EWCE 131
Ecology and Environmental Pollution

Lecture 4

Instructor

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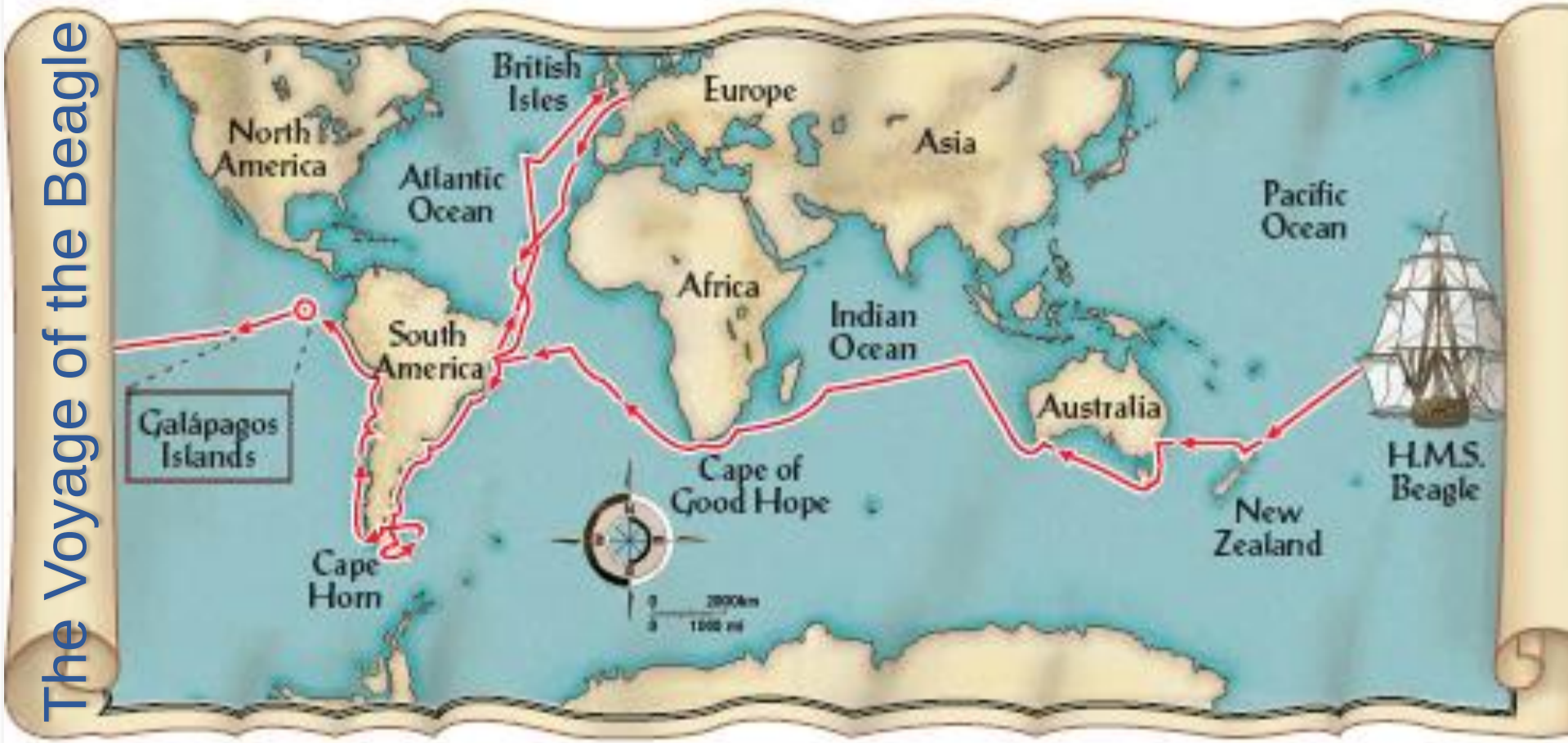
Lecture outline

Ecosystem Diversity

Topics

- **Biological evaluation, natural selection**
- **Influence of geography and geology on biological diversity**

Biological Evolution Hypothesis by Charles Darwin



Darwin's Voyage On a five-year voyage on the *Beagle*, Charles Darwin visited several continents and many remote islands. Darwin's observations led to a revolutionary theory about the way life changes over time.

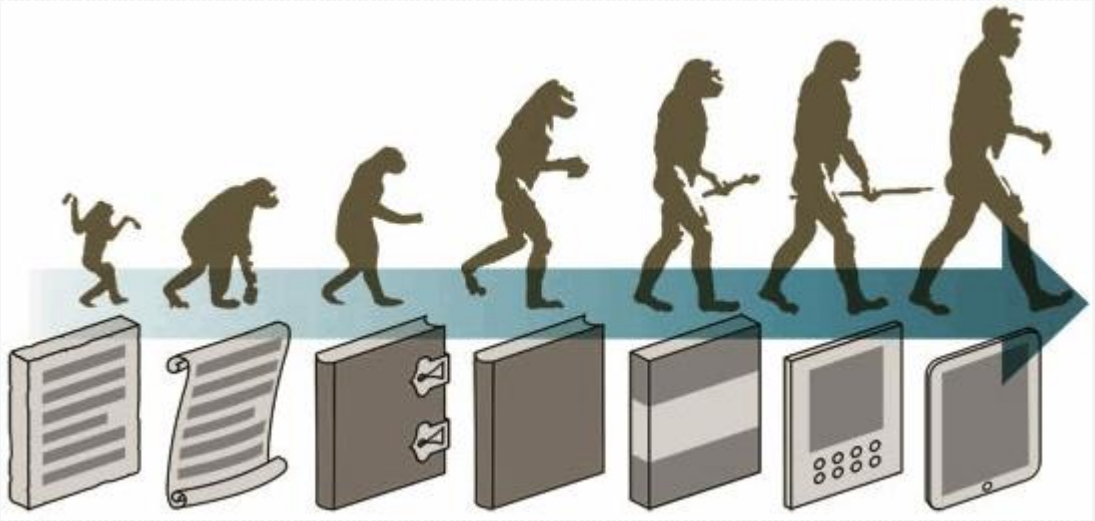
Biological Evolution Hypothesis by Charles Darwin

- During his travels, Darwin made numerous observations and collected evidence that lead him to propose a revolutionary hypothesis about the way life changes over time, e.g. **biological evolution**.

- **Theory of Evolution:** The theory that organisms today developed from more simple life forms and have changed (evolved) over time.

- **Theory of Natural Selection:** The theory that states that those organisms best adapted to their environment have a better chance of surviving and reproducing.

Biological Evolution



- Evolution –
  - Is how modern day organisms have changed from ancient organisms.
  - Is the gradual “change over time”
  - Occurs to species, not individual
  - Explains diversity on earth today

Biological Evolution

- **Biological evolution** refers to the change in inherited characteristics of a population from generation to generation.

- It can result in new species.

- Biological evolution is one of the features that distinguish life from everything else in the universe. (The others are carbon-based, organic-compound-based, self-replicating systems.)

Biological Evolution

- According to the theory of biological evolution, new species arise as a result of –
  - competition for resources and
  - the differences among individuals in their adaptations to environmental conditions.

- Since the environment continually changes, which individuals are best adapted changes too.

Processes of Biological Evolution

- Inherited Variation / Artificial Selection
- Natural Selection
- Species Isolation / Speciation
- Genetic Drift







Inherited Variation / Artificial Selection

- One of Darwin's most important insights is that members of any species have variations, or differences, among each other.

- He had no idea of how heredity, or genes, worked.

- He observed and reasoned that some variations were inherited.

Inherited Variation / Artificial Selection

- Darwin noted that farmers (both plant and animal) used this hereditable variation to improve their breeds.



