

¿What kind of plant-fungus and plant-herbivore interactions are found in a tropical rain forest?

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Pathogenic microorganisms are a special group of parasites that obtain their nutrients from plant tissues and cause DISEASES

They are found in all types of environments, but in several plant communities disease incidence is seasonal



Pathogens are rarely studied in natural communities

All stages of the life cycle of plants are susceptible to attack by pathogens





And pathogenic micoorganisms are affected by changes occuring during growth and development of their host plants







Seedlings

Through stages of seed germination and in young seedlings, nutritional resources available for pathogens are restricted



Therefore similar types of microorganisms, mainly soil borne pathogens, attack them.

Death

They modify the size of the population

70% of the *Platypodium elegans* (Fabaceae) seedlings that emerge around the parent tree die as a result of the attack by soil borne pathogens, mainly *Pythium* and *Phytophtora*







Seedlings become resistance after a few weeks

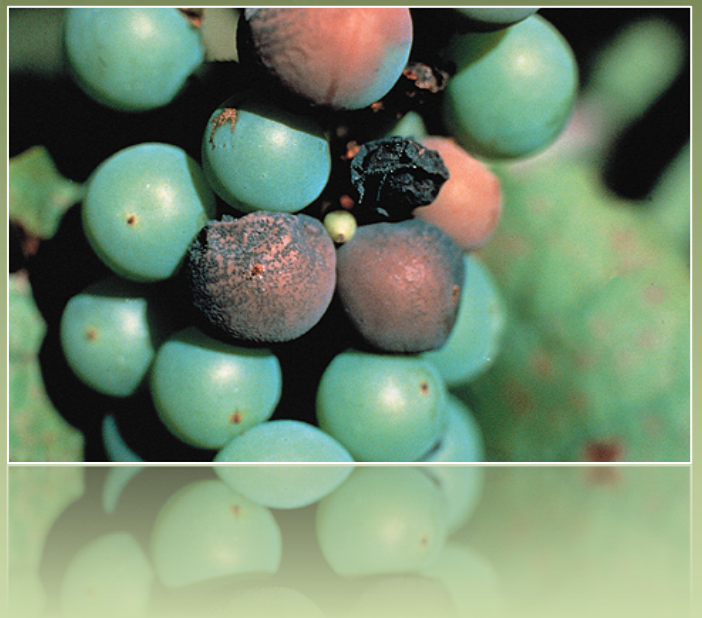
Infection by damping-off causes total destruction of seedlings

ADULTS







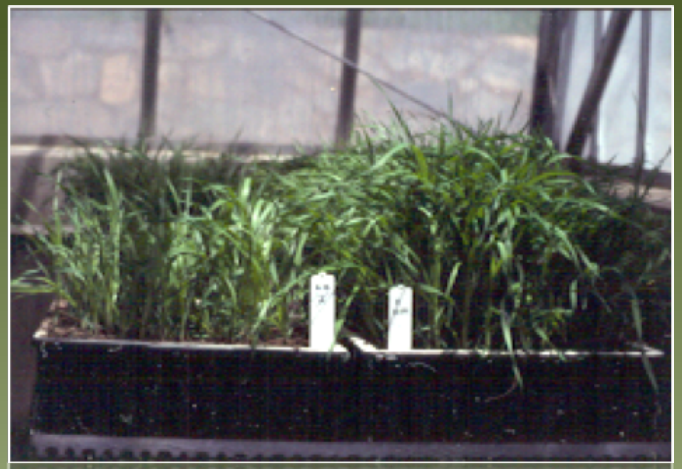


ADULTS

Pathogenic attack depends on:

Length of the plant life cycle (annual or perennial)

Plant part under attack





INFECTION

Death (rarely)

Reduction of vigour

Reduction or prevention of seed production

Changes in plant fitness

Very little is known about the role of pathogens in tropical forests

However, it is known that foliar diseases are very common, and affect a large number of plant species



	Dry season		Rainy season	
	n	Diseased (%)	n	Diseased(%)
Species	49	65.3	57	64.9
Plants	620	65.8	483	55.16
Leaves	3890	43.3	4475	45.4

Taken from Graciela García-Guzmán & Rodolfo Dirzo
American Journal of Botany
Vol. 88, No. 4 (Apr., 2001), pp. 634-645

Microscopic fungi show diverse life history strategies, and therefore comprise a very heterogeneous group









