SANGKALAN

Beberapa bagian dari salindia perkuliahan ini merupakan materi yang dilindungi oleh HAK CIPTA, dan penggunaannya dalam perkuliahan ini berdasarkan prinsip penggunaan wajar (*FAIR USE*) untuk keperluan edukasi.

Oleh karena itu, mohon untuk membatasi penyebarluasan materi ini secara daring; materi ini hanya untuk penggunaan pribadi mahasiswa peserta mata kuliah ini.

EKOLOGI KOMUNITAS

MUTUALISM

Definition

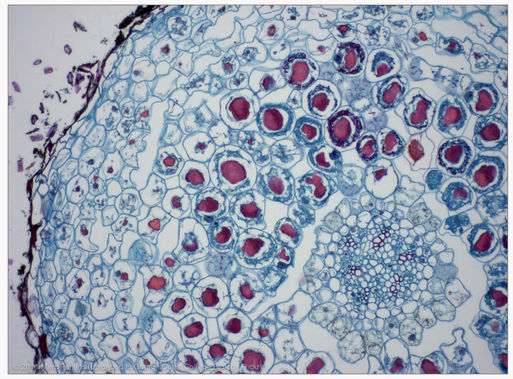
- Any long-term association between two species that confers mutual fitness benefits to individual members of both species.
- Through mutualism: species are better able together to secure resources or better able to defend themselves.
- Many, but not all, mutualistic relationships are symbiotic.
- Mutualism between two species can affect the entire community.
  - Commensalism is an association between two species that benefits only one, with the other species unaffected.

Types of mutualism

- **Facultative mutualisms:**
  - Each species gains a benefit from the presence of the other, but each can still survive without the other.
  - “Generalist” mutualisms.
  - Proto-cooperation.
- **Obligate mutualisms:**
  - Where at least one species cannot survive without the presence the other.
  - “Exclusive” mutualisms.

Obligate mutualism — examples

- Lichen: relationship between algae and fungi.
  - Algae provides the photosynthate
  - Fungi provides a safe habitat
- Ruminants and symbiotic bacteria.
  - Bacteria break down plant tissue to provide energy for their hosts.
- Roots of most plants and fungi.
  - Association between mycorrhizae fungus and root tissue.
  - Fungi obtain carbohydrates from their host.
  - Fungi increase access to mineral nutrition and water for the plant.



Facultative mutualism — examples

- Pollination: Bees and flowers.
  - Bees receive nectar or fruit from the plant; collect and transfer pollen in the process.
  - Either can get other sources of food/pollination agent from elsewhere.
- Cleaning symbiosis: orange chromides and green chromides.
  - Orange chromides act as a "cleaner fish" removing parasites from green chromides.
  - Orange chromides also feed on zooplankton and algae.


Bee covered in pollen


Orange chromide


Green chromide

Facultative vs. obligate mutualisms

Facultative	Obligate
• More common. • Extinction affect only one. • No two-way dependence. • Longer period to evolve.	• Less common. • Extinction affect both. • Two-way dependence. • Shorter period to evolve

Examples of mutualism

Examples of mutualism

- Plant–animal mutualism (most common, ~90%).
  - Defensive/protective mutualisms.
  - Dispersive mutualisms.
    - Seed dispersal mutualism.
    - Plant–pollinator mutualism.
- Animal–animal mutualism.
  - Cleaner mutualisms (aquatic and terrestrial).
  - Defensive/protective mutualisms.
- Other types of mutualism

Defensive/protective mutualism

Ants and “swollen thorn” acacias

- Acacias are protected from herbivores and other plants, saving energy by not producing expensive alkaloids.
  - Ants gain shelter and food.

