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DETANGLING THE EFFECTS OF TEMPERATURE AND NUTRIENT AVAILABILITY ON LEAF LITTER DECOMPOSITION

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The breakdown of organic matter, such as leaf litter, is a major contributor of carbon dioxide emitted into the atmosphere and various forms of C transported to oceans by streams and rivers (Battin et al. 2009). Litter is broken down through physical fragmentation, degradation by microbes, and feeding by detritivores (Follstad Shah et al., 2017; Woodward et al., 2012). Changes in these processes can affect the amount of terrestrial carbon that is assimilated into aquatic biomass, transported to the ocean, or respired into the atmosphere (Ferreira et al., 2014). Understanding the factors that influence litter breakdown rates, as well as those factors that influence how much carbon dioxide is lost to the atmosphere, is an important step towards better understanding the role of streams and rivers in global carbon cycling and predicting how these processes will be affected by climate change.

The purpose of our project was to determine if there is a stream nutrient enrichment effect on the temperature sensitivity of leaf litter decomposition mediated by microbes and detritivores. Metabolic theory predicts an apparent temperature sensitivity of 0.65 eV for leaf litter decomposition; however, a recent study has found it to be much lower (0.34 eV) (Follstad Shah et al., 2017). Understanding how factors such as stream nutrient enrichment can influence temperature sensitivity will provide a greater understanding of how carbon cycling will be affected by rising temperatures.

Using a dataset containing over 1300 observations from 57 studies, we isolated the effect of detritivore- and microbe-mediated breakdown from total breakdown using a mathematic approach developed in 2017 (Lecerf, 2017). The data were then sorted into nutrient categories (oligotrophic, mesotrophic, eutrophic) based on stream nitrogen and phosphorus concentrations. The coefficients for total breakdown (k_c), microbial-mediated breakdown ($\boldsymbol{\lambda}_M$), and detritivore-mediated breakdown ($\boldsymbol{\lambda}_F$) were plotted within their stream nutrient categorizations (oligotrophic, mesotrophic, eutrophic) as a function of temperature. The temperature sensitivity (E_a, eV; slope) and breakdown rate at 10 °C (intercept) were compared across breakdown coefficient types and trophic categories using linear mixed effect modeling in R.

Our results showed that temperatures sensitivity did not significantly vary amongst trophic categories. This indicates that the temperature sensitivity of leaf litter breakdown does not vary with external nutrient supply. Other factors, such as leaf chemistry, may better explain the low apparent temperature sensitivity found by Follstad et al. (2017) as compared to the rate predicted by metabolic theory. Additionally, we found that breakdown rate at 10 °C did not vary with trophic category for any breakdown coefficient type, indicating that nutrient supply does not elevate rates. These results contrast with the results of a previous study by Woodward et al. (2012) which determined that moderate nutrient enrichment can stimulate leaf litter breakdown rates streams (Woodward et al., 2012).

	Intercept at 10° C (95% CI)	Coefficient 10° C	E_a, eV (95% CI)	F value	p value
ln k_C	-3.85 (-3.95, -3.75)	0.0213 (0.0193, 0.0235)	0.49 (0.36, 0.62)	56.6	<0.001
ln λ_M	-4.22 (-4.30, -4.13)	0.0147 (0.0136, 0.0161)	0.48 (0.37, 0.59)	69.7	<0.001
ln λ_F	-5.22 (-5.36, -5.07)	0.0054 (0.0047, 0.0063)	0.56 (0.36, 0.76)	31.0	<0.001

Table 1. Regression coefficients from statistical modeling of the temperature sensitivity of leaf litter breakdown amongst types of breakdown coefficients (k_c, λ_M, λ_F).

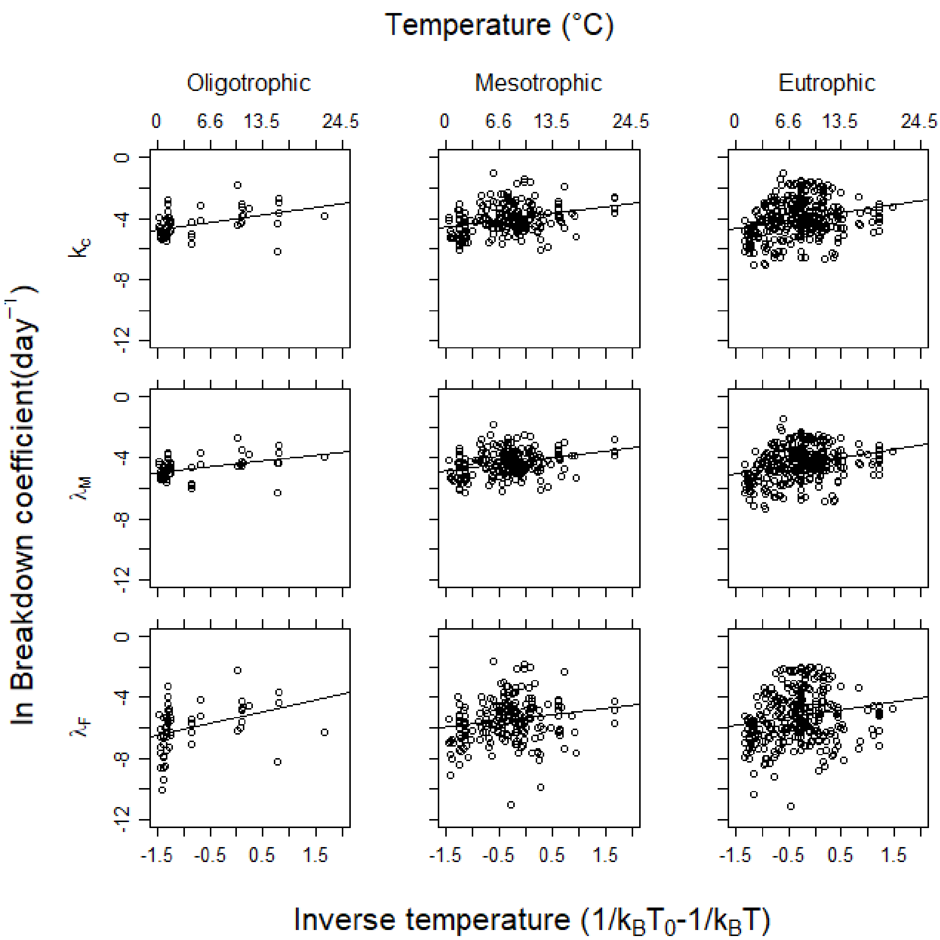

Figure 1. Neither temperature sensitivity (E_a, eV; slopes) nor breakdown coefficients at 10 °C (intercepts) varied amongst stream trophic categories (oligotrophic = low nutrient enrichment, mesotrophic = moderate nutrient enrichment, eutrophic = high nutrient enrichment) for each type of breakdown rate (k_c = total, λ_M = microbial, λ_F = detritivore).

Works Cited

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