A Pathogen’s Spatial Range is Not Constrained by Geographical Features in the Flax Rust Pathosystem

Keenan Duggal¹, Ian Miller¹, Juliana Jiranek², and Jessica Metcalf¹

¹Princeton University
²University of Virginia

May 22, 2023

Abstract

Climate change and shifting environmental conditions can allow pathogens to spread into previously unburdened areas. For plant pathogens, this dynamic has the potential to disrupt natural ecosystem equilibria and human agriculture, making predicting plant pathogen range shifts an increasingly important enterprise. Although such predictions will hinge on an accurate understanding of the determinants of pathogen range – namely the environmental, geographical, and host range characteristics that modulate local pathogen habitation – few studies to date have probed these in natural plant populations. Here, we characterize range determinants for the model system of Lewis flax (Linum Lewisii) and its pathogen, flax rust (Melampsora lini), in the Rocky Mountains. Transect surveys were performed to assess three relationships: i) the effect of geographical features – elevation, slope aspect, slope grade, and land-cover – on flax presence and density, ii) the effect of geographical features on flax rust presence and prevalence, and iii) the effects of flax’s local population density and metapopulation structure on flax rust presence and prevalence. We found that flax population density, but not host metapopulation structure, influences the distribution of flax rust. Additionally, we showed that, while the distribution of flax was broadly constrained to a relatively narrow range of geographical and resulting environmental features, flax rust was evenly distributed across the full range of settings measured. These results indicate that a warming environment, which is expected to modulate such features, may restrict the optimal range of the plant more so than that of its pathogen. Importantly, our results also suggest that even if flax shifts its spatial range to escape increasing climatic pressures, flax rust will not face any significant barriers to track this movement.

Hosted file

Main Text Figures:
Abiotic Pressures

Future Climate Range of Flax

Overlap

Current Range of Flax

Biotic Pressures

Viable Range of Flax Rust

Pathogen-Host Thermal Mismatch
Population Density ~ Elevation

Flax Population Density (n)

Elevation (m)