Dispersive

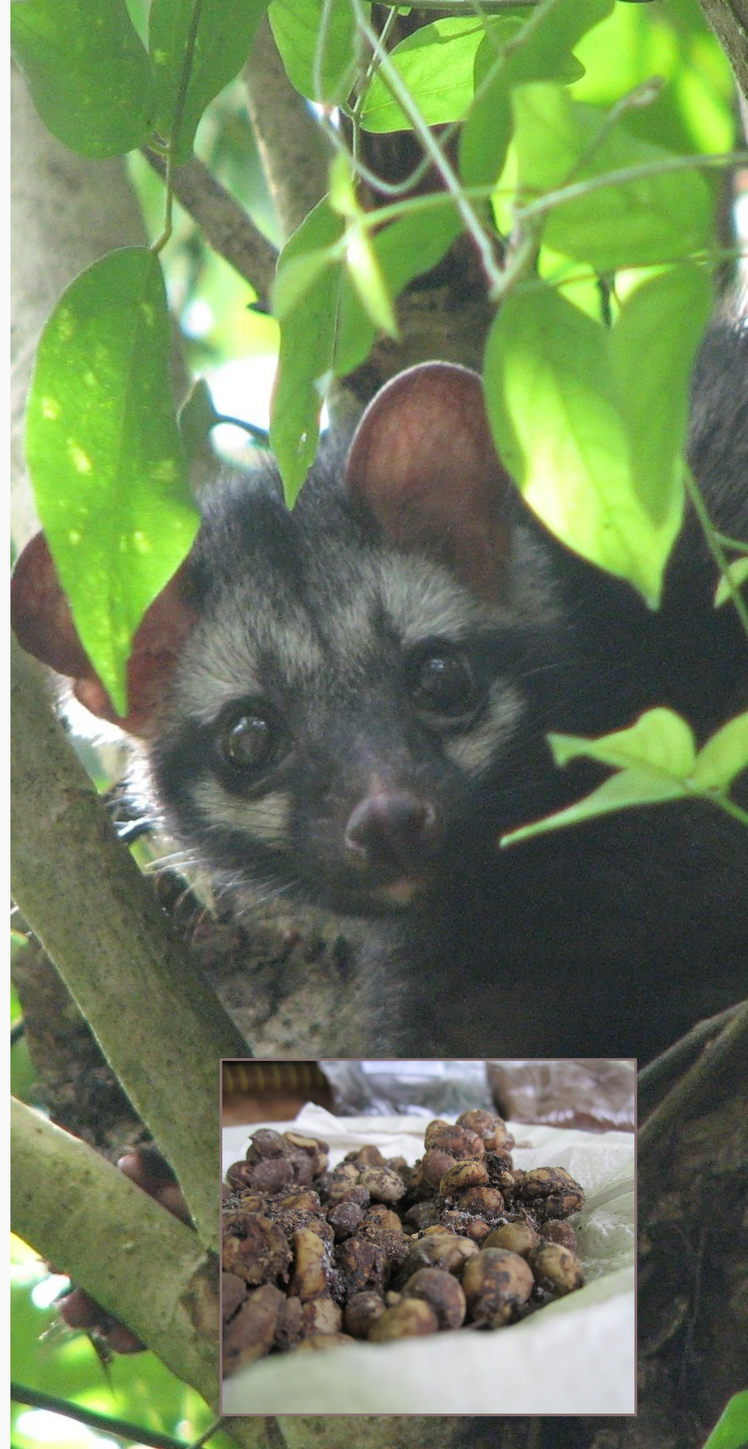
Seed dispersal mutualism

- Animals benefit from fruit; plants benefit from seeds being moved to favorable germination sites.
  - Most are facultative, but some are obligate.
- Seed dispersal systems account for almost 30% of all mutualisms.
  - In tropics some fruits are dispersed by birds that are frugivorous.
  - Fruit provides balanced diet for birds.
  - Birds disperse seeds.

Dispersive

Seed dispersal mutualism

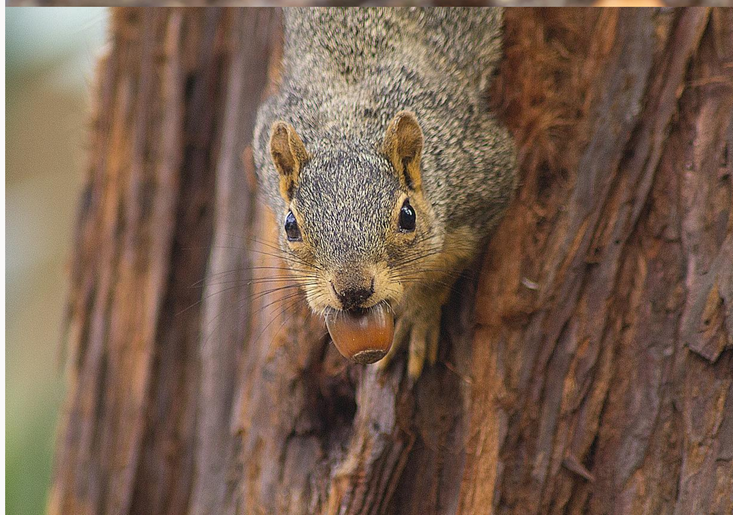
- Seed dispersal mechanisms are not as obligatory as plant-pollinator systems
  - Performed by more generalist agents.
- Mechanisms for attraction
  - Birds and mammals: attractive colors, and odorless (birds).
  - Nocturnal bats: give off pungent odor.



