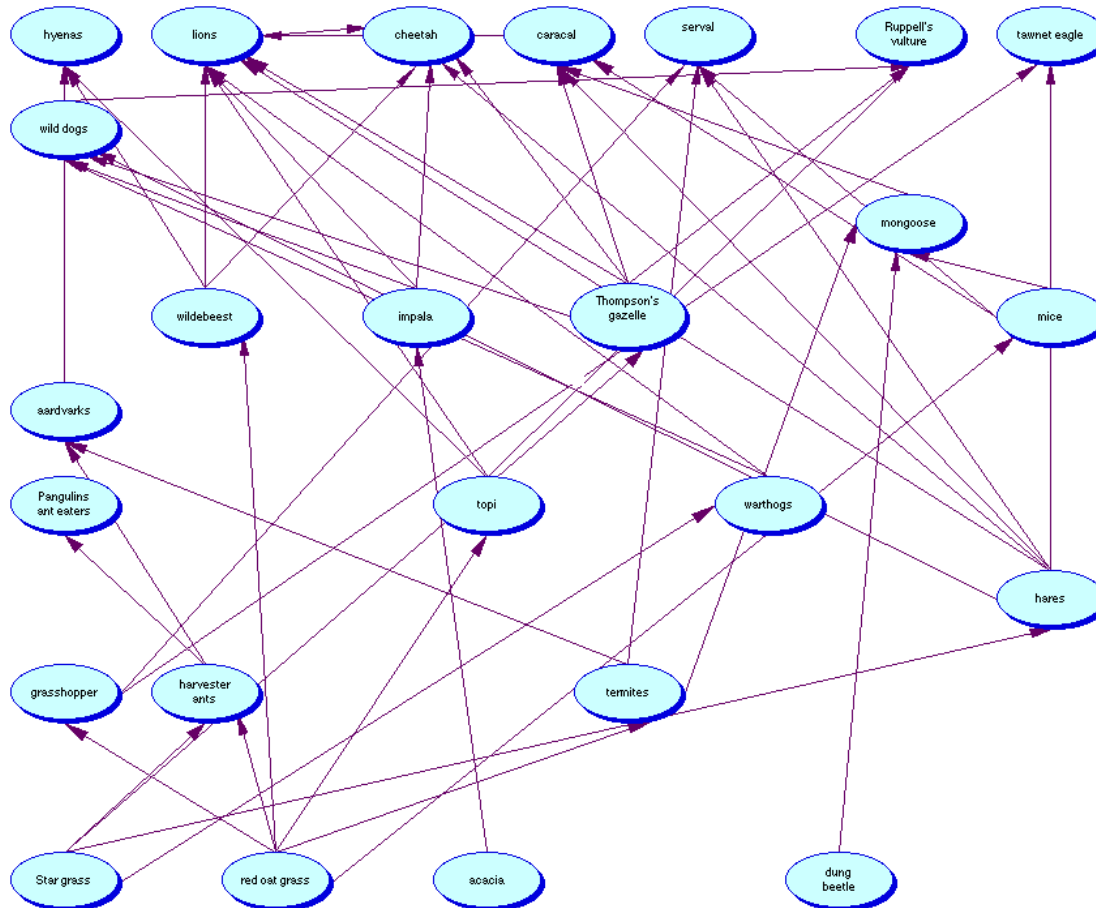




Community ecology

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Community ecology is very complex





