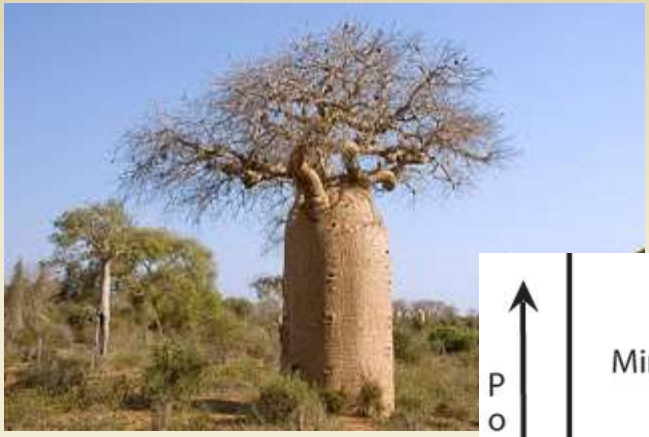
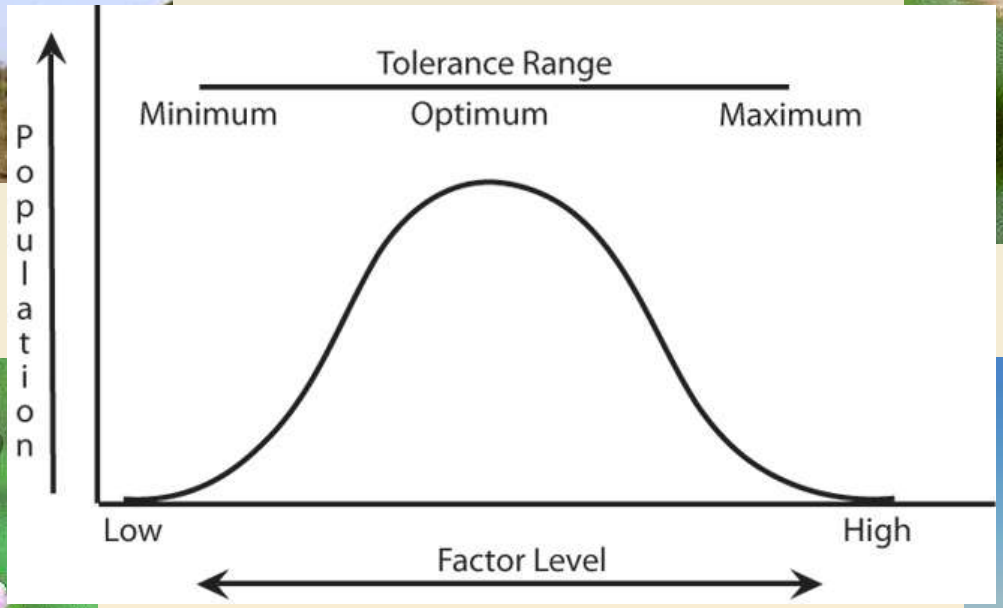
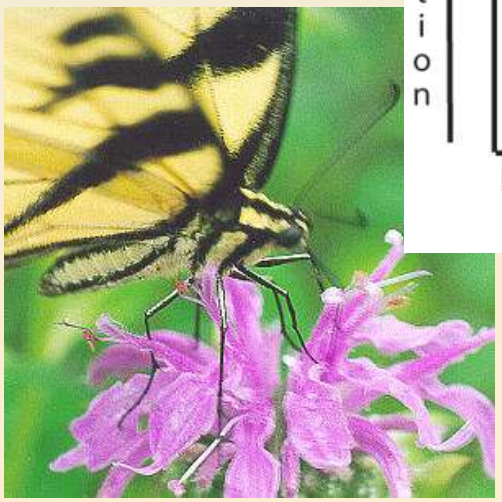
Adaptive Traits







Adaptive Traits

Natural selection results in evolution of adaptations

Adaptation: trait that enhances an organism's survival and reproduction

“*Nothing in biology makes sense except in the light of evolution*”

Theodosius Dobzhansky (1900 – 1975)

