4th Quizzes

- Compare and contrast density dependence to explain disease spread and the Janzen Connel Hypothesis to explain high forest diversity
- Explain the type of dilution of fungal spores normally observed. Describe the importance of the slope of the spore dilution curve for predictive purposes
- What do we mean by counterweighs to numerical effects of disease
- We briefly mentioned a simple way to determine whether a disease is infectious

More Ecology of Forest Diseases (Gilbert 2002)

- Density Dependence
- Counterweights to numerical effects
- Disease and competition
- Dispersal and Local Adaptation

Density Dependence

- Most studies have shown a positive relationship between density and disease incidence
  - Shorter distance to be covered
  - Potentially limiting resources

  - However there are examples that show a different pattern, in particular for diseases that are vectored, and for diseases that require an alternate host

Counterweights to numerical effects

- Disease = damage, but communities will compensate
  - Disease reduced number and size of survivors, but at maturity disease-infested plots had the largest trees
  - Survivors produce more seed

- Cross generational effects
  - Diseased mothers will produce inferior seed
  - Diseased mothers will generate progeny that is more resistant to that disease

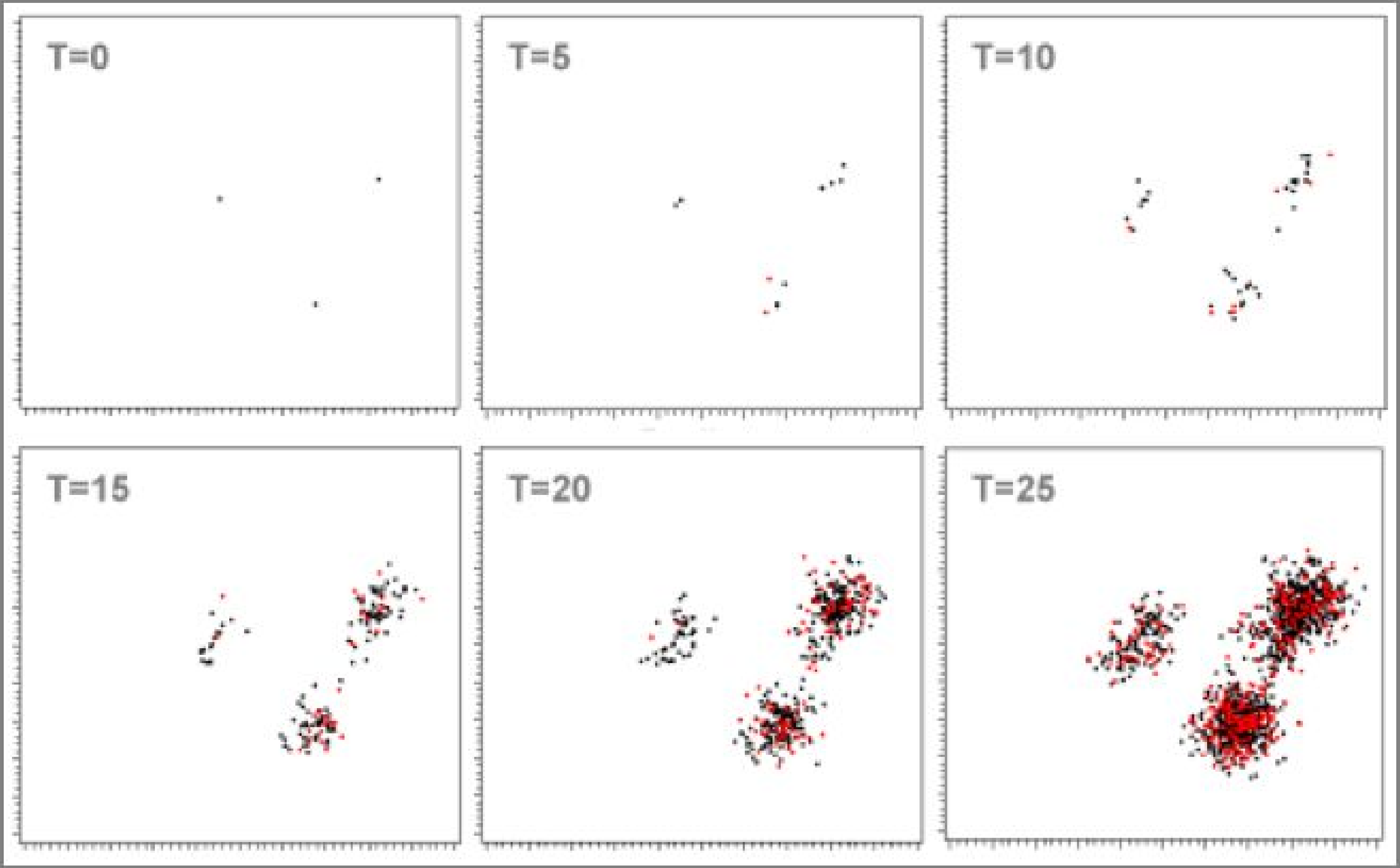
Disease and Competition

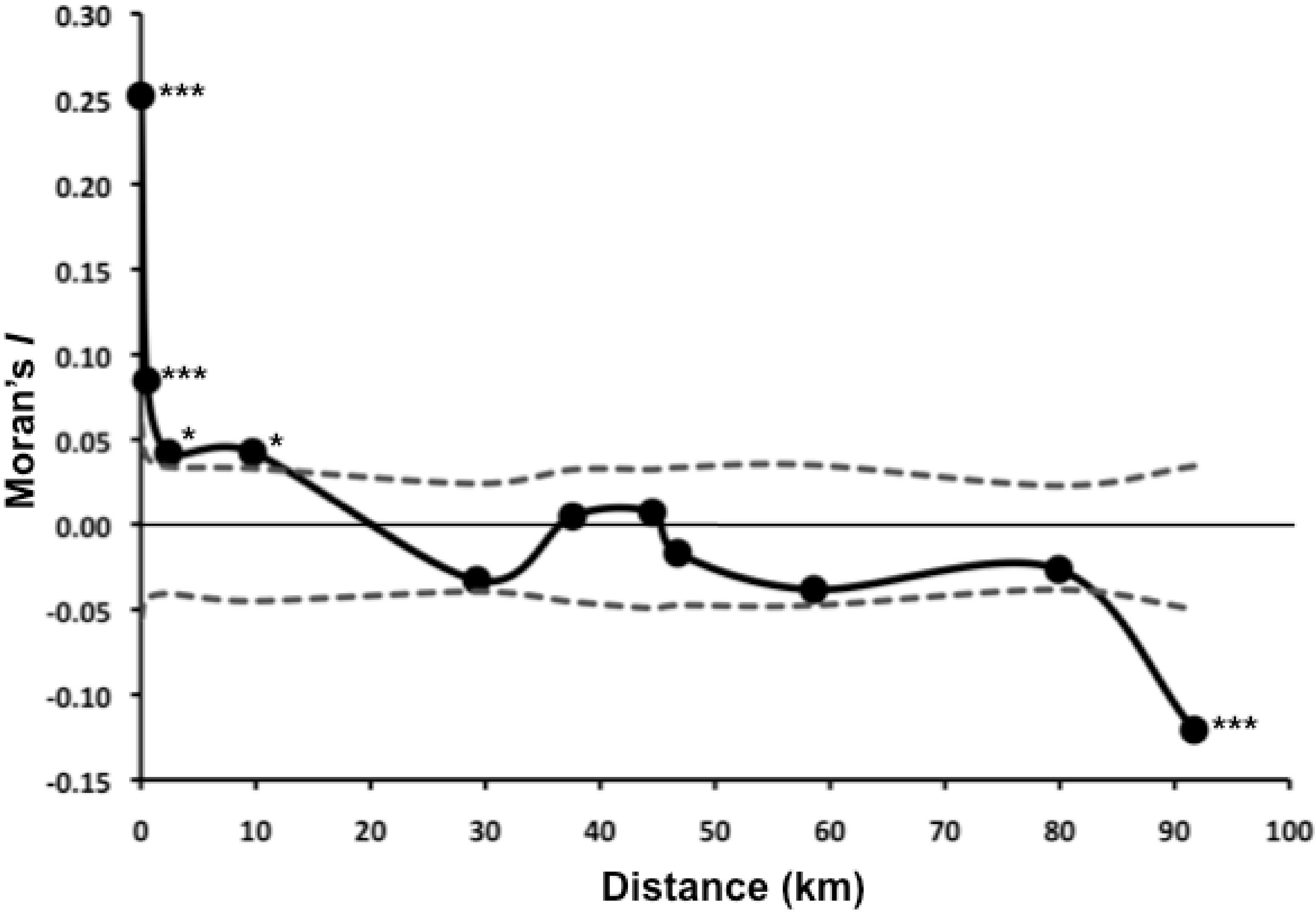
- More competition = more stress=more disease
- Disease reduces competitivity, by reducing growth and ability to use light. Effect is larger than damage
- Apparent Competition: a generalist pathogen reduces growth of two hosts, but allows for the second host to coexist
- Soil feedbacks: Negative feedbacks: build-up of soil pathogens with growth of same species (reason behind need for crop rotation. The more limited the dispersal of the pathogen, the stronger the effect (that’s why effect is measurable for soil pathogens). The more important sexual reproduction is in hosts , the slower theeffect