Niches

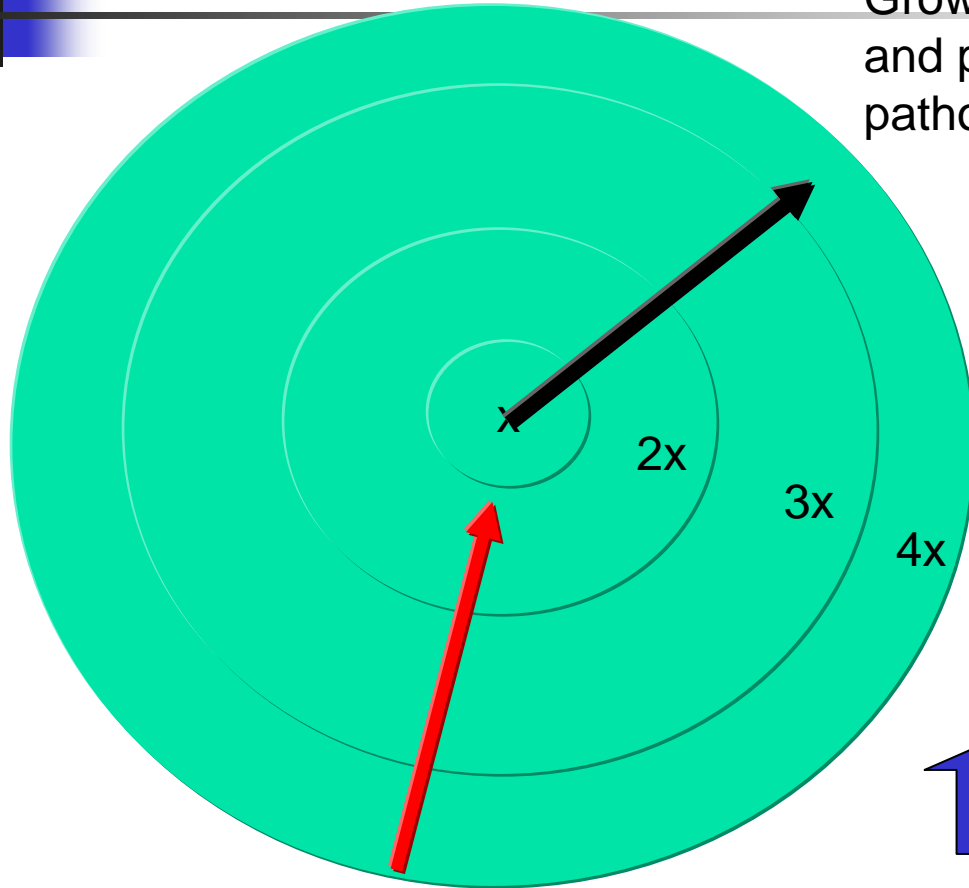
- The term 'Niche' was coined by the naturalist Joseph Grinnell in 1917, in his paper "The niche relationships of the California Thrasher." However, it wasn't until 1927 that Charles Sutherland Elton, a British ecologist, gave the first working definition of the niche concept.
- The niche concept was popularized by the zoologist G. Evelyn Hutchinson in 1957. Hutchinson wanted to know why there are so many different types of organisms in any one habitat.



Niches, definition

- A species' niche is the range of environmental conditions under which it can persist.
- More formally, the niche includes how a population responds to the abundance of its **resources** and **enemies** (e. g., by growing when resources are abundant, and predators, parasites and pathogens are scarce) and how it affects those same factors (e.g., by reducing the abundance of resources through consumption and contributing to the population growth of enemies by falling prey to them).

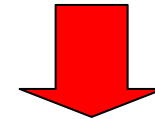
Niches



Growing: resources are abundant, and predators, parasites and pathogens are scarce



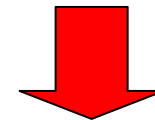
Food



Enemies



Enemies



Food

Extinction: reducing the abundance of resources through consumption and contributing to the population growth of enemies by falling prey to them



Niches, definition

- The **abiotic** or physical environment is part of the niche because it influences how populations affect, and are affected by, resources and enemies.



realized niche.

- The **full range of environmental** conditions (biological and physical) under which an organism can exist describes its **fundamental niche**.
- As a result of **pressure** from, and interactions with, other organisms (e.g. superior competitors) species are usually **forced to occupy** a niche that is narrower than this and to which they are mostly highly adapted.



Niches, description.

- The description of a niche may include descriptions of the organism's life history, habitat, and place in the food chain.
- According to the competitive exclusion principle, no two species can occupy the same niche in the same environment for a long time.
- **Interactions** among species often **restrict** the range of a species to only part of its potential distribution.