Dispersive

Seed dispersal mutualism

- Problem for plants
  - Many seed dispersers are also seed predators.
- Solutions:
  - Mast seeding: synchronous production of seed at long intervals by a population of plants.
  - “Choosing” dispersal agent.



Mast seeding

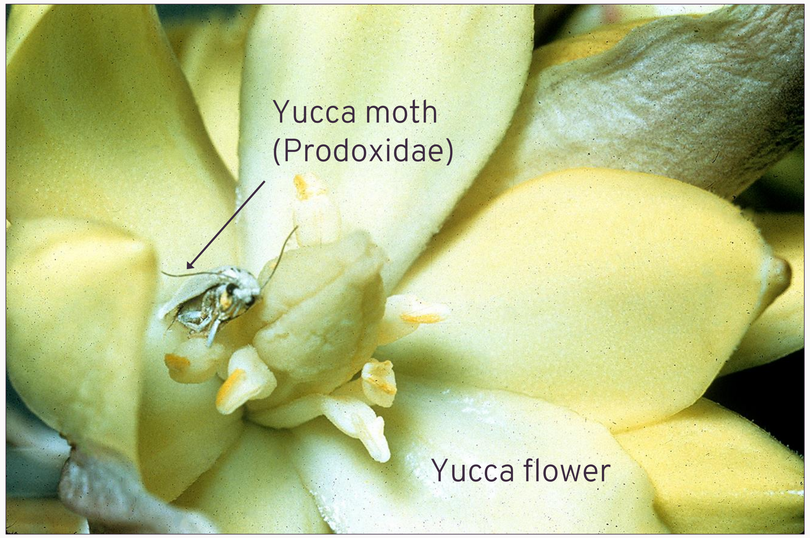
- All trees of a particular species in a given area produce large seed crops simultaneously.
- Alternating years of high and low production.
- Example: oak tree.
  - Production of acorns.
  - Squirrels can’t retrieve all.

“Choosing” dispersal agent

- Toxic or distasteful fruits are one way for a plant to ‘choose’ its dispersal agents.
- Fruit characteristics and forager choice:
  - Toxin content, fruit appearance, and nutrient content.
- Example: chili peppers and birds.
  - Capsaicinoids distasteful to mammals, but very tasty to birds.

