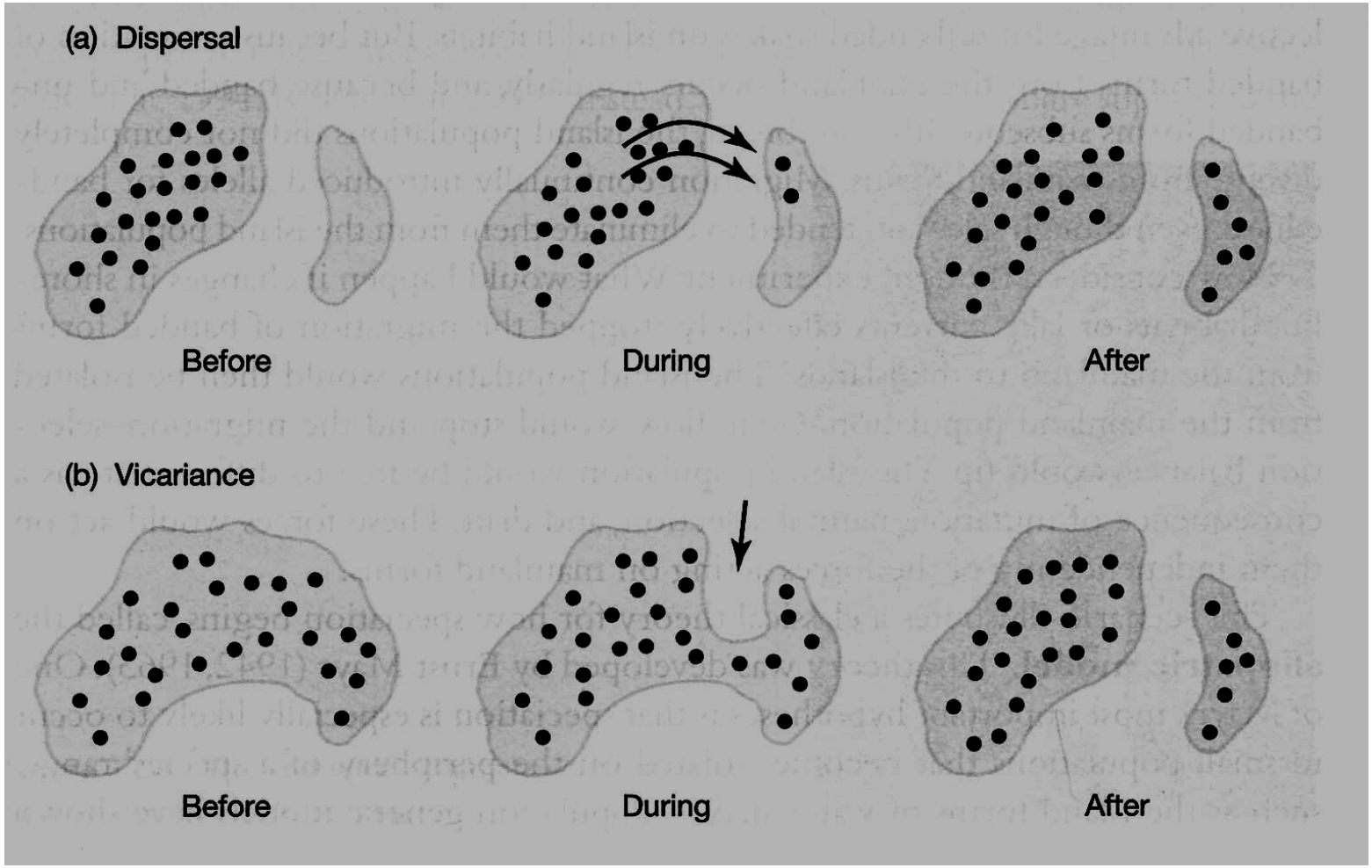
Process of speciation

- Isolation
  - Physical barriers - allopatry
    - Dispersal
    - vicariance
- Divergence
  - Drift
  - Natural or sexual selection
- Sometimes secondary contact
  - Hybridization
    - Reinforcement
    - Fusion

Allopatric speciation

- Allopatry: not in the same place
  - Divergence occurs in geographically separated groups
- Some physical barrier to migration of alleles from one population to another
- Initial separation of populations could be
  - Dispersal
  - vicariance

