STUDY MATERIAL

VIVEKANANDA COLLEGE THAKURPUKUR

NAAC ACCREDITED GRADE—'A'

Subject: ZOOLOGY
Topic: SPECIATION

Name of the Teacher: Dr. Shaoli Majumder

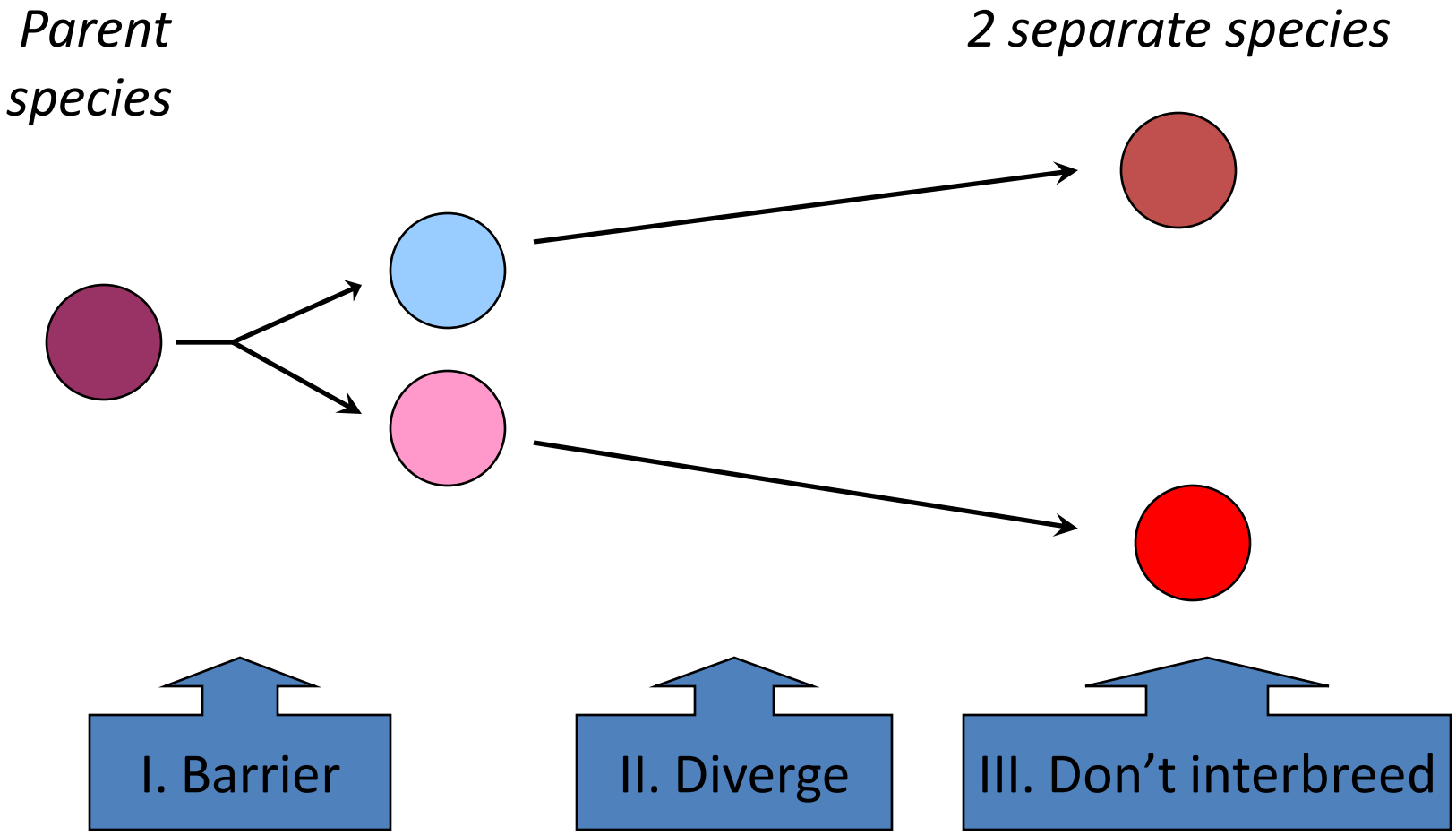
What is a species?