An architect
of the
Modern Synthesis of Evolutionary Biology

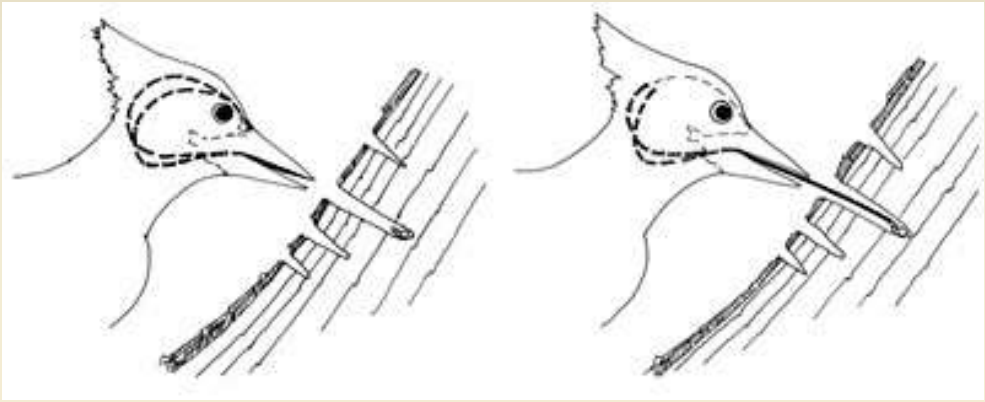
Photo of Dobzhansky from Wikipedia

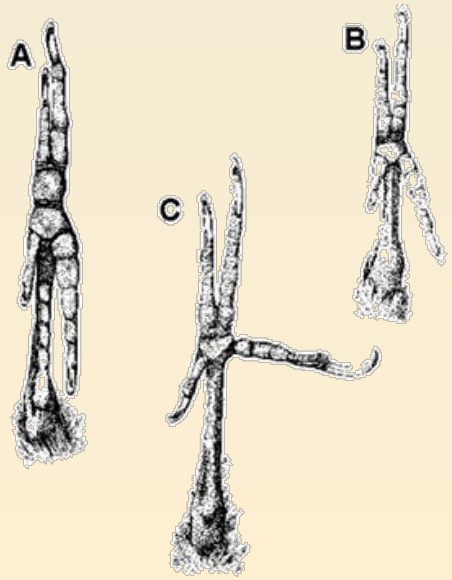
Theodosus Dobzhansky

1. *Adaptation* is the evolutionary process whereby an organism becomes better able to live in its habitat or habitats.
2. *Adaptedness* is the state of being adapted: the degree to which an organism is able to live and reproduce in a given set of habitats.
3. An *adaptive trait* is an aspect of the developmental pattern of the organism which enables or enhances the probability of that organism surviving and reproducing

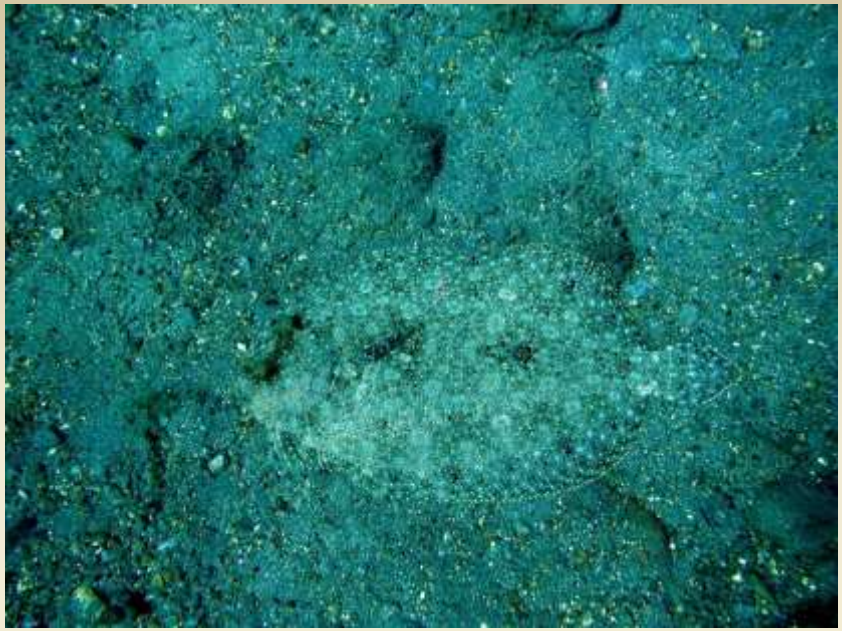
Adaptation – a critical concept.

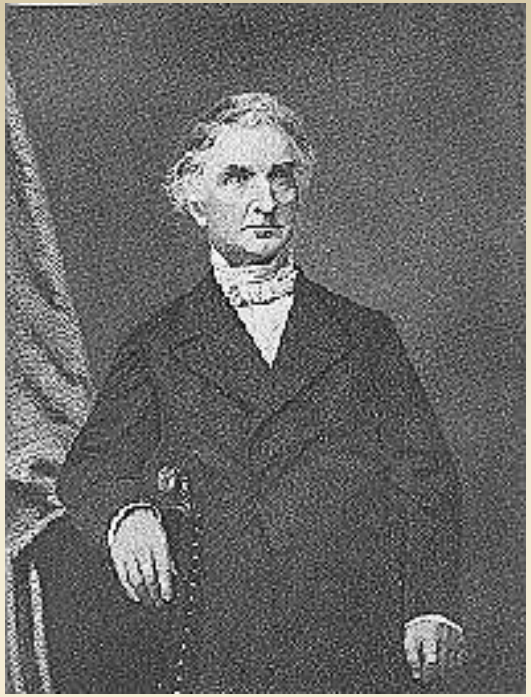
Living things show marvelous adaptations.