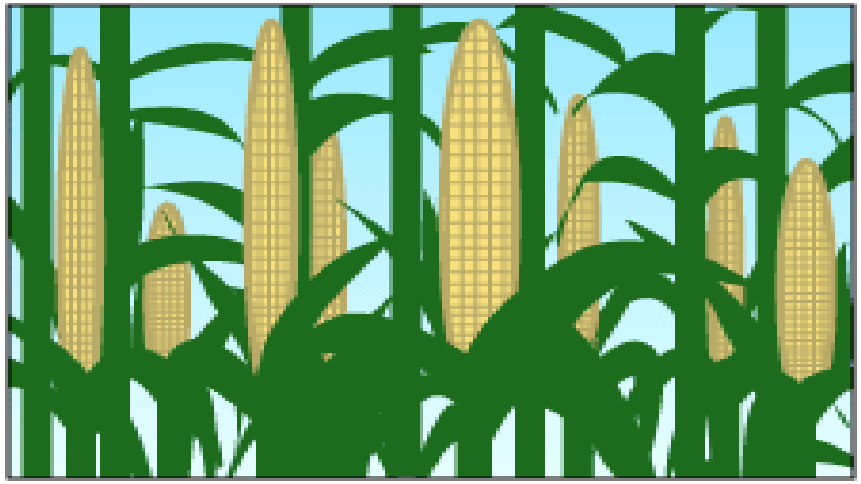
- Examples:

- some horses are faster than others,
- some cows give more milk,
- some sheep have better wool

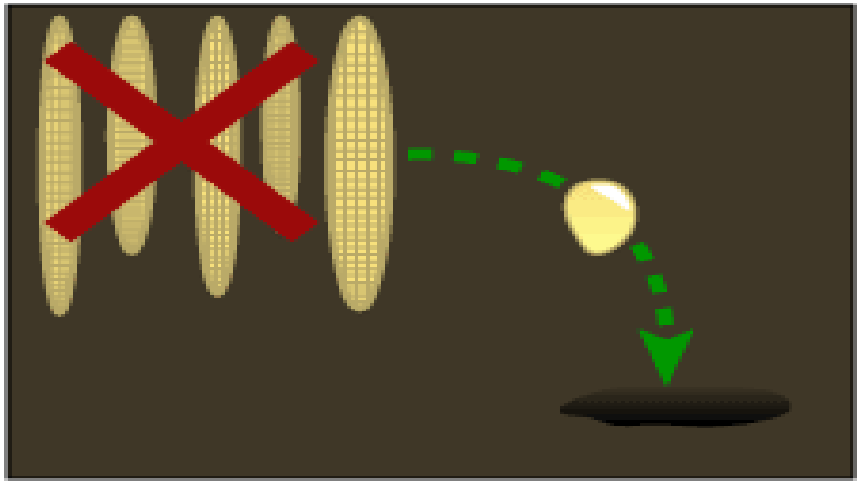
Inherited Variation / Artificial Selection

- These farmers, or breeders, only selected the most favorable traits to breed.
- Over many generations, the species would be different than the original population.
- Population is defined as all the individuals of a species living in a particular area.
- Nature provides the variation, but since it is humans SELECTING which traits are favorable/useful (not nature), this is called **artificial selection**.

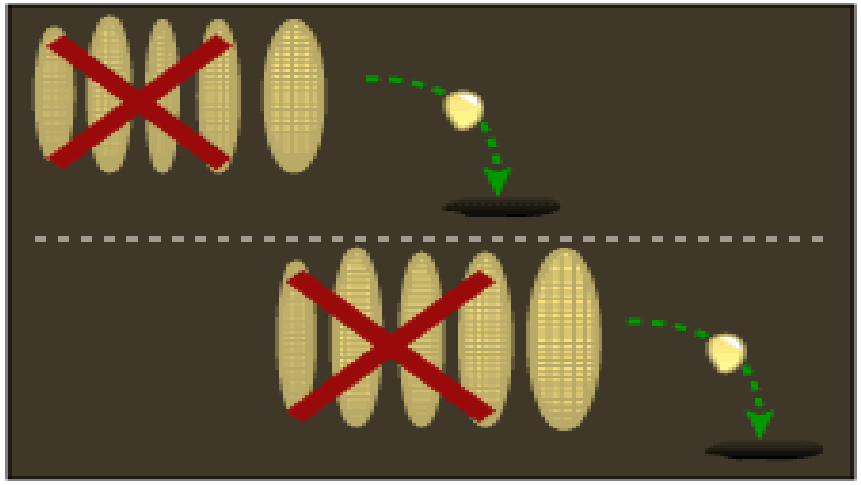
Inherited Variation / Artificial Selection



1. Natural variation occurs in the wild population.



2. Seeds for the next generation are chosen only from individuals with the most desirable traits.



3. Repeat this process for several generations.



4. Over time, the quality of the crop increases.

Inherited Variation / Artificial Selection





Brassica oleracea

http://lsvl.la.asu.edu/plb598/kpigg/Brassica.htm
http://www.fishing-in-wales.com/_pics/plantpic/seaspics/wildcabb.jpg

Artificial

Selection



Broccoli



Cauliflower



Collard Greens



Brussel Sprouts



Kohlrabi

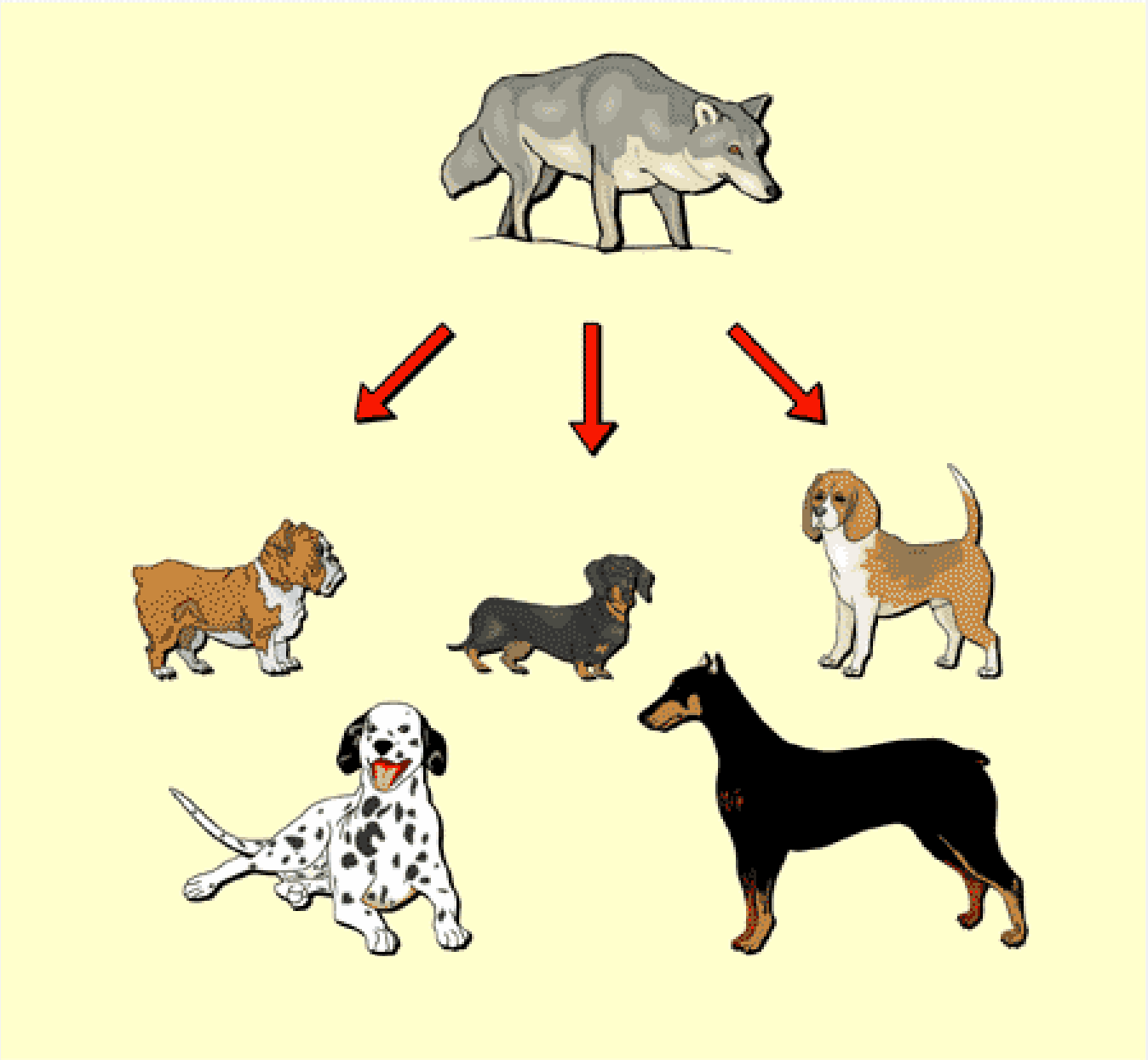


Cabbage



Kale

Inherited Variation / Artificial Selection



Evolution by Natural Selection

- Natural selection is also called “survival of the fittest.”

- This theory is an explanation for how life changes over time, or evolves.

Conditions of Natural Selection

1. Overproduction –

- Every species produces more individuals than will survive.
- Example: insects, fish etc.