Species **are groups of actually or potentially interbreeding natural populations, which are reproductively isolated from other such groups (*Ernst Mayr, 1969*)**

What is speciation?

- **Classically, speciation has been viewed as a three stage process:**
  - **Isolation of populations.**
  - **Divergence in traits of separated populations (e.g. mating system or habitat use).**
  - **Reproductive isolation of populations that maintains isolation when populations come into contact again (secondary contact).**

Process of speciation:



Reproductive Isolation is the driving force behind Speciation

- **Reproductive Isolation:**

  The existence of biological factors (barriers) that prevent two individuals of a species from mating and producing viable and fertile offspring

  A new species will form when reproductive isolation occurs i.e. in Absence of gene flow

Isolating mechanisms

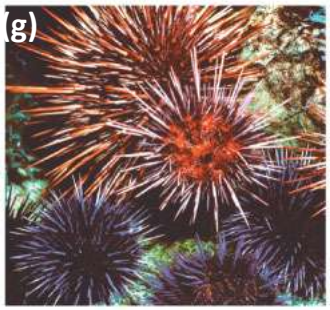
- **Isolating mechanisms fall into two categories:**
  - **Prezygotic (those that reduce chances of mating and fertilization taking place) and**
  - **Postzygotic (those that reduce the viability or hybrid offspring).**

Prezygotic barriers block fertilization from occurring by:

- **Impeding different species from attempting to mate**
- **Preventing the successful completion of mating**
- **Hindering fertilization if mating is successful**

- **5 types of prezygotic barriers**

Prezygotic barriers



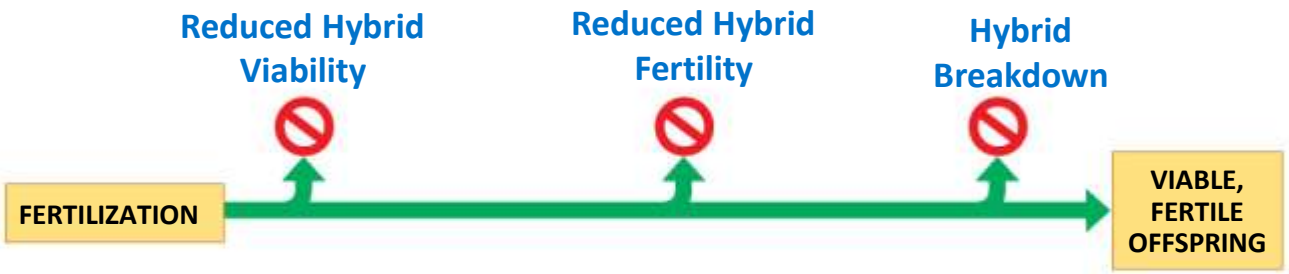
Postzygotic barriers block fertilization from occurring by:

- **Hybrid sterility, e.g. in horse and donkey**

  - mother horse, father donkey: offspring is a mule (sterile)

  - mother donkey, father horse: offspring is a hinny (sterile)
- **Hybrid inviability eg. sheep-goat embryos**

