Modern Synthesis

- What is the modern synthesis?
- How do we define evolution?

Questions

- What are the four forces of evolution?
- How does each change gene frequencies within and between populations?
- What is a population?

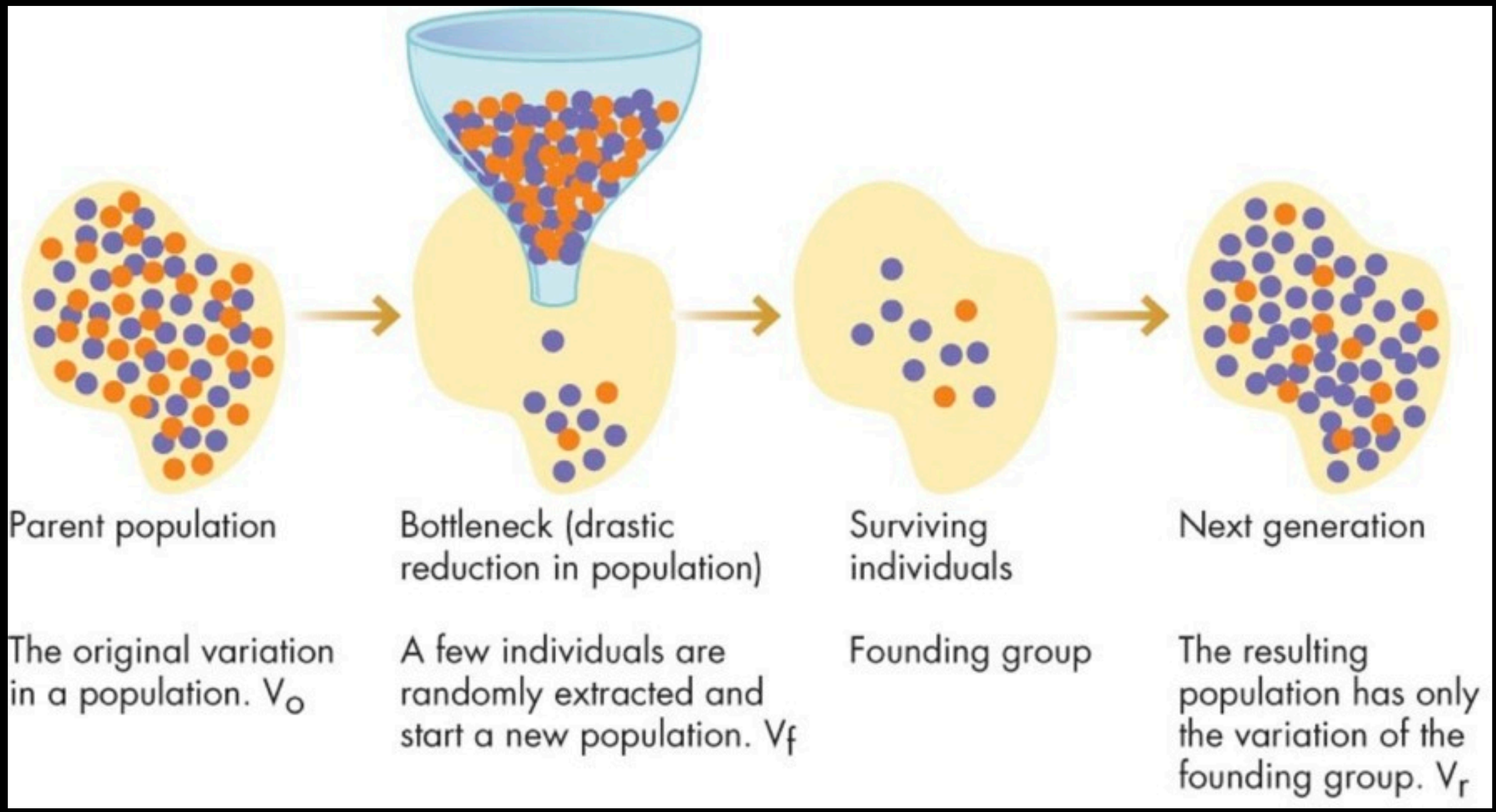
The four forces

- What is genetic drift?
    - When is genetic drift most effective?
- Why is mutation so important?
- What is the role of gene flow in maintaining species?
- What are the different ways in which Natural selection works?

