Smut fungus in broomsedge populations: infection frequency, photosynthesis,

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Abstract. Plant pathogens may regulate host populations and/or act as agents of natural selection if they infect at high frequency and strongly influence plant reproduction and/or survival, yet they are often neglected in ecological studies. Old-field communities in the eastern United States are often dominated by the perennial grass broomsedge (*Andropogon virginicus*), which is subject to infection by the floral smut fungus *Sporisorium ellisii*. Four of 13 (31%) broomsedge populations surveyed in New Jersey harbored infection. Close study of four populations revealed infection rates within populations of 30% (of 1000 plants), 29% (of 48 plants), 31% (of 1043 plants), and 15% (of 155 plants). Of the infected plants in one of these populations, 75% exhibited systemic infection with complete sterility, and 25% had both infected and uninfected tillers. In another population 36% of the infections were systemic. Host plant density in square meter plots in the latter population was positively correlated with infection frequency (Spearman rank correlation r=0.26, P<0.001). Infection was related to physiological and growth variables as well. Photosynthesis rates measured in situ with a Li-Cor 6400 were lower for infected plants [non-infected plants mean=10.03 mmol/m^2/s (se 0.799), infected plants mean=7.57 mmol/m^2/s (se 1.084), t =1.82, P=0.04, df=50]. More severely infected plants were shorter (Spearman rank r = -0.19, P=0.04). Partially infected plants had greater tiller numbers than did uninfected and systemically infected plants (ANOVA F=10.91, P<0.001, df = 2,171). *Sporisorium ellisii* has potential as an important regulator of broomsedge populations because of its high frequency both among and within broomsedge populations, its negative relationship with photosynthesis rate and seed production, and its possible influence on plant growth.

Old field in early spring with previous season's broomsedge clumps

Healthy broomsedge infructescence
photo from Texas Vascular Plant Image Library
http://www.csdl.tamu.edu/FLORA/taes/tracy/610/infl/andropogon_virginicus_i.jpg

Sorisporium ellisii teliospores in smutted broomsedge infructescence

INTRODUCTION

Plant pathogens have potential to help regulate their host plant populations if they infect at high frequency and have significant effects on plant survival and/or reproduction. Many graminoid species are hosts for smut fungi, a type of parasite that often infects the reproductive structures and therefore negatively affects seed production. The floral smut fungus *Sporisorium ellisii* infects various *Andropogon* species, and in old field communities of the eastern United States it can be found infecting *A. virginicus*, or broomsedge. This warm-season grass is a perennial bunchgrass with the C_4 photosynthesis pathway, flowering in late summer and setting fruit during the fall months. Its above-ground tissue senesces at the onset of winter but remains attached to the plant and continues to disperse seeds until spring, when new growth appears and the old culms finally collapse. During the first 10 years of old field succession, broomsedge is an important community member, where it may dominate on low pH, nutrient-poor soils. Populations may be entirely free of infection or may have many infected individuals, and infected plants often harbor a mycophagous beetle as well. Until now no ecological research has been done on this plant-pathogen interaction, even though the disease has the potential to strongly influence reproduction. The studies presented here illustrate the frequency of infection among and within populations, and the parasite's effects on host photosynthesis, reproduction, and morphology.

METHODS

Among population disease survey : Broomsedge populations on public park land searched for systematically in central New Jersey. Disease presence and absence per plant assessed by transect sampling (with additional Long Island population).

Focused population disease surveys : Three populations sampled intensively for disease severity and plant morphology; two populations also assessed for beetle presence inside smut sori ; one population sampled for host density and disease.

Photosynthesis measurements : A Li-Cor 6400 portable photosynthesis system measured photosynthesis on infected and uninfected plants in one New Jersey population in September, during flowering.

RESULTS

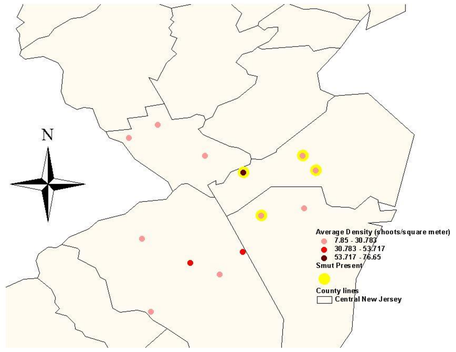

Figure 1 – NJ POPULATION SURVEY

A. virginicus plants were sampled by dividing central New Jersey into 40 grid squares, and searching each square for populations that occur in public natural areas. If more than one population was located in a grid square, the one closest to the center was chosen. Populations were mapped with a GPS and graphed with ArcView. Four of the 13 sampled populations (31%) harbored smut fungus disease.

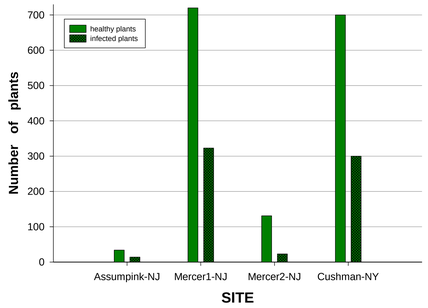

Figure 2 – INFECTION FREQUENCY

Four populations surveyed in detail showed overall infection rates ranging from 15% to 31 % .

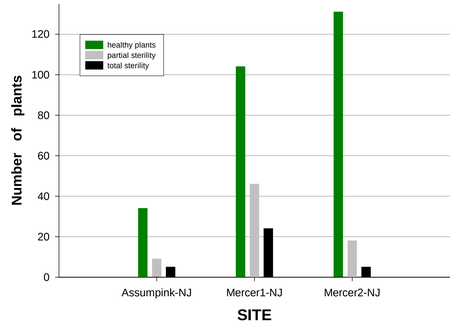

Figure 3 – DISEASE SEVERITY

Individual plants within a population may be uninfected and produce seeds normally, may have partial infection with only some sterile spikelets, or have all spikelets infected and so be completely sterile.

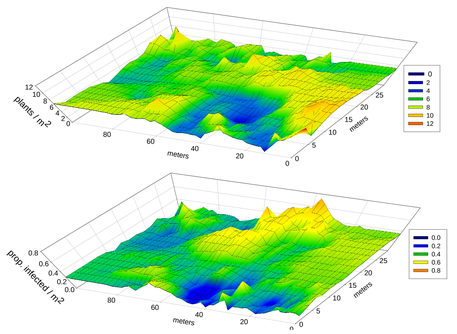

Figure 4 – PLANT DENSITY AND DISEASE Plant density (top) and infection rate (bottom) show similar spatial pattern across the Mercer1 site, and are positively correlated (Spearman's rank r = 0.26, P<0.001, n = 174 plots).