Dispersal

- Dispersal of pathogen, pollen, and seed
  - Pathogen: effective dispersal depends on traits of spores (size, moisture, UV susceptibility) and threshold number needed for infection
  - Dilution is not linear, but rather exponential
  - Longer movement sometimes through stepping stones
  - Usually infection shows patterns of aggregation (clustering) that is an easy way to show infectious disease

Infectious diseases spread not randomly but around initial infections





0.30
0.25
0.20
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0.05
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Moran's I
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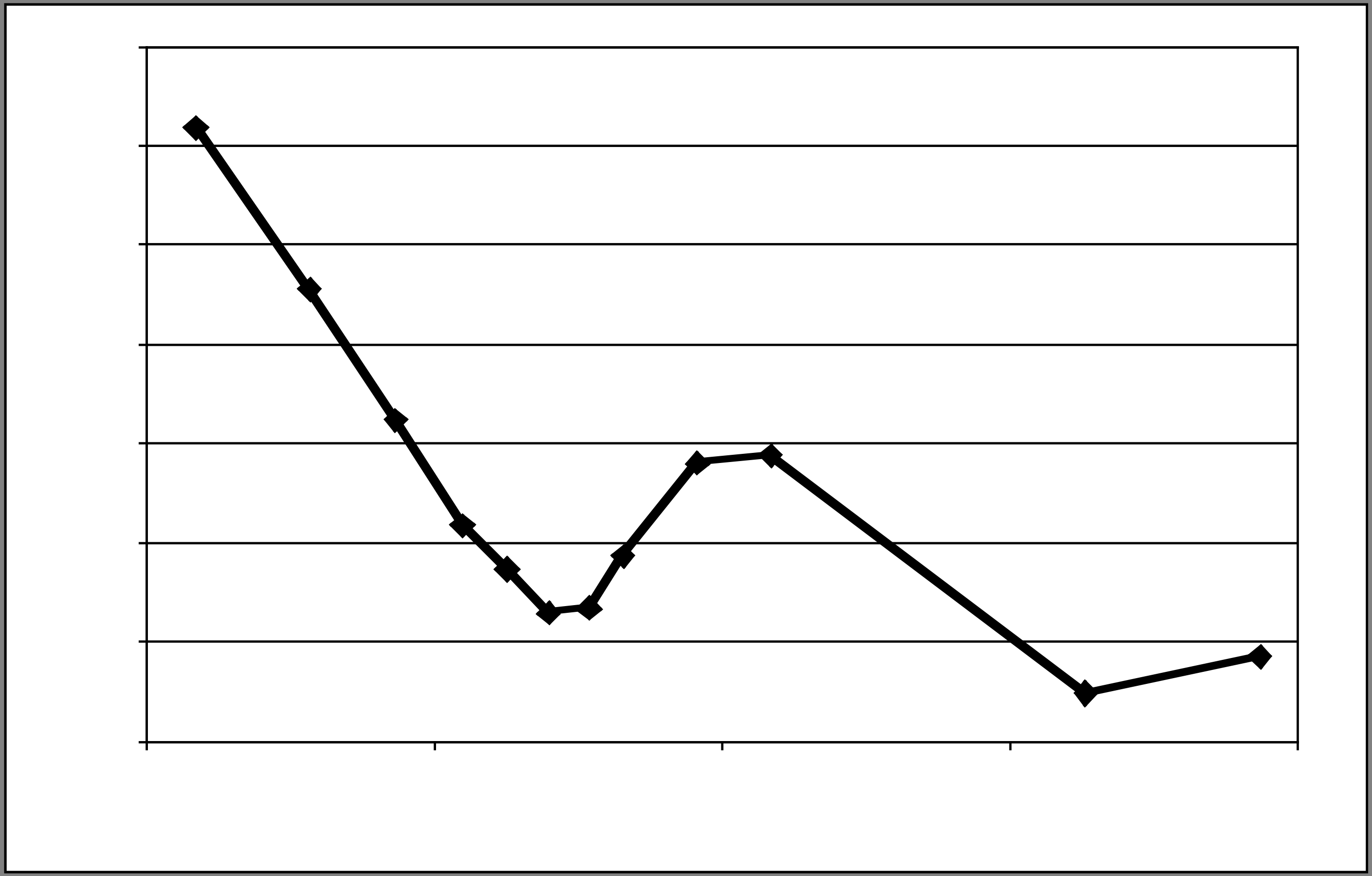
0
10
20
30
40
50
60
70
80
90
100
Distance (km)