Dispersive
Plant–pollinator mutualism

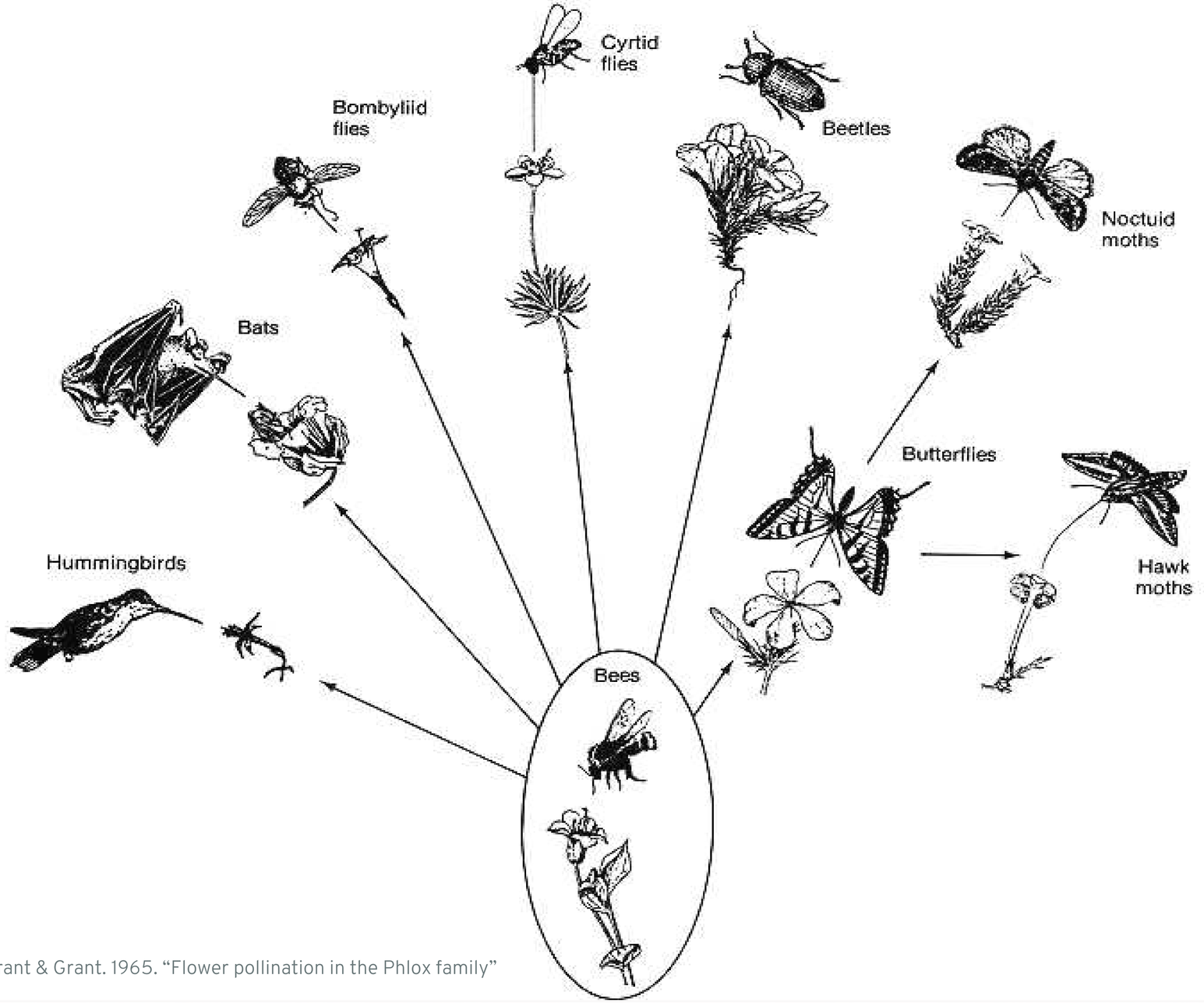
- Most frequent type of mutualism.
  - 45% of all studies of mutualism .
  - Coevolved systems.
- Selective pressures for plants to develop intimate relationship with pollinators.
  - *Ficus* spp. must be pollinated by its own species of agaonid wasp.
  - Yucca plants and yucca moths.



Insects as pollinators

- Most specialized pollinators.
- Have evolved more obligate mutualisms than birds or mammals.
  - Able to pollinate a greater variety of flowering plants.
  - Short life cycles, short generation times, and many offspring.
  - Small brains
  - Can move quickly from plant to plant, remember the last species visited.

Phlox family adaptations to many different pollinators



Grant & Grant. 1965. “Flower pollination in the Phlox family”

Cleaner mutualisms

Animal–animal mutualism

- Cleaner fish (e.g. remora, wrasse).
- Birds on mammals and crocodiles.

Dragon wrasse and rainbow cleaner wrasses

Banded coral shrimp

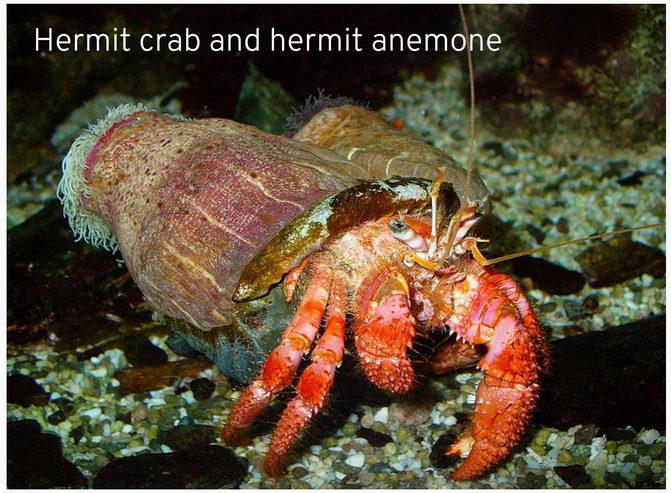
Red-billed oxpecker & African buffalo

Nurse shark & remoras

Defensive/protective mutualisms

Animal–animal mutualism

- Food supply in return for protection.



Hermit crab and hermit anemone

Colombian lesserblack tarantula and dotted humming frog

Coral mutualism

- Zooxanthellae live within coral tissues, receive nutrients from coral.
- Coral receives organic compounds synthesized by zooxanthellae.
- Corals control rate of zooxanthellae population growth and density by influencing organic matter secretion.

