AMERICAN SOCIETY OF AGRONOMY | CROP SCIENCE SOCIETY OF AMERICA | SOIL SCIENCE SOCIETY OF AMERICA

CROPS, SOILS, AGRONOMY

CSA NEWS

JANUARY 2006 V51 N01

www.asa-cssa-sssa.org/news.html

Will Herbivore Range Expansions Exacerbate the Effects of Global Climate Change on Soil Microclimate?

In the United States, insects and pathogens impact over 20.4 million hectares of forest per year, at a cost of over $2 billion dollars. As temperatures rise in response to climatic change, insect herbivores are expected to expand their range size into previously uninfested forests. Outbreaks of insects in new areas will most likely exceed the normal amount of herbivory experienced by plants in these ecosystems.

With funding from the National Science Foundation, scientists from Oak Ridge National Laboratory and Northern Arizona University have found that insect herbivores can have major impacts on soil microclimate, an important driver of ecosystem energy flow and nutrient cycling. These impacts may be particularly important in areas located at environmental temperature and moisture extremes (such as arid woodlands and the arctic) because plants in these climates are already frequently stressed, and these are the locations where global change is predicted to have the greatest impact on temperature and moisture regimes. Hence, studying the impacts of herbivory in ecosystems that are already stressed provides an important "barometer" for the kinds of effects that may occur in other ecosystems as the global climate continues to change. Surprisingly, this study is the first to assess the long-term effects of insect herbivores on soil microclimate in a dry coniferous forest, even though insect herbivores and drought are common in this economically important and widespread ecosystem.

Researchers took advantage of an ongoing 20-year herbivore-removal experiment within a piñon pine ecosystem at Sunset Crater National Monument in northern Arizona to test the general hypothesis that herbivore alteration of plant architecture can impact soil microclimate, a major driver of ecosystem-level processes. Two insect herbivores chronically attack piñons at this site: the stem-boring moth (*Dioryctria albovitella*) attacks adult piñons, while the piñon needle scale (*Matsucoccus acalyptus*) attacks juvenile piñons. Some piñon trees are naturally resistant to both insects; thus, the study plots were broken up into treatment groups based on piñon susceptibility or resistance to stem-boring moths and needle scale insects, with an herbivore-removal treatment included for both insects. Soil microclimate data (soil moisture and temperature) were collected at several soil depths from June of 1999 to July of 2002 beneath all trees. These data were supplemented with one year of tree crown throughfall data (the amount of rain able to penetrate the tree crown) and tree leaf area data.

Three major patterns emerged from this work:

1. scale herbivory reduced leaf area index (LAI) of susceptible trees by 39%, whereas moths had no effect on LAI;

Scale-resistant branches on a piñon pine at Sunset Crater National Monument in northern Arizona. Scale herbivory on piñons can have a huge impact on tree architecture and thus soil microclimate. Scale-susceptible trees only have one year of needles, while resistant trees have around seven.

2. scale herbivory increased soil moisture and temperature beneath susceptible trees by 35 and 26%, respectively, whereas moths had no effect; and
3. scale and moth herbivory decreased crown interception of precipitation by 51 and 29%, respectively.

These results suggest that insect herbivores can have large impacts on microclimate through different effects on tree canopy and morphology. Alterations in the microclimate below susceptible trees were similar to predicted climatic change scenarios over the next century and sufficient to drive changes in ecosystem processes. The findings are presented in the November–December 2005 issue of the *Soil Science Society of America Journal*.

"Climatic change assessments and models tend to focus on how large-scale alterations in climate may alter vegetation," says lead author Aimée Classen. "However, a major challenge in dealing with climatic change effects now and in the future is trying to predict the secondary and cascading effects in ecosystems. Vegetation not only responds to changes in climate but also creates distinct microclimate patterns; ecosystem processes are affected by both the general climate and by these microclimate patterns. Insect outbreaks are predicted to increase with climate change and can cause rapid changes in vegetation with concomitant changes in microclimate. Understanding how herbivores indirectly alter the soil microclimate will enable scientists to make better predictions about how to manage systems under changing climatic regimes."

Classen, A.T., S.C. Hart, T.G. Whitman, N.S. Cobb, and G.W. Koch. 2005. Insect infestations linked to shifts in microclimate: Important climate change implications. Soil Sci. Soc. Am. J. 69:2049–2057. View the full article online at http://soil.scijournals.org/content/vol69/issue6/