Strategies for spore liberation: evolution in a stochastic environment

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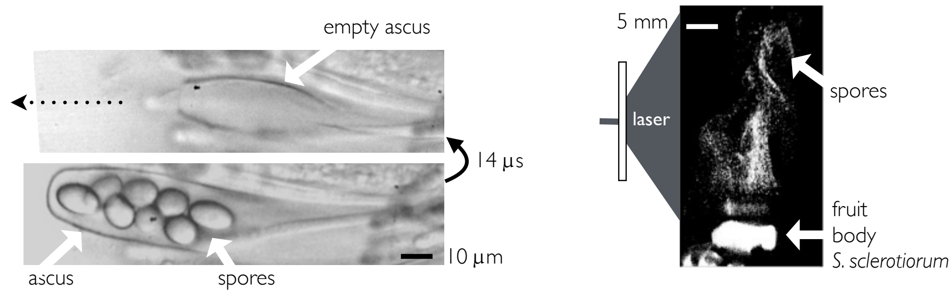

(I) Single ascus firing filmed at 67 Kfps, too slow for dynamics
Credit A Seminara, J Fritz

(II) Puffing filmed from side at 7 Kfps.
Credit A Seminara, MM Bandi

The fungal kingdom is a largely under-explored domain of life, encompassing most of the biodiversity on Earth. The percentage of described fungal species barely touches few percent, out of an estimated grand total of 1 to 8 million species. Fungi range from decomposers, symbionts, parasites and pathogens and are simultaneously among the worst threats (Fisher et al 2012, Kupferschmidt 2012) and the most fundamental components of many ecosystems (Werner Kiers 2012). Many fungi live cryptic lifestyles hidden in the soil as decomposers on dead matter, or in symbiosis with plants, animals or other fungi. The fungi may lack legs, fins or wings for locomotion, but they routinely translocate across hundreds of km and even across oceans. Their locomotion and survival rely on the dispersal of microscopic propagules - the spores. Here, we acknowledge that a complex interplay between deterministic and stochastic events dictates the fate of a spore and thus shapes the evolution of a species survival strategies.

How does evolution operate to select the biological response of organisms living in a fluctuating physical environment? Fungal spore dispersal is ideally suited to explore this fundamental question. The fungi control spore discharge to the slimmest level of precision (Fritz et al 2013, panel I figure; Roper, Seminara et al 2010 and panel II of figure), but the fate of their progeny is dramatically affected by a combination of stochastic events, unknown to the fungus. Here, we explore how this fundamental ignorance shapes the evolution of the fungal strategies for spore liberation. We aim at following fungal spore dispersal from take-off to landing to unveil how fungi face uncertainty and probe the fundamental mechanisms that dictate species distribution. With emerging fungal diseases causing some of the most severe extinctions ever witnessed in wild species, and crop pathogens jeopardizing food security, the need for understanding fungal dispersal is urgent.

In this project, we will explore the transition between sedentariness and migration using stochastic models and epidemiology. We will explore the optimal release strategy for a fungal pathogen on crops, namely the release patterns that maximize probability of infection. We will then use a combination of weather data and numerical simulations to explore to what extent the initial condition on spore release may control landing. Finally, we will combine available data on crop infection to infer the large scale spore release patterns for various fungal pathogens. In collaboration with A. Pringle (University of Wisconsin Madison) we will compare our theoretical models to real data of spore dispersal in the field.

References:

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