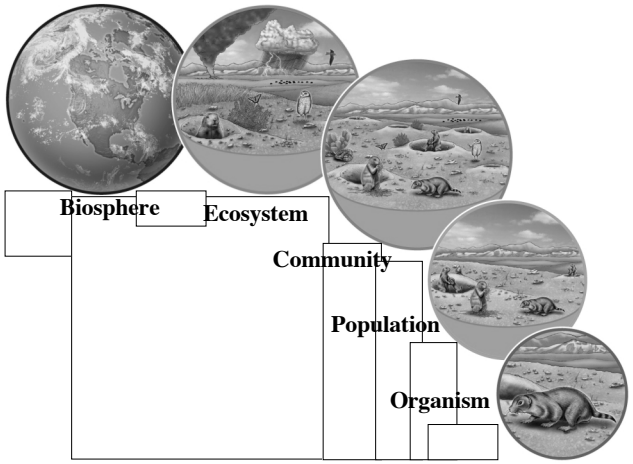
## Scales of Ecological Organization




## Coevolution

A change in one species acts as a new selective force on another species.

Counteradaptation of the second species, in turn, affects selection of individuals in the first species.

## Coevolution

Many species have close, regular relationships with other species.

Parasitism: One species benefits, the other is harmed

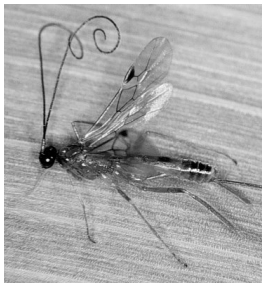
Commensalism: One species benefits, the other is unaffected

Mutualism: Both species are benefited

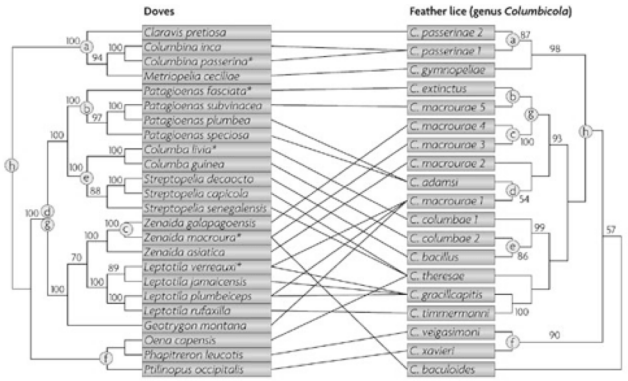
If both interacting species have reciprocal effects on the fitness of the other species, the two species may co-evolve.

## Examples of parasitism:

Parasitoid wasps are very specific as to the host species they will lay their eggs in. The host is eventually killed by the time the larvae emerge and spin their cocoons. Some parasitoid wasps are used for natural biological control of certain crop pests



Natural selection would favor parasite traits that more effectively exploit the host, and host traits that more effectively resist the parasite.

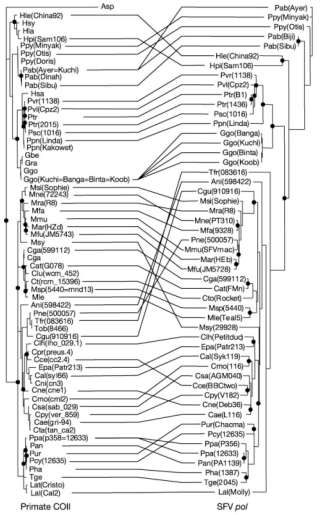



Coevolution of doves and bird lice

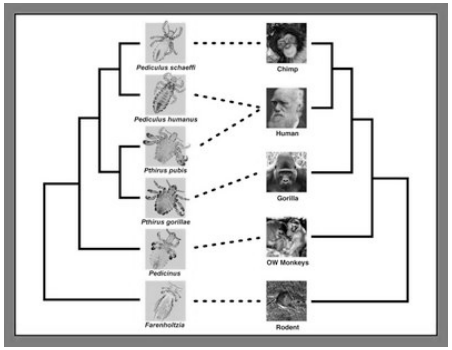
Coevolution of SFV (simian foaming virus) and primates

SFV: non-pathogenic RNA retroviruses that infect all primates

COII from monophyletic lineages within the Hominoidea (Pan/Homo, Gorilla, Pongo and Hylobates) and seven monophyletic lineages within the Cercopithecoidea, infraorder Catarrhini (Colobidae, Trachypithecus/ Pygathrix/ Colobus, Cercopithecus/ Chlorocebus/ Erythrocebus, Allenopithecus, Macaca, Mandrillus/ Cercocebus and Papio/ Theropithecus/ Lophocebus)




Things that make you go hmmmm…….




Pubic lice from humans and gorillas seem to have diverged more recently from one another, than gorillas and humans did.

Insects and Host Plants: An analogue of parasitism

Insects that eat plants without being effective pollinators are essentially the same thing as parasites. Many insects are very specialized on the plant species they eat.

True coevolution -- two species each having reciprocal influence on evolutionary change in the other -- has occurred between insects and their host plants via an evolutionary arms race.