competitive exclusion principle

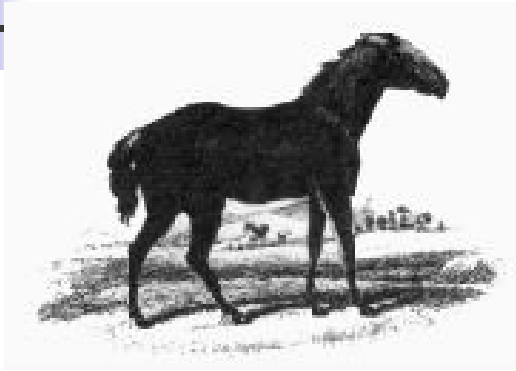
- The **competitive exclusion principle**, sometimes referred to as **Gause's Law of competitive exclusion** or just **Gause's Law**, states that:
- Two species that compete for the exact same resources cannot stably coexist.
- One of the two competitors will always have an ever so slight advantage over the other that leads to extinction of the second competitor in the long run (in a hypothetical non-evolving system) or (in the real world) to an evolutionary shift of the inferior competitor towards a different ecological niche.
- As a consequence, competing related species often evolve distinguishing characteristics in areas where they both coexist.

competitive exclusion principle



- Two lichenes species on a rock, in two different ecological niches

competitive exclusion principle



- Once a niche is left vacant, other organisms can fill into that position. For example, the niche that was left vacant by the extinction of the tarpan has been filled by other animals (in particular a small horse breed, the konik).



Niches, summary

- A species' niche is the range of environmental conditions under which it can persist.
- Interactions among species often restrict the range of a species to only part of its potential distribution.



Competition: Seeking Scarce Resources

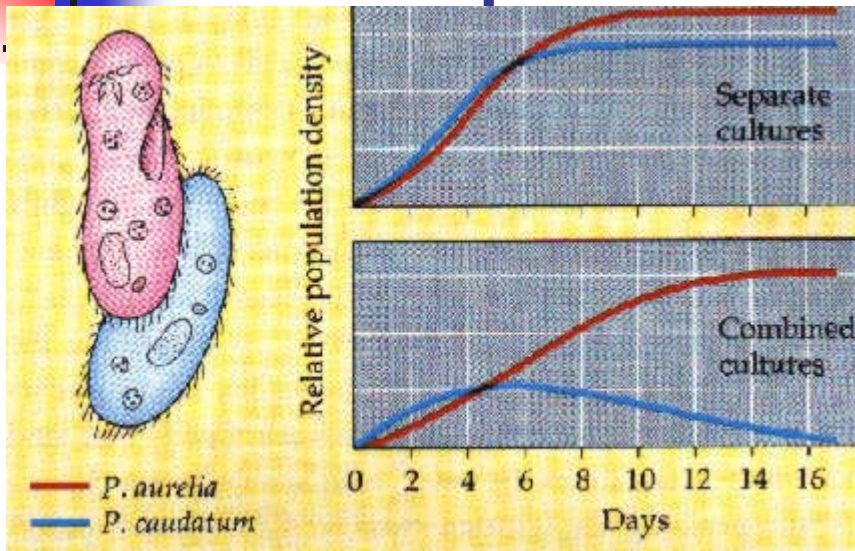
- If organisms use the same resources and those resources are in short supply; the individuals are competitors.
- Competition may be either intraspecific or interspecific.



Interspecific competition

- Interspecific competition is competition for resources (such as food, space, water, light, etc.) between members of different species, and in general one species will out-compete another one.
- This can be demonstrated by growing two different species of the protozoan *Paramecium* in flasks in a lab.

Interspecific competition



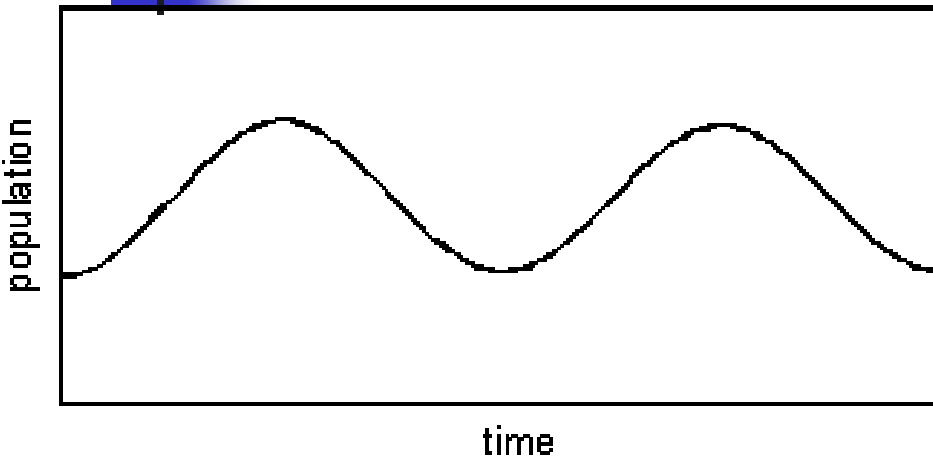
The diagram below shows data about 2 populations of 2 species of Paramecium. The first graph shows the 2 species' population growth when kept in separate culture bottles. The second graph shows what happens when both species occupy the same bottle.