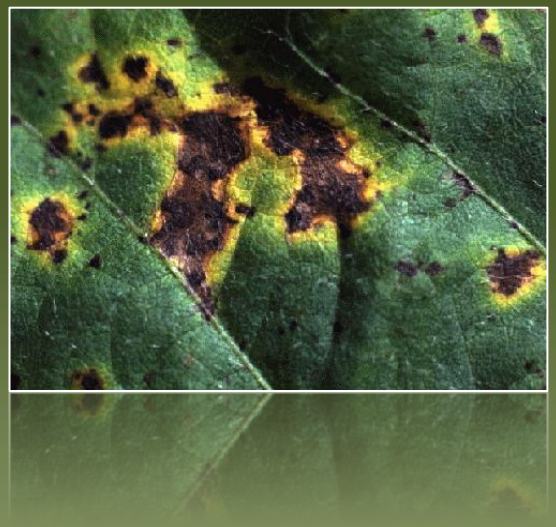


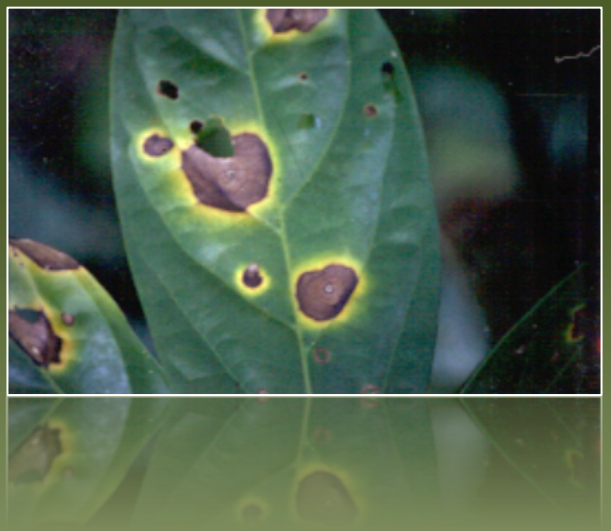




The studies that we have carried out in the Los Tuxtlas forest show that the main type of pathogenic fungi affecting the foliage of plants are necrotrophic fungi

Necrotrophic pathogens secrete enzymes that kill the host cells from which they subsequently feed



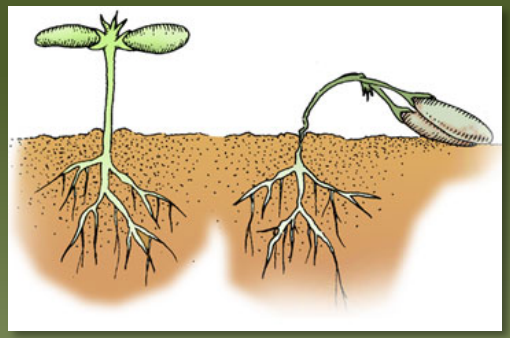






Several studies sugest that the effects of pathogens in tropical plants are consistent with the Janzen-Connell hypothesis

Damping-off
(studies by Augspurger 1983, 1984)





Carol K. Augspurger, *Oikos*
Vol. 40, No. 2 (Feb., 1983), pp. 189-196

Augspurger, C. K., & Kelly, C. K.
Oecologia, *61*(2) (1984), 211-217.

Seedlings and adults canker
(Gilbert et al. 1994)