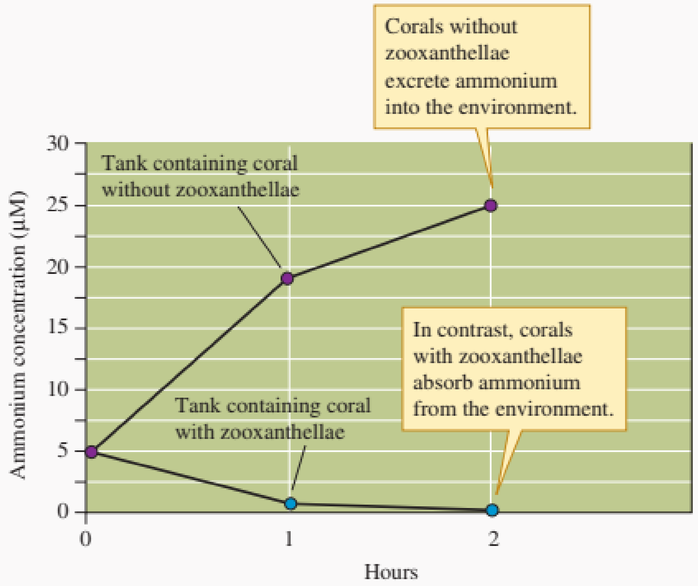
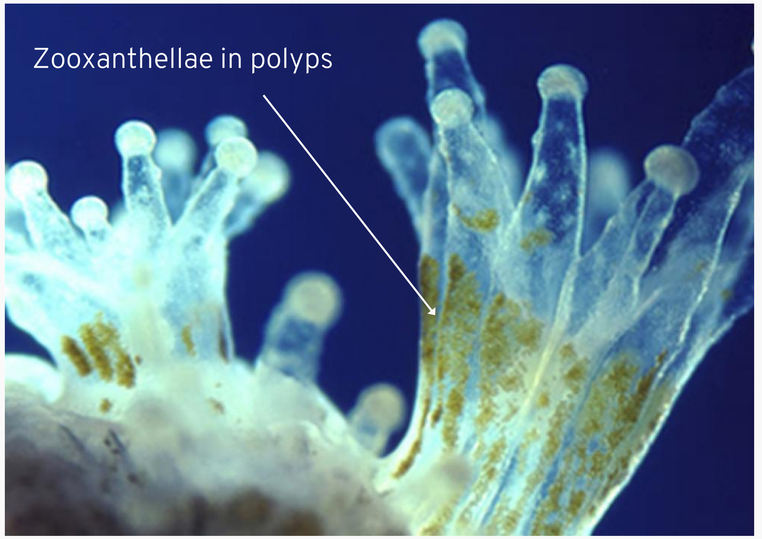


Figure 15.17 Zooxanthellae, corals, and ammonium flux (data from Muscatine and D'Elia 1978).
Source: Molles Jr. 2013. Fair Use rationale.



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Coral protection mutualism

- Glynn's (1983) findings:
  - 13 coral species protected by crustacean mutualists.
  - Crustacean mutualists help protect coral from attack by sea stars.