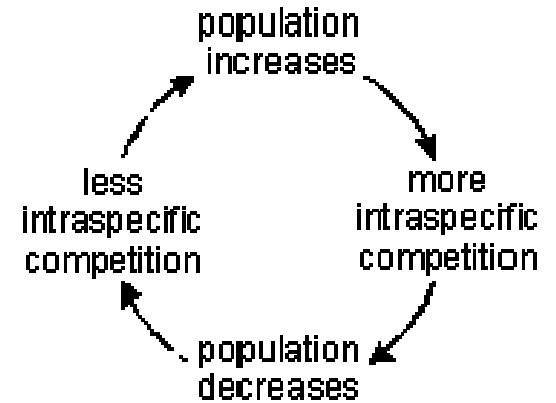
Intraspecific competition

- Intraspecific competition is competition for resources between members of the same species. This is more significant than interspecific competition, since members of the same species have the same niche and so compete for exactly the same resources.
- Intraspecific competition tends to have a stabilising influence on population size. If the population gets too big, intraspecific population increases, so the population falls again. If the population gets too small, intraspecific population decreases, so the population increases again:

Intraspecific competition

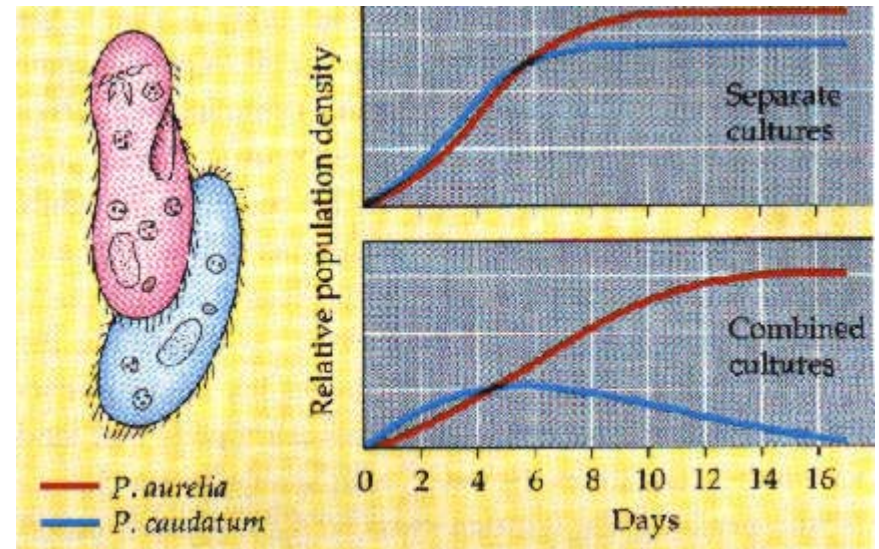
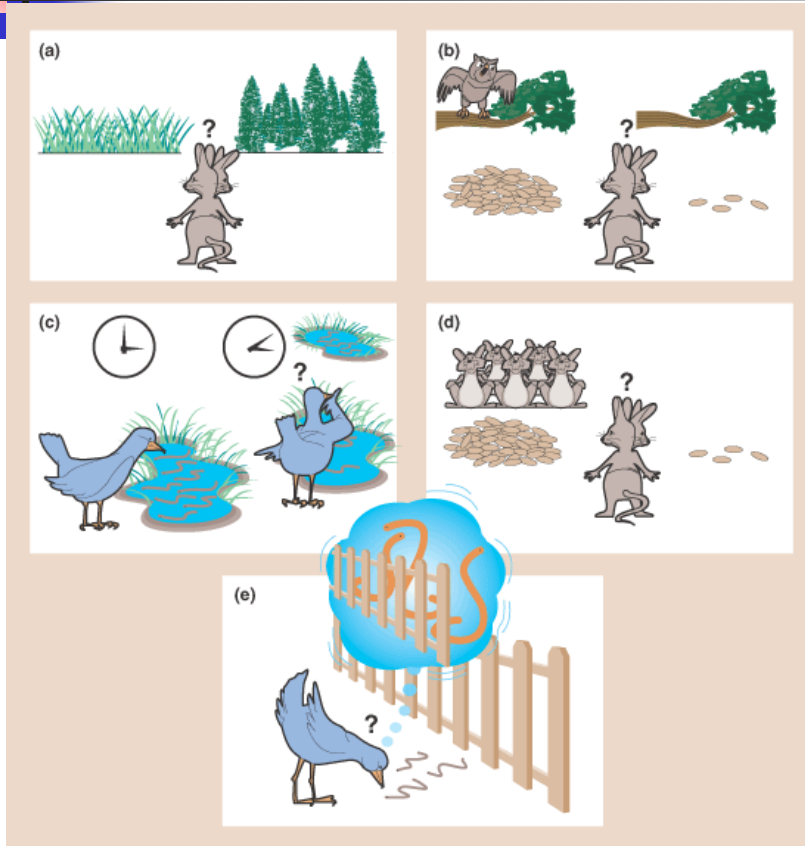