© Stephen Street

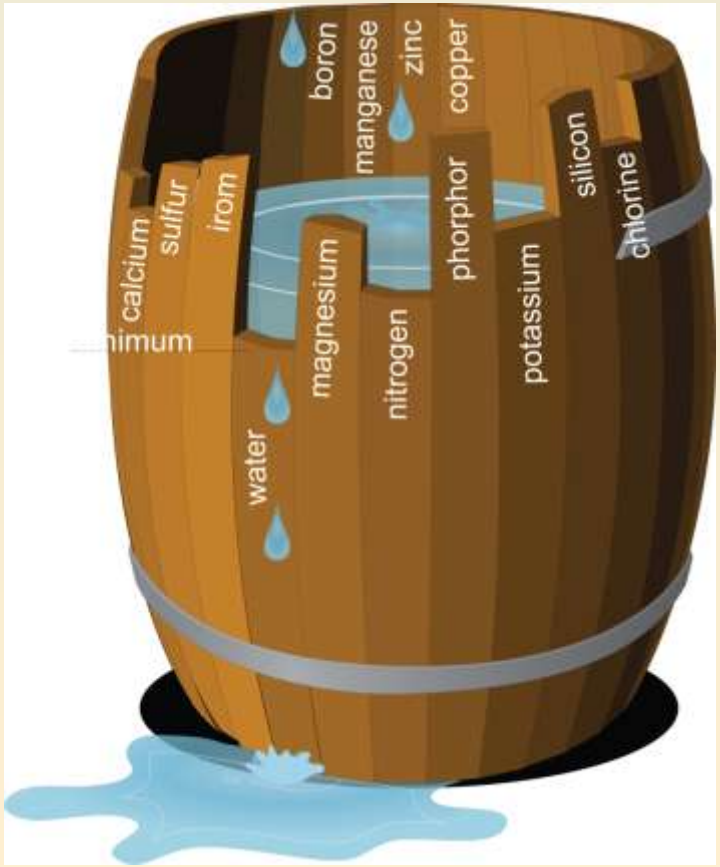




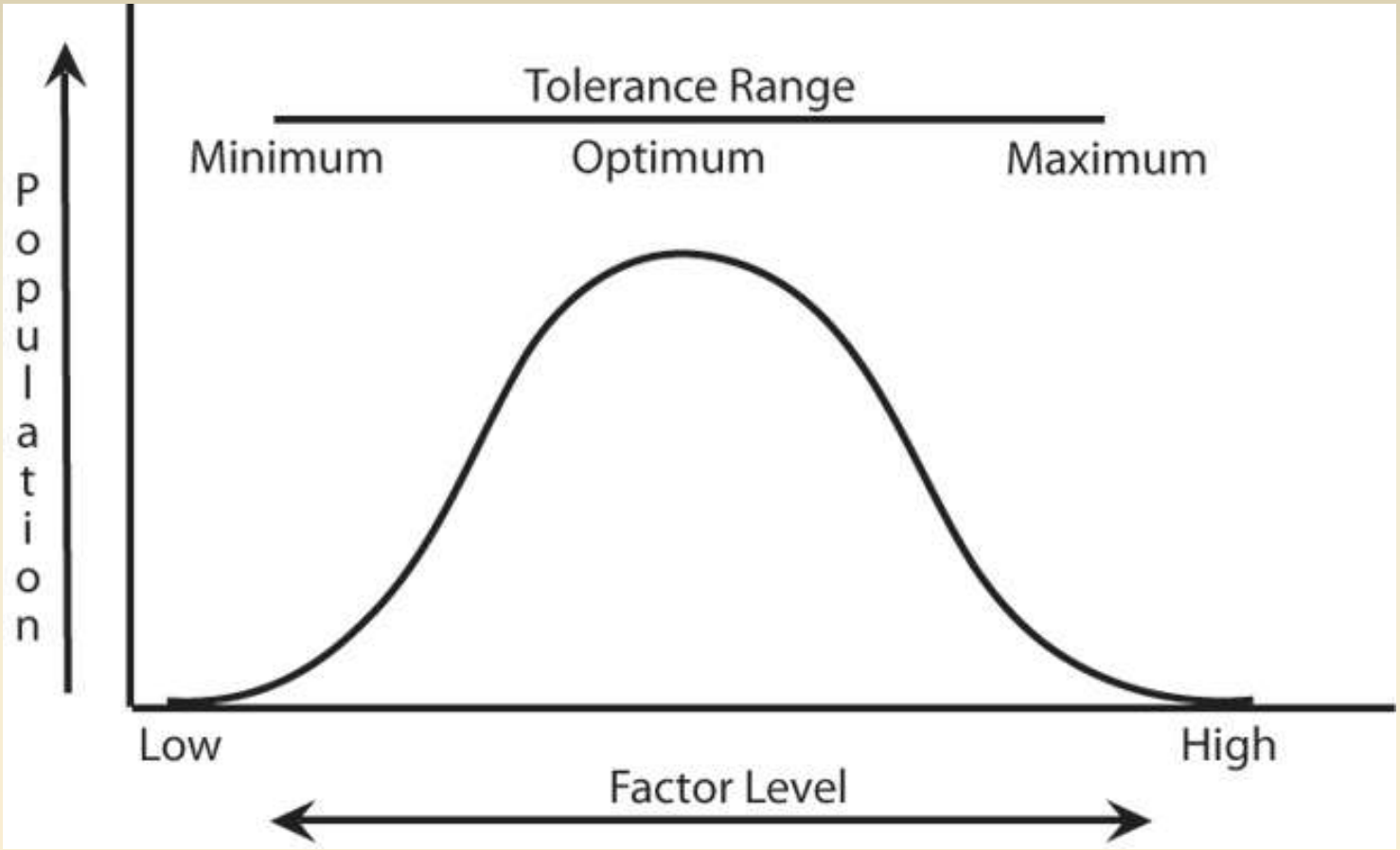
Justus von Liebig
(1803-1873)

Liebig's Law of the Minimum

States that yield is proportional to the amount of the most **limiting factor**, whichever nutrient it may be



Shelford's Law of Tolerance



For every organism there is an optimum in regard to environmental factors. When environmental factors are not favorable the number of individuals will decrease.

Cacti are well adapted for survival in the desert. They have:

Stems that can **store water**.

Widespread root systems that can collect water from a large area.

Spines instead of leaves that minimise the surface area and so reduce water loss by transpiration.

Spines also protect the cacti from animals that might eat them.

CAM metabolism – stomata stay shut during day/

Camels live in deserts that are hot and dry during the day, but cold at night.

Large, flat feet to spread their weight on the sand.

Thick fur on the top of the body for shade, and thin fur elsewhere to allow easy heat loss.

A large surface area to volume ratio to maximise heat loss.

The **ability to go for a long time without water** (they don't store water in their humps, but they lose very little through urination and sweating).

The ability to **tolerate body temperatures** up to 42°C.

Slit-like nostrils and two rows of eyelashes to help keep the sand out.