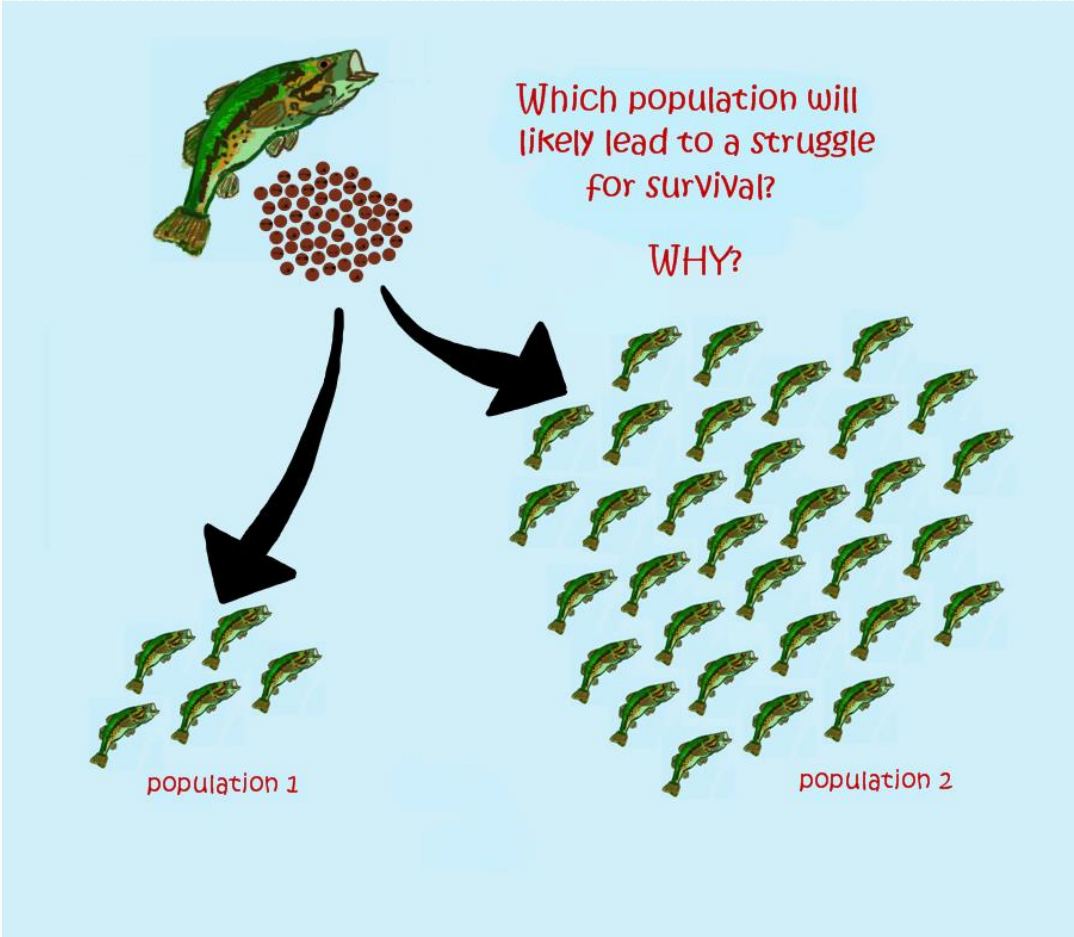


Conditions of Natural Selection

2. Struggle for Survival

Individuals within a species will compete for resources.

- Example: environmental conditions: food, space, water, etc.

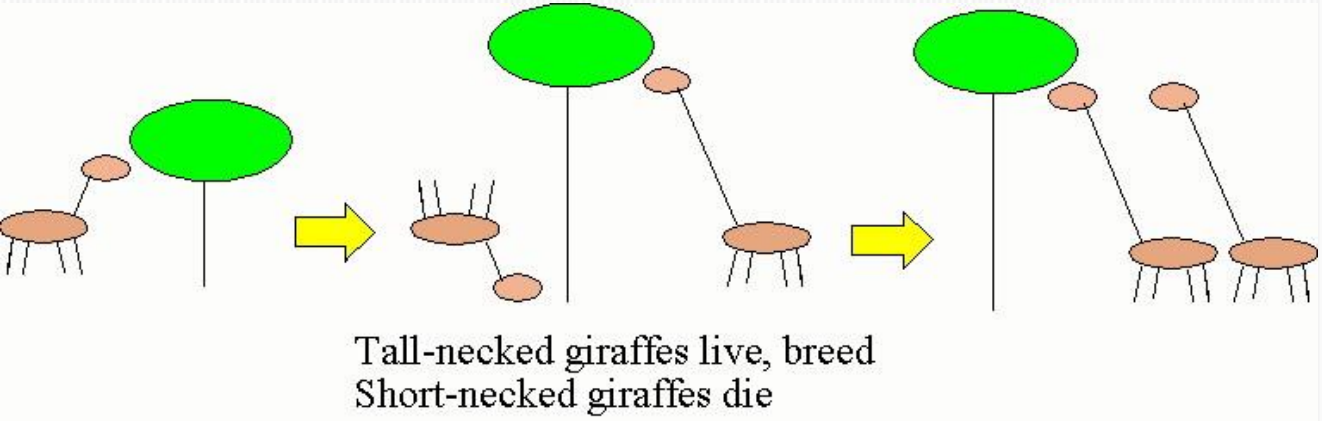


Conditions of Natural Selection

3. Adaptation (adaptive value) –

- Any genetic trait that helps an organism survive, compete, and reproduce better than others.
- Example: Grasshoppers with longer legs

  Lions with sharper teeth





Conditions of Natural Selection - **Adaptation**

(a) Structural Adaptation

- Physical structure, e.g. actual body parts or coloration that help an organism survive in their environment.

- Example: camouflage, mimicry, bent hind legs, sharp teeth and claws, body structures.







Structural Adaptation

Camouflage

- A structural adaptation that enables an organism to blend in with the environment for protection from predators or to help sneak up on prey.

Use:

- Obtaining food
- Protection









Structural Adaptation

Warning Coloration

- Bright colors make an organism easily recognized







Structural Adaptation

Mimicry

- A structural adaptation that provides protection for an organism by copying the appearance of another, more threatening, species

Use:

- Obtaining food
- Protection



Non-poisonous king snakes mimic poisonous coral snakes.



Katydids have camouflage to look like leaves.

Structural Adaptation

Bent hind legs

- Prey run fast to escape
- Predators run fast to catch prey

Use:

- Protection
- Locomotion





Structural Adaptation

Teeth

- Flat teeth grinding for plant eaters
- Sharp teeth cutting for meat eaters



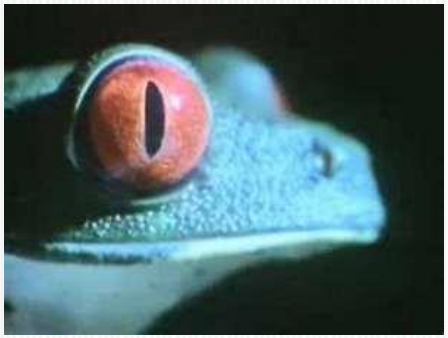




Structural Adaptation

Body Structure

- Prey – Eyes on the side of the head





- Predator - Eyes facing forward to find prey.





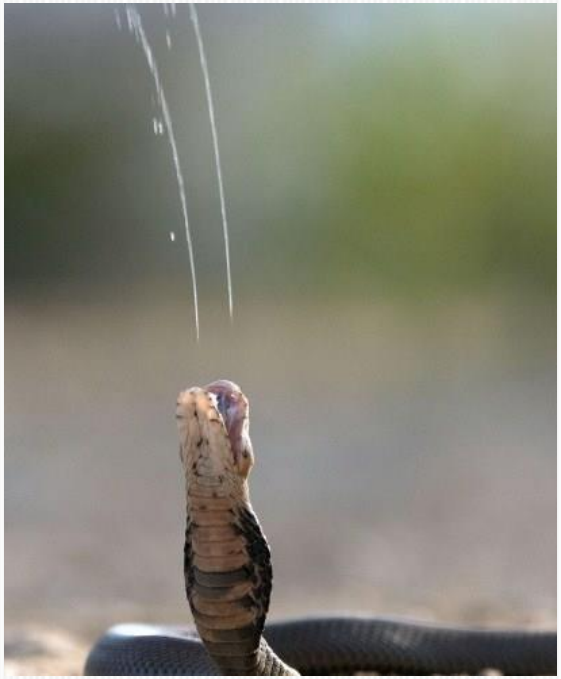
Conditions of Natural Selection - **Adaptation**

(b) Chemical Adaptation/ Defense

- Chemical that helps organism survive
- Kind of chemical defense : venom (released by snake, spider), ink, spray etc



Sea hare Aplysia californica releasing ink



Venom being sprayed by a snake into the air

Behavioral Adaptation

- It is the way an animal reacts or behaves in certain situations.

- Behaviour adaptations can be learned or instinctive.
  - Social behaviour
  - Behaviour for protection

- Instinctive behavior: These behaviors happen naturally & don’t have to be learned.