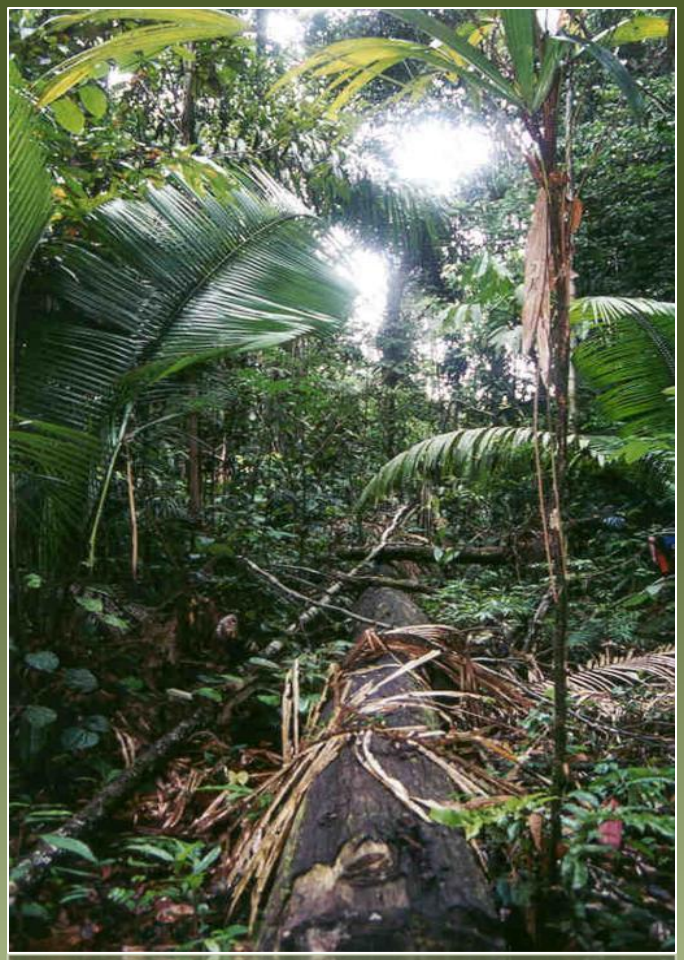
Gilbert GS , Foster RB & Hubbell, SP
Oecologia 98 (1) /1994), 100-108

Pathogens can cause branch or tree falls

Gap formation

Tropical rain forest regeneration





Pathogenic microorganisms and herbivorous insects

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Biodiversity



Herbivory

Herbivores can behave as:

True predators

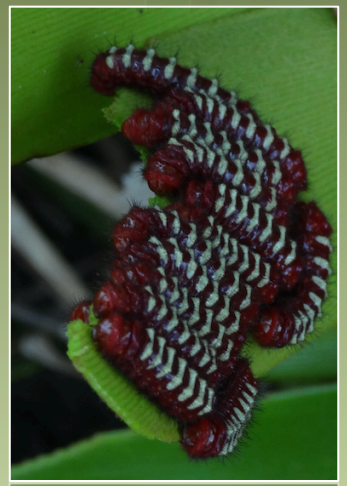
Grazers

Parasites



Herbivores can mold:

Composition, diversity and structural complexity of plant communities





Effect of herbivorous vertebrates depends on:

Herbivores food preference

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Growth rate and plants competitive hability

↓

Communities dominated by particular species or combinations of species

Herbivory → succesional processes

Floristic composition and diversity of areas protected against rabbit herbivory are very different from those unprotected

→

In tropical forests, herbivorous vertebrates affect the survival of seeds and seedlings