Genetic Drift

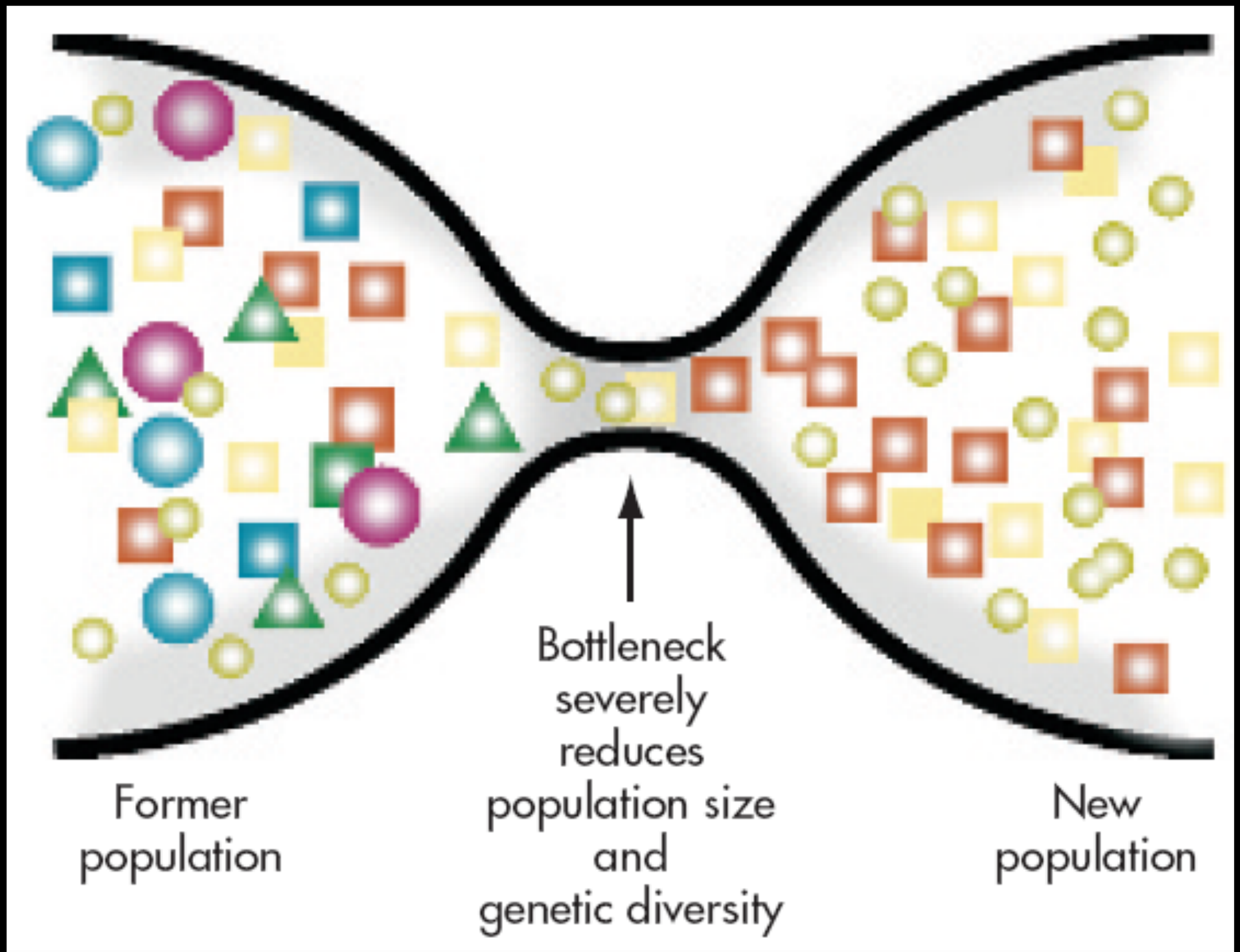
- The random factor
- Greatest effect in small populations
- Founder effect

Genetic Drift - Bottleneck



Parent population	Bottleneck (drastic reduction in population)	Surviving individuals	Next generation
The original variation in a population. V_o	A few individuals are randomly extracted and start a new population. V_f	Founding group	The resulting population has only the variation of the founding group. V_r