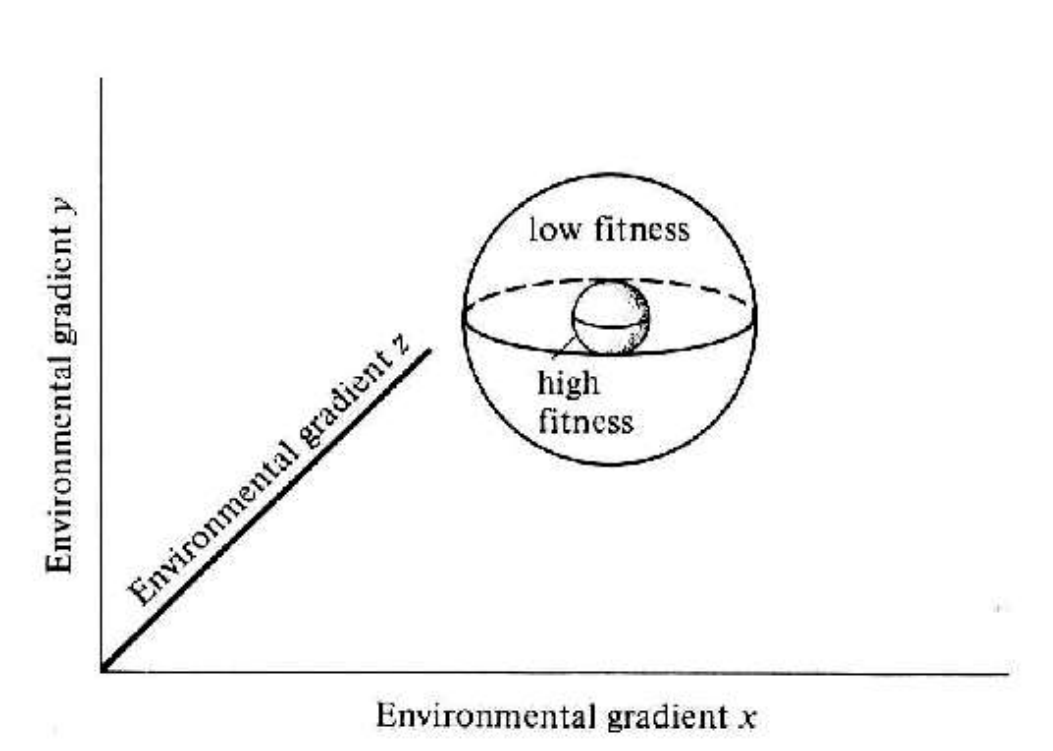
Niche

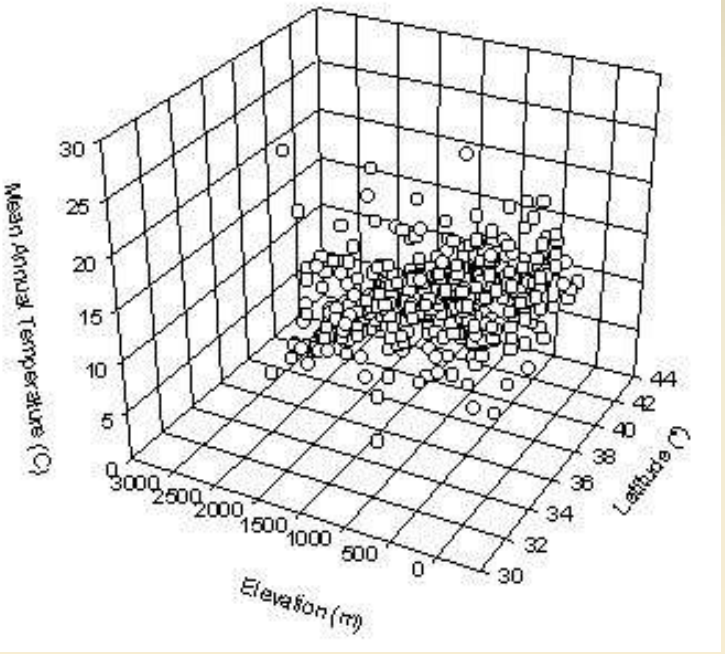
Important theoretical concept, pervades all of ecology. Many definitions and potential meanings, used in many different ways. Ecology might be described as the study of niches.

In general, a niche is the ecological role of a species, what it does, what it eats, it’s "occupation" (habitat is "address").

It is the sum total of the adaptations, all the ways it conforms to its particular environment.

Ecological niche = an N-dimensional hypervolume





G.E. Hutchinson (1957, 1965) suggested that an organism's niche could be visualized as a multidimensional space, or hypervolume, formed by the combination of gradients of each single environmental condition to which the organism was exposed.

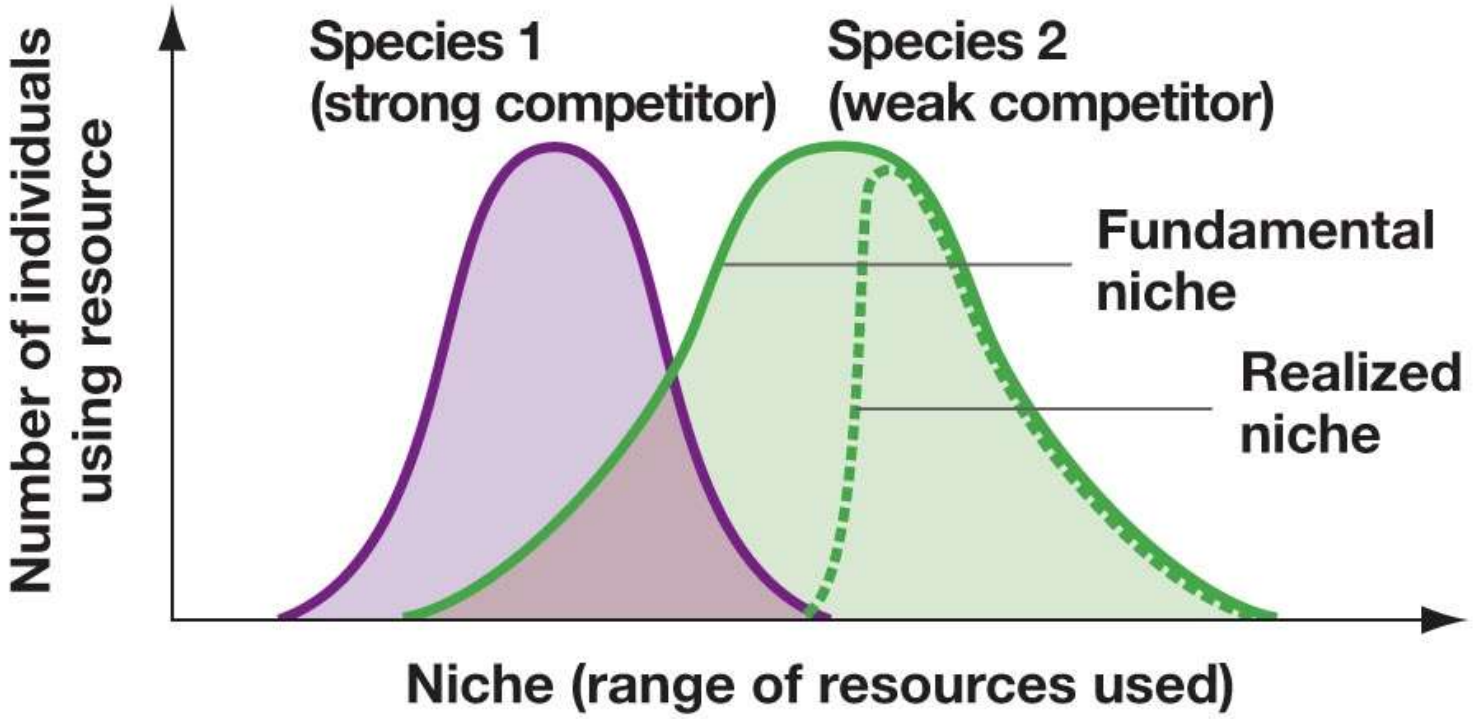
Niche Overlap - Occurs two or more species are using a portion of the same resource. Competition is taking place, but some space is exclusive to either species.