Chajul, Chiapas

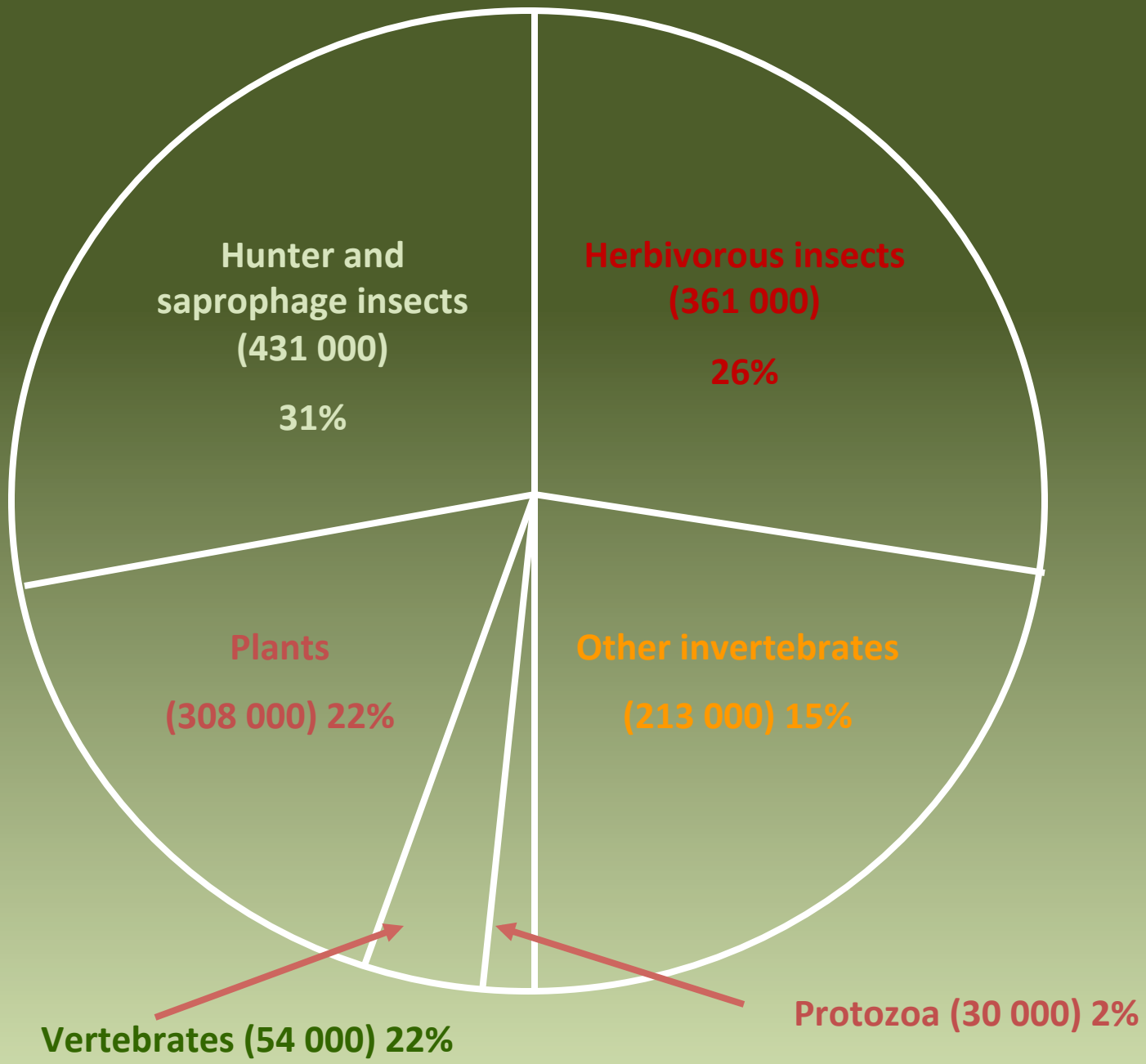
Great abundance of herbivorous mammals

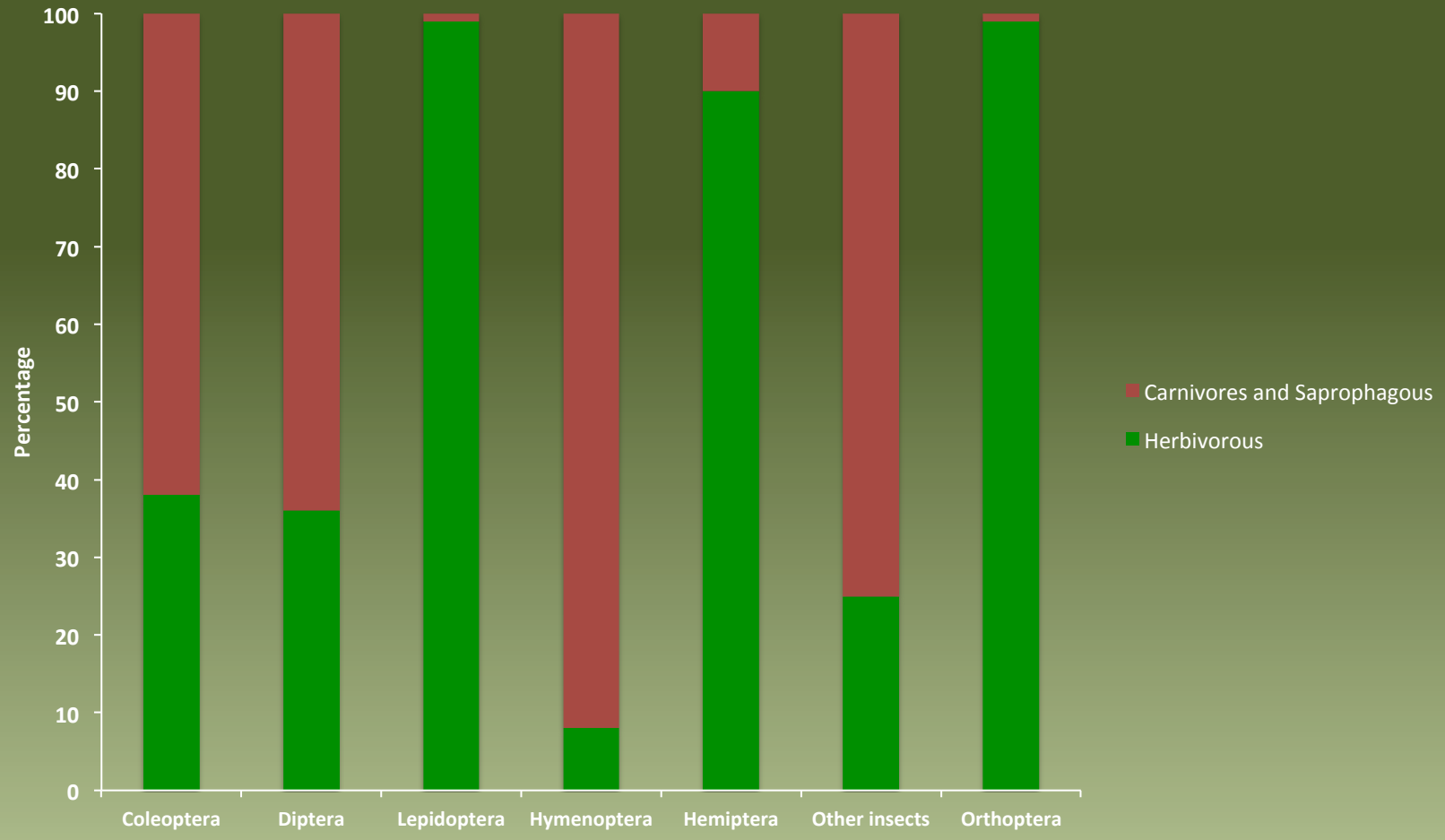


Los Tuxtlas, Veracruz

Few herbivorous mammals




Hunter and saprophage insects (431 000)
31%
Herbivorous insects (361 000)
26%
Plants
(308 000) 22%
Other invertebrates
(213 000) 15%
Vertebrates (54 000) 22%
Protozoa (30 000) 2%


100
90
80
70
60
50
40
30
20
10
0
Percentage
Coleoptera
Diptera
Lepidoptera
Hymenoptera
Hemiptera
Other insects
Orthoptera
Carnivores and Saprophagous
Herbivorous

Types of herbivores

Foraging herbivores that consume any part of the leaves.
These include mammals, birds, Orthoptera, Hymenoptera and Lepidoptera.







Leafminers

These feed on mesophyll, while the epidermis remains undamaged.
They include Lepidoptera, Hymenoptera and some Diptera.





Skeletonizers

Feed on the leaf surface leaving the veins untoched.
These include Coleoptera and Lepidoptera.



Flower, fruit and seed consumers

These can affect the fitness of plants.

Two types:

Feeders *in situ*

Dispersers

Represented by birds, mammals and insects of the orders Bruchidae and Hymenoptera



Phloem suckers

Modifications in the oral structure. The jaws and maxilla form a pronounced and thin stylet that allows them to suck the phloem of the plant.
These are mainly Homoptera and Hemyptera





Gall Formers

The formation of galls is associated with substances introduced during the oviposition of an adult insect.

These are formed during the development of larvae.

The insect controls the formation of the gall



It has been suggested that gall formation results from the interaction between an offensive stimulus (by the insect) and a defensive response (by the plant).

We found Hymenoptera and Homoptera, some mites and nematodes to form galls in our studies.





Root eaters

These have been little studied in tropical forests.

In temperate systems the most common root eaters are coleopteran larvae, nematodes and some mammals



Process that determine herbivory

1. **The probability of a plant being found by a herbivore depends on:**

Characteristic of the plant:

- **size,**
- **abundance and**
- **persistence over time**

} **appearance**

Characteristics of the herbivore:

- **Scope of search**
- **Density**
- **Sensory capacity**

Process determining Herbivory

2. Probability of a plant or any part of a plant being consumed by a herbivore.

Depends on:

Characteristics of the plant:

- **Defence mechanisms**
- **Nutritional status (acceptability)**

Characteristics of the herbivore:

- **Detoxification mechanisms**
- **Nutritional requirements (feeding behavior)**

Herbivory and plant communities

- Can affect richness and relative abundance of plant species
- Can determine distribution of plant species

Exclusion experiments have shown that:

Herbivory positively affects species richness, but depends on the successional status of the site.

