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2004 EPA STAR Graduate Fellowship Conference *Next Generation Scientists—Next Opportunities*

Exploration of complex interactions between multiple pathogens and environmental stress, using amphibians as model hosts

Overview

Most models in disease ecology assume that pathogens do not interact with each other. I will test this critical assumption in experiments that ultimately incorporate a range of environmental conditions. My results will help build better models with greater utility for controlling infectious diseases.

Environmental Issue: Infectious Diseases

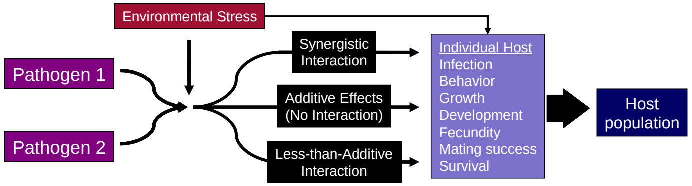
▪Strategies to limit undesired effects of infectious diseases rely on theoretical models of how pathogens act in host populations.

▪In nature, hosts are often exposed to multiple pathogens simultaneously, but how the pathogens interact is not well known. For simplicity, most models in disease ecology are one-pathogen models that ignore possible interactions (e.g. synergisms) between pathogens and assume the system contains only one pathogen.

▪ Goals:

1. Test the assumption of no interactions between pathogens using amphibians as model hosts.
2. Determine how pathogens interact over a gradient of environmental stress.

Conceptual Model



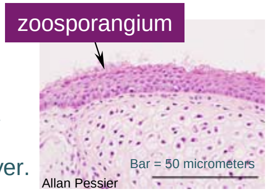
▪Two pathogens may have a synergistic interaction, a less-than additive interaction, or no interaction.

▪Environmental stress may directly affect hosts, may affect susceptibility of hosts to pathogens, and may influence the way that the two pathogens interact.

Pathogens: *Batrachochytrium* and *Saprolegnia*

▪*Batrachochytrium dendrobatidis* is a fungus that infects the keratinized mouthparts of frog tadpoles and the skin of juvenile and adult frogs and salamanders. It has been associated with amphibian population declines in North, Central, and South America, Australia, and Europe.

Histological section through a tooth row of a western toad tadpole infected with *Batrachochytrium*. *Batrachochytrium* zoosporangia (round to flask-shaped open spaces) are in the outermost layer.



▪*Saprolegnia* is a water mold that infects a wide variety of organisms, including amphibians, and also grows on decaying organic matter. The mold contributes to massive embryo mortality in western toads and Cascades frogs in the Cascade Mountains, Oregon.

Experimental exposure of a Pacific treefrog tadpole to *Saprolengia.* The white fuzz is *Saprolegnia.*

Amphibian Hosts

Four frog species, each species tested separately.


western toad


Pacific treefrog


Cascades frog


red-legged frog tadpole

Environmental Stressor

▪Nitrate is a widespread environmental contaminant in aquatic systems, where it can reach toxic levels. Sources include fertilizer and human and livestock waste.

▪Nitrate is toxic to many organisms, including humans and amphibians.

Research Approach

▪I will perform two series of experiments in artificial ponds stocked with tadpoles.

▪Each experiment will measure tadpole survival, infection, mass and length at metamorphosis, and time to metamorphosis.

▪Series 1: Four different experimental treatments (all possible combinations of the addition or non-addition of *Batrachochytrium* and *Saprolegnia*).

▪Series 2: Tadpoles will be exposed to each of the four pathogen treatments over a gradient of different nitrate levels. Nitrate treatments will be 0, 5, 10, and 20 mg/L.

Expected Impact

▪My results will serve as evidence that one-pathogen models are adequate, or will alert us that the models need to incorporate interactions between multiple pathogens.

▪Knowledge gained about how multiple pathogens interact and how environmental stress affects multiple-pathogen systems will help develop general principles about the way disease affects host populations under realistic ecological conditions.

▪Models that incorporate these principles will achieve greater accuracy in their predictions and will result in strategies that have greater success in combating infectious diseases.

Acknowledgements: My advisor Dr. Andrew Blaustein and the members of the Blaustein laboratory.

This fellow is sponsored by EPA's STAR or Greater Research Opportunities (GRO) Program.