- Insects go through adaptive radiation onto host plants
- Plants evolve mechanical or chemical defenses against the insects
- Plants undergo adaptive radiation once “freed” from the insects
- Insects evolve ways to cope with the new plant defenses
- Insects go through adaptive radiation onto new host plants

## Evolutionary Toxicology

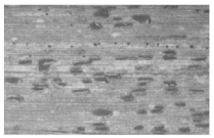
- Study of the "arms race" between toxins and their biological targets
  - insect resistance to pesticides
  - toxins involved in predator/prey relationships
  - pathogen resistance to drugs

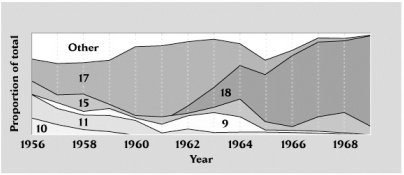
Pyrethroid resistant CEW

Tetrodotoxin resistant garter snake eating toxic *Taricha* newt

Chloroquine resistant *Plasmodium* merozoites

## Pathogen - Plant system






Rust (*Puccinia graminis*) infects wheat plants

Resistant wheat strains are bred by crop geneticists

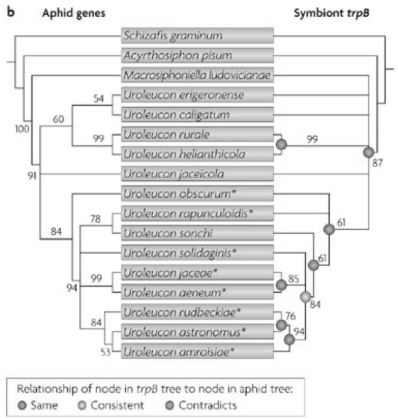
New rust strains migrate in, or mutations occur

## Commensalism

Examples of commensalism

Birds and some epiphytic plants, such as bromeliads, benefit from living in tree branches but do not harm the tree.

The clownfish or anemonefish has evolved the ability to resist the potentially dangerous stings of sea anemones. Different species of fish associate with different species of anemones. The fish gains a habitat safe from predators. The anemone does not benefit, nor is it harmed.




Coevolution of aphids (insects) and their obligate bacterial symbionts (that do not benefit the aphids)

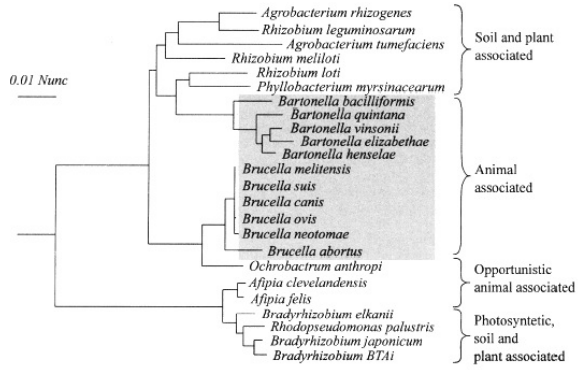



**Fig. 1 Phylogenetic tree of representative plant-associated, free living, opportunistic and animal-associated *Proteobacteria* of the a subdivision. The tree** was constructed by the neighbour-joining method (Saitou and Nei 1987) from Knuc values derived from 16SrRNA sequences available in EMBL, GeneBank and DDBJ Nucleotide Sequence Database. The shadowed area includes bacteria in which plasmids or lysogenic phages have not been found, and in which natural acquisition of genes from foreign sources have not been demonstrated. Therefore these animal-associated bacteria may be considered as clonal evolutionary units.

## Types of Mutualisms

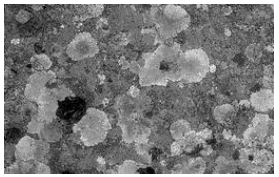
trophic -- partners that cooperate to obtain energy and nutrients

defensive -- partners that exchange food for defense against parasites, competitors, or predators

dispersive -- animals that transport pollen between flowers, or that eat fruit and disperse seeds

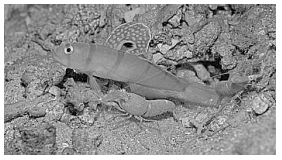
Examples of mutualism:

Lichens consist of a species of fungus and a species of algae. The fungus holds water and can help attach the lichen to a sunny place, while the alga conducts photosynthesis, providing energy for both.

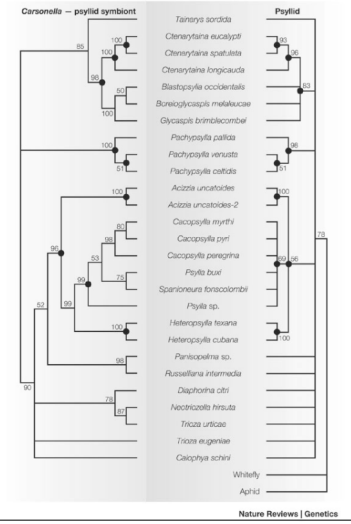


The caterpillars of Lycaenid butterflies produce liquids that are nutritious to ants; in return for these liquids, the ants "tend to" the caterpillars and protect them from predators.