Genetic bottleneck

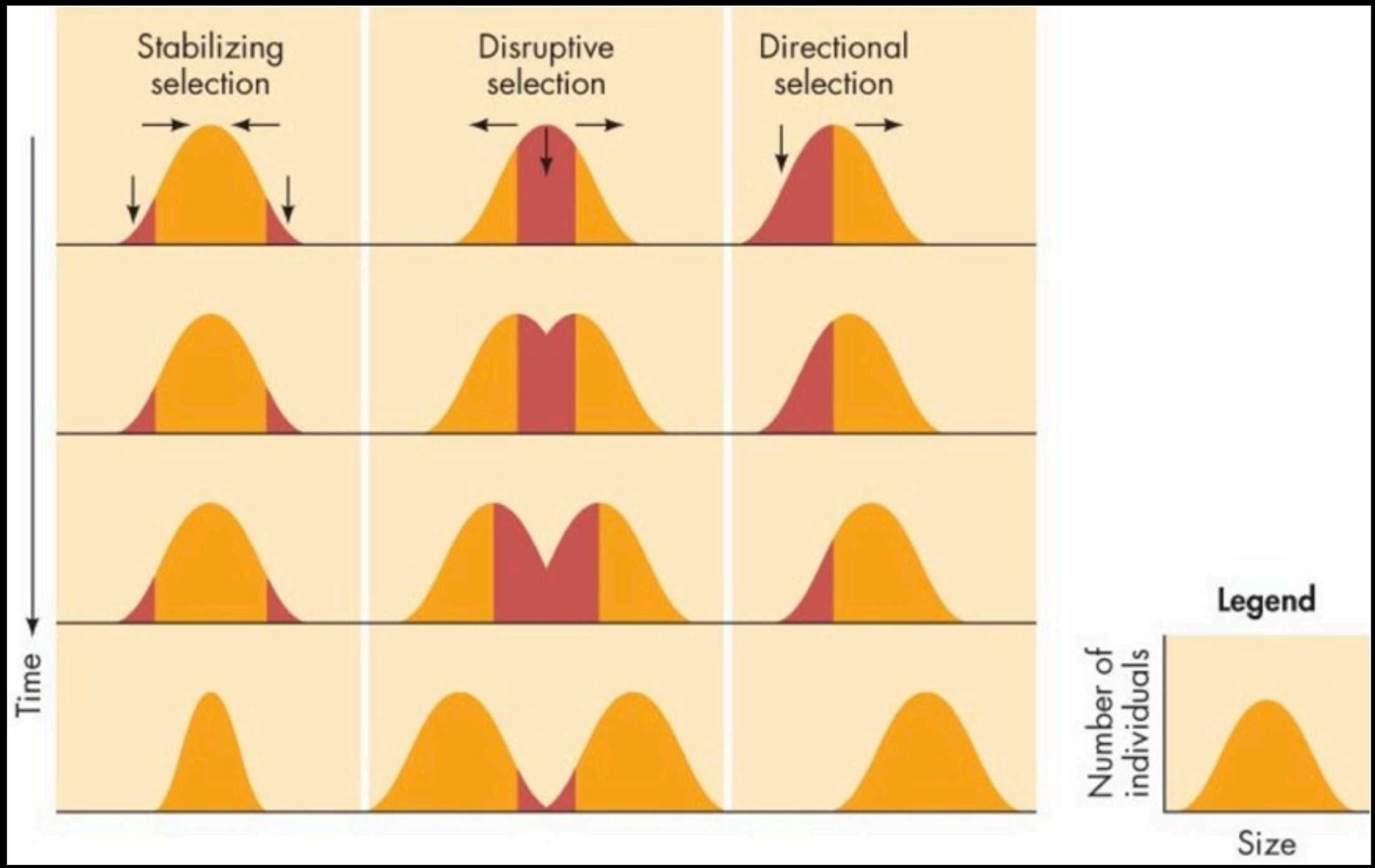


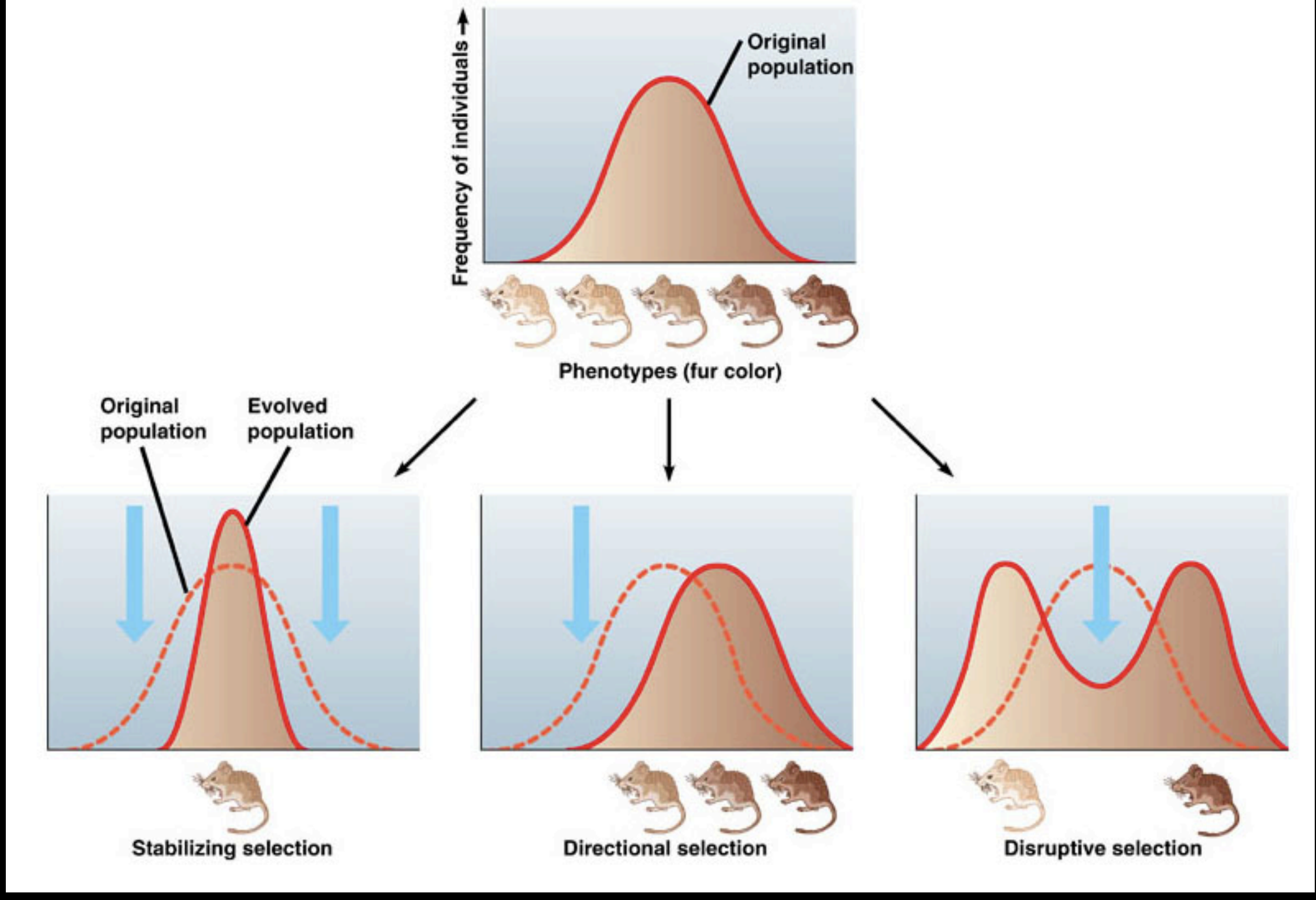
Natural selection

- differential reproductive success over multiple generations

- some variations are more successful than others, leading to a change in the entire population over time

Natural Selection




Frequency of individuals
Original population
Phenotypes (fur color)
Original population
Evolved population
Stabilizing selection
Directional selection
Disruptive selection