Explanation:



Intraspecific competition is also the driving force behind natural selection, since the individuals with the "best" genes are more likely to win the competition and pass on their genes. Some species use aggressive behaviour to minimise real competition.

Competetion studies



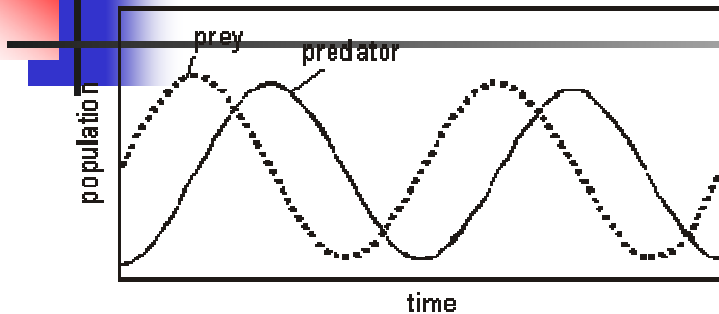
Competition is easily studied in the laboratory; where competitive exclusion is common in homogeneous environments, but not in heterogeneous ones.



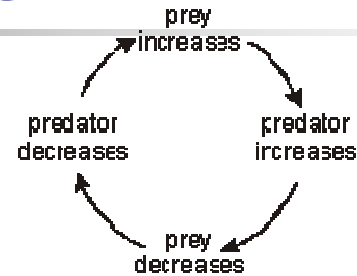
Predator-Prey Interactions

- Predators are classified as herbivores, carnivores, or suspension feeders depending upon what they eat.
- Herbivores consume large quantities of plant parts, which have low nutritional value.
- Carnivores eat other animals.
- Suspension feeders extract large numbers of small prey from water.

Predator-Prey Interactions



Explanation:



The populations of predators and their prey depend on each other, so they tend to show cyclical changes.

This has been famously measured for populations of lynx (predator) and hare (prey) in Canada,

and can also be demonstrated in a lab experiment using two species of mite: *Eotetranchus* (a herbivore) and *Typhlodromus* (a predator).

If the population of the prey increases, the predator will have more food, so its population will start to increase.

This means that more prey will be eaten, so its population will decrease, so causing a cycle in both populations:

Predator-Prey Interactions



lynx (predator)



hare (prey)

Experimental manipulation of **predators** in nature reveals that they are often important in **determining both numbers and distributions of their prey.**

Predators may prevent prey from living in some environments that are otherwise suitable for them.

Predators act as **evolutionary agents** against which prey evolve adaptations, such as toxic hairs and bristles, tough spines, noxious chemicals, and mimicry of inedible objects or dangerous organisms.



Commensal interactions

- Where the host neither gains nor is harmed by the presence of another specie.
- In this example the host acts as a safe haven or a means of transportation.