- Learned behavior: These behaviors must be taught.

Behavioral Adaptation

Instinctive behavior:

- These behaviors happen naturally & don't have to be learned.





Methods of gathering & storing food

Defending oneself

Hibernating

Finding shelter

Raising young

Migrating

Behavioral Adaptation

Learned behavior:

- These behaviors must be taught.

- Obtained by interacting with the environment and cannot be passed on to the next generation except by teaching.

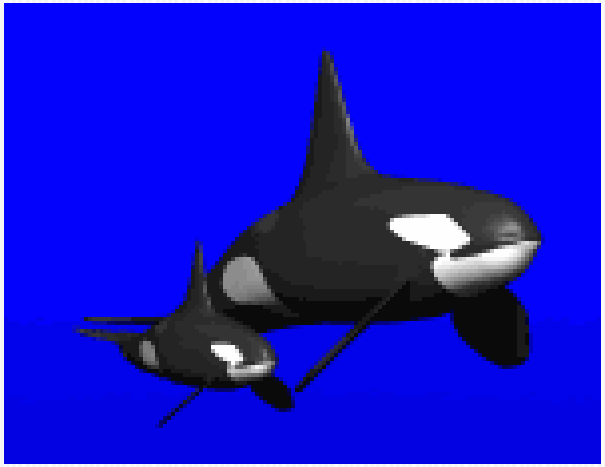


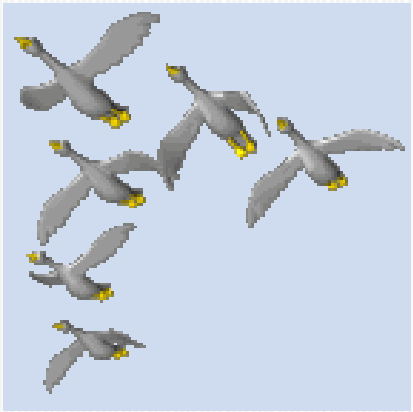
Behavioral Adaptation

1. Migration

- Seasonal or periodic movement of animals in response to changes in climate or food availability, or to ensure reproduction.

- Migration most commonly involves movement from one area to another and then back again.





Examples: geese, whales, salmon, Monarch butterflies

Behavioral Adaptation

2. Hibernation

- Adaptive winter survival technique where animal becomes inactive and all body processes slow down.
- In cold weather most animals must eat large quantities of food to obtain the energy needed to carry on normal body activities.



Examples: bears, chipmunks, squirrels, bats,





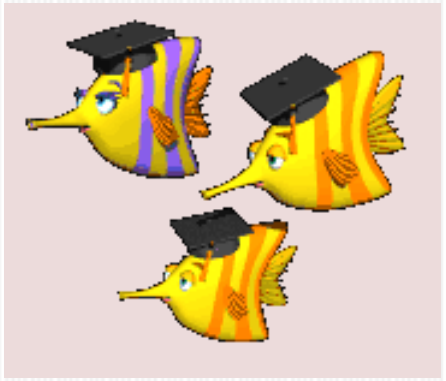
Behavioral Adaptation

3. Living in a Group

- More eyes in a group to watch out for prey or predator, protection



Examples: fish, walruses, lions etc



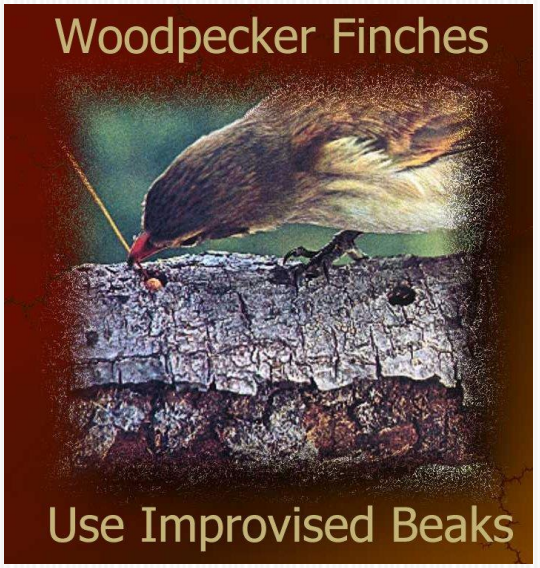




Behavioral Adaptation

4. Tool Use

- Any object manipulated by an animal in order to perform a specific task.
- Example: monkeys, birds



5. Playing Dead

- By pretending that they are dead, some animals escape bodily harm.
- Example: snakes, possums



Behavioral Adaptation

6. Calling

- Communication between animals



7. Threatening Gestures

- Scares off potential predators.

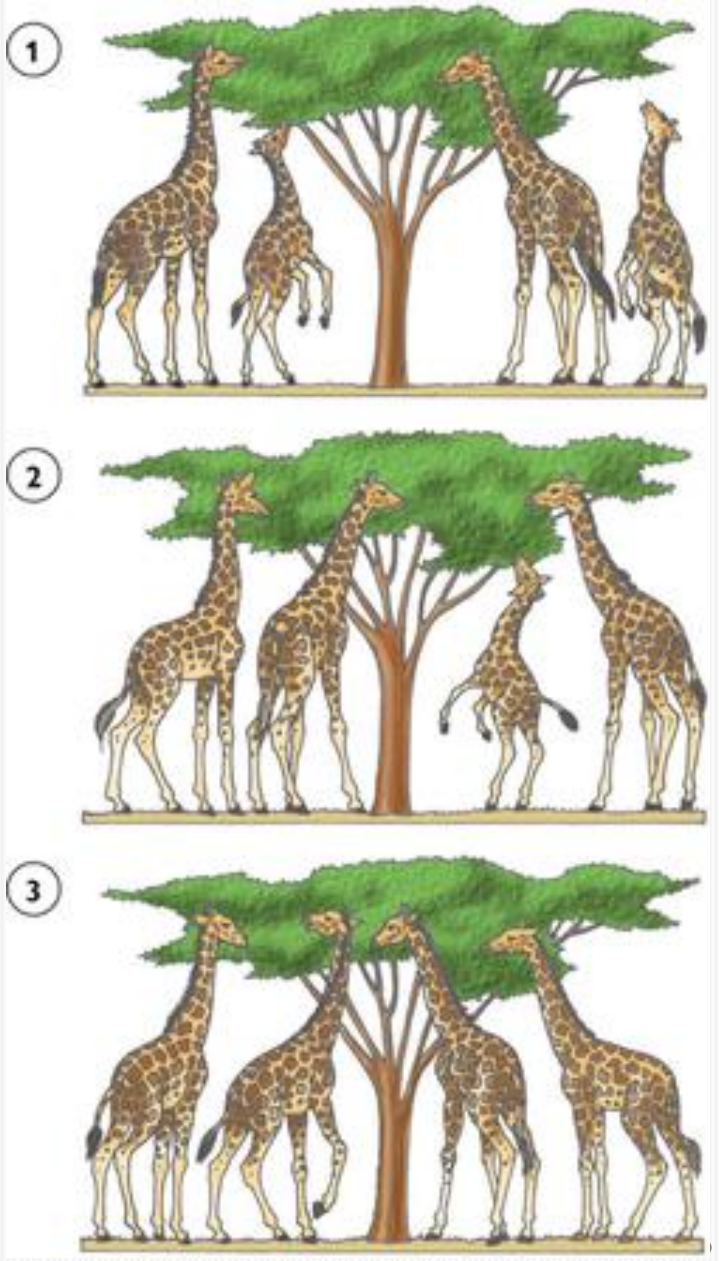


Conditions of Natural Selection

4. Survival of the Fittest –

- Individuals who have certain variations will be able to survive if environment changes.

- Example: Disease and resistance/immunity



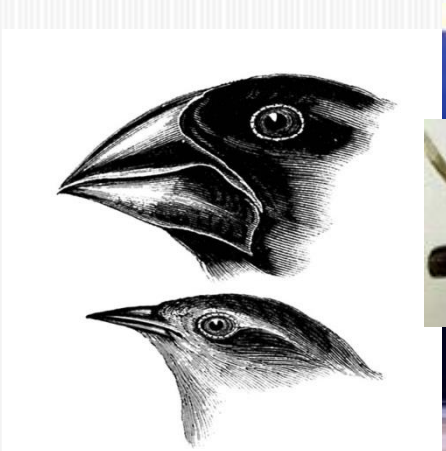
Conditions of Natural Selection

5. Speciation – those individuals that survived to reproduce, may develop into a new species, due to

Reproductive isolation –

- a population may become separated by a geographical barrier.