Pepper Moths

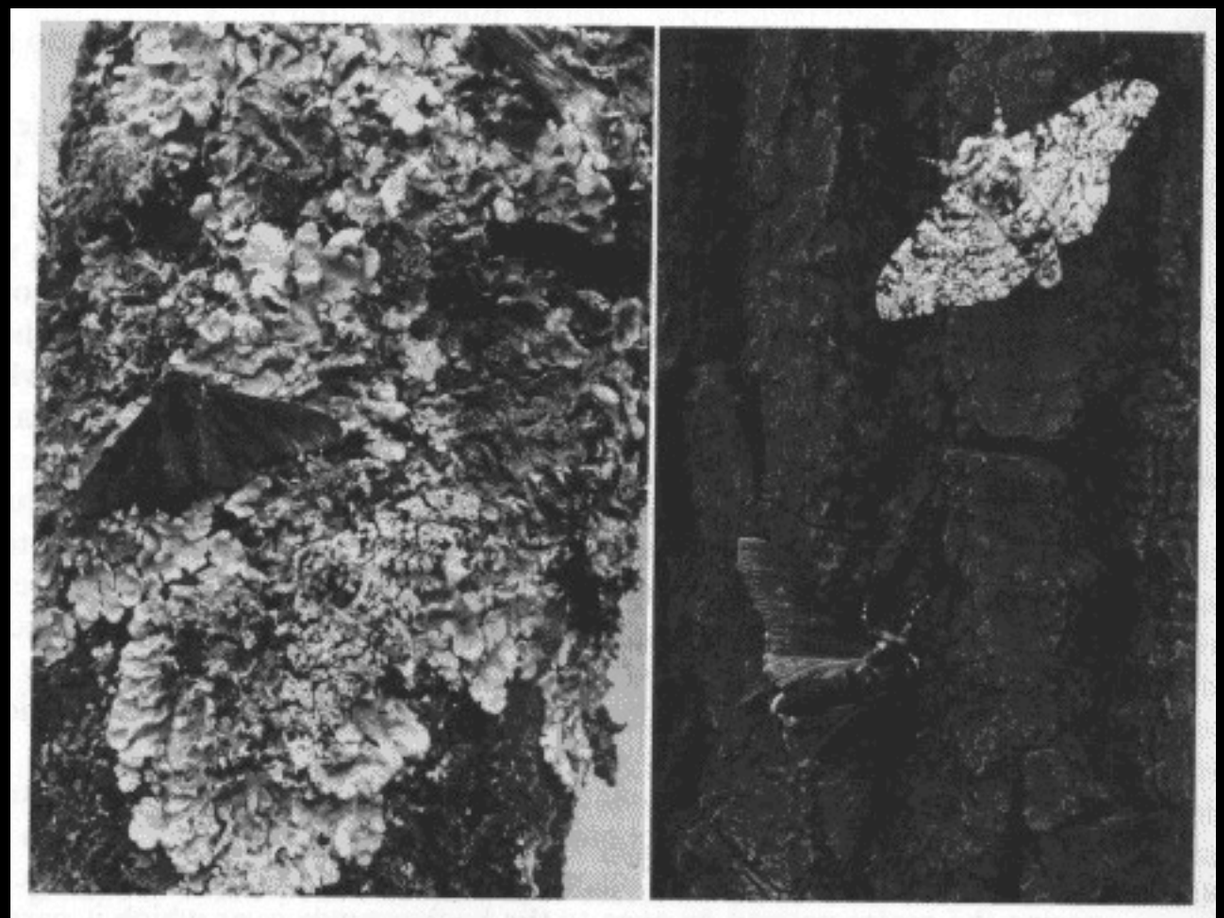


Figure 6.6 The *typical* and *carbonaria* forms of *Biston betularia*, the peppered math, are shown at rest on a lichen-covered tree trunk in the unpolluted countryside on the left and at rest on a soot-covered oak trunk near Birmingham, England, on the right. The *typical* form may be found in the left-hand picture just below and to the right of the black moth. [Courtesy of H. B. D. Kettlewell.]

(from Mettler et al. 1986)

Four Forces and Populations

	Within	Between
Mutation	↑	↑
Genetic Drift	↓	↑
Natural Selection	= ↓	↑
Gene Flow	↑	↓

MICROEVOLUTION = the small changes in gene frequencies in a population from generation to generation

MACROEVOLUTION = the cumulative effect of these small changes over a long period of time - may lead to SPECIATION

What is a species?
What is speciation?

What is a species?

- an interbreeding group of animals or plants that are reproductively isolated though anatomy, ecology, behavior, or geographic distribution from all other such groups

Reproductive Isolating Mechanisms

- Premating RIMs

  Habitat isolation
  Temporal isolation
  Behavioral isolation
  Mechanical incompatibility