Niche Width (Breadth) - the number of resources used by an organism. Refers to how specialized the species is. Niches may be narrow (specialist) or broad (generalist).

Niche Shift - adaptation of new behavior to reduce competition.

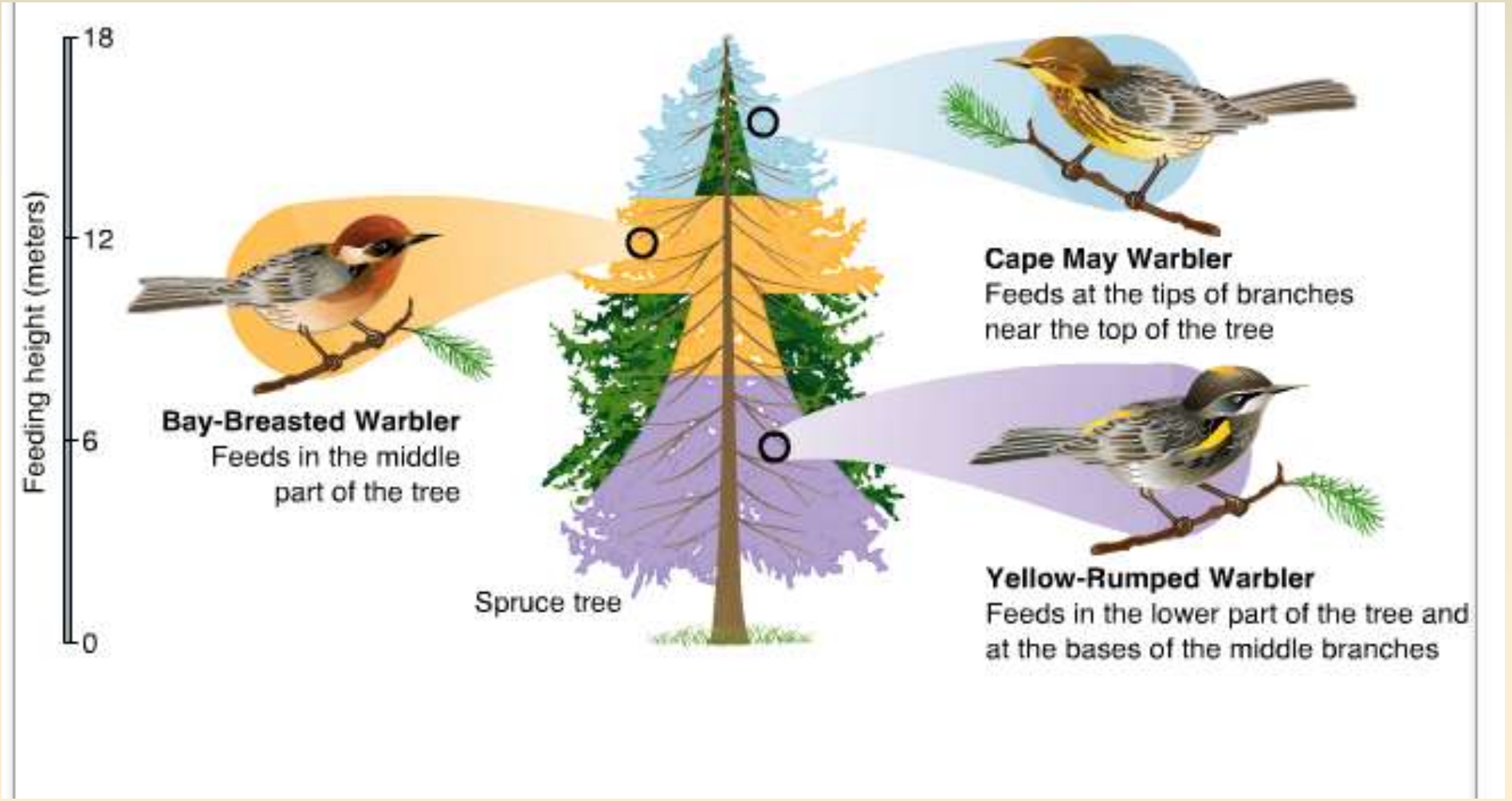
Niche partitioning - closely related species may occupy separate niches within a broader niche

(d) When competition is asymmetric and niches do not overlap completely, weaker competitors use nonoverlapping resources.