Mantel test among all individuals. [Moran’s I vs ln (geographic distance)]

Site ID	Correlation coeff. (r)	P-value (1000,000 perm)
ALL	-0.2153	<0.000001



Local Adaptation

- Process strongly dependent on generational rates, that is why microbes increase virulence more rapidly than hosts, however a generational turn over of the host may increase host resistance

- Importance of metapopulations: locally co-evolving hosts and pathogens are more likely to undergo selective processes. If long distance effective dispersal occurs, resistance will be slower to show up in hosts, and virulence will increase more slowly in pathogens

- Red queen hypothesis: relationship between hosts and pathogens is always dynamic: pathogen increases virulence, plants will be selected for increased resistance. Often virulence and resistance are determined by individual genes, but these genes cannot be accumulated indefinitely due to their cost

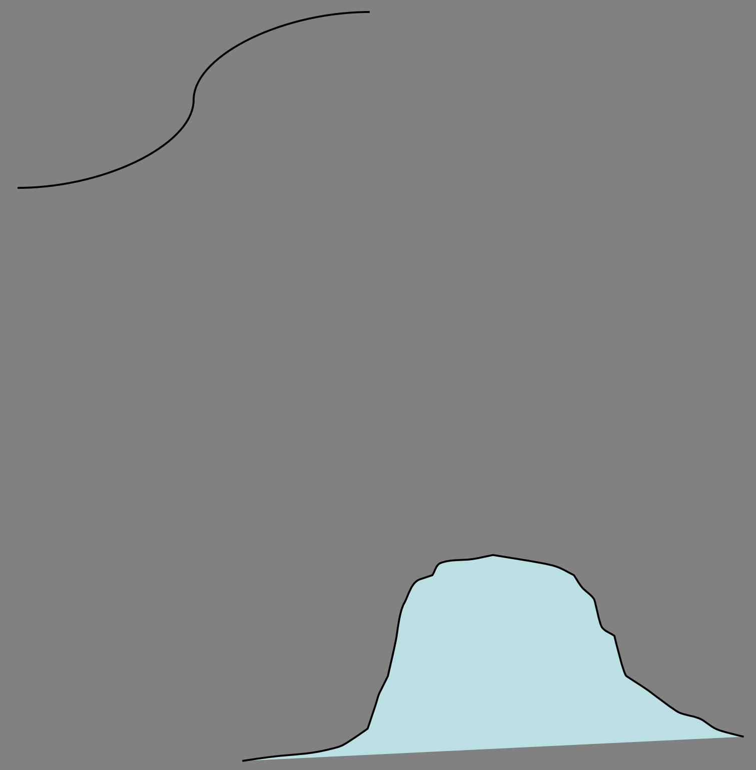
Forest Disease Concepts

(Tainter and Baker, chapter 5)