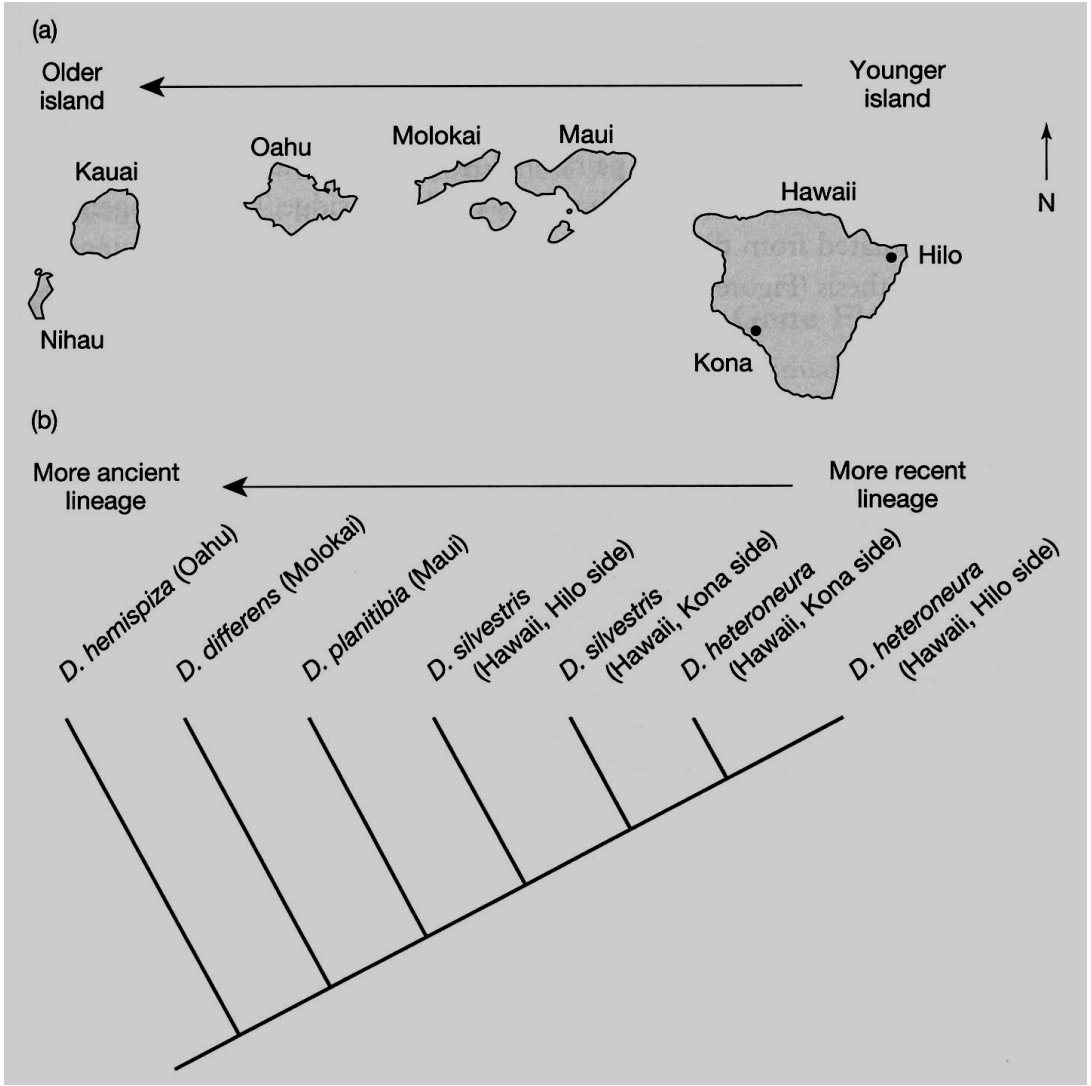
Allopatric models



Dispersal and colonization

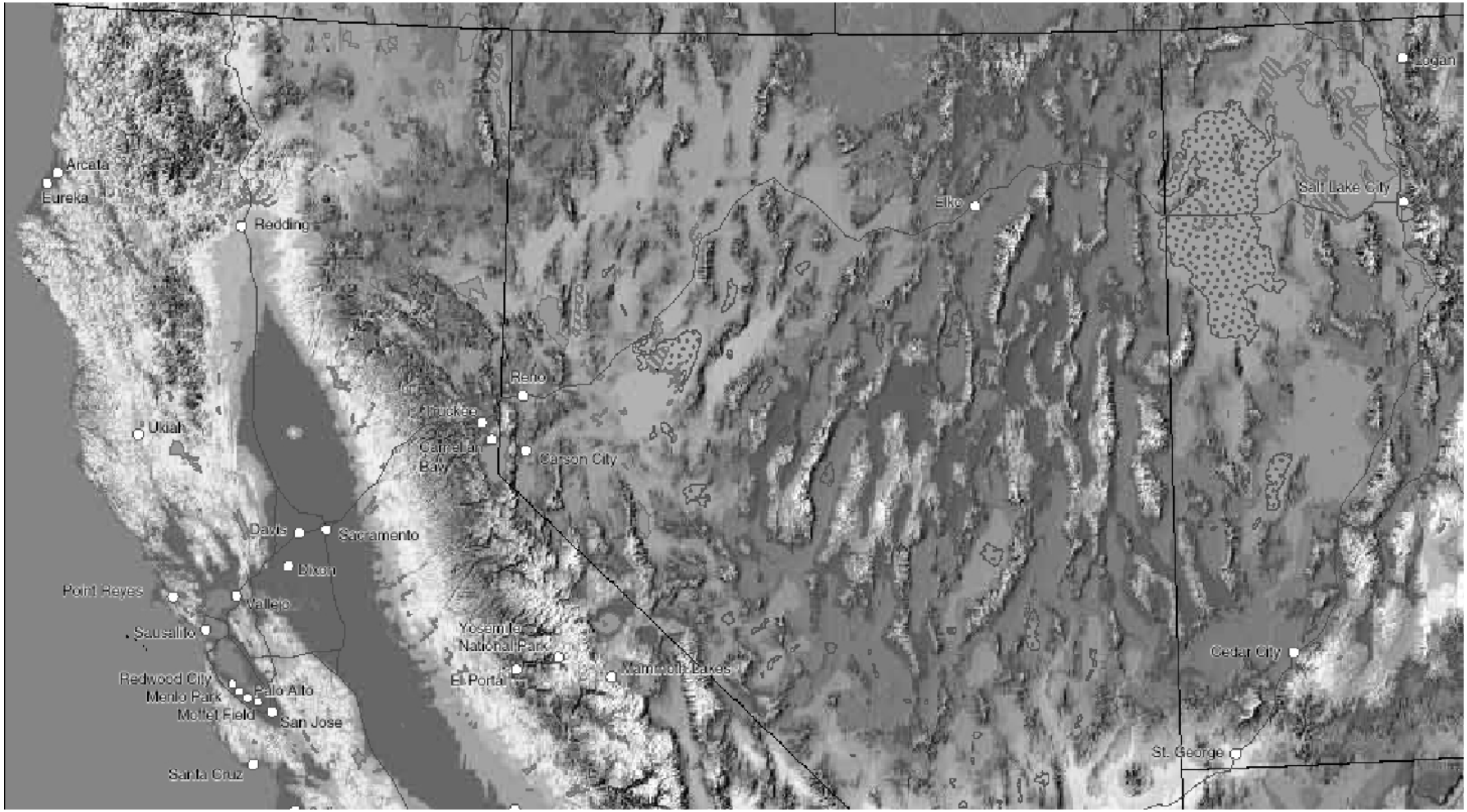
- Example, Hawaiian Drosophilidae
  - Over 500 species in 2 genera
- Founder hypothesis predicts
  - closely related species on adjacent islands
  - Phylogeny should correspond to island ages

Hawaiian island chain

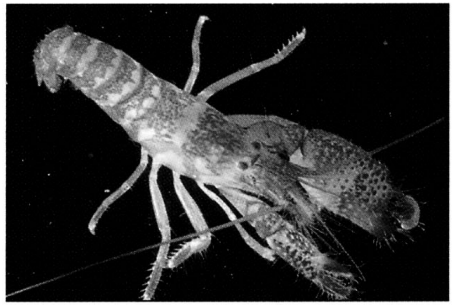


Other sort of ‘islands’