Ruderal areas

Treatment with pesticides

↓

Increase in species richness

Treatment without pesticides

↓

Growth of grasses and exclusion of other plant species

In Tropical Rain Forests
(Janzen 1970)

- Number of seeds declines with distance from the parent tree.
- The adult tree, its seeds and seedlings are resources source for host-specific pathogens and parasites.



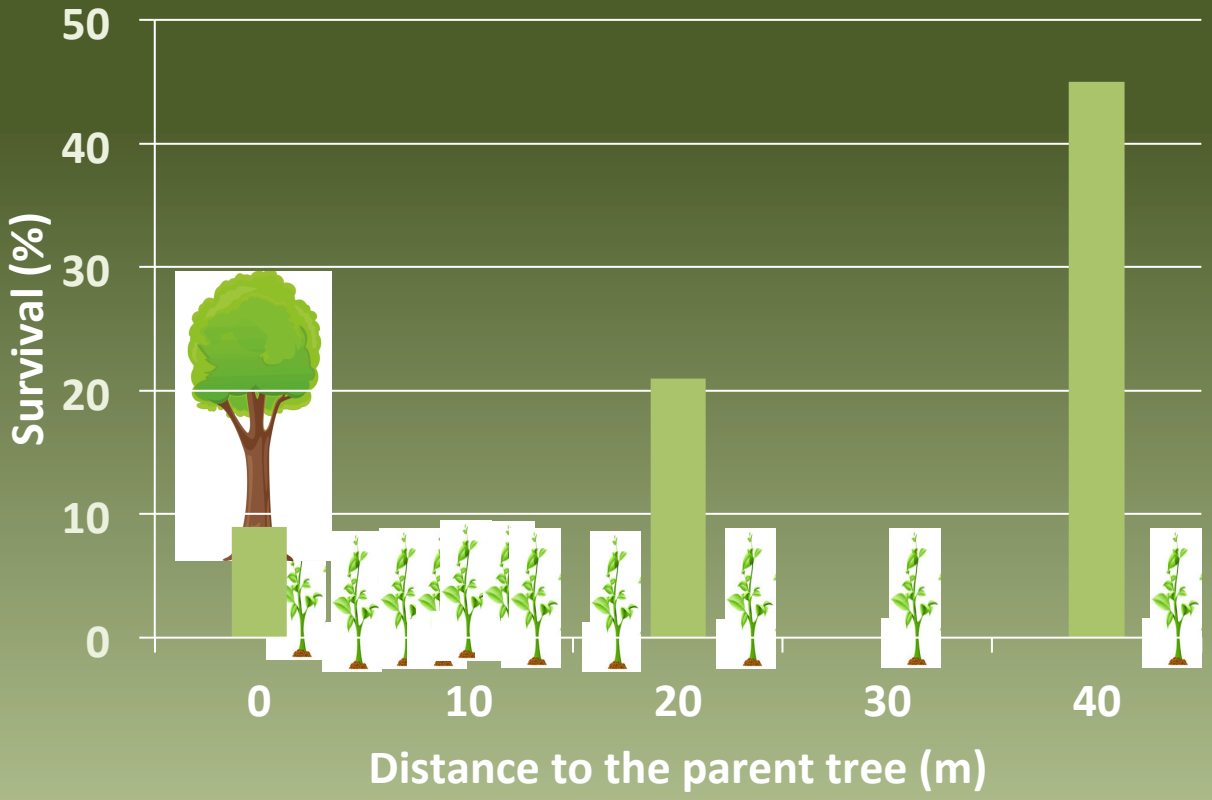
High diversity of tropical trees

Low density of adult trees

Large distances between conspecific trees

Herbivorous insects and pathogenic microorganisms affect survival of their host plants

Janzen-Connell Hypothesis (1971)



Janzen, D. H. 1970. Herbivores and the number of tree species in tropical forests. – Am. Nat. 104: 501–528.

Connell, J. H. 1971. On the role of natural enemies in preventing competitive exclusion in some marine animals and inrain forest trees. – In: Den Boer, P. J. and Gradwell, G. (eds), Dynamics of populations. PUDOC, pp. 298–312.

Several studies support the Janzen-Connell Hypothesis

Dispersion of seeds of the palm *Maximiliana maripa* by tapirs increases survival









Seeds of *M. maripa* are preyed upon by beetles of the family Bruchidae

Pachymerus sp.
and
Speciomerus
sp.

Bruchid beetles





Fragoso, J., Silvius, K. M., & Correa, J. A. (2003). Long-distance seed dispersal by tapirs increases seed survival and aggregates tropical trees. *Ecology*, *84*(8), 1998-2006.