- Inoculum and its sources: inoculum defined as the organism itself or specialized cells of an organism that are capable of infecting a host
- Viruses, bacteria, mycoplasmas the organisms themselves, nematodes also their eggs
- Fungi: mycelia, rhizomorphs or strands, chlamydospores, spores, sclerotia
- Release: active or passive (weather controlled)

- Dispersal: in general limited, vast majority of spores stay within 100 m, however, longer distances are reported: 500 m up to 500 Kms, Some fungi are vectored by insects, others by water. Insects can carry spores on surface or mycelia in specialized organs called mycangia
- Dormancy and survival: fungal spores usually survive from a few days to about a year. Oomycete mycelia: 2 months, Basidiomycete mycelia 63 years, zoospores three weeks
- Disease Expression=Inoculum potential x disease potential, where ip=effective inoculum density and dp=host susceptibility

Infection rate



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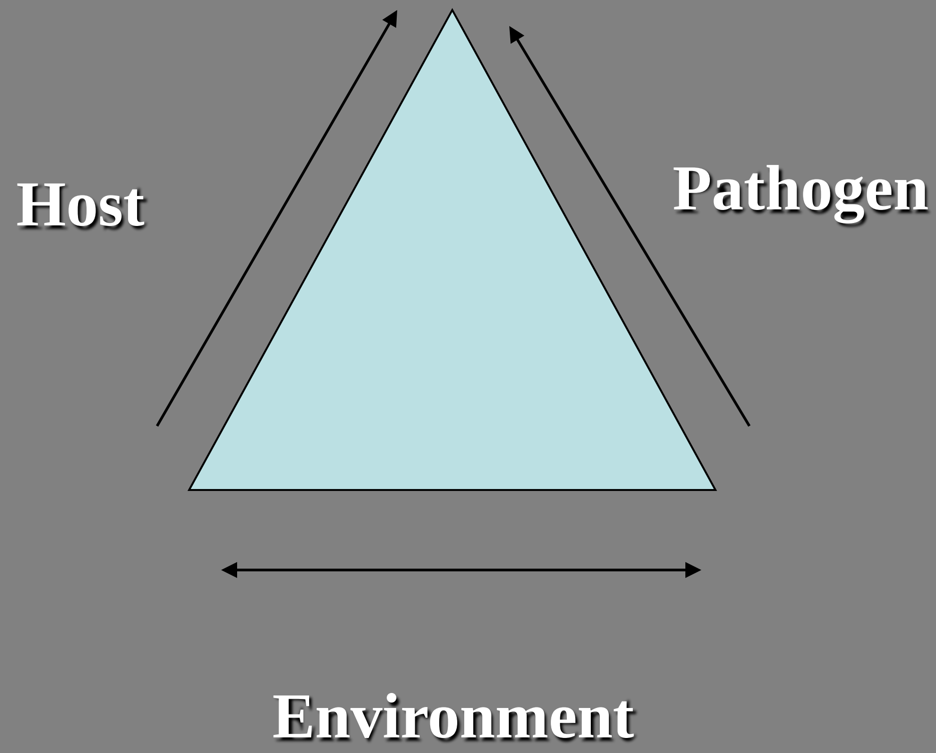
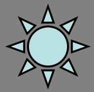
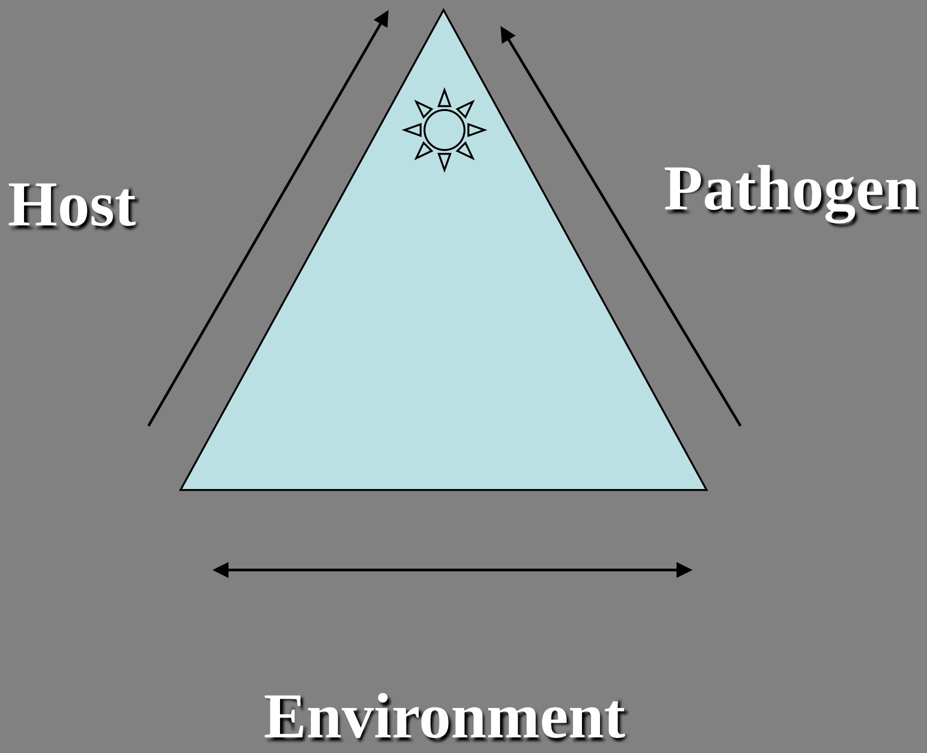
DISEASE TRIANGLE