Acanthaster planci


Pistol shrimp

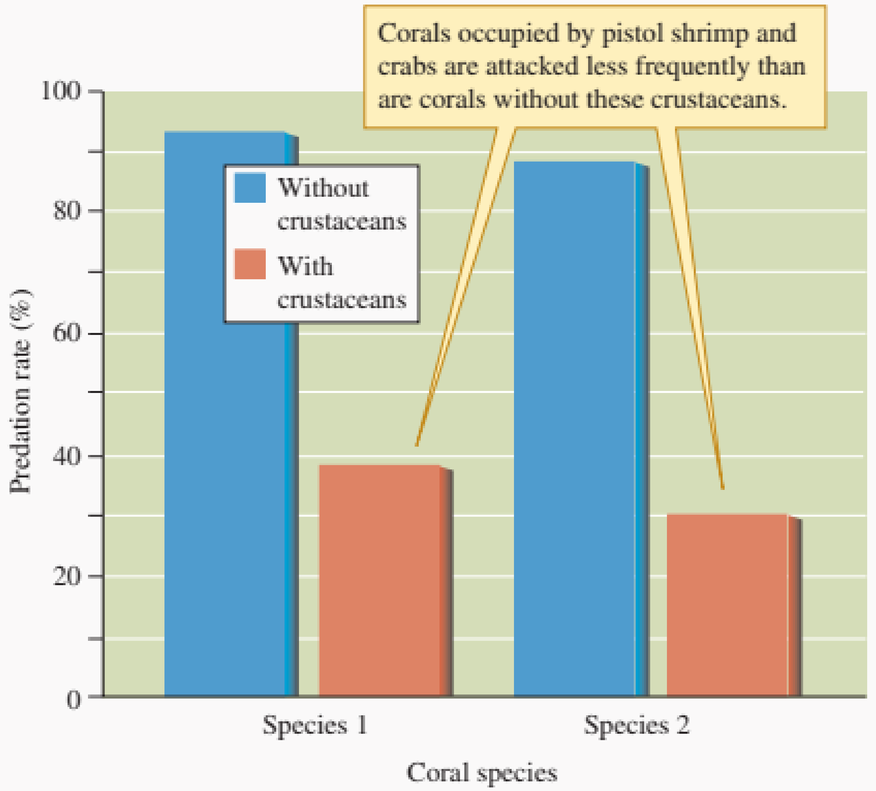

Figure 15.19 Attacks on corals with and without pistol shrimp and crabs (data from Glynn 1983).

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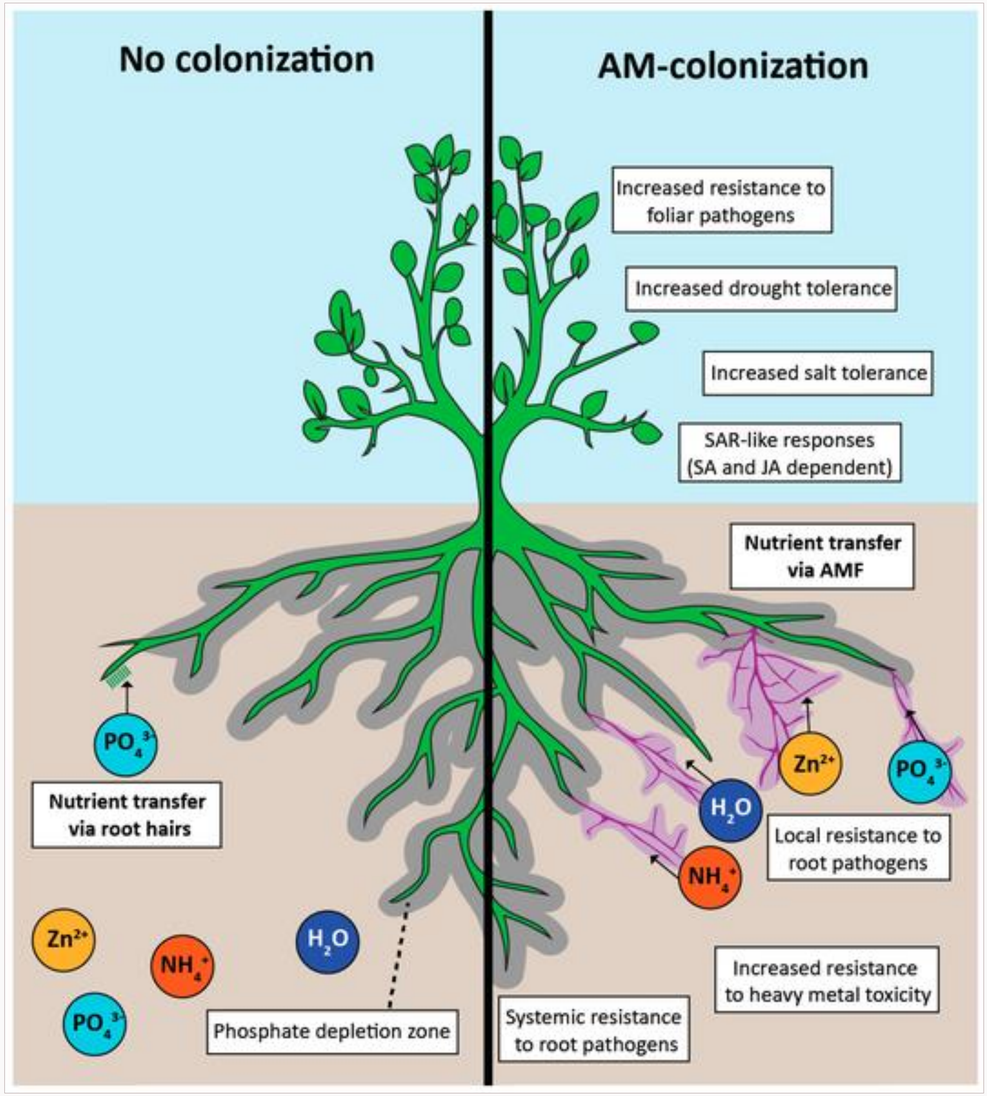
Mycorrhiza
Other types of mutualism

- A symbiotic association between a green plant and a fungus
- Improves water and nutrient availability



Evolution of mutualism

Evolution of mutualism

- For a population to be mutualistic, fitness of successful mutualists must be greater than unsuccessful or non-mutualists.
- If not, natural selection will eventually eliminate the interaction.