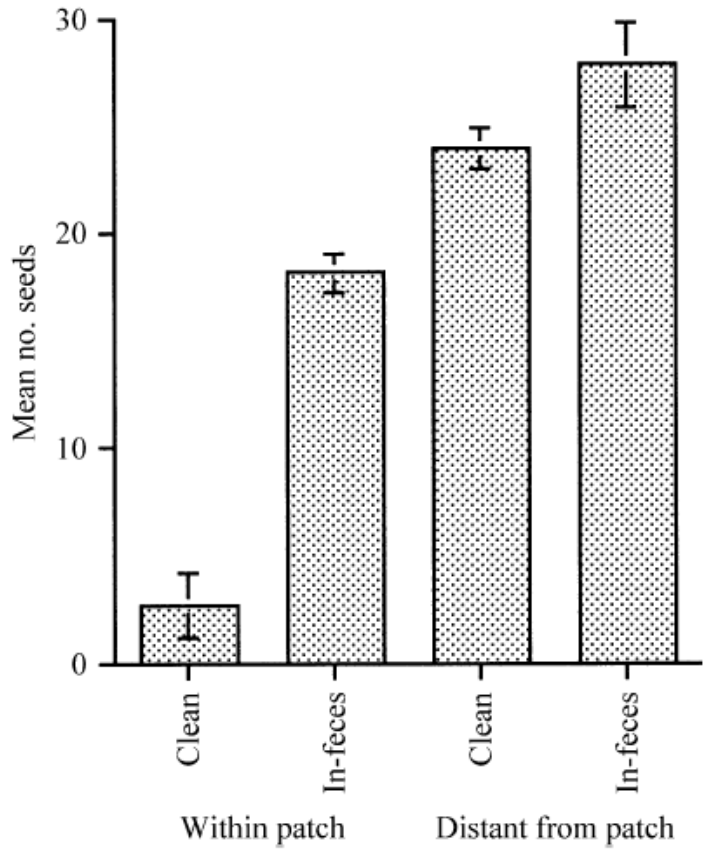
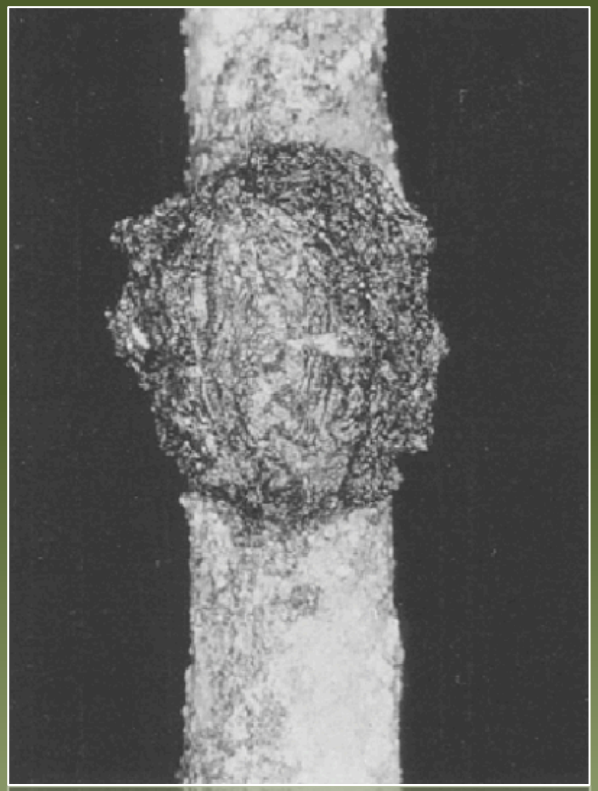


FIG. 2. The mean number (±1 SE) of *M. maripa* seeds alive within and distant from conspecific aggregations ("patch") and in-feces or clean after 7 mo exposure in the field. Seed survivorship was significantly different in all pairwise comparisons, using the Bonferroni adjustment, except for distant clean vs. distant in-feces, which had similar survivorship rates.

Ocotea whitei





- Canker disease depends on the host plant density
- Greater mortality near the parent tree

Gilbert, G. S., Foster, R. B., & Hubbell, S. P. (1994). Density and distance-to-adult effects of a canker disease of trees in a moist tropical forest. *Oecologia*, *98*(1), 100-108.