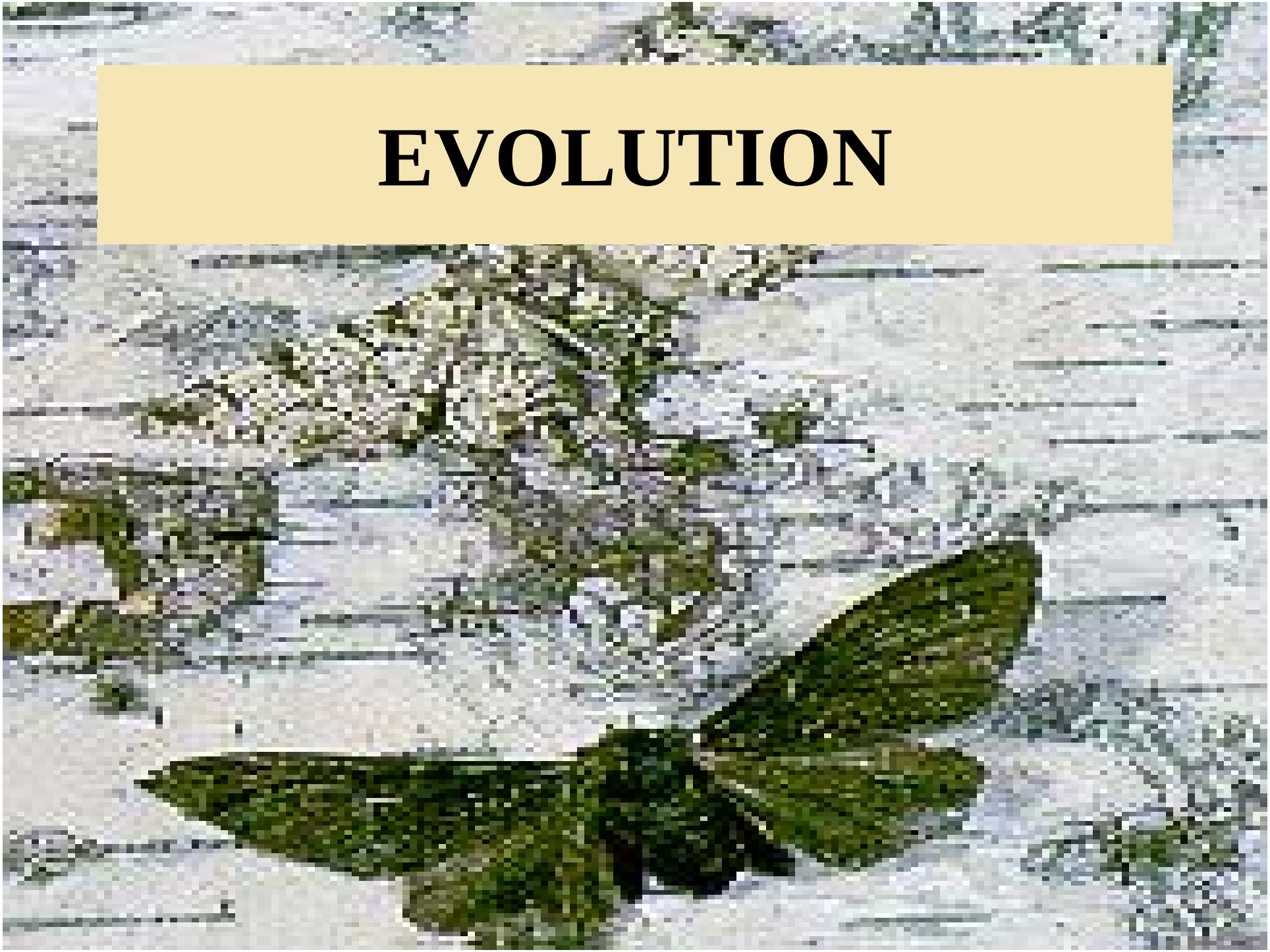
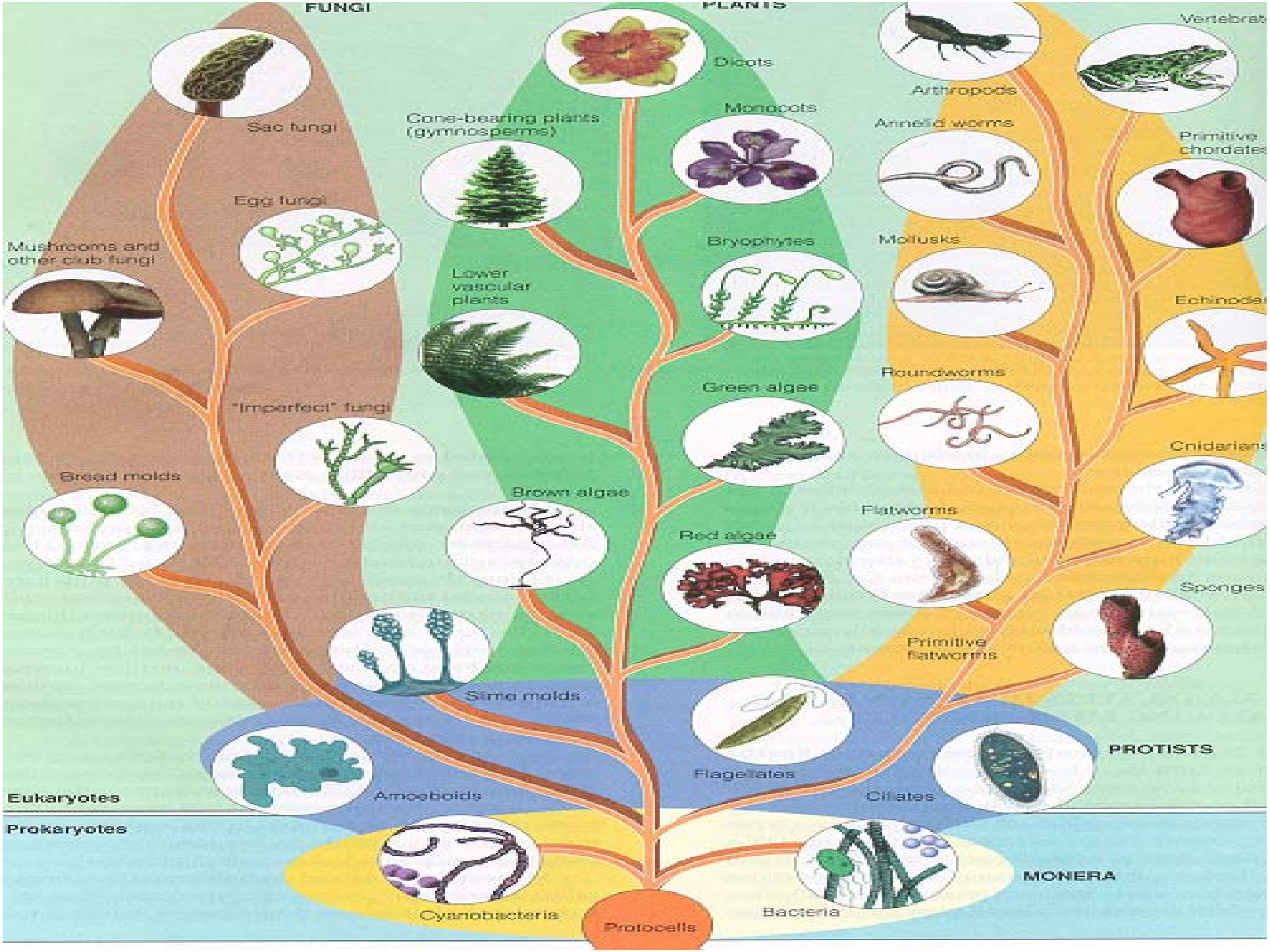
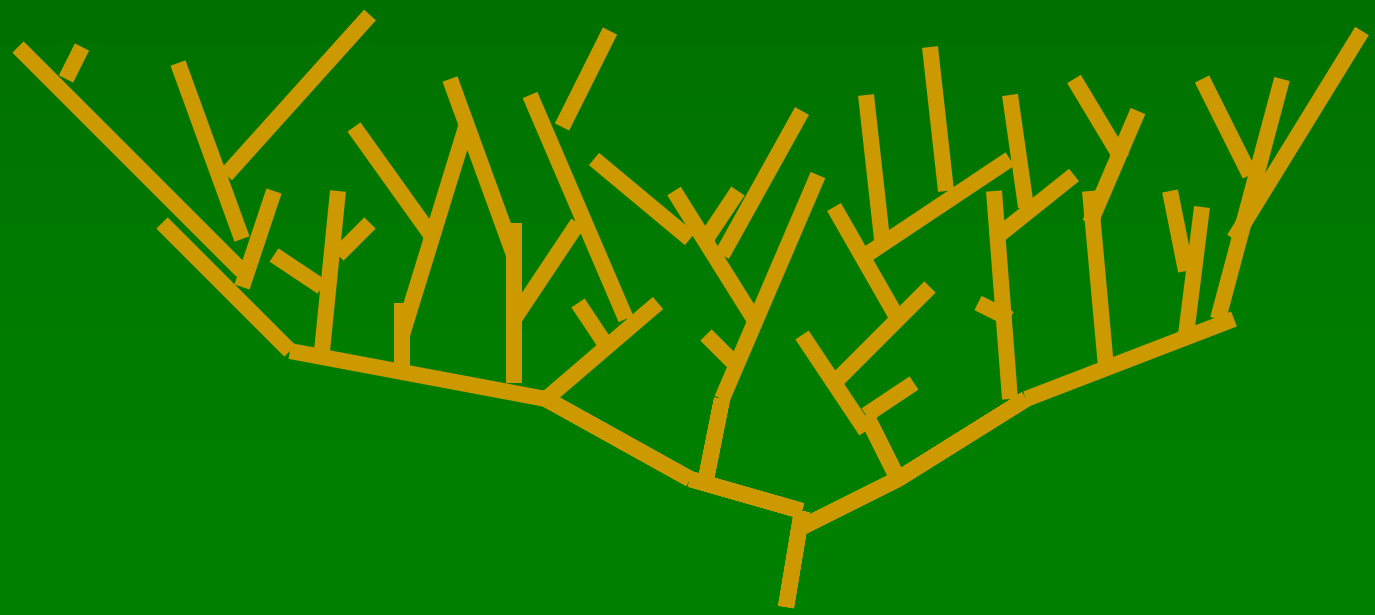

