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Genetic diversity important for plant survival when nitrogen inputs increase

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Genetic diversity is important for plant species to persist in Northern forests that experience human nitrogen inputs. This is one conclusions that Franziska Bandau draws in her PhD thesis.

Nitrogen is an essential nutrient for plants. In Northern forests, nitrogen availability to plants is limited, but plant species growing in these forests are well adapted to the low nitrogen conditions. However, nowadays humans are increasingly adding nitrogen to forests. Through the burning of fossil fuels, fertilizer production, and agriculture men release large amounts of nitrogen into the atmosphere, which is transported by winds, and deposited in the environment tens or even thousands of kilometers away from the pollution source. Besides these unintentional nitrogen inputs into forests, land owners also intentionally fertilize their forests to increase their wood harvest.

These two forms of human nitrogen input can have numerous effects. One consequence can be the loss of plant species, which in turn reduces biodiversity. There are two mechanisms believed to cause these plant species losses. First, extra nitrogen may change how plants compete with each other, and plant species that can use extra nitrogen faster may replace plant species that are well adapted to generally low nitrogen conditions. Secondly, additional nitrogen can cause changes in leaf chemistry, which in turn influence how strongly plants are attacked by natural enemies, i.e. insects or fungi.

In her thesis, Franziska Bandau performed a series of fertilization experiments with the model tree species aspen, to investigate which effects human nitrogen inputs could have on genetically diverse plant individuals. Franziska Bandau grew a number of aspen individuals that possessed varying abilities to produce certain chemical compounds in their leaves, called condensed tannins. These compounds have been described to potentially protect plants from insect attacks by making leaves un-tasty or un-nutritional, and to defend plants against some pathogenic fungi. During her work, Franziska Bandau found that plants that obtained nitrogen doses simulating atmospheric deposition and forest fertilization were generally more damaged by insects and fungi than plants that did not received any extra nitrogen, but plants with a high-tannin production were always less damaged than low-tannin plants.

"I also observed that aspen with a genetically pre-determined, high tannin production were restricted in growth at ambient nitrogen and atmospheric deposition levels, but that this growth constraint was removed, when plants received nitrogen doses corresponding to forest fertilization rates, and when natural enemy levels were high", Franziska Bandau says.

As competition and changes in plant-enemy interactions have been suggested to drive plant species losses, both low- and high-tannin plants could potentially be favored under altered nitrogen conditions. When natural enemies are key drivers of vegetation change, high-tannin plants would be more likely to survive. However, when competition drives vegetational change, low-tannin plants that grow more under slightly elevated nitrogen conditions than high-tannin plants, would probably perform better.

"But as both nitrogen conditions and enemies pressure vary a lot across space and time, genetically diverse populations would have the highest chances to persist in environments that experience human nitrogen inputs", Franziska Bandau says.

More information: Read the dissertation: urn.kb.se/resolve?urn=urn:nbn:se:umu:diva-120248

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