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Are low-producing plants sequestering carbon at a greater rate than high-producing plants?

A test within the genus *Chionochloa*

A thesis presented in partial fulfilment of the requirements for the degree of Master of Science in Ecology

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Abstract

Plant life and primary production play an important role in the global carbon (C) cycle through the fixing of atmospheric C into the terrestrial biosphere. However, the sequestration of C into the soil not only depends on the rate of plant productivity, but also on the rate of litter decomposition. The triangular relationship between climate, litter quality, and litter decomposition suggests that whilst low-producing plants fix C at a slower rate than high-producing plants, they may release C at an even slower rate, due to the production of a recalcitrant litter.

Here, the relationships between environment, productivity, litter quality and decomposition are investigated to determine their relative influences on C sequestration for taxa in the genus *Chionochloa.* Annual productivity was measured *in situ* for 23 taxa located across New Zealand, whilst litter and soil were collected for analyses and two *ex-situ* decomposition experiments; litter incubation on a common alpine soil, and litter incubation on each taxon's home-site soil.

Plant growth rate was found to be positively correlated with both litter nitrogen and litter fibre content. Litter decomposition on the common soil was instead negatively correlated with lignin content, which showed a strong correlation with phylogeny, as opposed to environment or growth rate. When incubated on home-site soils, litter quality had no influence on decomposition, which was instead positively correlated with the rate of soil C decomposition, and negatively correlated with both soil organic matter and soil water content.

On the common soil there were weak correlations between productivity and decomposition; however the proportional increase in productivity was greater than the corresponding increase in decomposition, resulting in high-producing plants sequestering C at a greater rate than low-producing plants. However, there was no correlation between productivity and decomposition on the home-site soil, with soil water content being a better predictor of C sequestration rate than productivity.

Despite the range of variation in morphology, ecophysiology, productivity and habitat displayed within the *Chionochloa* genus, taxa all produced litter of a very similar quality. Breakdown of that litter is then most strongly influenced by the environment in which decomposition occurs, as opposed to the quality of the litter. Any subsequent differences in rates of C sequestration are therefore most influenced by the environment decomposition occurs in, with wet and cool environments likely to result in increased rates of C sequestration, independent of the rate of productivity.

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