TOM'S SHELL
Self Serve
Cash or Credit
Regular
ARM 9
Plus
LEG 9
Premium
First 9 Born

EVOLUTION



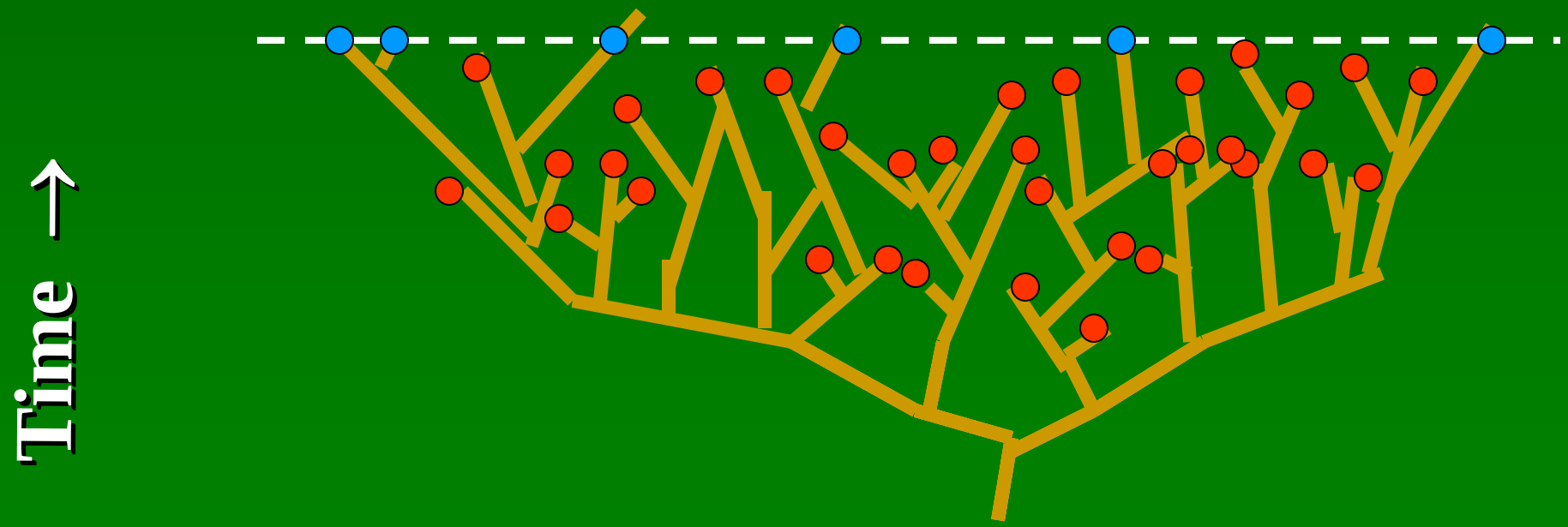

FUNGI
PLANTS
Sac fungi
Egg fungi
Mushrooms and other club fungi
"Imperfect" fungi
Bread molds
Cone-bearing plants (gymnosperms)
Dicots
Monocots
Bryophytes
Lower vascular plants
Green algae
Brown algae
Red algae
Slime molds
Amoeboids
Flagellates
Ciliates
Arthropods
Annelid worms
Mollusks
Roundworms
Flatworms
Primitive flatworms
Vertebrat
Primitive chordates
Echinoder
Cnidarians
Sponges
PROTISTS
Eukaryotes
Prokaryotes
MONERA
Cyanobacteria
Protocells
Bacteria

Evolutionary Bush --
thousands of earlier and later branches.



At any given moment (e.g. the 'present'), all we see is current diversity…

all extinct forms are gone (99.9%)



Species Theory

- What is a species?
  - Two populations of sexually reproducing organisms can be considered separate species if they **cannot interbreed** (or are reproductively isolated)

Species Theory

- What is the problem with this definition?
  - Many species don't have the opportunity to interbreed, so how do you know if they can?
  - What if they breed, but don't produce viable offspring? (mules)
  - What about asexually reproducing species?
  - These days we can separate species based on % of shared DNA-- how much is too much?
  - This is a vague area

Evolution

- Definition
  - heritable changes in the genetic make-up of a population of successive generations

How did life evolve?

- Best hypothesis:
- Chemical Evolution - 1 billion years
  - formation of early molecules--> proteins --> proteins--> complex organic molecules
- Biological Evolution - 3.7 billion years
  - prokaryotes-->eukaryotes-->diversification

Four causes of evolutionary change:

1. **Mutation: fundamental origin of *all* genetic (DNA) change.**

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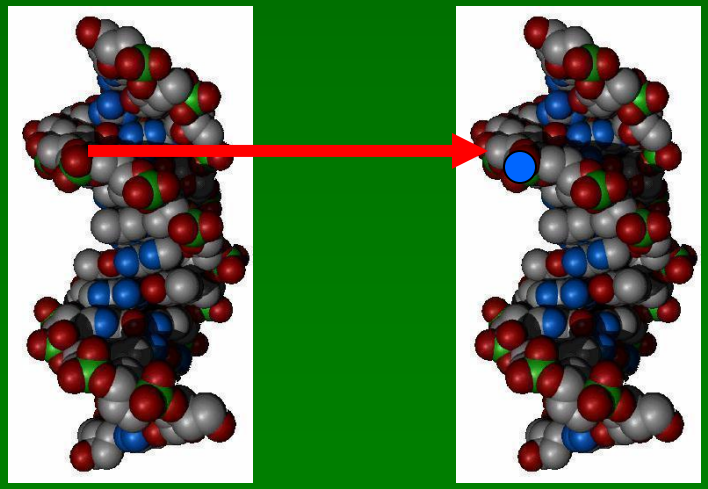
Point mutation

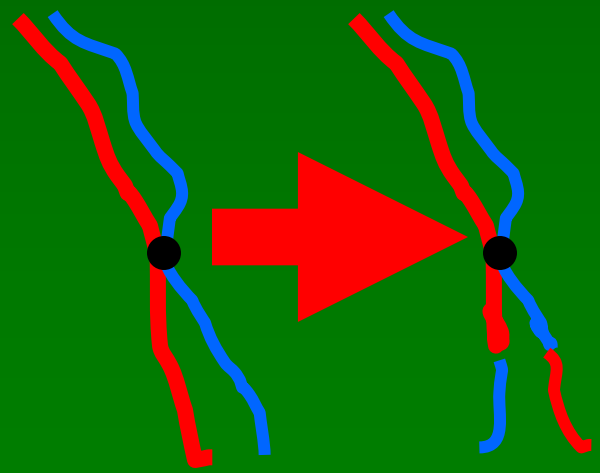


…some at base-pair level

Four causes of evolutionary change:

1. **Mutation: fundamental origin of *all* genetic (DNA) change.**

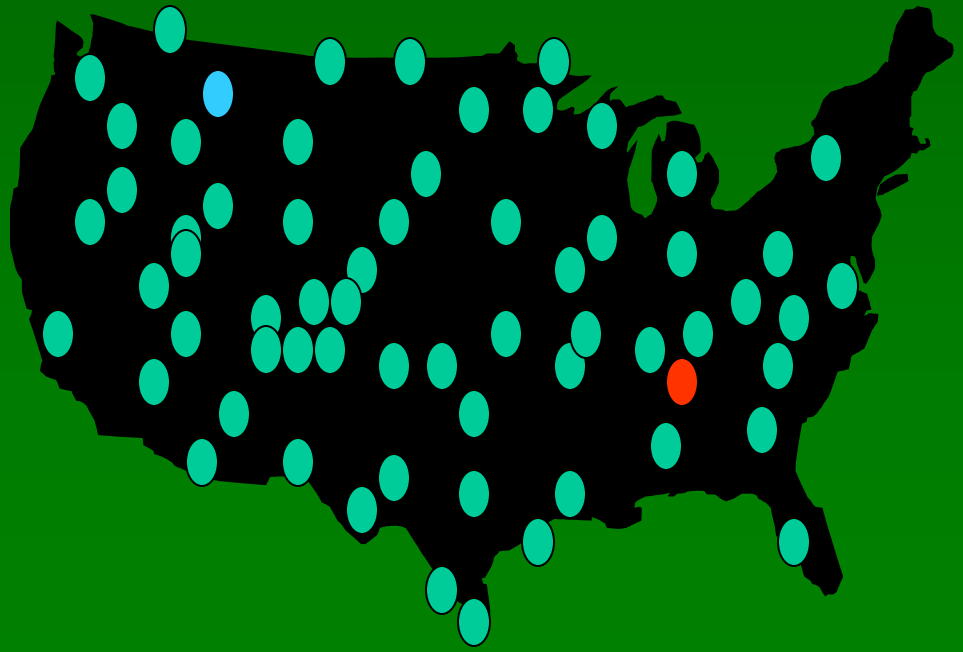
Crossing-over



…others at grosser chromosome level

Four causes of evolutionary change:

1. **Mutation: fundamental genetic shifts.**
2. **Genetic Drift: isolated populations accumulate different mutations over time.**



In a continuous population, genetic novelty can spread locally.

Four causes of evolutionary change:

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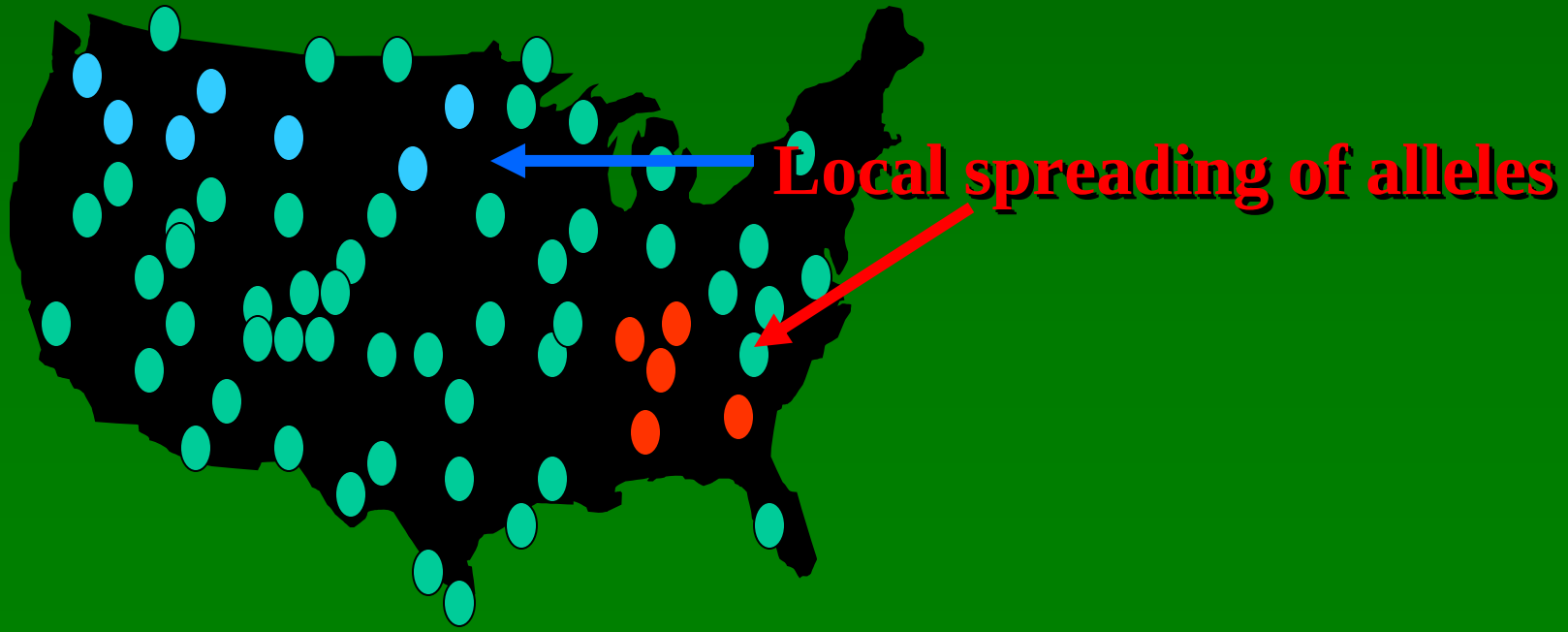

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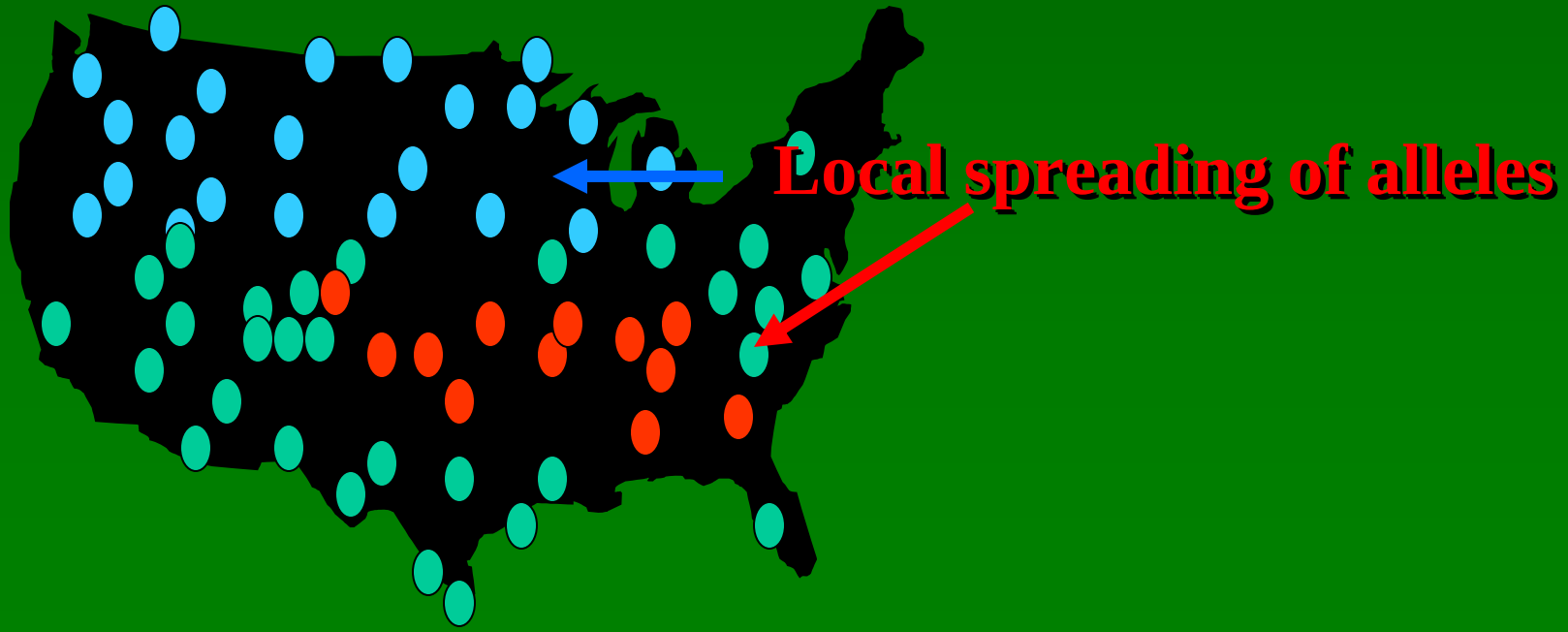