- Ramoras hitch a free ride on sharks but do nothing in return.
- It was once thought that they cleaned up parasites but this has been disproved.

sharks visit cleaning stations for this purpose - and get cleaned by the cleaner fish living here.



Mutualistic interactions

- Both participants benefit, are common in nature.
- Mutualistic interactions occur between members of different kingdoms (between plants and prokaryotes, between fungi and algae, and between animals and protists).



Mutualistic interactions

- A mutualism is an interaction where both sides benefit. Pollination is a common mutualistic interaction. The plant gains gamete transfer, the animal gets nectar (and also pollen).

Mutualistic interactions

A mutualism between certain ants and a small tree, the acacia, provides an excellent example of an obligate mutualism.

This particular system has been extensively studied in Costa Rica.

The acacia provides a number of benefits to the ants, including shelter (hollow thorns), protein (beltian bodies at tip of leaflets), nectar (secreted near base of leaves).

The ant (*Pseudomyrmex*) provides several forms of protection. It attacks and removes herbivorous insects, It also removes vines that might overgrow the acacia, and kills the growing shoots of nearby plants that might become competitors. It clears away leaf litter from near the plant, and since the acacia grows in a seasonally dry environment where it occasionally is threatened by fire, the ant's activities protect the tree from fire damage as well.

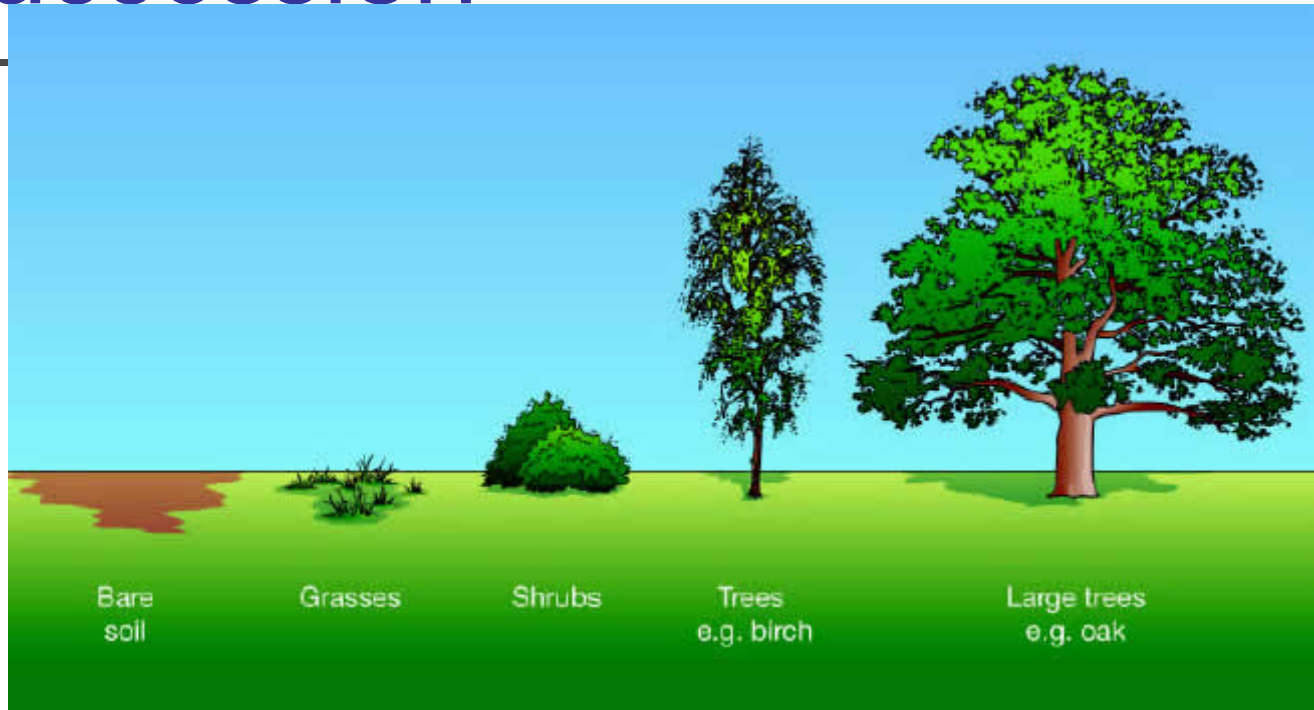




Succession

- **Succession**
- **Ecosystems are not fixed, but constantly change with time. This change is called succession.
Imagine a lifeless area of bare rock. What will happen to it as time passes?**

Succession



The diagram shows an example of a succession from some bare soil to broad-leaved woodland.