Postzygotic barriers



Types of speciation

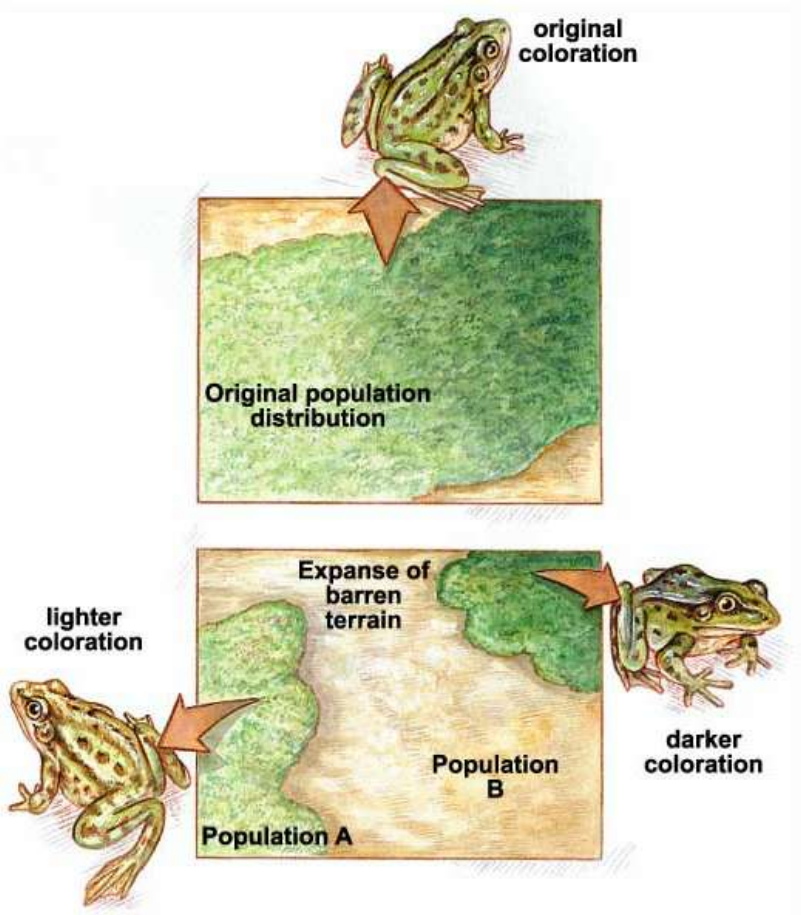
Speciation - the mechanism by which a new species is formed.

- **Types of speciation are:**
  1. **Allopatric speciation**
  2. **Peripatric speciation**
  3. **Parapatric speciation**
  4. **Sympatric speciation**

Allopatric speciation

(allo = other, patric = place)

- This is the essence of Ernst Mayr's allopatric model of speciation.
- Occurs when two populations are *geographically isolated* from one anotherand selection favors genetic divergence of that population.. They are separated by distance or an impassable barrier.



Possible types of barriers in allopatric speciation

- **Mountain ranges**
- **The sea (for terrestrial species), or bodies of freshwater**
- **The land (for aquatic, especially freshwater species)**
- **Glacial masses**
- **Valleys**

Evidence of Allopatric Speciation: a case study

- **15 pairs of sibling species of snapping shrimp (*Alpheus*) are separated by the Isthmus of Panama**
- **These species originated 9 to 13 million years ago, when the Isthmus of Panama formed and separated the Atlantic and Pacific waters**