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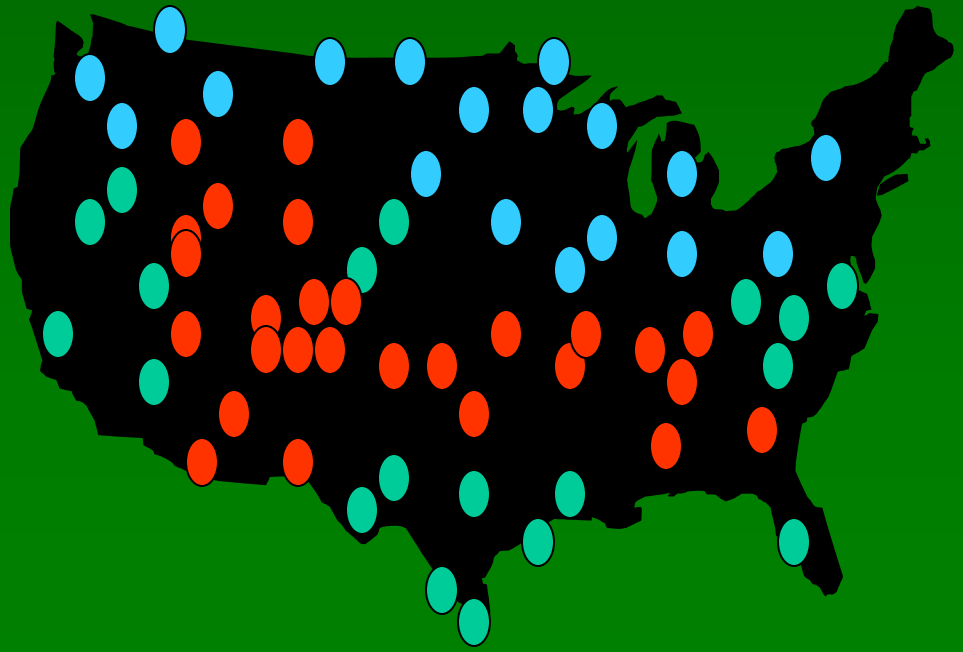
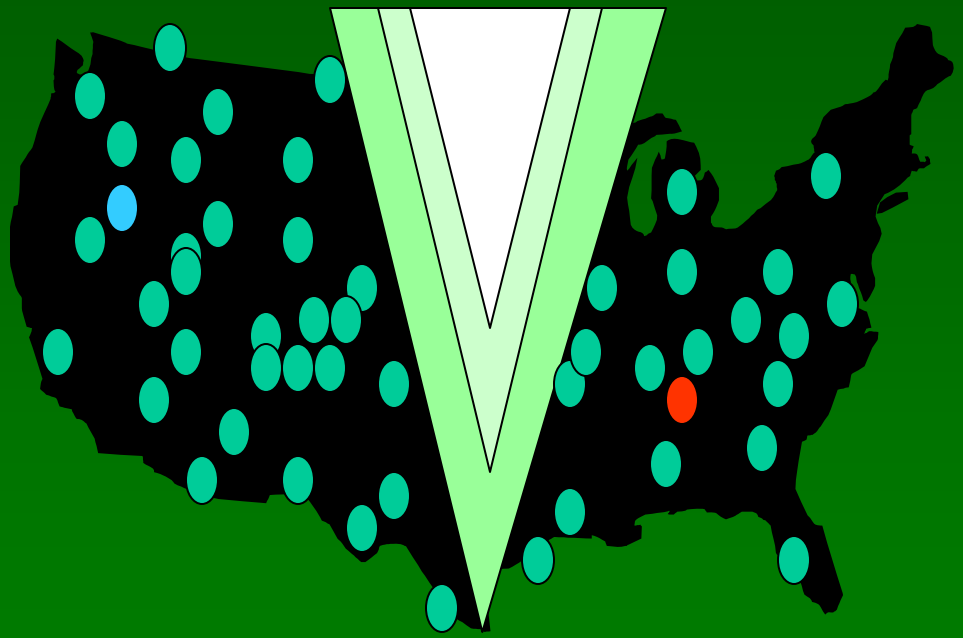


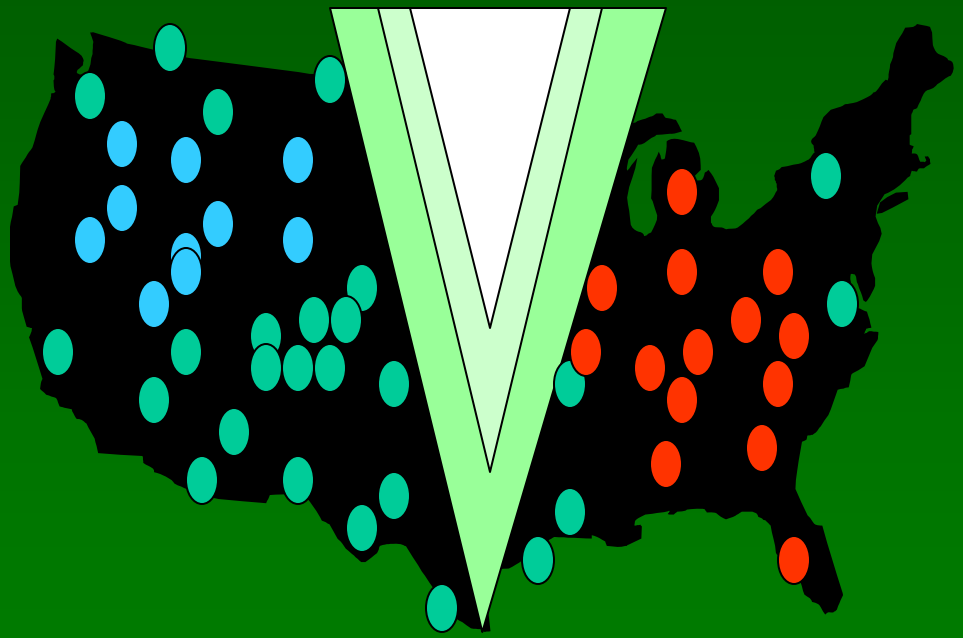
Spreading process known as 'gene flow'.

Four causes of evolutionary change:



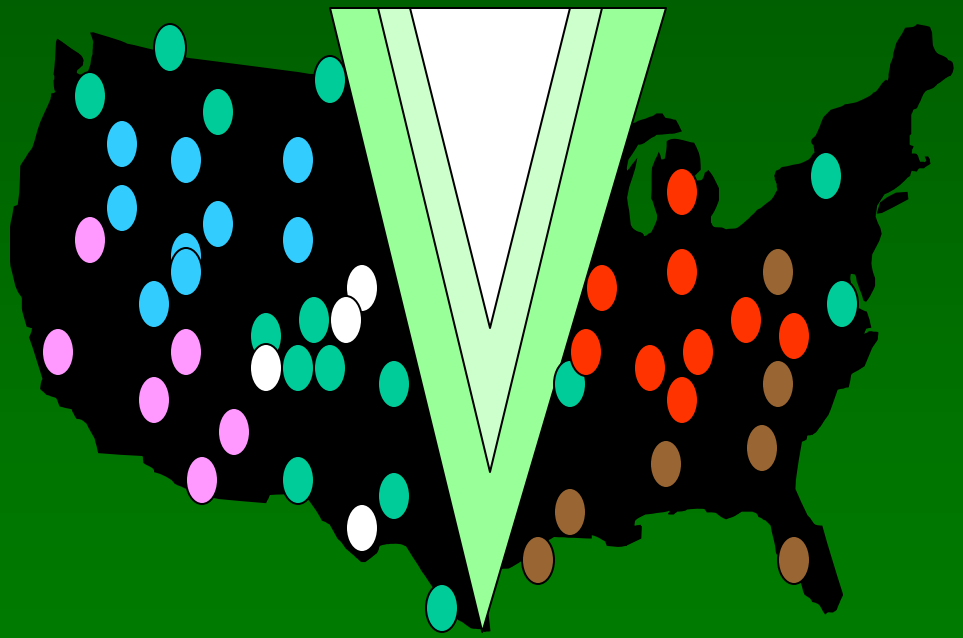
But in discontinuous populations, gene flow is blocked.