- Postmating RIMs

  Sperm-egg incompatibility
  Zygote inviability
  Embryonic or fetal inviability

Theridon grallator

Pan

Common Chimpanzee

Bonobo

Gorilla

Mountain

Eastern lowland

Western lowland

X

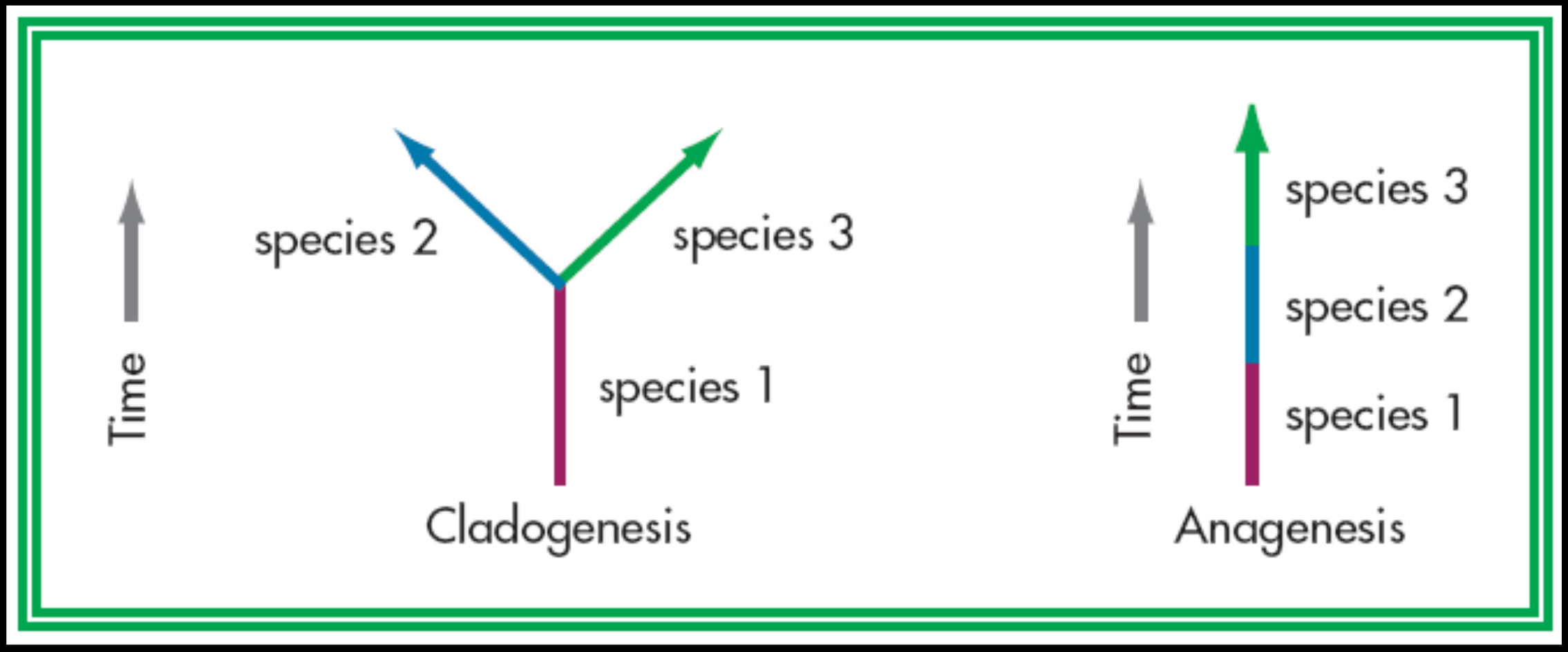
X

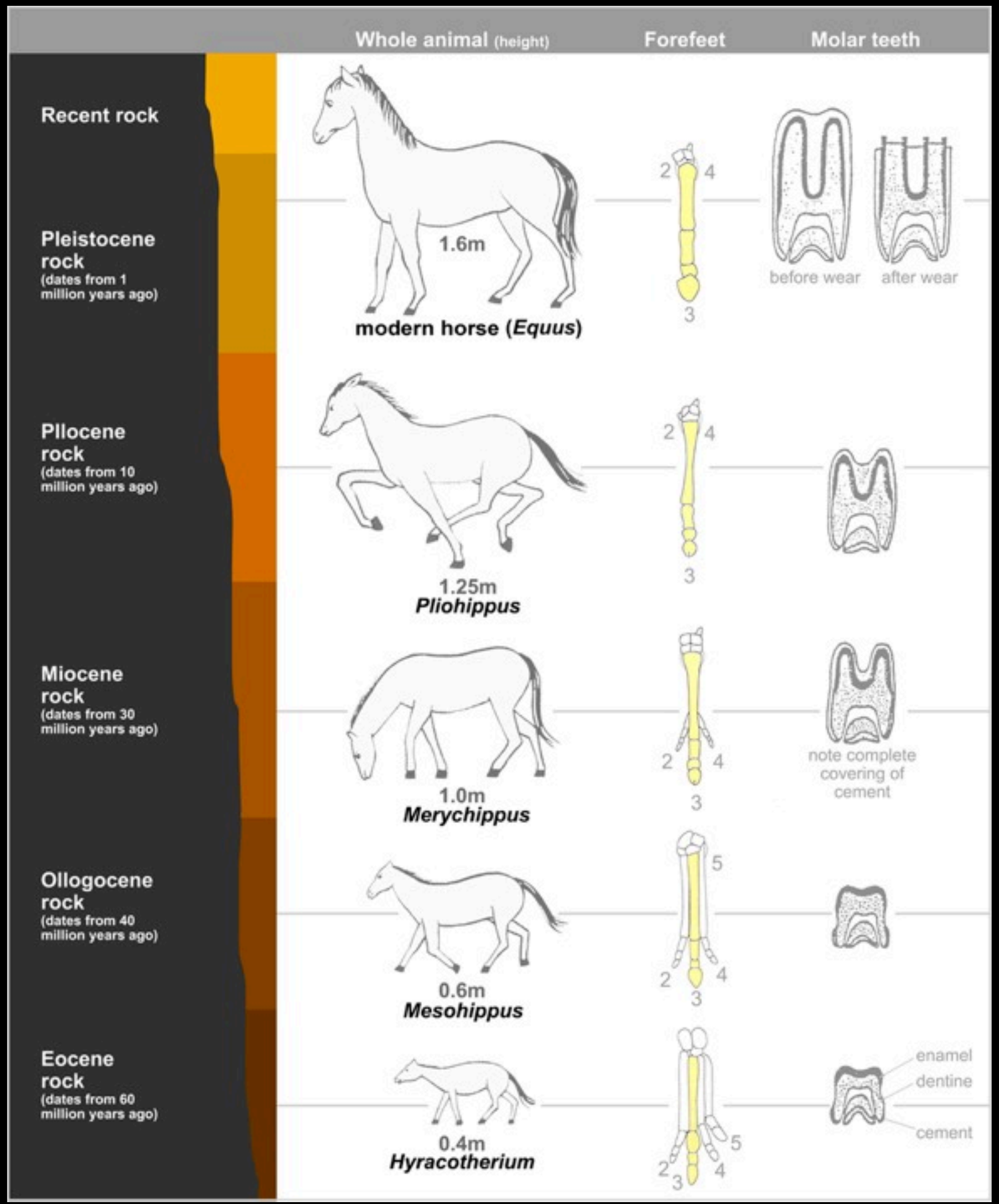
=

Species Concepts

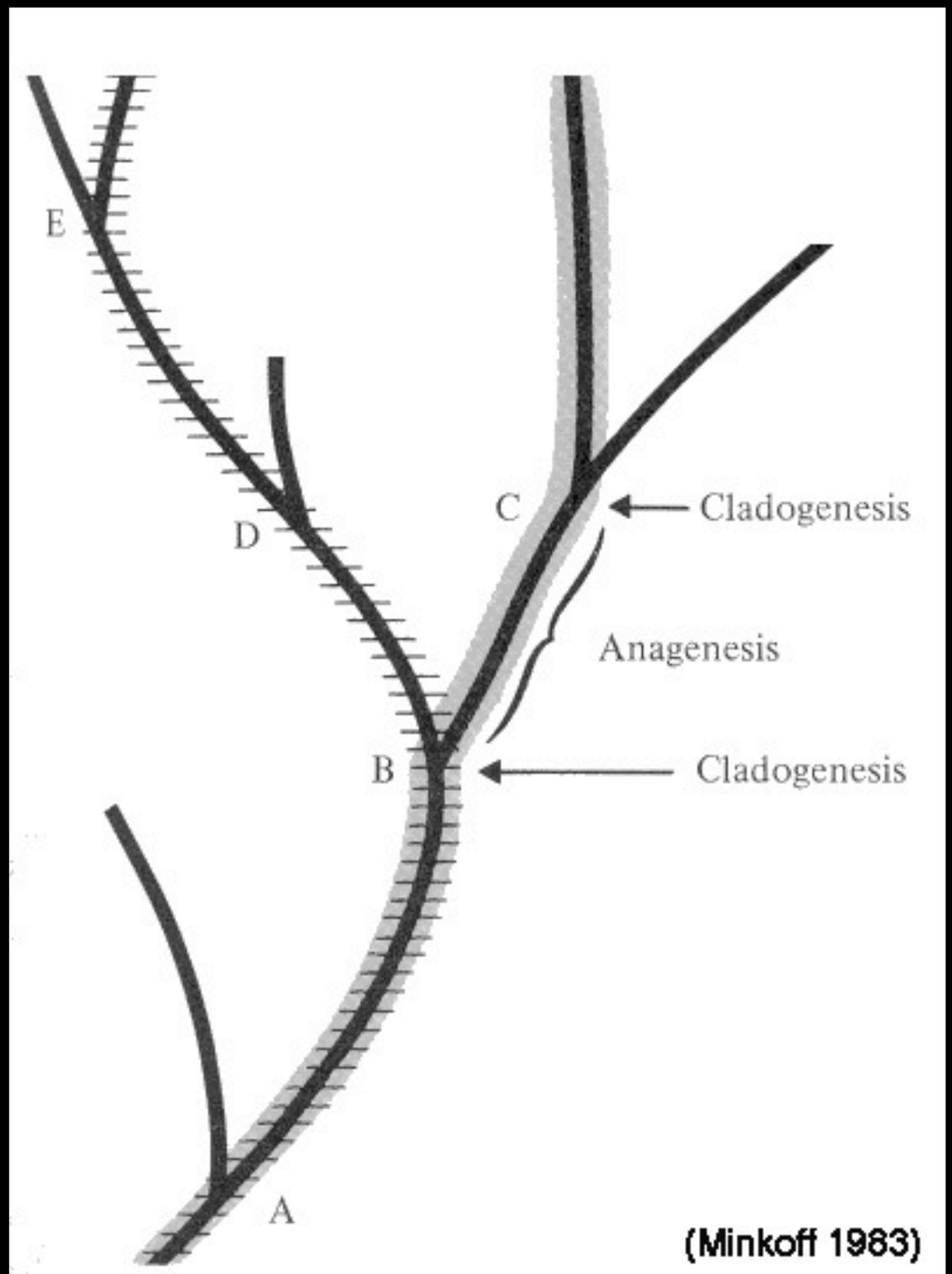
- **Biological species concept**: Defines species as interbreeding populations reproductively isolated from other such populations.
- **Evolutionary species concept**: Defines species as evolutionary lineages with their own unique identity.
- **Ecological species concept**: Defines species based on the uniqueness of their ecological niche.
- **Recognition species concept**: Defines species based on unique traits or behaviors that allow members of one species to identify each other for mating.