Evidence of Allopatric Speciation: another case study

Kaibab Squirrel

Abert Squirrel

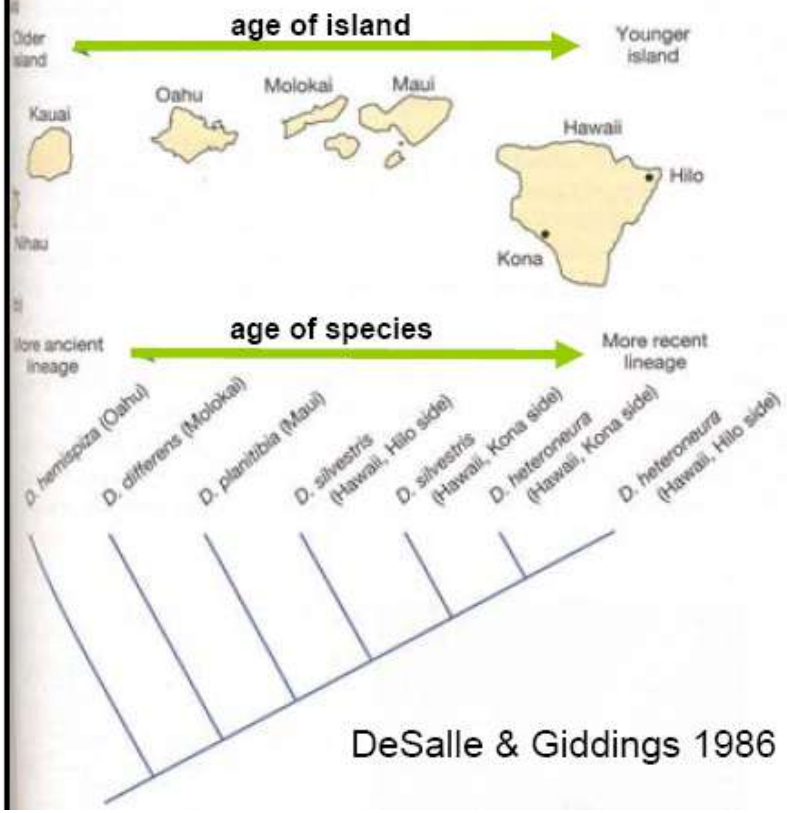
Two species of ground squirrel are postulated to have descended from a common ancestral population that was separated by formation of the Grand Canyon.

Peripatric speciation

- **can be produced by founder events – where very few individuals (or indeed a single pregnant female) gets displaced to a location (e.g. an island, or lake) that was previously uninhabitated by this species**

Evidence of Peripatric Speciation: a case study

Hawaiian picturewing *Drosophila* flies may have rapidly speciated multiple times involving founder events and sexual selection



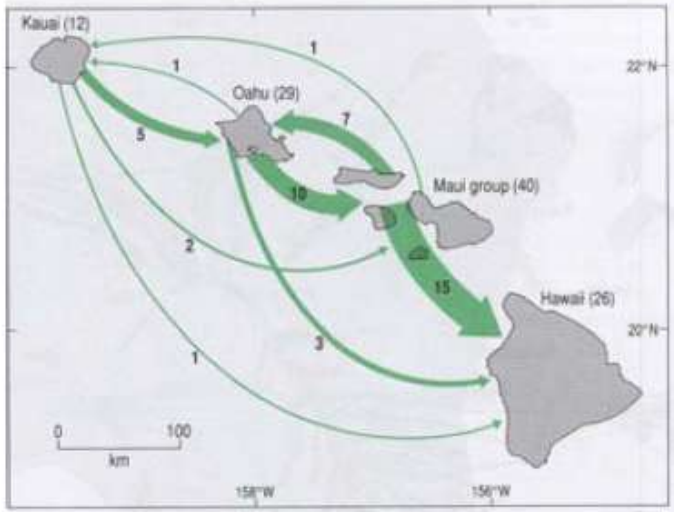
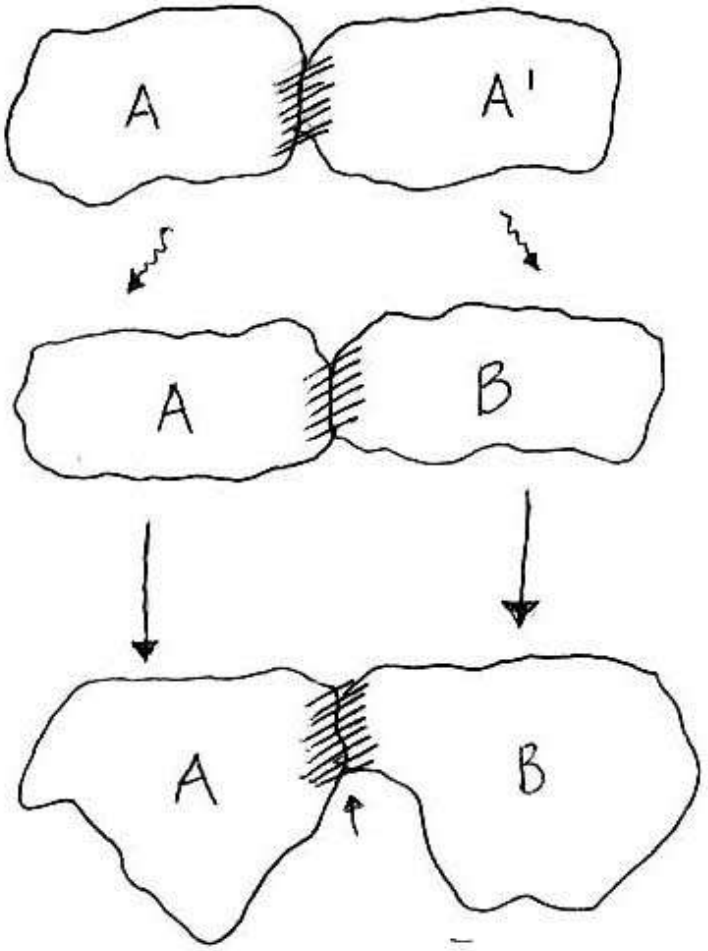