Four causes of evolutionary change:



Variations accumulate without **inter-demic** exchange

Four causes of evolutionary change:

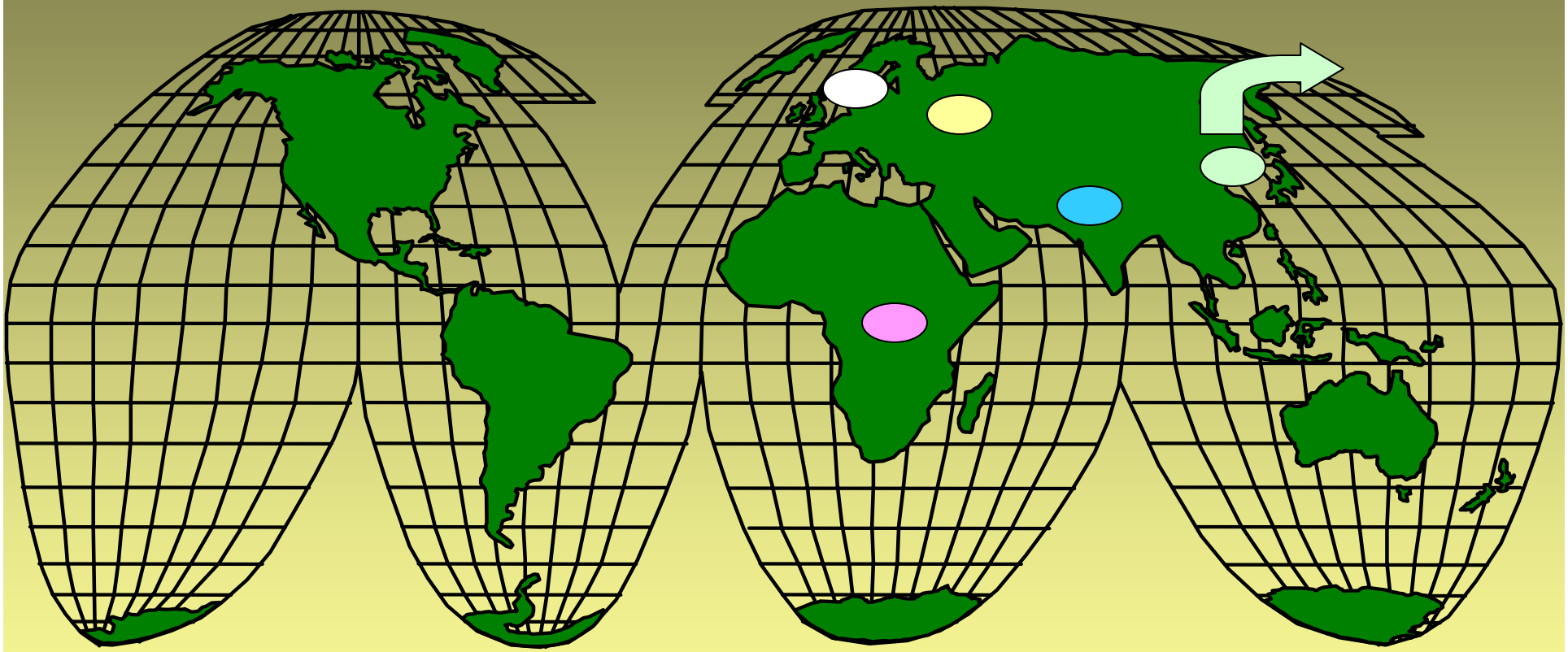


Of course, this works at many loci simultaneously

Four causes of evolutionary change

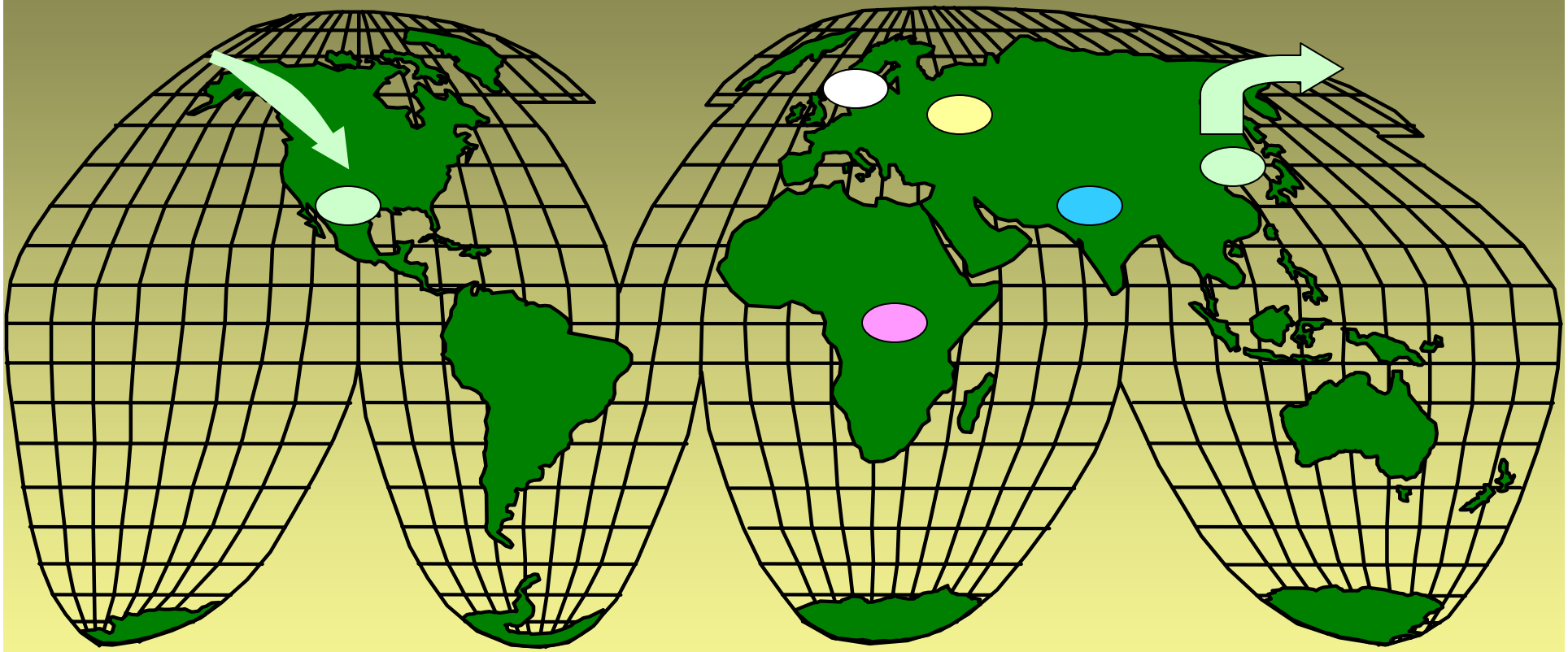
1. **Mutation: fundamental genetic shifts.**
2. **Genetic Drift: isolation → accumulate mutations**
3. **Founder Effect: *sampling bias* during immigration. When a new population is formed, its genetic composition depends largely on the gene frequencies within the group of first settlers.**

Founder Effect.--



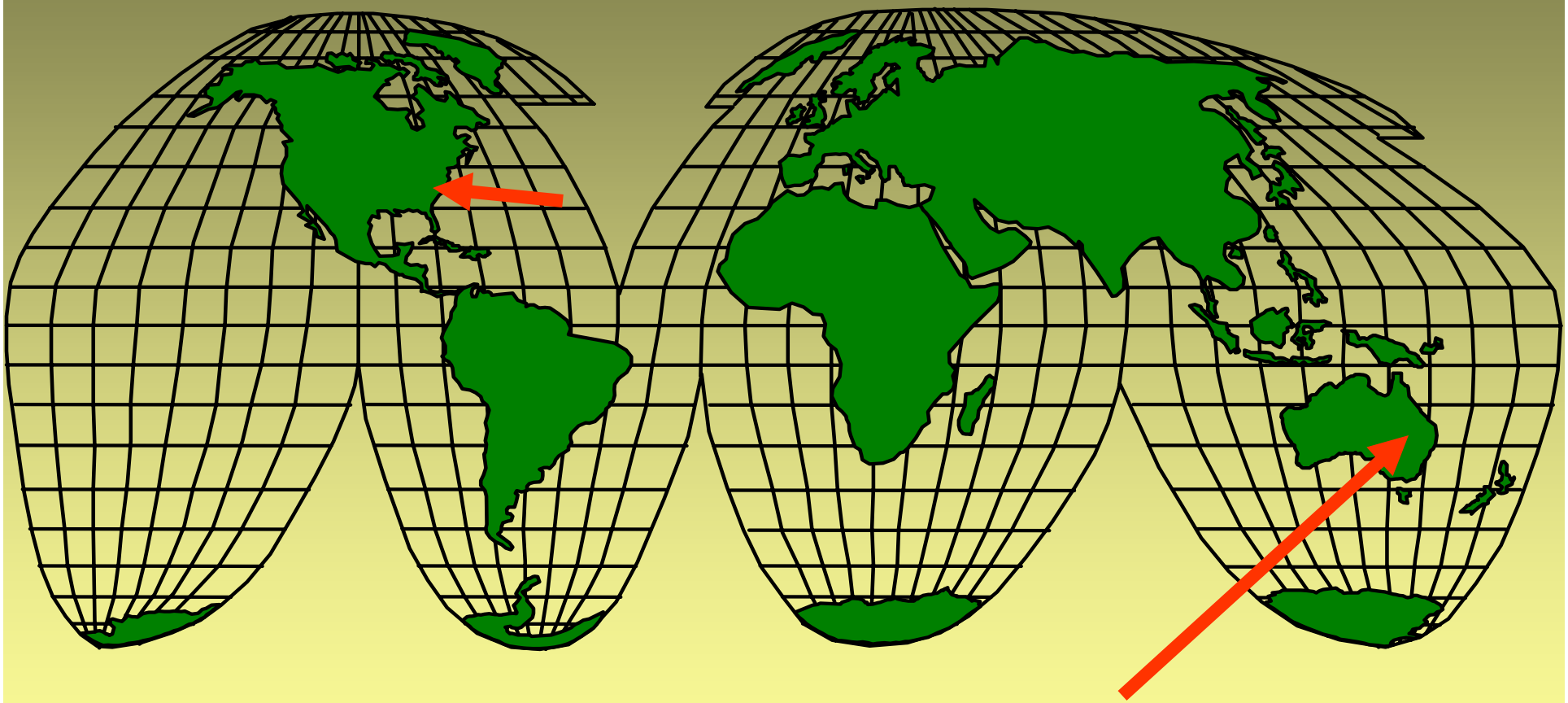
Human example: your tribe had to live near the Bering land bridge…

Founder Effect.--



…to invade & settle the ‘New World’!