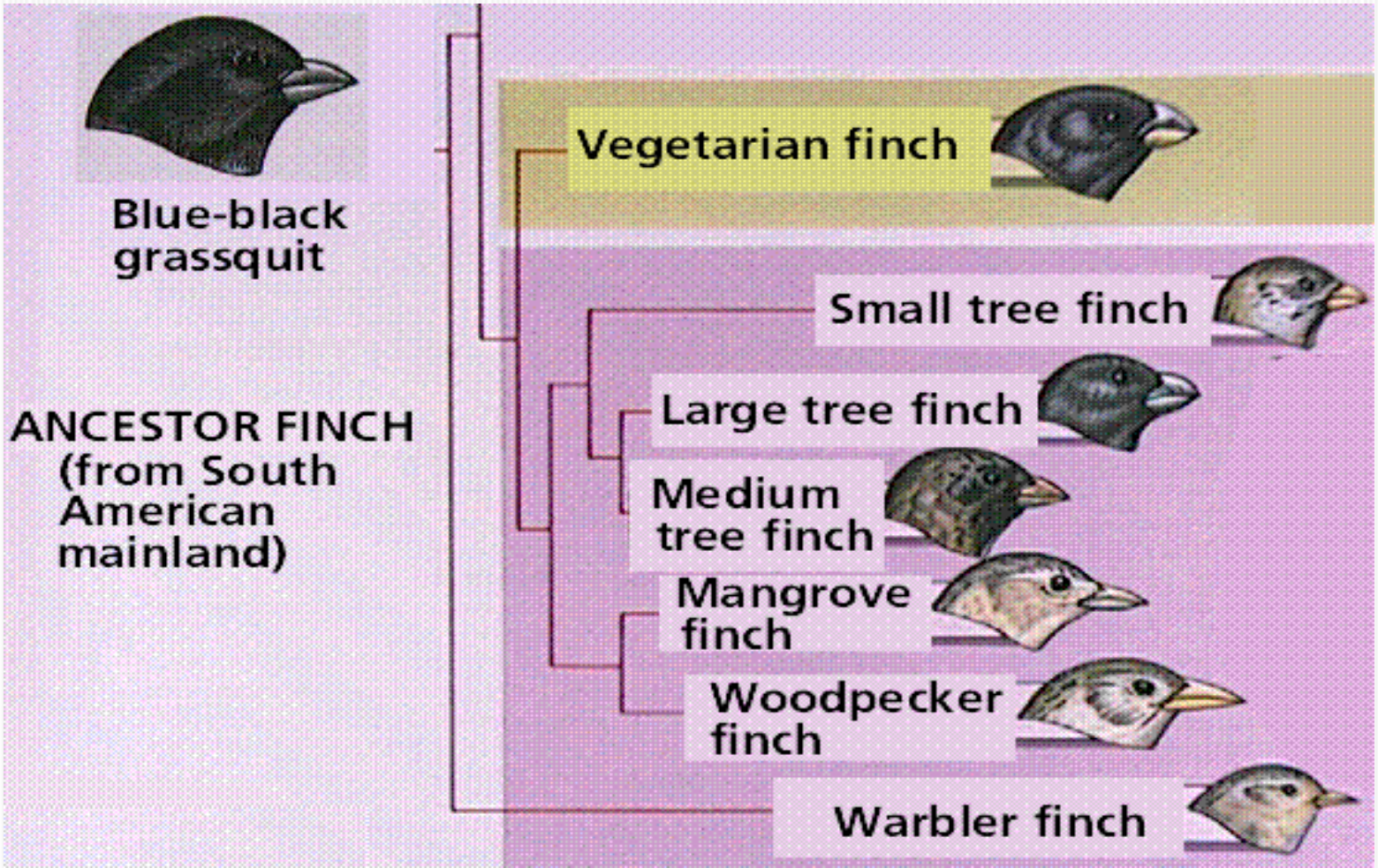
- Example: River, mountain range, earthquake, ocean





Conditions of Natural Selection

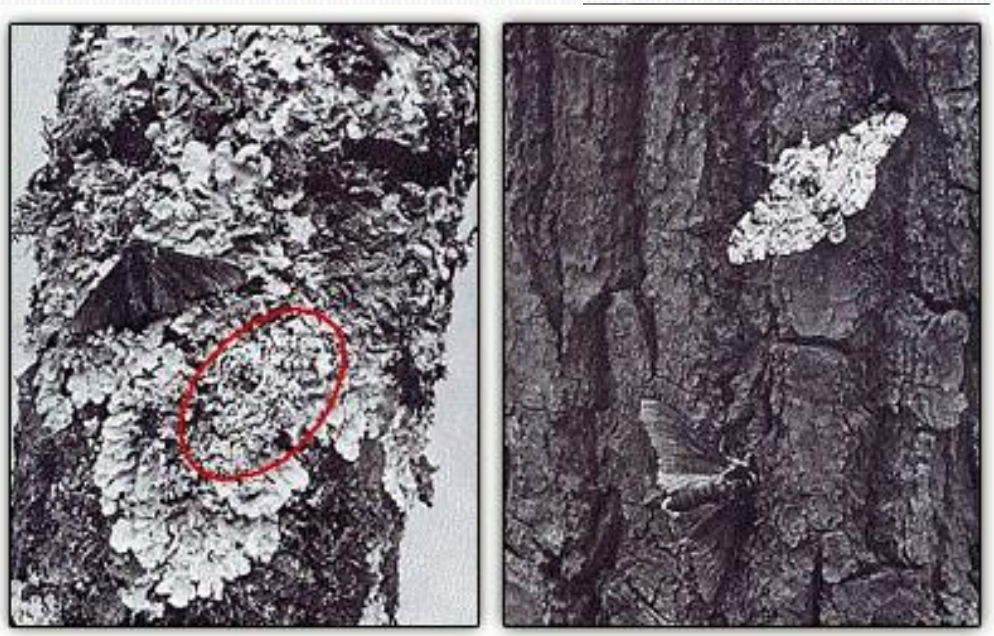
- Many new species of finches develop from isolation.
- Differences in beak sizes/shapes result from different environments (food sources).



Example of Natural Selection

1. Peppered Moth Evolution

- Change in moth color from white to black due to change in their environment from white to black (especially due to industrial pollution).





Light and dark Peppered moths

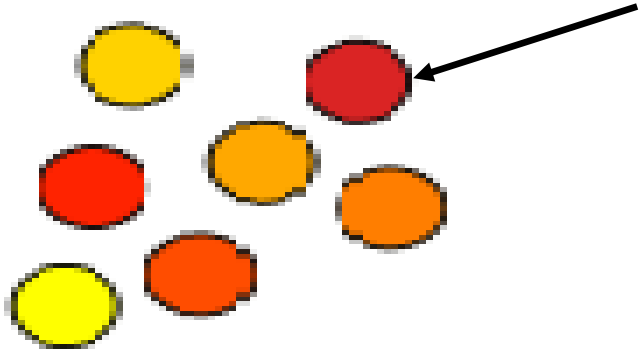
Example of Natural Selection

2. Antibiotic Resistance

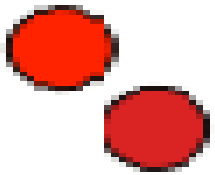
- Antibiotics – kill bacteria that causes diseases.
- Through natural selection, some bacteria mutate and become resistant (not affected) to antibiotics.
- These resistant bacteria multiply (asexually) and soon become the only bacteria around.
- New antibiotics must now be made.

Example of Natural Selection

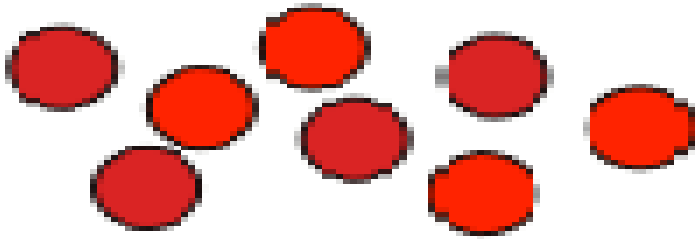
Red Bacteria have mutation for resistance