Figure 9.15 Summary of the hypothetical founder events invoked to account for the origin of the picture-winged group of Drosophila *in the Hawaiian islands. The width of the arrows is proportional to the number of proposed founder events; the number of species found on each island is given in brackets.*

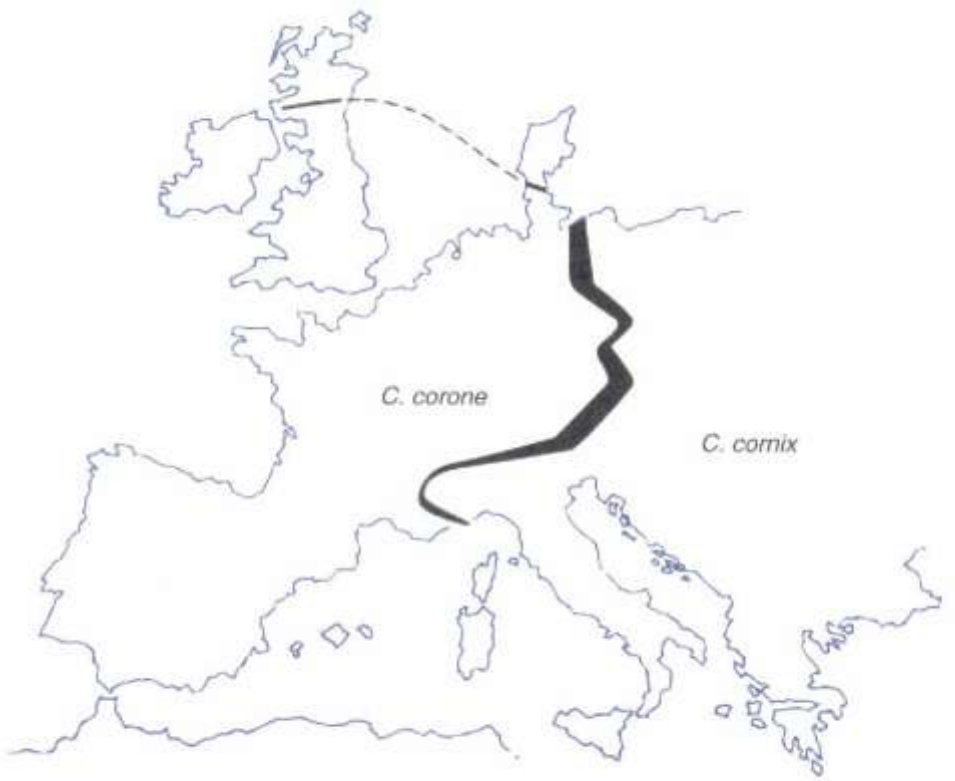
Parapatric speciation

- Parapatric speciation occurs between contiguous populations.
- The parent population does not completely split.