Founder Effect



Human examples: consider penal colonies

Steps of Evolution

1. Genetic variation is added to genotype by mutation
2. Genetic mutations lead to visible changes to the organism (phenotype)
3. Phenotype is acted upon by natural selection
4. Individuals that are most well suited to the environment produce more offspring

Steps of Evolution

5. A population changes over time
6. Allopatric or sympatric speciation
7. Development of reproductive isolating mechanism

Microevolution

Small genetic changes in a population such as the spread of a mutation, or the change in the frequency of a single allele due to selection

ex. peppered moths

Macroevolution

Long-term, large-scale changes in organisms. Usually involves major changes among groups of species (development of new genera) ex. horses

Natural Selection

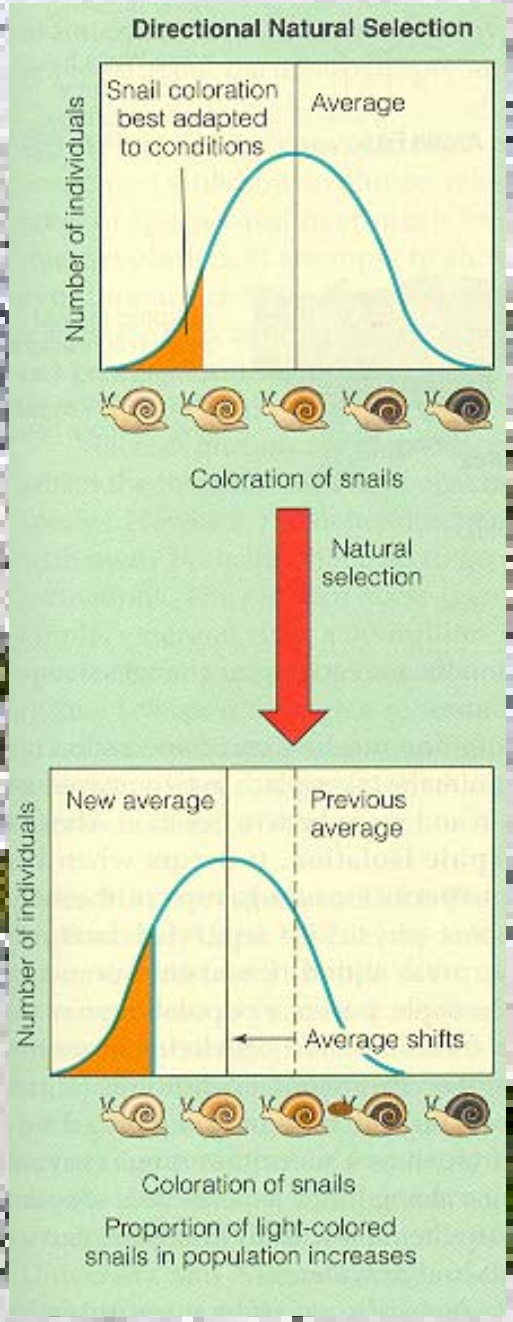
Definition - nonrandom breeding of individuals where the individuals that have the highest reproductive success are those that are most suited to the environment

Types - directional

stabilizing

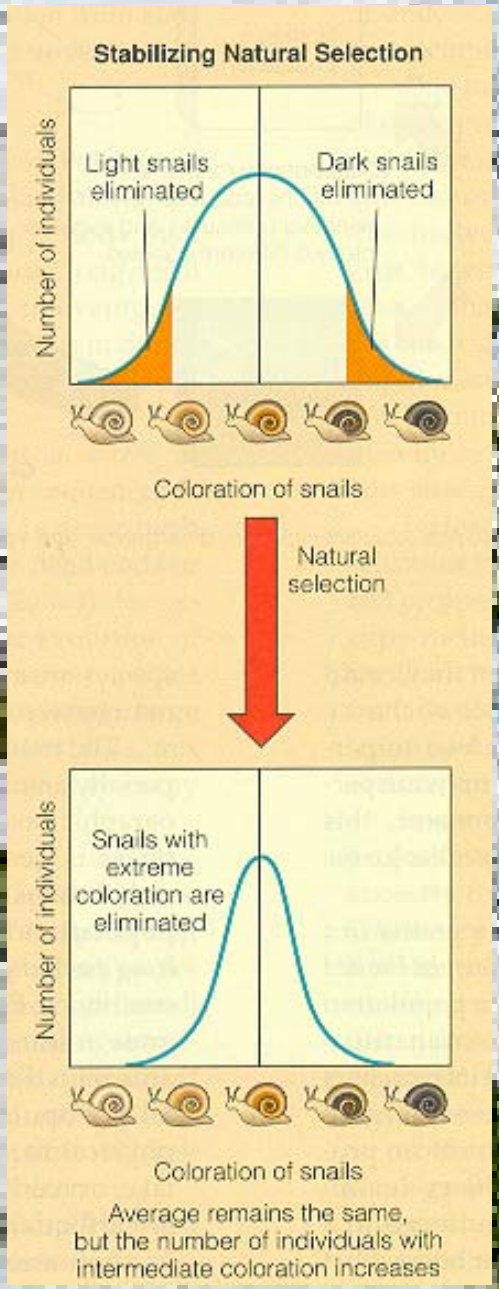
diversifying

Directional Selection



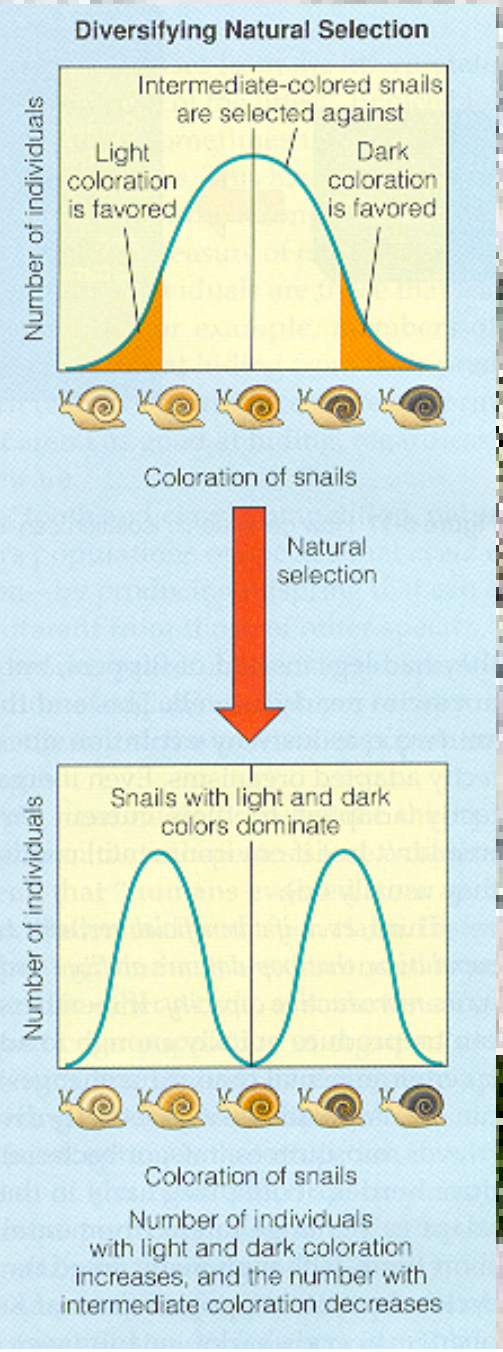
- Individuals from just one side of the distribution reproduce
- population looks different over time
- mean changes
- range does not change

Stabilizing Selection



- Individuals from the center of the distribution are the only ones to reproduce
- individuals look more similar over time
- mean does not change
- range narrows

Diversifying Selection



- Individuals from the ends of the distribution are the only ones to reproduce
- produced 2 separate phenotypes
- mean does not change (but few individuals at mean)
- range increases

What is the result of natural selection?