After Treated with Antibiotic

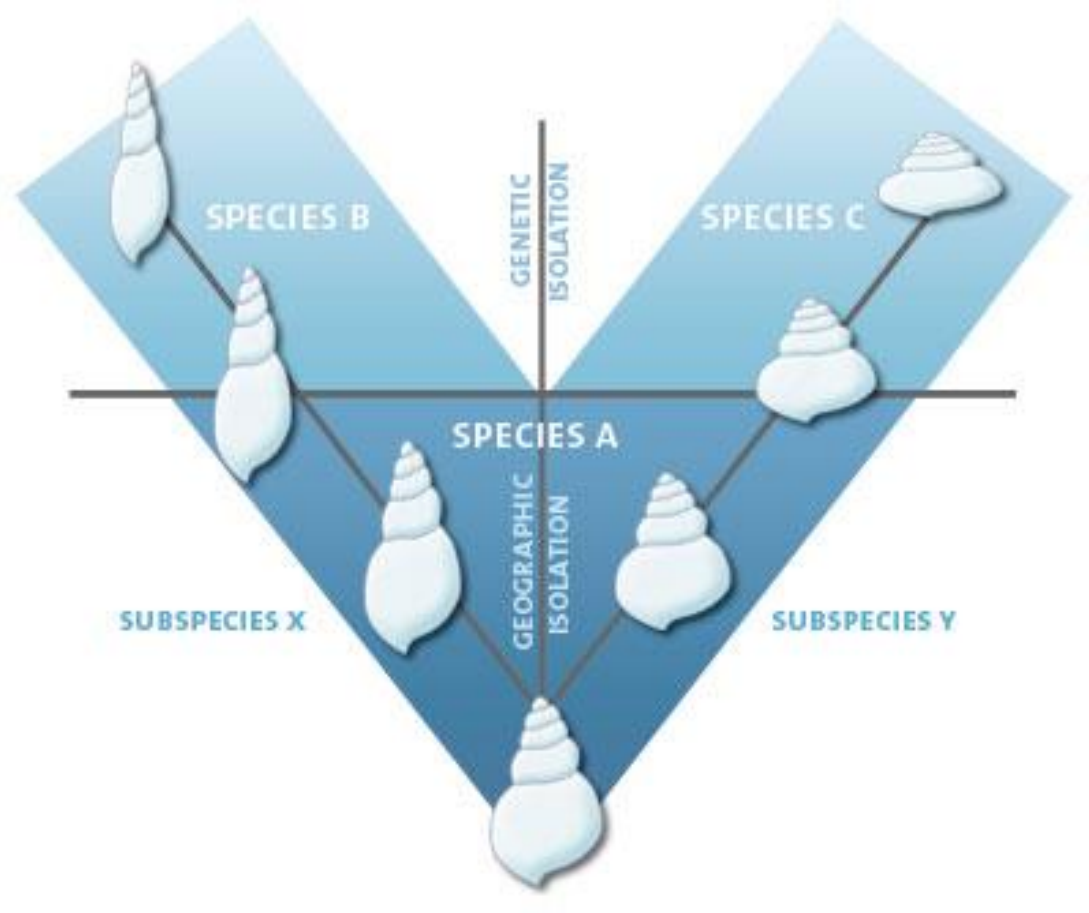


Only Red Bacteria survive and pass on good mutation



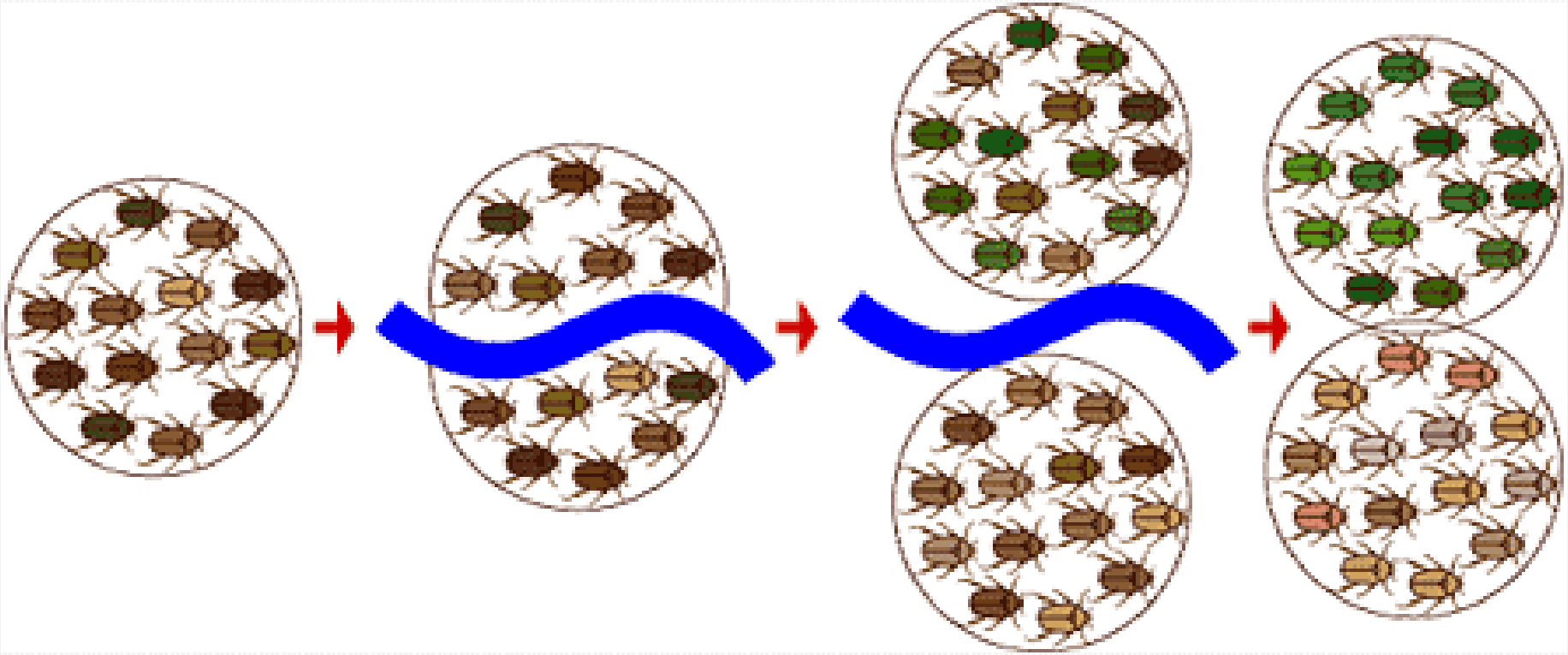
Species Isolation/ Speciation

If one part of a population is separated or isolated from another, speciation (evolution of new species) is more likely.



Geographic Isolation

Two populations are separated by geographic barriers such as rivers, mountains, oceans etc.



Geographic Isolation

- The **Kaibab squirrel** evolved from the **Abert squirrel** when the Colorado river split the species (Abert) into two separate populations, thus two separate gene pools.
- Natural selection worked separately on each group and led to the formation of two distinct species of squirrels.





Genetic Drift

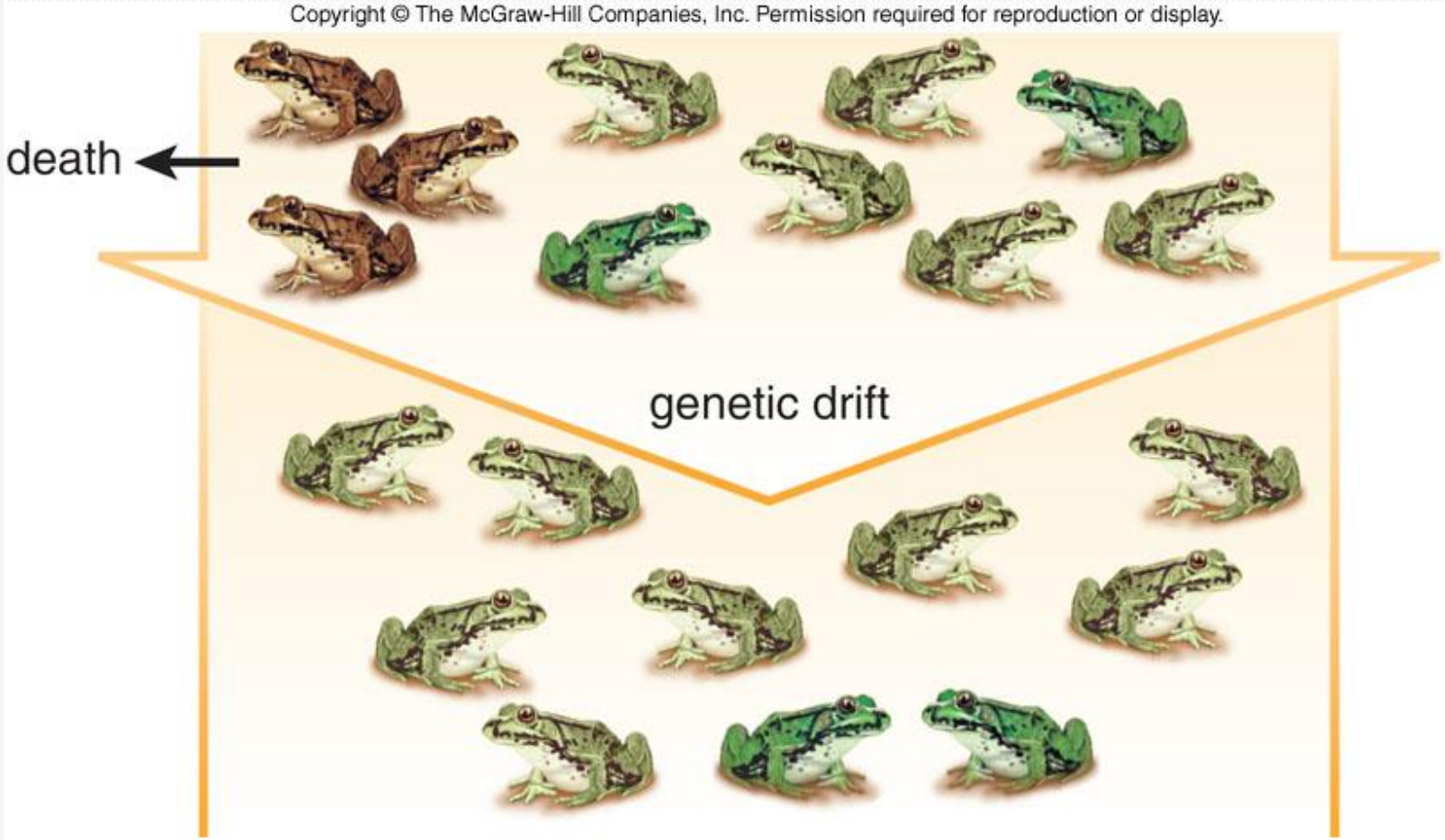
- Genetic drift is a mechanism of evolution that occurs by random chance rather than natural selection.