Succession

- These stages are called seral stages, or seral communities, and the whole succession is called a sere.
- Each organism modifies the environment, so creating opportunities for other species.
- As the succession proceeds the community becomes more diverse, with more complex food webs being supported.
- The final seral stage is stable (assuming the environment doesn't change), so succession stops at the climax stage.



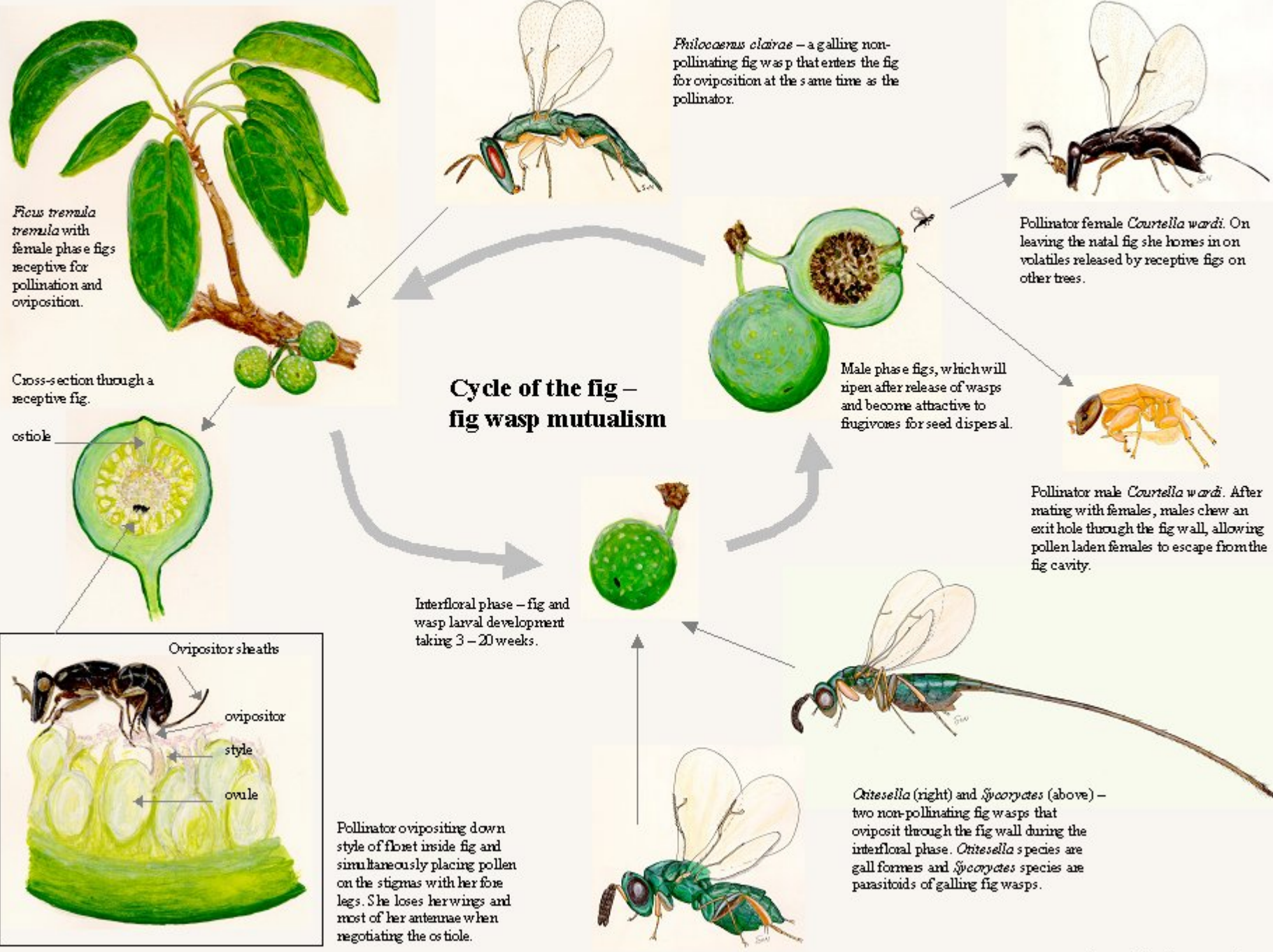
Succession

- Succession may begin at sites that have never been modified by organisms.
- Succession may take place when all or part of the dead body of some organism is decomposed.