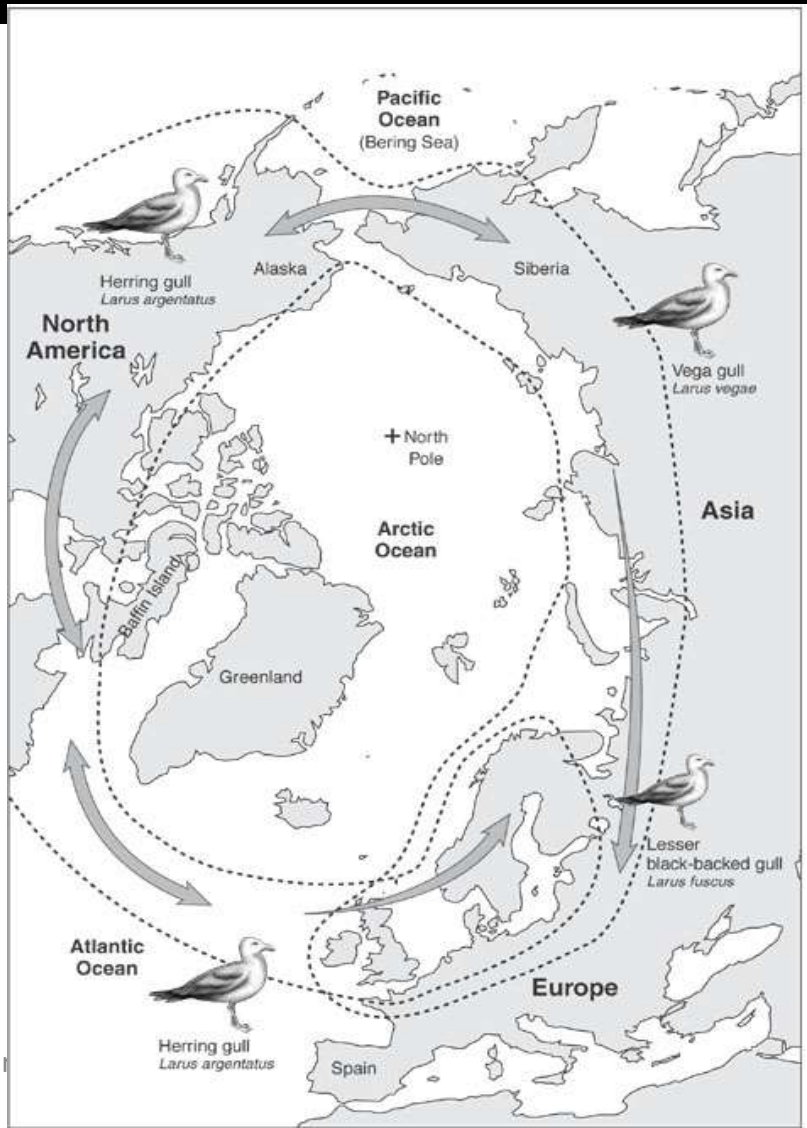
Evidence of Parapatric Speciation: a case study

Two species of crows, *Corvus corone* and *Corvus cornix*, meet along a line in central Europe. Along that line they produce hybrids. Speciation is incomplete.



Ring Species - Herring Gulls

- As glaciers retreated, herring gulls (*Larus argentatus*) were released out of a north Pacific refugia spreading one way across North America and into western Europe; and spreading in the other direction across Alaska into Siberia.
- From Siberia, as the herring gull now extended its range further across Asia, it tended to differentiate, producing a subspecies (or species by some ornithologists) such as the vega gull (*Larus vegae*) and farther west the lesser blackbacked gull (*Larus fuscus*).
- Eventually its current circumpolar distribution became established (dashed lines). Adjacent subspecies interbreed (solid arrows), but where the ends of the circular range of the herring gull meet and overlap in Europe, there is very little interbreeding.