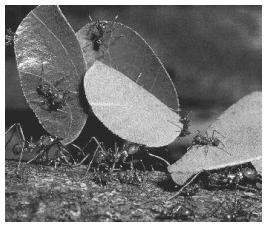
Some fishes called gobies live together inside a burrow with a shrimp. The goby keeps a watch out for predators, and protects the shrimp while the shrimp tends the burrow and cleans the goby.

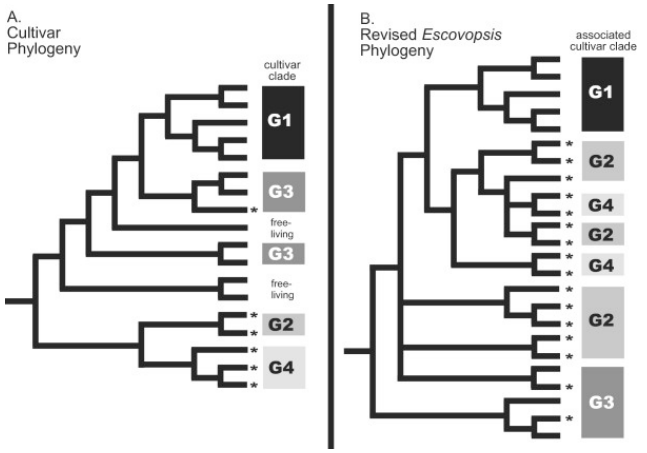


Co-speciation of psyllid insects and their endosymbiotic (gut) bacteria *Carsonella* that aid in digestion




- Leafcutter ants of the genus *Atta* live in intimate symbiosis with Basidiomycete fungi that cannot live without the ants.
- Different species of ants tend different species of fungi.
- Termites have a similar fungal symbiosis






Occasional host shifts in fungi associated with fungus-growing ants

Coevolution of flowering plants and their pollinators

## Ant - Plant Mutualism

plant: *Acacia*
ant: *Pseudomyrmex*

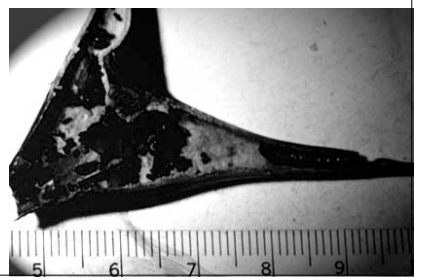
The ant is dependent upon the acacia for food and shelter

The acacia is dependent upon on the ant for protection from herbivorous insects and neighboring plants

## Ant - Plant Mutualism

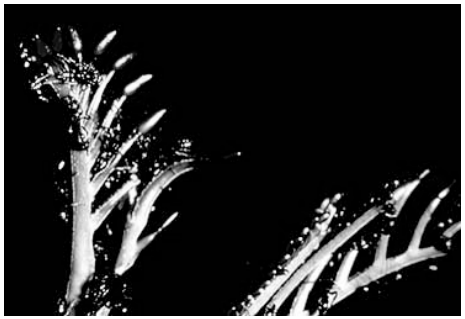
Swollen-thorn acacias

Enlarged stipular thorns normally tenanted by ants



## Ant - Plant Mutualism

Ants get sugar from enlarged foliar nectaries



Modified leaflet tips called Beltian Bodies are eaten by ants as a protein source

## Ant-Plant Mutualism

Workers attack any other insects on the acacia and drive them off by biting and stinging

Ants also attack plants which touch the swollen thorn acacia

Ants receive carbohydrates and protein and housing from the plant

Benefits:
- Acacias can grow in spaces free of other plants, further protecting them from fire

- Year round leaf production and maintenance, even in areas with a strong dry season when most other trees are deciduous

*Unoccupied* swollen-thorn acacias show severe defoliation and competition with vines that shade it.

## Coevolution

A change in one species acts as a new selective force on another species.

Counteradaptation of the second species, in turn, affects selection of individuals in the first species.

*Heliconius* butterflies

*Passiflora* vines

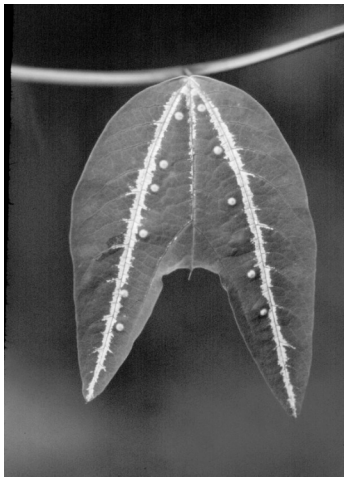
## Coevolution "gone wild"

The vines produce toxic chemicals to reduce damage to young shoots and leaves by butterfly larvae.

Butterfly larvae of can tolerate these chemicals due to digestive enzymes which break down the toxic chemicals (a counteradaptation).

Females of some butterfly species avoid laying eggs (which are bright yellow) on leaves where other yellow egg clusters have been laid; reduces intraspecific competition on individual leaves, SO…

…some species of passionflowers develop large, yellow nectaries which resemble eggs; an adaptation that may divert egg-laying butterflies to other plants.



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These nectaries, as well as smaller ones, also attract ants and wasps which prey on butterfly eggs and larvae.