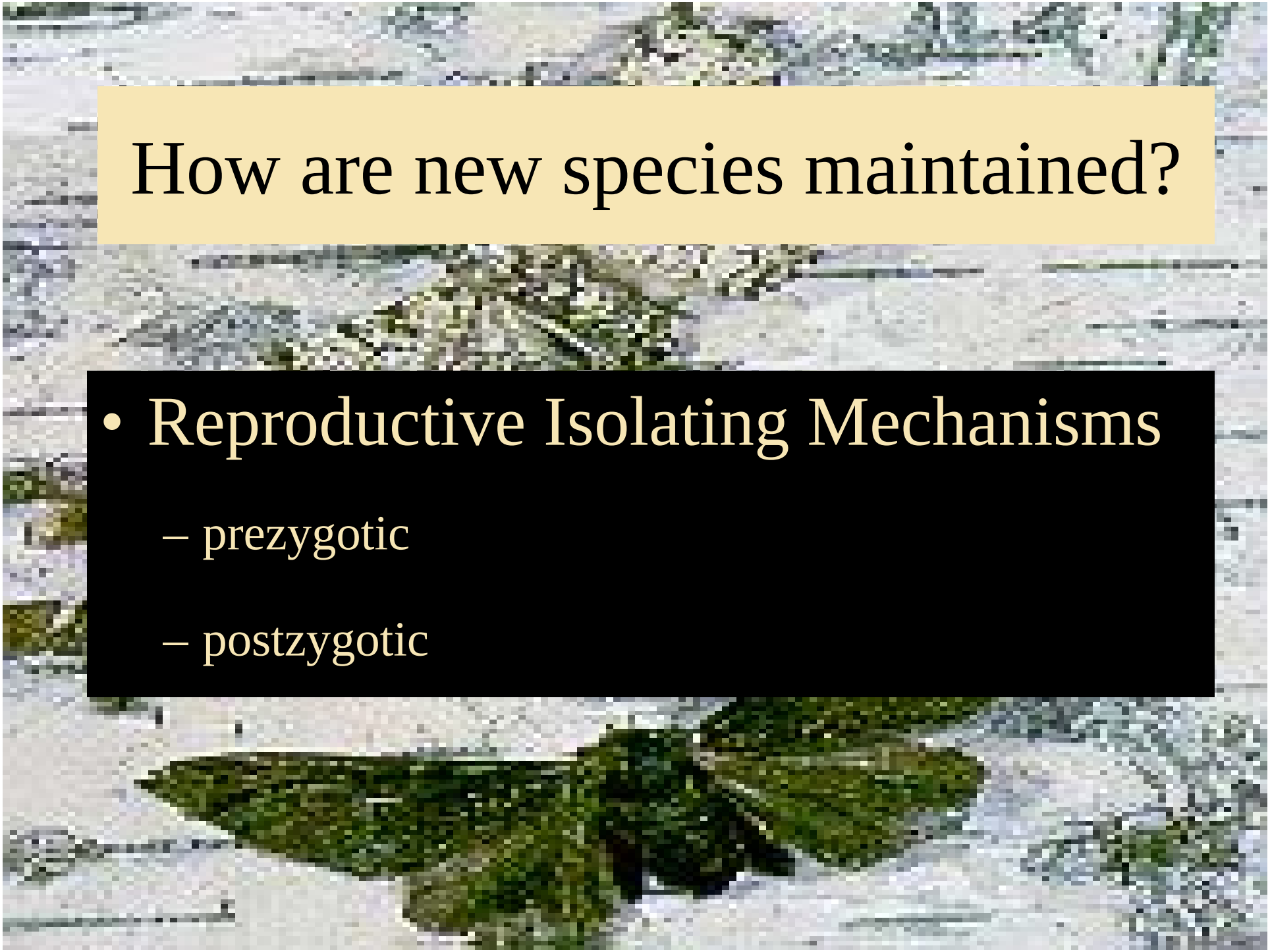
- Speciation

How does speciation occur?

allopatric speciation

sympatric speciation

polyploidy



How are new species maintained?

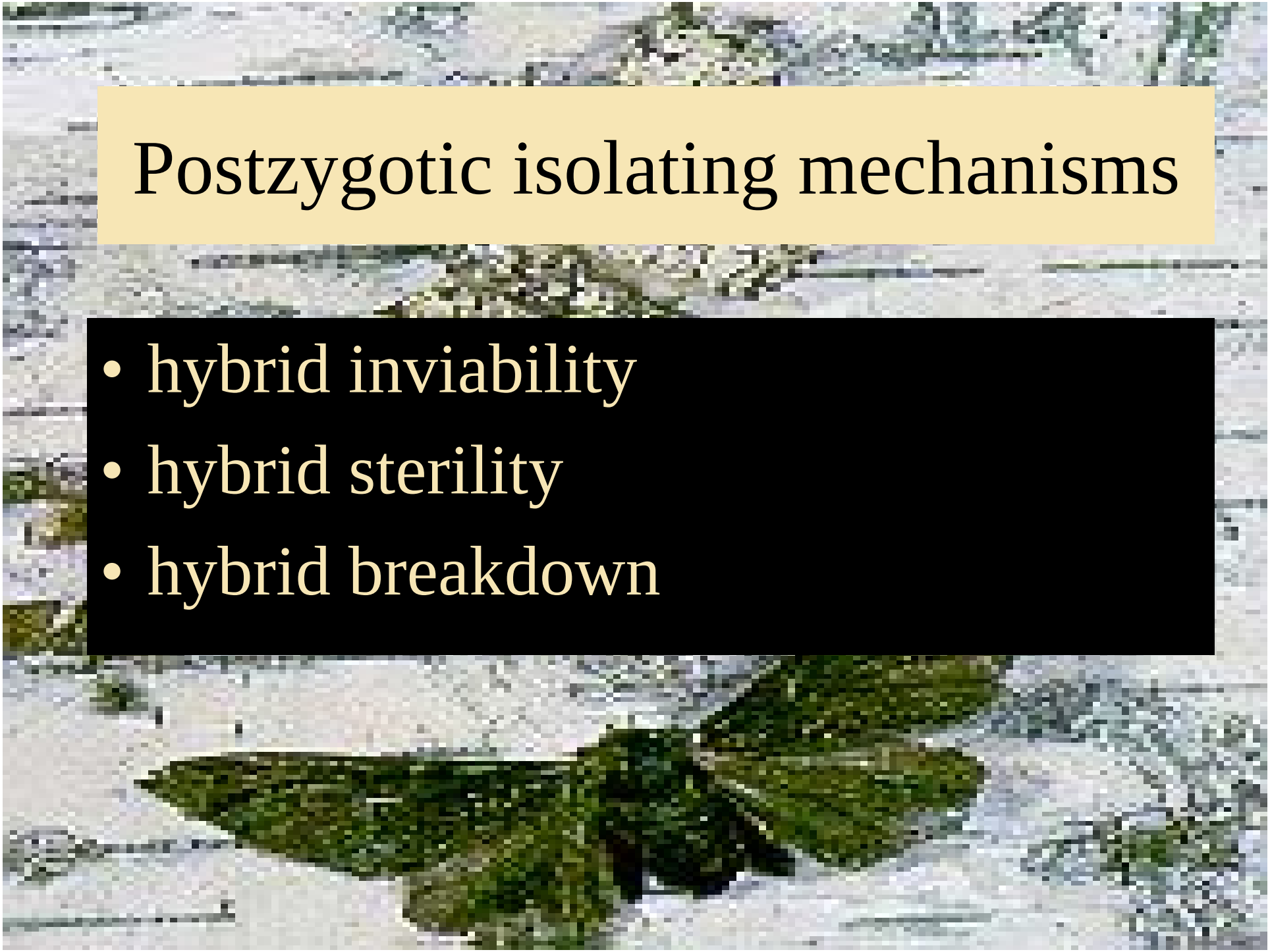
- Reproductive Isolating Mechanisms
  - prezygotic
  - postzygotic

Prezygotic isolating mechanisms

- geographical isolation
- temporal isolation
- behavioral isolation
- mechanical isolation
- gametic isolation

Postzygotic isolating mechanisms

- hybrid inviability
- hybrid sterility
- hybrid breakdown



What are the limits to adaptation?

- Genetic drift
- limited genetic variability in population
- compromises in evolution
- time delays
- reproductive capacity

What determines biodiversity?