Niche Partitioning

MacArthur's Warblers



Competition: -two organisms compete for the same resource (food, space, mates, etc.)., both negatively impacted

Sexual selection –shifts allele frequency

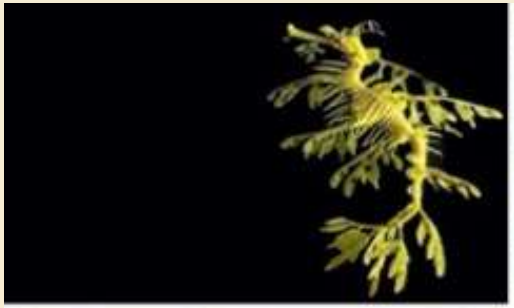
http://subjunctive.net/photoblog/2003/peacock-wooing-peahen.jpg


Benjamin
Cummings

Predation: -one organism (the predator) consumes another (the prey), including herbivory and parasitism.

Response to Predation: Protection and Mimicry

Response to Predation: Camouflage



The Red Queen Hypothesis

In the arms race between hosts and parasites, there is constant, strong selection for new gene combinations.

In the host-parasite arms race, parasites and pathogens are evolving fast, and hosts infected by them must also evolve fast in order to survive.

If species fail to adapt, they may go extinct

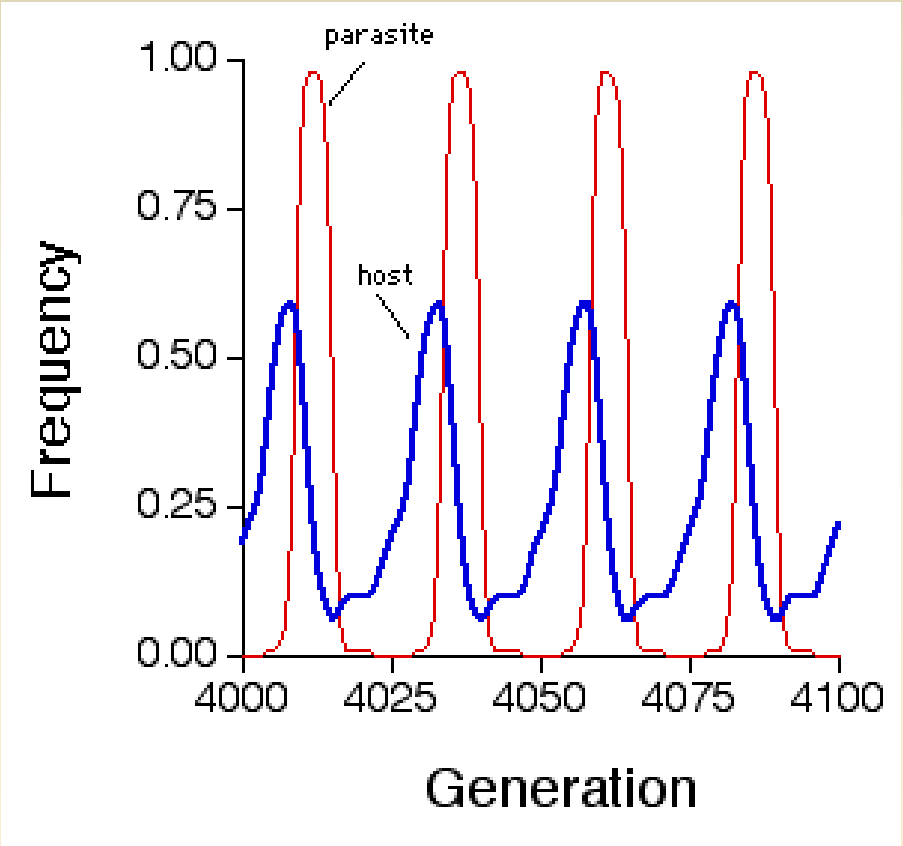
Sexual reproduction facilitates this process.

The Red Queen hypothesis is an evolutionary arms race

Sexual reproduction confers species variability and a faster generational response to selection by making offspring genetically unique.

Sexual species are able to improve their genotype in changing conditions.

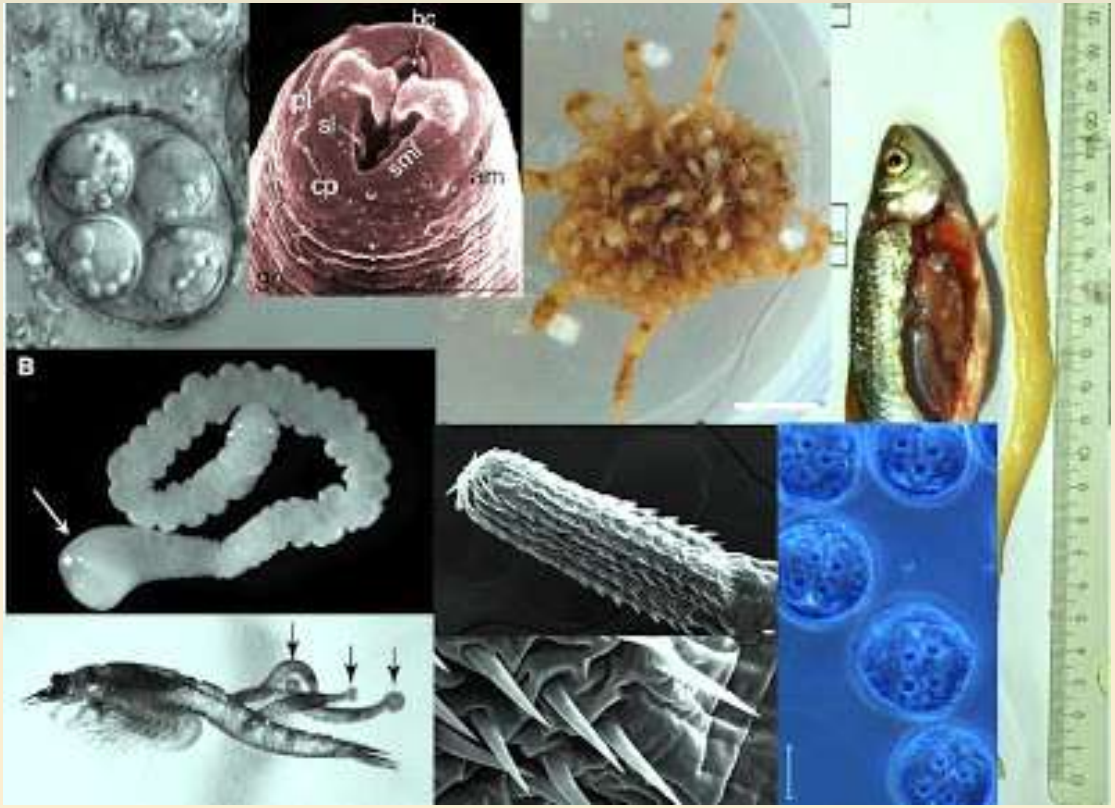
Red Queen dynamics:



Results from a computer simulation for host-parasite coevolution. Note that both genotypes oscillate over time, as if they were "running" in circles.

Herbivory: -plant is eaten by another organism. Unlike predation, plants often survive grazing by an herbivore.

Parasitism: A parasite is physiologically dependent upon its host for nutrition. While the host is negatively affected by the loss of nutrients to the parasite, parasitism rarely leads directly to the host's death.

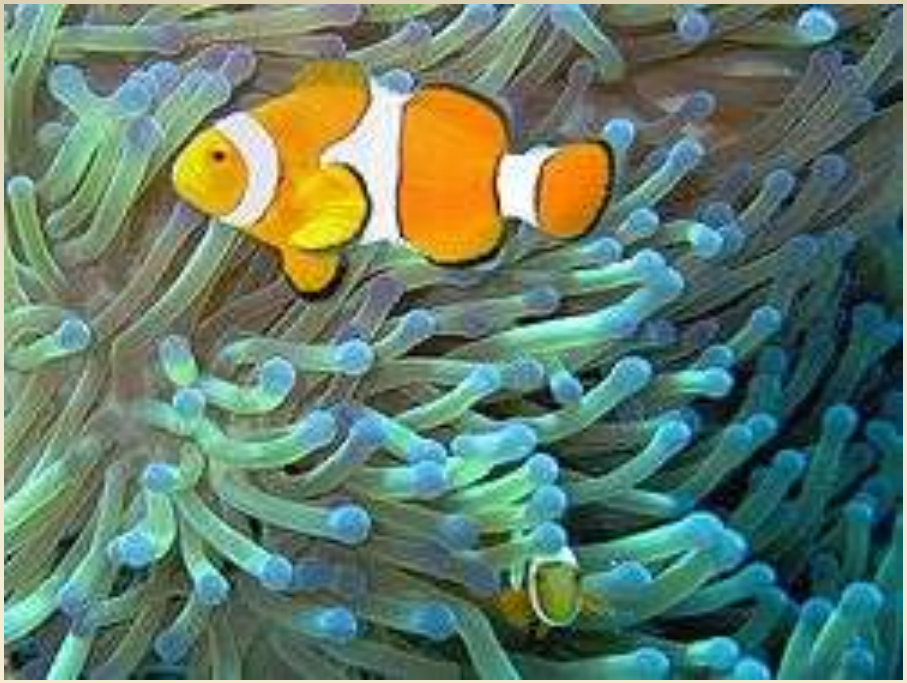


Mistletoe

Species Interactions

Interactions	Affects on Population Growth	
neutral	0	0
mutualism	+	+
commensalism	+	0
parasitism	+	-
predation	+	-
competition	-	-

Mutualism: both partners benefit from the relationship.



Clown Fish - Anemone

Yucca – Yucca Moth

Plants and Pollination

Commensalism: Commensalism occurs when one organism is positively affected by the relationship while the other organism is not affected, either negatively or positively, by the interaction.

Symbiosis Example: Aphids and several ant species. The aphids provide honeydew to the ants while the ants will take the aphids into their nests at night to protect them from predators and escort them back to a plant the next morning.

Natural selection results in evolution of adaptations

Adaptation: trait that enhances an organism's survival and reproduction

Are all phenotypic traits adaptations?

The Adaptationist Approach

1) identify trait likely to be under selection
2) construct functional argument for how trait has adaptive value (relate to fitness)
3) determine if mean value of trait in population is optimal in terms of design and function
4) if not:

    construct new functional argument

    invoke other factors to explain discrepancy between optimal and observed

General Consensus

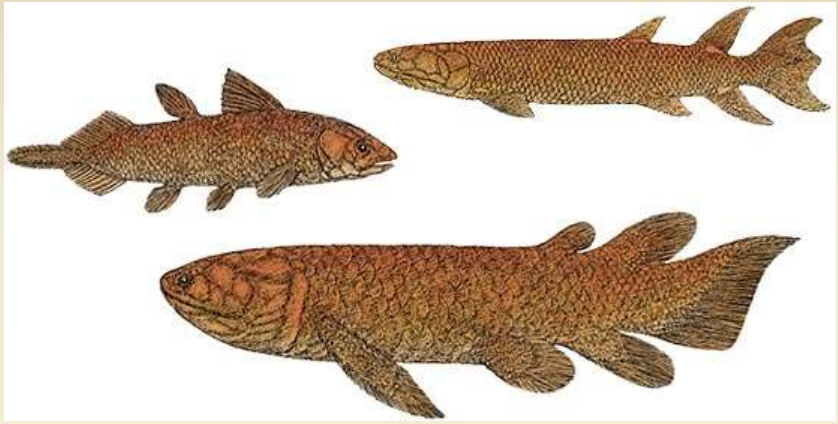
Not all characters are adaptations

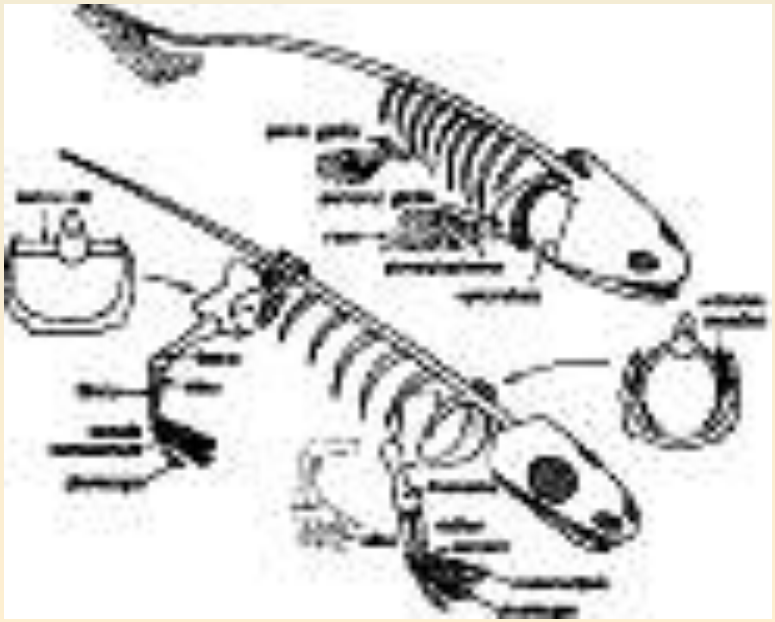
There are alternative, non-adaptational H_o explaining traits

But, shouldn't throw away adaptive approach entirely

Exaptations: Lobe-finned Fishes

- Original Function:
  Stabilizers
  Movement on Land
- Later Function:
  Tetrapod Limbs

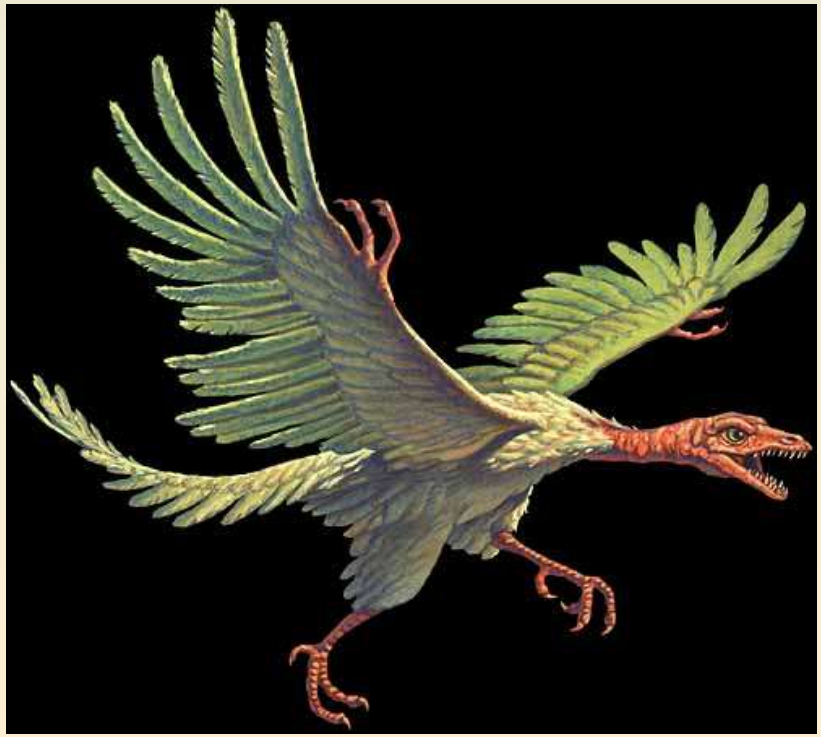




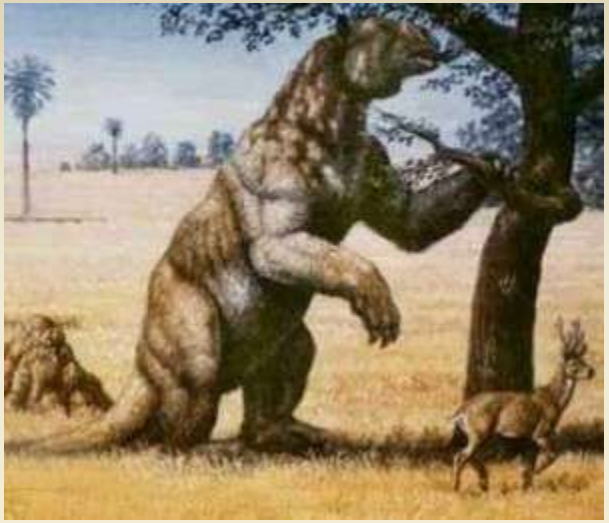
More exaptations

Archaeopteryx:

- Feathers
  - Insulation → flight
- Bone
  - Phosphate storage → support



Ghosts of Evolution?



Natural Selection

Natural selection is NOT the only cause of evolution

mutation, gene flow, genetic drift

Natural selection can slow down evolution :
removes variation from populations

Natural selection IS the only cause of adaptation because other processes don't act via fitness differences

Natural selection does not produce perfect organisms

Evolution is limited by historical constraints (*e.g.*, humans have back problems because our ancestors were 4-legged).

Adaptations are compromises. (Humans are athletic due to flexible limbs, which often dislocate or suffer torn ligaments.)

Not all evolution is adaptive. Chance probably plays a huge role in evolution and not all changes are for the best.

Selection edits existing variations. New alleles cannot arise as needed, but most develop from what already is present.

End