- In genetic drift, a population experiences a change in the frequency of a given allele (gene arising from mutation and causes heredity variation), prompted by random luck rather than a need for adaptation.

- This differs from natural selection, in which allelic frequency is altered based on the fittest genes surviving to reproduce and the weaker genes dying off.

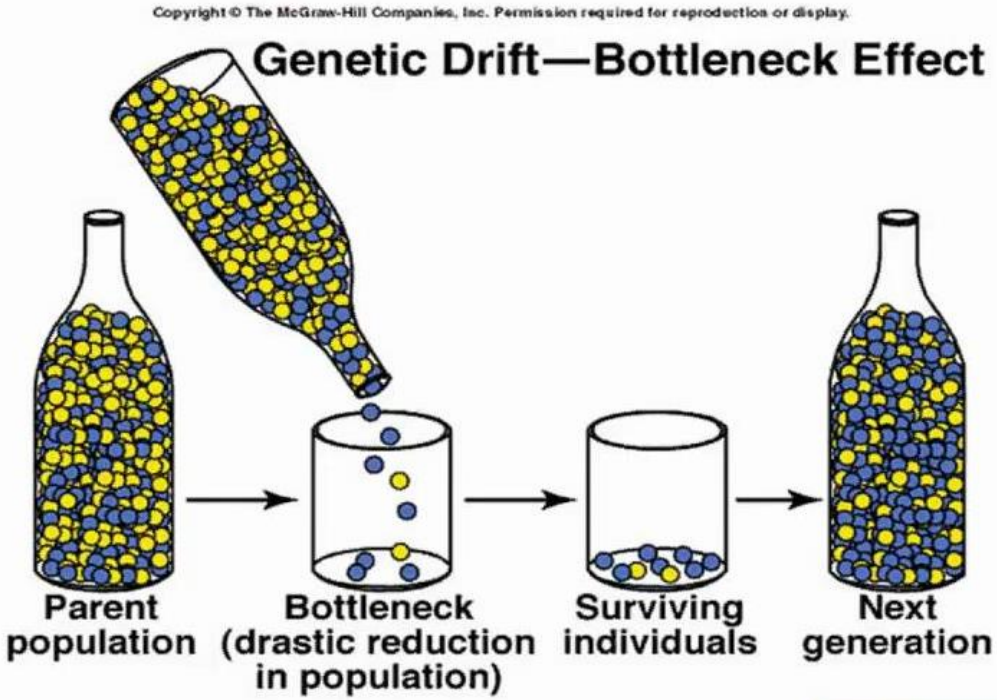
Genetic Drift

- Genetic drift tends to be a phenomenon amongst smaller populations, while natural selection holds sway in larger populations.

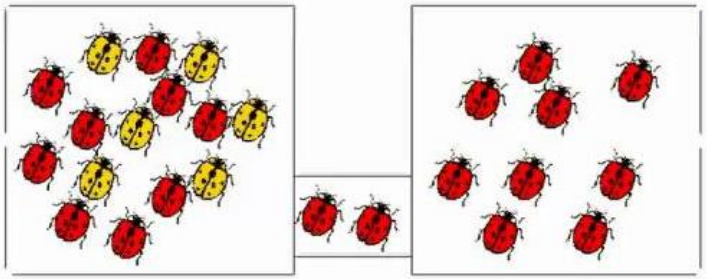


Genetic Drift

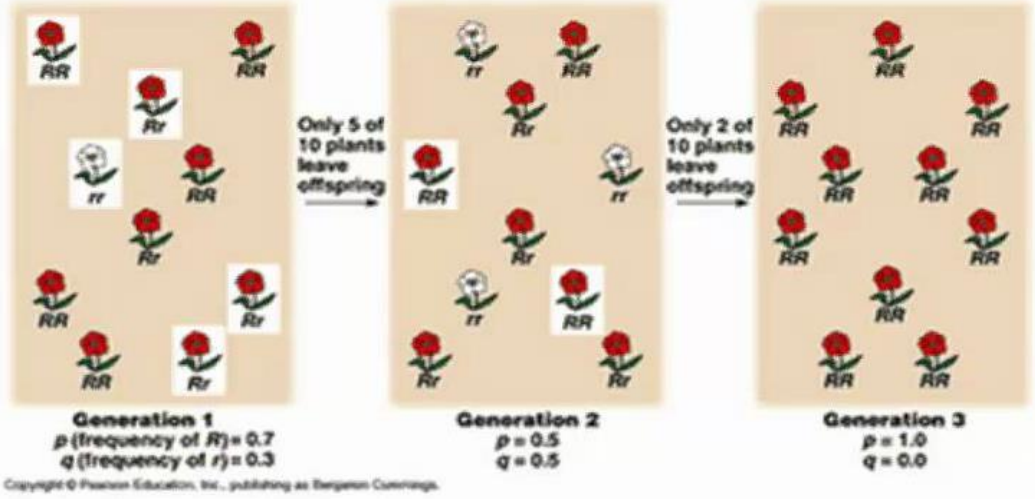
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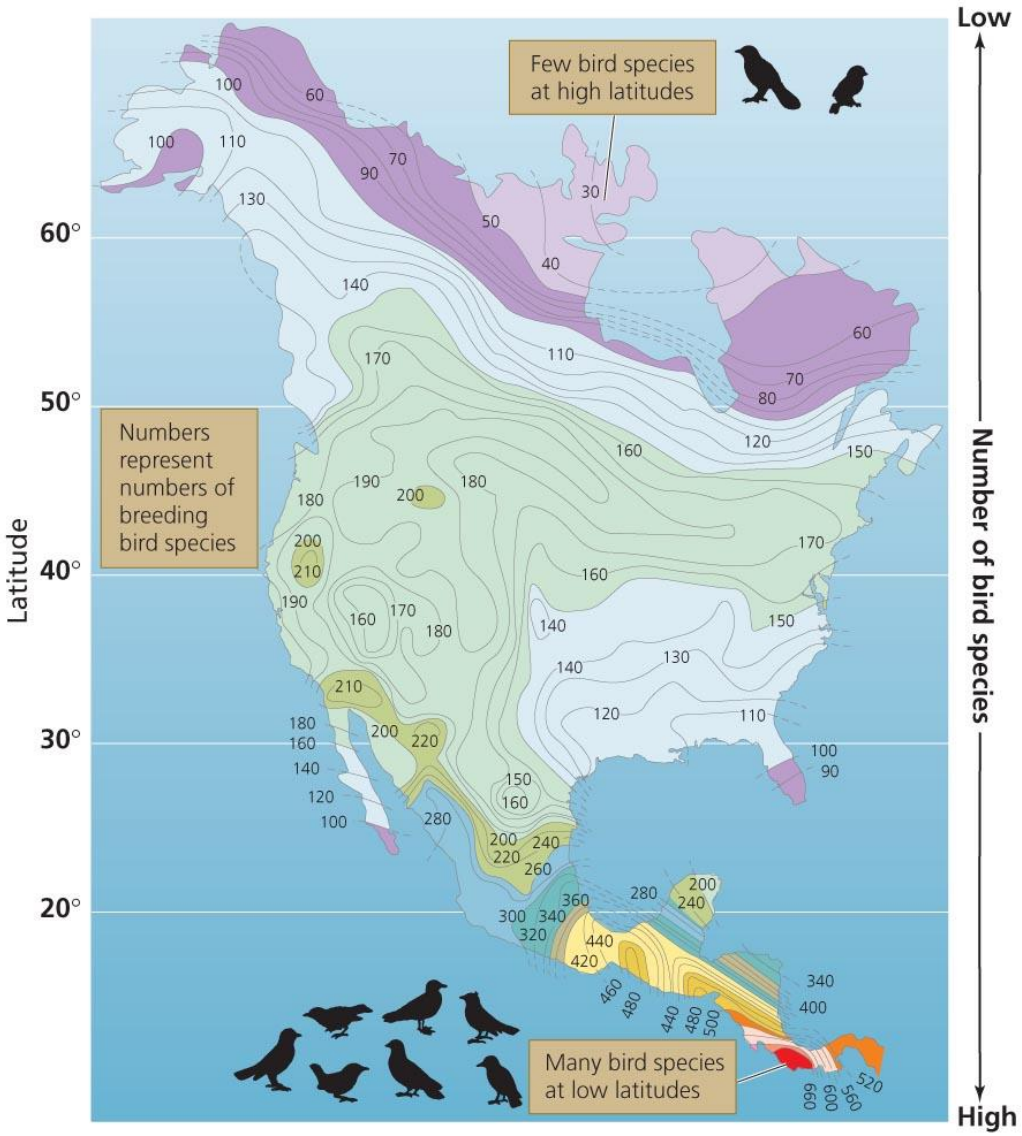
- bottleneck example