Biodiversity = Speciation - Extinction

(number of species on the planet)

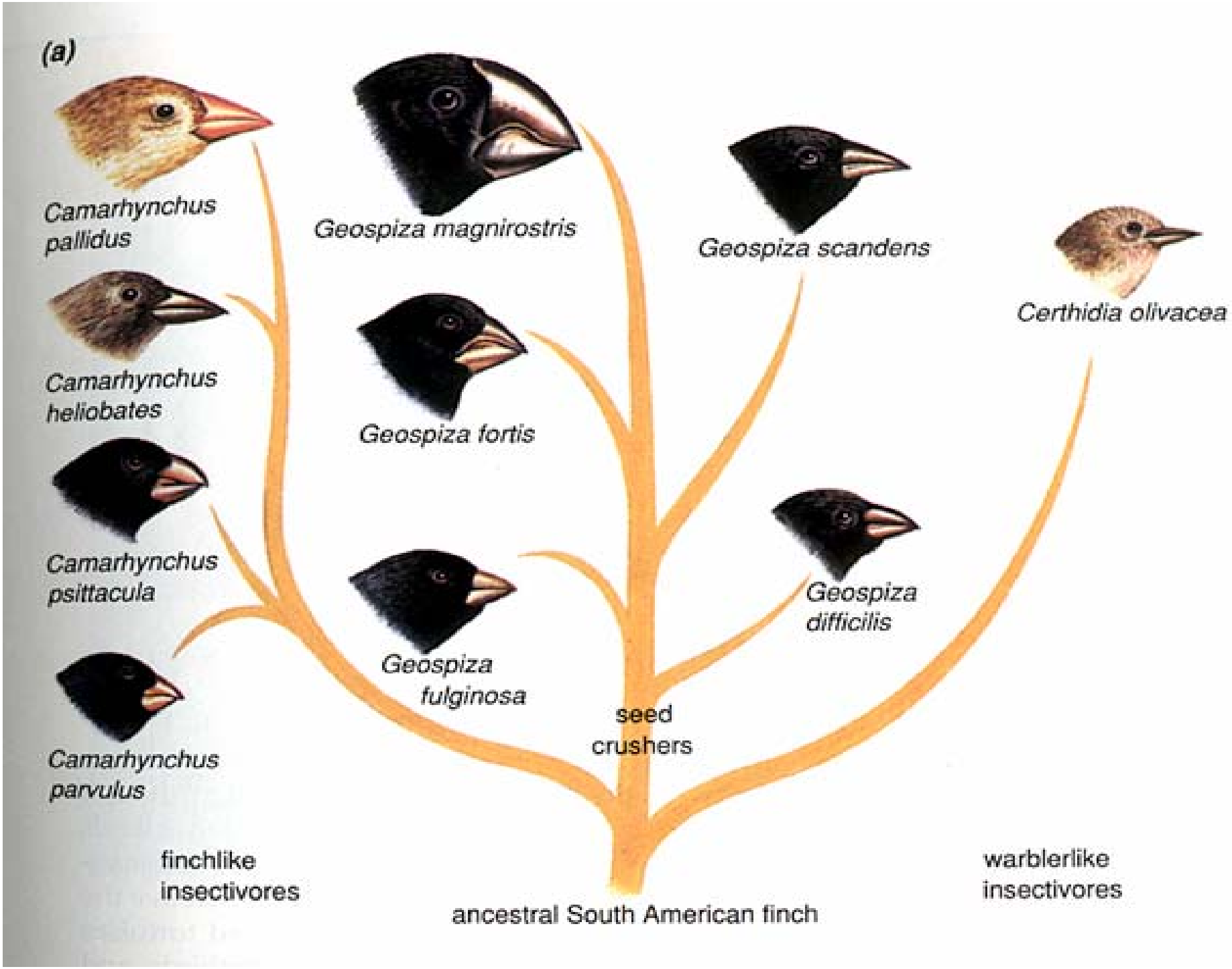
creation of new species

removal of species

Speciation

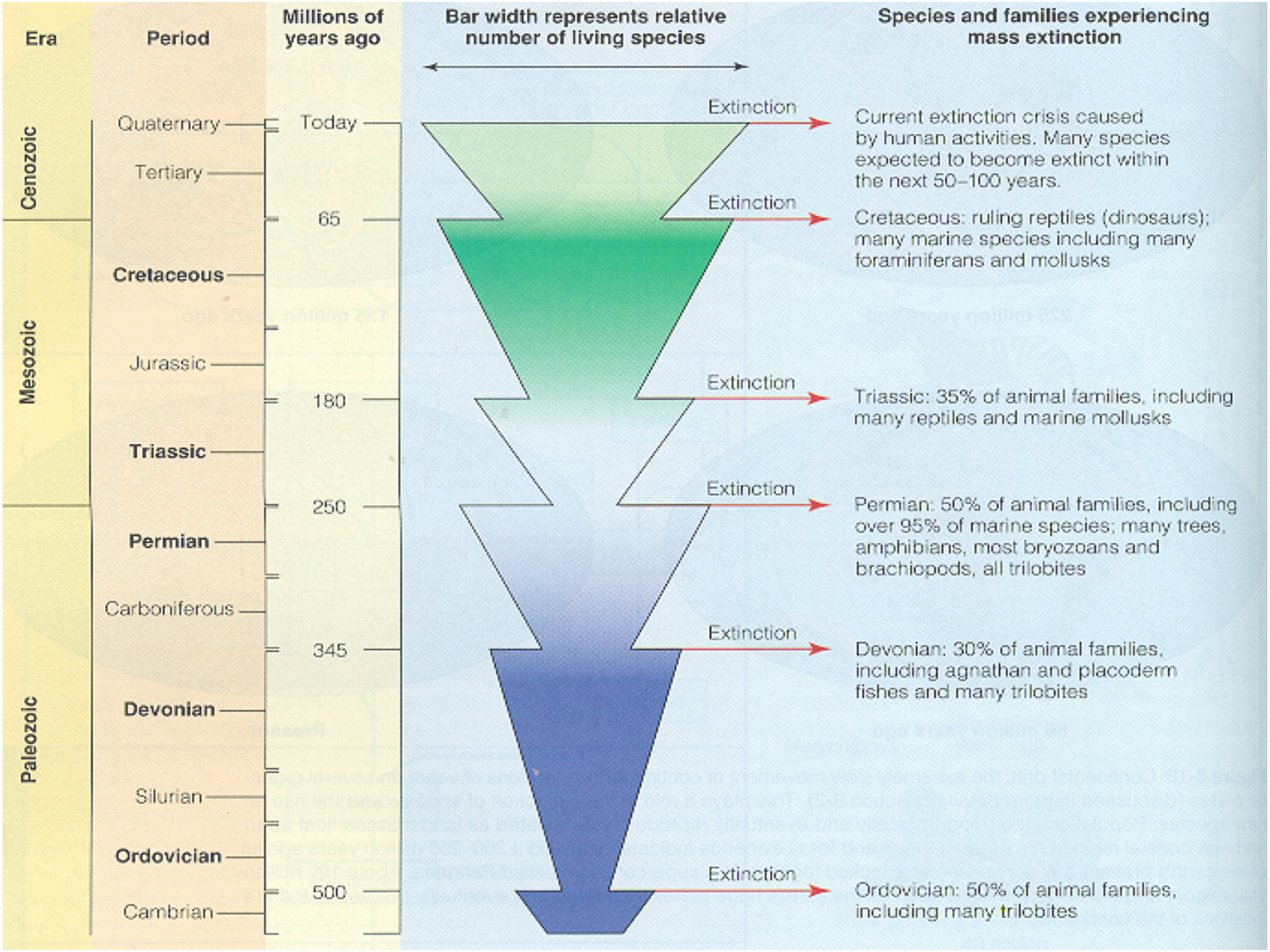
New species are produced through the mechanisms already described

Massive explosions of new species = ADAPTIVE RADIATIONS (usually follows mass extinctions)


(a)
Camarhynchus pallidus
Geospiza magnirostris
Geospiza scandens
Certhidia olivacea
Camarhynchus heliobates
Geospiza fortis
Camarhynchus psittacula
Geospiza difficilis
Geospiza fulginosa
Camarhynchus parvulus
seed crushers
finchlike insectivores
warblerlike insectivores
ancestral South American finch

Extinction

- The elimination of all individuals in a species from the earth
- background extinction rate - relatively constant rate of extinction in the fossil record
- mass extinction - major loss of species
  - climate change, humans, catastrophic events


Era
Period
Millions of years ago
Bar width represents relative number of living species
Species and families experiencing mass extinction
Cenozoic
Mesozoic
Paleozoic
Quaternary
Tertiary
Cretaceous
Jurassic
Triassic
Permian
Carboniferous
Devonian
Silurian
Ordovician
Cambrian
Today
65
180
250
345
500
Extinction
Current extinction crisis caused by human activities. Many species expected to become extinct within the next 50–100 years.
Extinction
Cretaceous: ruling reptiles (dinosaurs); many marine species including many foraminiferans and mollusks
Extinction
Triassic: 35% of animal families, including many reptiles and marine mollusks
Extinction
Permian: 50% of animal families, including over 95% of marine species; many trees, amphibians, most bryozoans and brachiopods, all trilobites
Extinction
Devonian: 30% of animal families, including agnathan and placoderm fishes and many trilobites
Extinction
Ordovician: 50% of animal families, including many trilobites

How do we affect extinction rates?

- Simplify ecosystems (monocultures/disturbed habitats)
- strengthening pest populations (resistance to pesticides)
- eliminating predators (can create new pests)
- introducing new species (starlings)
- over harvesting
- interfering with chemical cycling and energy flow (UV/ozone, heat pollution)