DISEASE TRIANGLE

 HIGH DISEASE



Pathogen

Does it need a wound to infect a host?

Can it survive in the environment without a host?

- soil, water
- on alternate host

How does it move around?

- airborne/waterborne
- animal vectors
- humans

Virulence + reproductive potential=transmission

Host

Must be physically present with pathogen

Must be physically compatible with pathogen

Must provide window of opportunity f

Tolerance

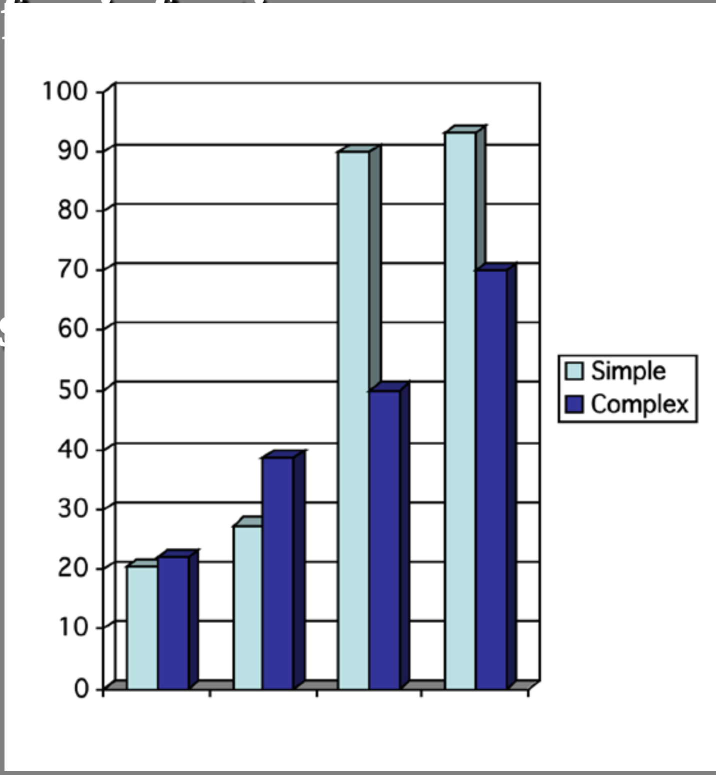
losses where infected

but ability to redirect resources

What type of resistance?

simple= one gene

complex=several genes



Environment

Climatic

Climate patterns match pathogen biology (high RH, rainfall when needed, temp range for growth: thermophilic vs. psychrophilic organisms, Max-min temperatures)

Host phenology: synchrony between pathogen and host