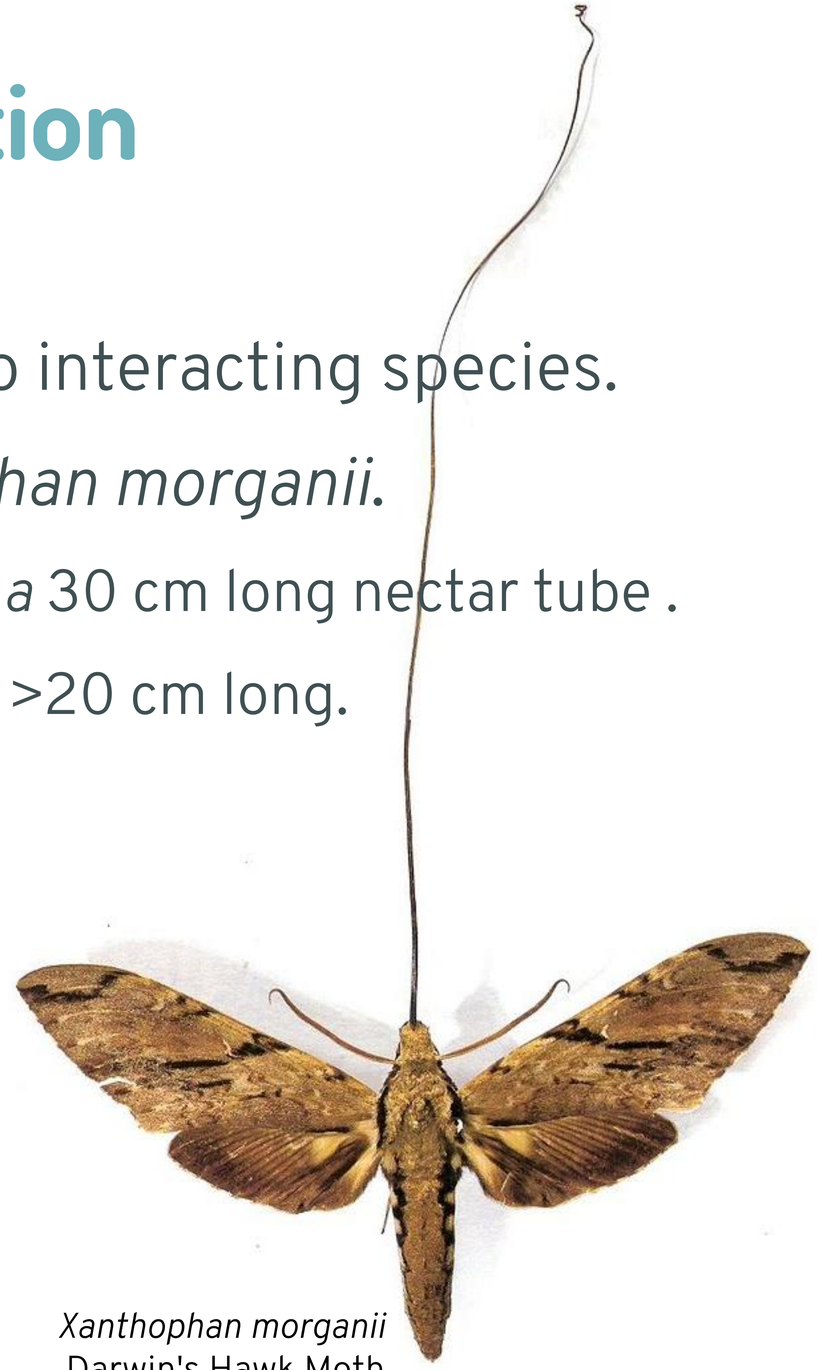
Models of mutualistic interactions

- Mutualism predicted to evolve where the benefits of mutualism exceed the costs.
- Keeler (1981, 1985) developed models to represent relative costs and benefits of different mutualistic interactions.
  - Non-mutualists: neither give nor receive benefit.
  - Successful mutualists: give and receive benefits.
  - Unsuccessful mutualists: give, but do not receive benefit.