Distribution of Biodiversity

- Living things are not distributed evenly on Earth
- Latitudinal gradient = species richness increases toward the equator

Canada has 30–100 species of breeding birds, while Costa Rica has more than 600 species



(a) Latitudinal gradient in species richness for birds in North America

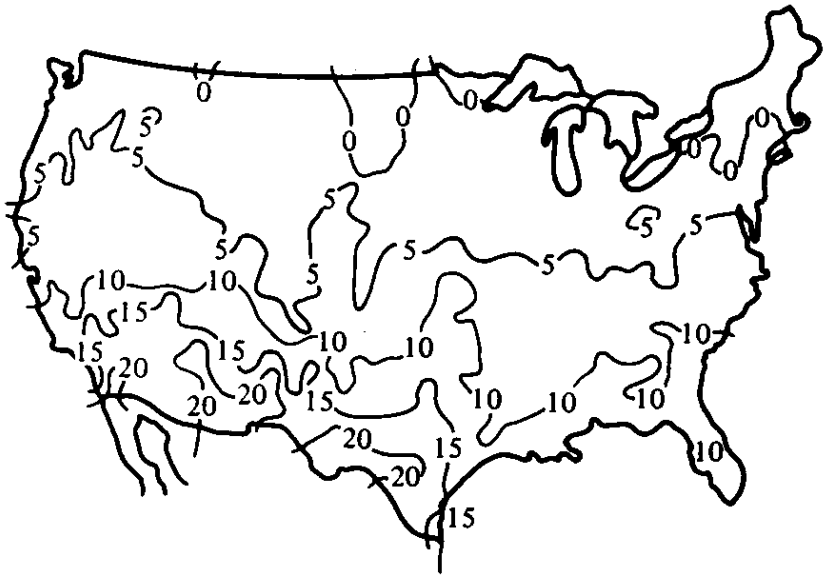
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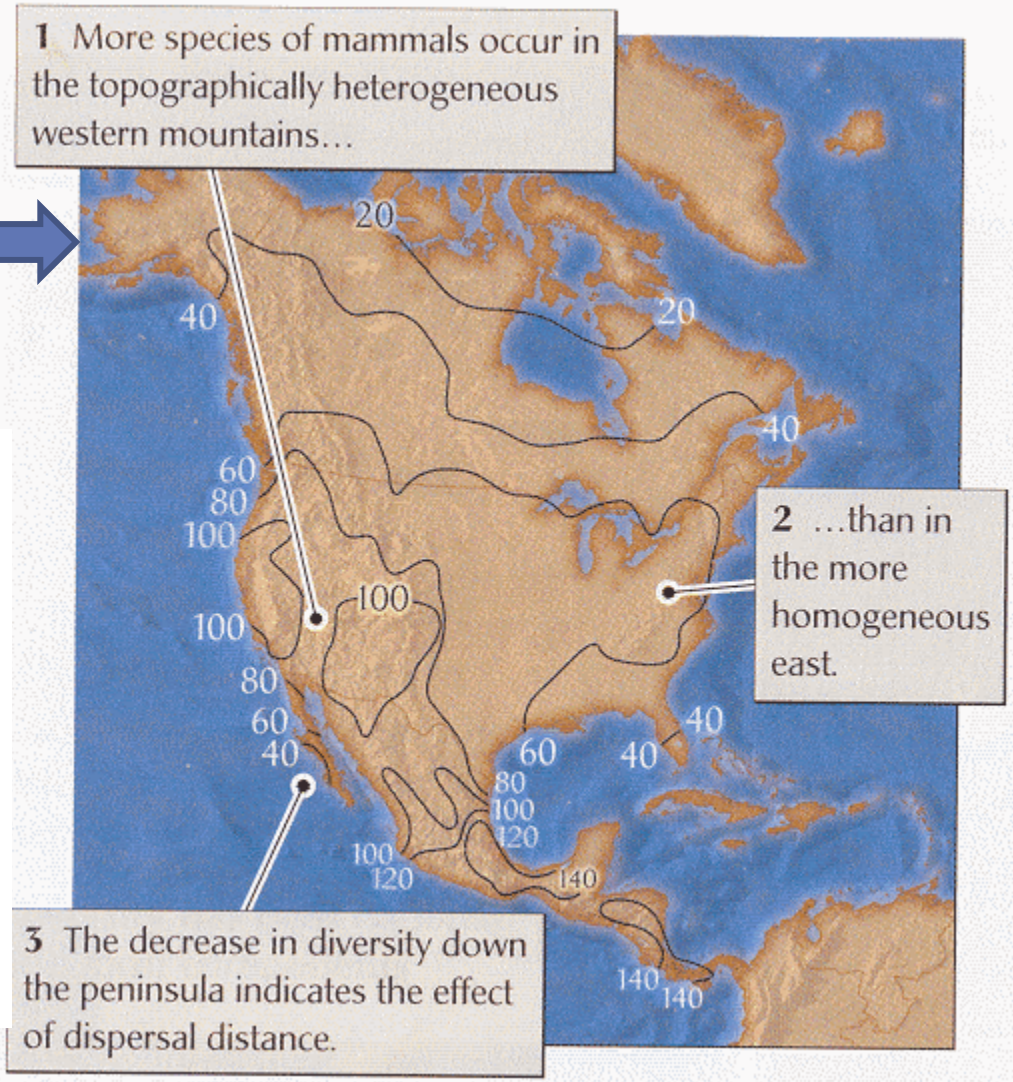
Distribution of Biodiversity

- Many taxa have been surveyed in North America.
- Mammals also fit the latitudinal pattern, so do lizards.

Lizards

Mammals





Causes of Biodiversity Gradient

- Climate stability, high plant productivity, no glaciation

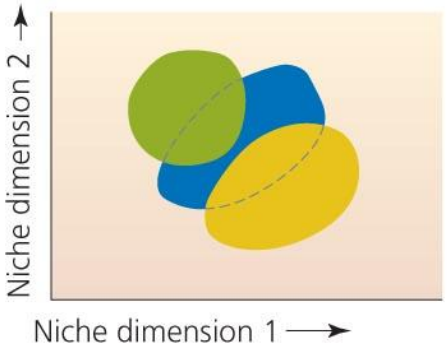
  - More niches, species coexistence

- Diverse habitats increase species diversity and evenness

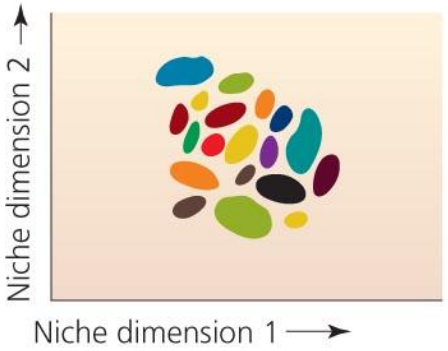
  - Tropical rainforests and drylands

- Human disturbance (in intermediate frequency/ intensity),can increase habitat diversity

  - But only at the local level



Temperate and polar latitudes: Variable climate favors fewer species, and species that are widespread generalists.



Tropical latitudes: Greater solar energy, heat, and humidity promote more plant growth to support more organisms. Stable climate favors specialist species. Together these encourage greater diversity of species.

(b) One hypothesis to explain the latitudinal gradient

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