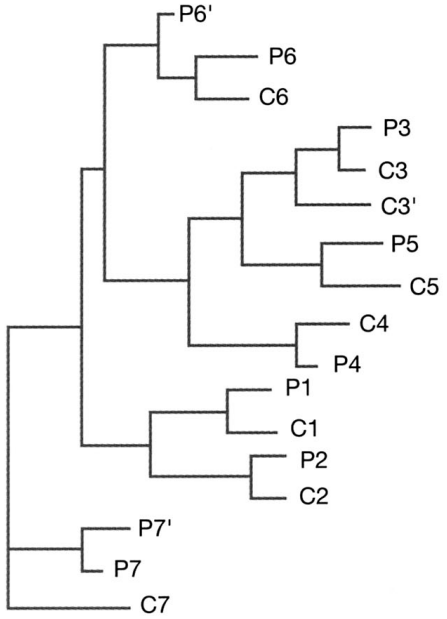
- Basins; Mountain ranges

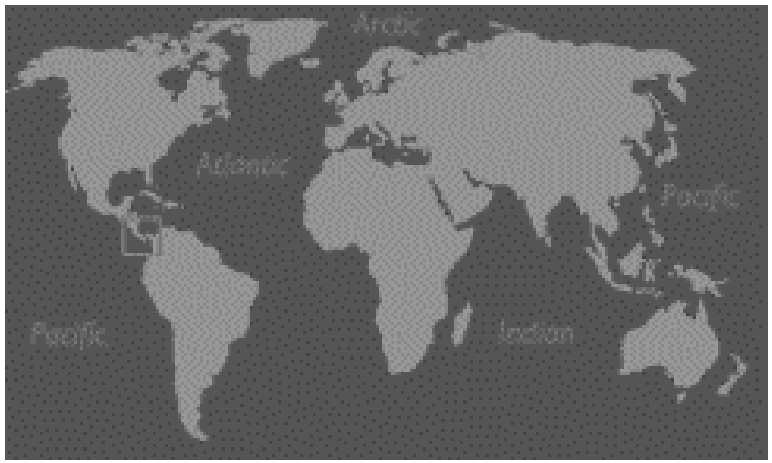


Vicariance example



Alpheus malleator





Genetic barriers - polyploidy

- Changes in chromosome number
- Individuals with different karyotypes reproductively incompatible
- Important mechanism in plant speciation
  - Perhaps 43% of dicots; 58% of monocots descended from polyploid ancestors
  - NOT 43% and 58% of speciation events