Species-specific coevolution

- Mutual evolutionary influence between only two interacting species.
- Example: *Angraecum sesquipedale* and *Xanthophan morganii*.
  - 1862, Darwin found *A. sesquipedale* specimen has *a* 30 cm long nectar tube .
  - 1907, *X. morganii* was identified to have proboscis >20 cm long.


Angraecum sesquipedale Darwin's Orchid

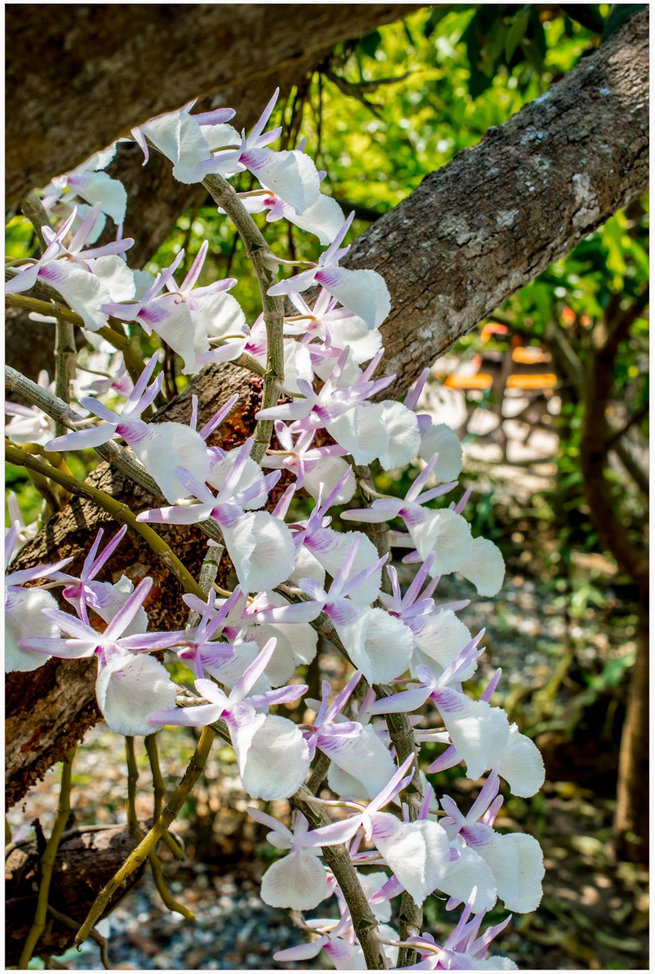

Xanthophan morganii
Darwin's Hawk Moth

Facultative ant-plant mutualisms

- For a facultative ant-plant mutualism to evolve and persist:
  - Plant's energy budget ants save from destruction by herbivores > proportion of the plant's energy budget invested in extrafloral nectaries and nectar.
- Conditions that may produce higher benefits than costs:
  - Low proportion of plant's energy budget invested in extrafloral nectaries.
  - High probability of attracting ants.
  - Low effectiveness of alternate defenses.
  - Highly effective ant defense.

A short note on commensalism

- Commensal relationship: one member benefits and the other is unaffected.
- Examples:
  - Orchid and a tropical tree.
  - Cattle egrets and cattle.



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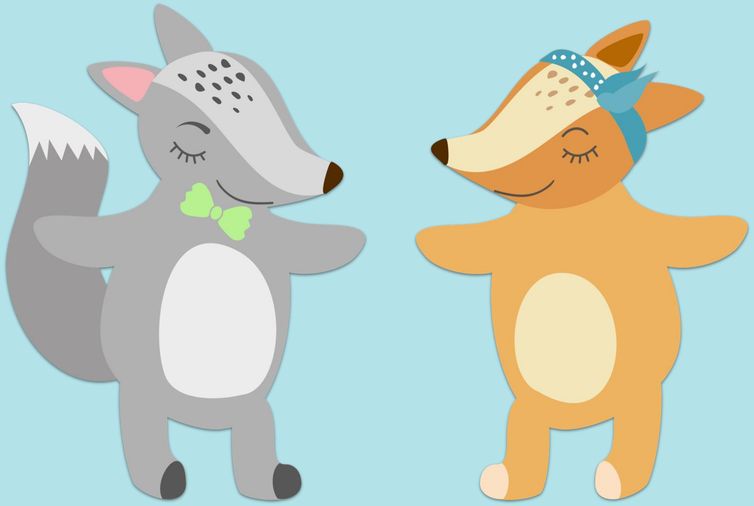

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