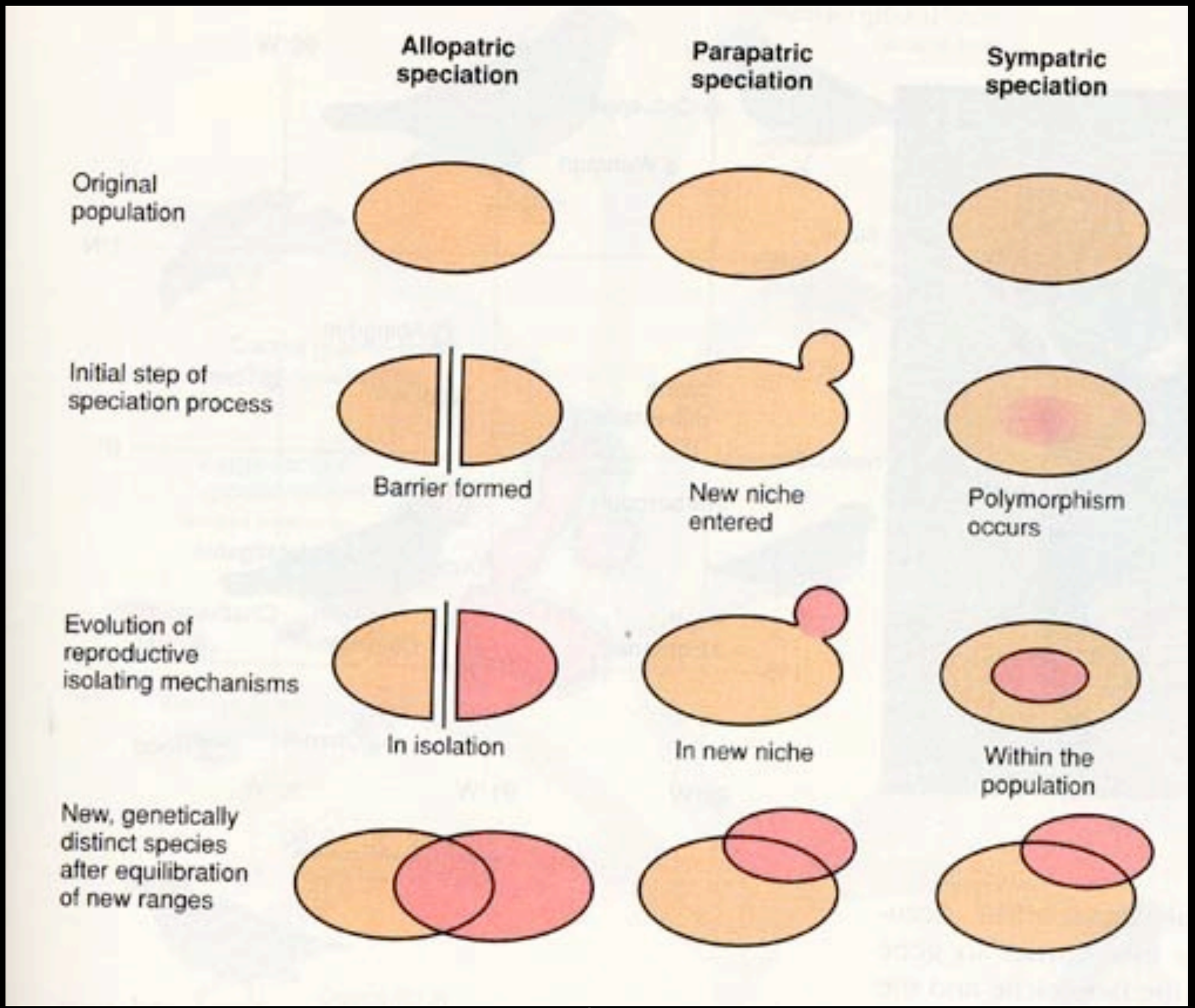
Modes of Evolutionary Change

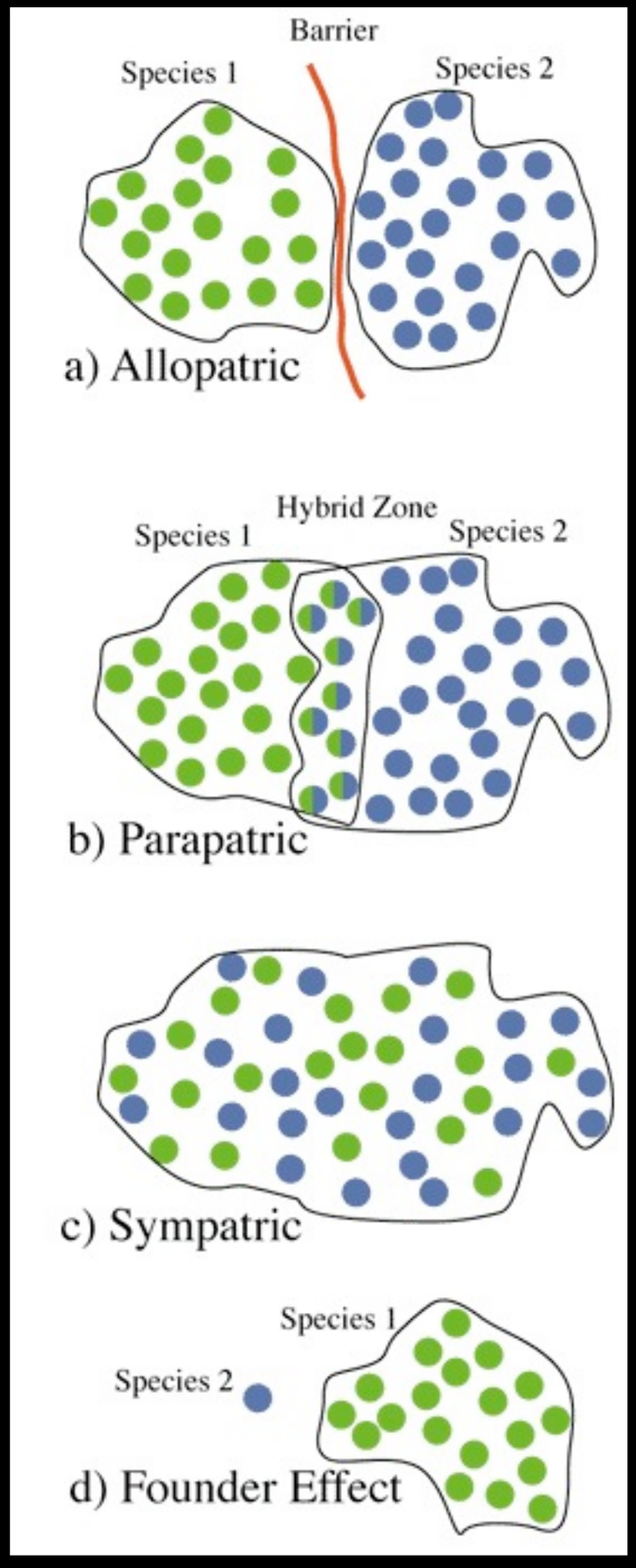


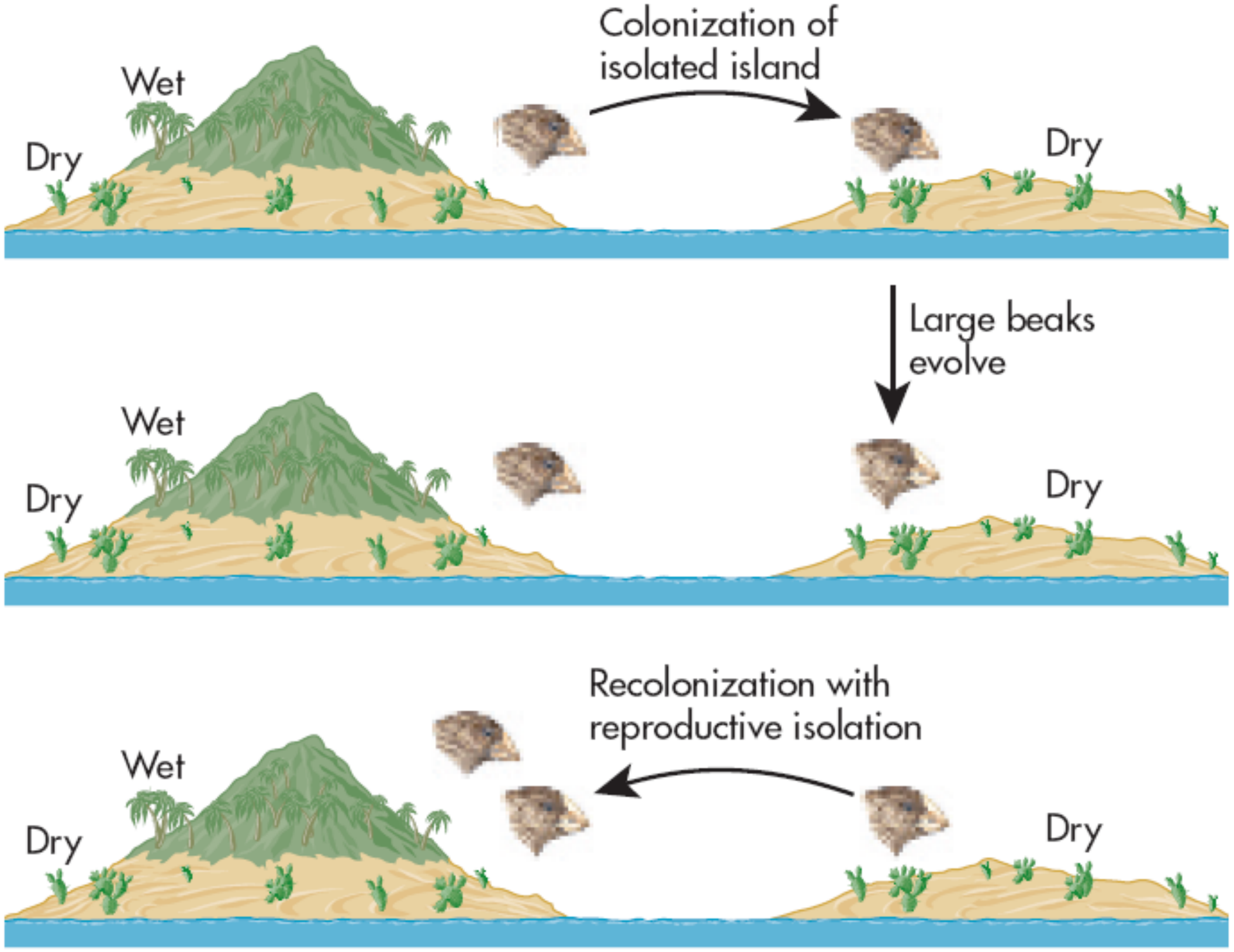

Whole animal (height)
Forefeet
Molar teeth
Recent rock
Pleistocene rock (dates from 1 million years ago)
1.6m
modern horse (Equus)
2
4
3
before wear
after wear
Pllocene rock (dates from 10 million years ago)
1.25m
Pliohippus
Miocene rock (dates from 30 million years ago)
1.0m
Merychippus
note complete covering of cement
Ollogocene rock (dates from 40 million years ago)
5
0.6m
Mesohippus
Eocene rock (dates from 60 million years ago)
0.4m
Hyracotherium
enamel
dentine
cement

Cladogenesis

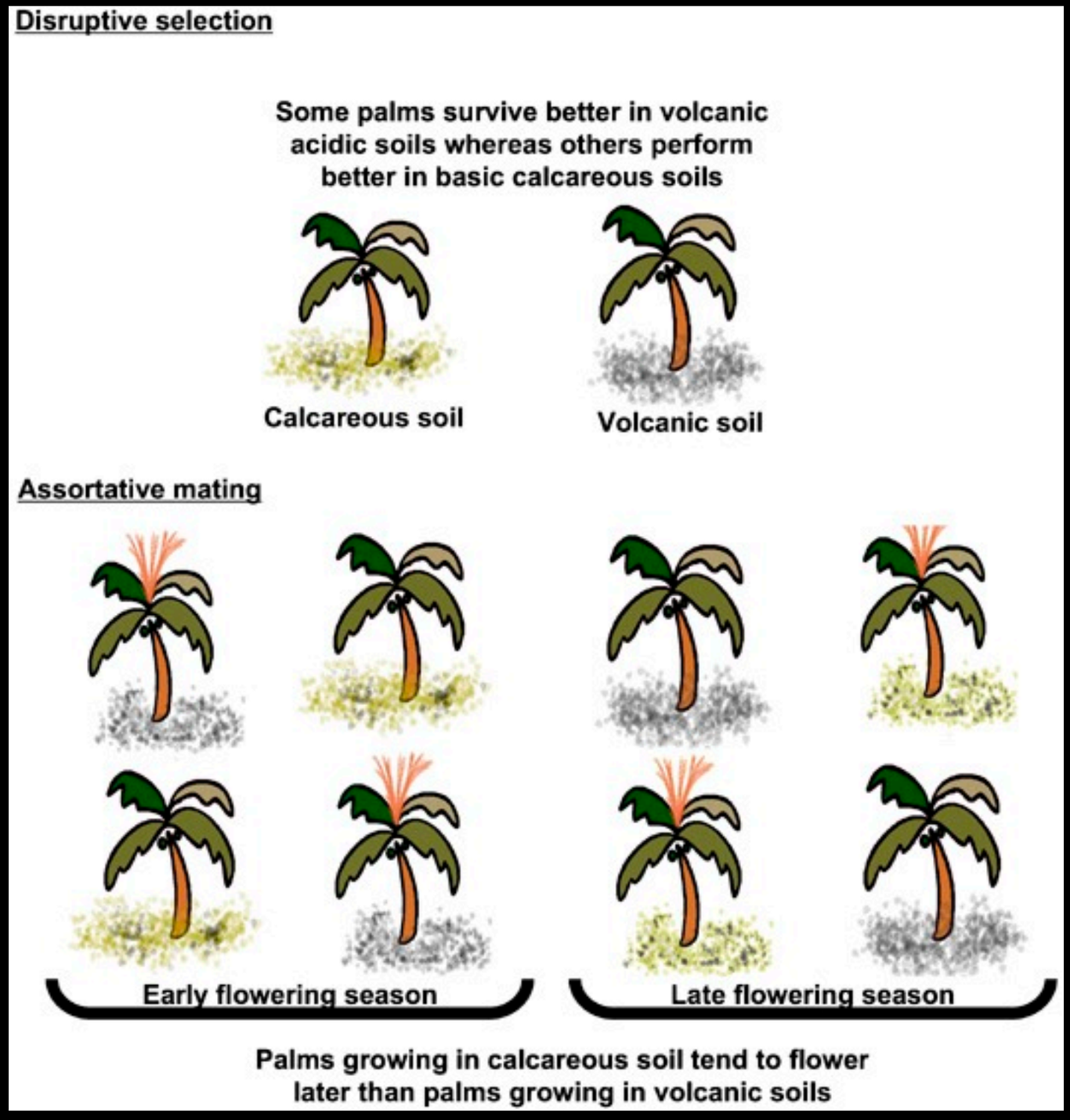



Allopatric speciation
Parapatric speciation
Sympatric speciation
Original population
Initial step of speciation process
Barrier formed
New niche entered
Polymorphism occurs
Evolution of reproductive isolating mechanisms
In isolation
In new niche
Within the population
New, genetically distinct species after equilibration of new ranges


Barrier
Species 1
Species 2
a) Allopatric
Hybrid Zone
Species 1
Species 2
b) Parapatric
c) Sympatric
Species 1
Species 2
d) Founder Effect


Colonization of isolated island
Wet
Dry
Dry
Large beaks evolve
Wet
Dry
Dry
Recolonization with reproductive isolation
Wet
Dry
Dry

Sympatric speciation



Speciation creates clades

- clades are evolutionarily related groups
- Classification is the naming of these groups
- Started with Linnaeus
  - tried to group organisms together based on relationship
  - based on similarity

Tempo of Speciation?

- Gradualism?
- Punctuated Equilibrium?