Coevolution of interacting species

- Some mutualistic relationships, such as those between figs and fig wasps and yuccas and yucca moths, are tightly coevolved, but diffuse co-evolution between many species is much more common.



Ficus tremula tremula with female phase figs receptive for pollination and oviposition.

Philocærus clavæ – a galling non-pollinating fig wasp that enters the fig for oviposition at the same time as the pollinator.

Pollinator female *Courtella wardi*. On leaving the natal fig she homes in on volatiles released by receptive figs on other trees.

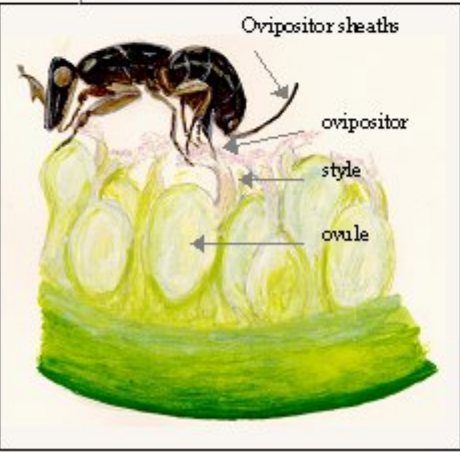
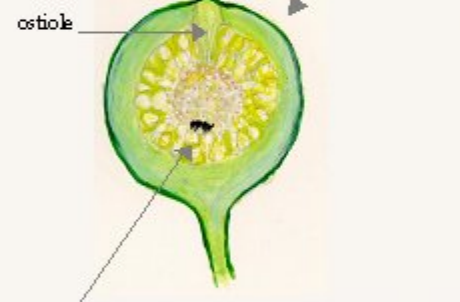
Male phase figs, which will ripen after release of wasps and become attractive to frugivores for seed dispersal.

Pollinator male *Courtella wardi*. After mating with females, males chew an exit hole through the fig wall, allowing pollen laden females to escape from the fig cavity.

Interfloral phase – fig and wasp larval development taking 3 – 20 weeks.

Oritesella (right) and *Sycoryctes* (above) – two non-pollinating fig wasps that oviposit through the fig wall during the interfloral phase. *Oritesella* species are gall formers and *Sycoryctes* species are parasitoids of galling fig wasps.

Cross-section through a receptive fig.



Pollinator ovipositing down style of floret inside fig and simultaneously placing pollen on the stigmas with her fore legs. She loses her wings and most of her antennae when negotiating the ostiole.

Coevolution of interacting species



- Consideration of how fig trees are pollinated may leave the observer with a conundrum. Pollinators of plants can often be predicted, based on flower characteristics of colour, fragrance and shape. For example, white, fragrant flowers with a long corolla tube are usually pollinated by Hawk moths, which are nocturnal and have a long tongue. Fig trees are unique in that the flowers are completely concealed within the fig, an enclosed inflorescence, with the hundreds of tiny florets lining the inside of a central cavity. Attempting to guess who pollinates figs and how the act is carried out would no doubt lead to the conclusion that the pollinator, as for many plant species, must be highly specialized. Careful, close and patient observation of figs that are receptive for pollination would enlighten the observer to a fascinating world, for fig trees are completely dependant on tiny wasps, a couple of millimeters long, for their propagation and survival. These fig wasps are the sole pollinators of fig trees and in turn, fig wasps can breed nowhere else but inside figs, a relationship that is a classic example of an obligate mutualism (neither party can survive without the other) that has evolved over the last 90 or so million years.



Indirect Effects of Interactions among Species

- Indirect effects of species interactions affect many species populations. For example, mice prevent gypsy moth populations from recovering quickly after they defoliate oak trees, thereby allowing the trees to recover.

Indirect Effects of Interactions among Species



Gypsy moth



Oak tree



mice

Biological Control
mice feeding on larva