Sympatric speciation

(sym = same, patric = place)

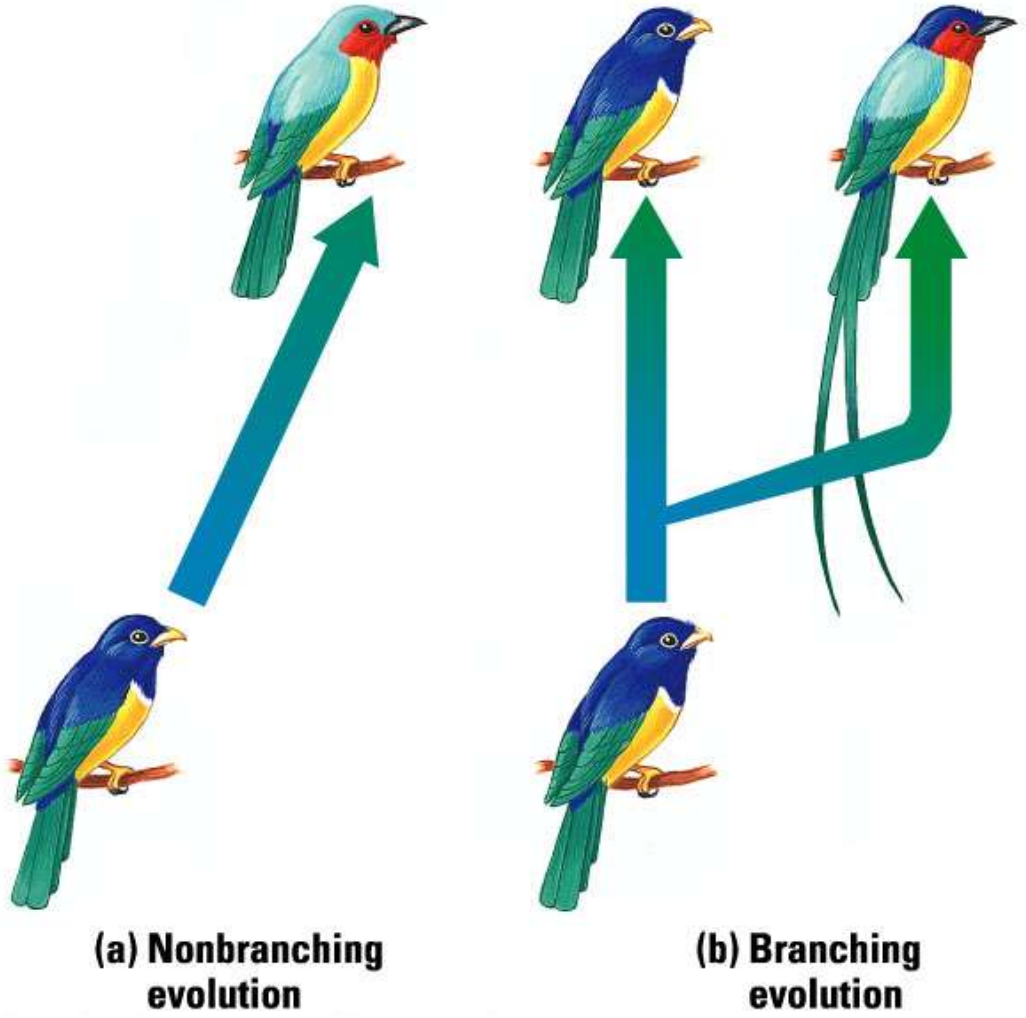
- **Sympatric speciation occurs without any separation of the ancestral geographic range.**
- **New species develops when members of a population develop a genetic difference that prevents them from reproducing with members of the original species. various factors can limit gene flow:**
  - **Polyploidy**
  - **Habitat differentiation**
  - **Sexual selection**

Some evolutionary biologists doubt this ever happens.

Evidence of Sympatric Speciation: a case study

North American maggot fly can live on native hawthorn trees as well as more recently introduced apple trees

Two Patterns of Speciation



Speciation Dynamics - Gradualism or Punctuated Equilibrium?

Punctuated equilibrium appears to be a more accurate view of speciation dynamics.