ABSTRACT

Page, Blair D. Interactions of calcium and nitrogen cycles in forested watersheds of the Adirondack Mountains, NY. Word processed and bound dissertation. 168 pages,11 tables, 46 figures, 2006.

I evaluated the interactions between calcium (Ca^{2+}) and nitrogen (N) cycling of forested stands and watersheds in the Adirondack Mountains of New York State. Specifically I focused on soil Ca^{2+} availability as it both influenced and was influenced by tree species composition and the resulting effects on litter quality in regulating N mineralization and nitrification. These terrestrial biogeochemical processes were linked to nutrient export and stream water chemistry with respect to soil and drainage water acidification.

In Chapter 2, I examined two nearly adjacent catchments (14 and 15) in the Arbutus Lake watershed with significant differences in stream water Ca^{2+} (817 and 306 $\mu eq\ L^{-1}$, respectively, $P < 0.001$) and NO_3^- (55 and 16 $\mu eq\ L^{-1}$, respectively, $P < 0.001$) chemistry. Catchment 14 had higher soil base concentrations (especially Ca^{2+}) than Catchment 15. Base cation concentrations were positively correlated to basal areas of those tree species, including American basswood (*Tilia americana*) and sugar maple (*Acer saccharum*), which had an affinity for base-rich soil. These two tree species also had better litter quality (lower lignin: N ratios) than the other co-dominant species, American beech (*Fagus grandifolia*), the latter of which was more abundant in Catchment 15. Soil Ca^{2+} concentrations were positively related to forest floor inorganic N concentrations (*ln* inorganic N = 1.15 + 0.26 x *ln* forest floor Ca^{2+}; $R^2 = 0.48$, $P < 0.001$). Spatially, a relatively small area near the highest elevation of Catchment 14 was a "hot spot" where high soil Ca^{2+} concentrations and high litter quality from associated tree species converged resulting in the highest nitrification rates for both catchments 14 and 15.

In Chapter 3, I evaluated the relationships between soil Ca^{2+} and inorganic N using 11 sites throughout the Central Adirondacks. Among all sites, the relative basal areas of sugar maple and basswood were positively related to upper mineral soil Ca^{2+} concentrations (sugar maple relative basal area = 0.32 + 0.17 x *ln* mineral soil Ca^{2+}; $R^2 = 0.31$, $P = 0.08$ and basswood relative basal area = -0.04 + 0.05 x *ln* mineral soil Ca^{2+}; $R^2 = 0.42$, $P = 0.03$), while beech was negatively related to Ca^{2+} concentrations (relative basal area = 0.33 - 0.13 x *ln* mineral soil Ca^{2+};

$R^2 = -0.40$, $P = 0.04$). In soil samples collected over two growing seasons, 60% of the variability of field-extracted inorganic N from the forest floor was attributed to four variables. There was a negative relationship of N to both percent soil moisture and mean ambient temperature prior to sampling. There was a positive relationship between inorganic N concentrations and both percent organic matter and soil Ca^{2+} concentrations. I suggest that this reflected the availability of higher quality substrates on more Ca^{2+} rich sites which would favor N mineralization by microbes.

In Chapter 4, I developed a conceptual model of Ca^{2+} chemical cycling and the distribution of Ca^{2+} stable isotopes in a site with relatively high soil Ca^{2+} concentrations as compared to a site with more moderate soil Ca^{2+} concentrations. I indicated how Ca^{2+} stable isotopic composition would be expected to differ with Ca^{2+} abundance. When soil Ca^{2+} concentrations greatly exceeded vegetation Ca^{2+} demand, the cycling tended to be more "open" with leached Ca^{2+} being isotopically lighter (lower ^{44}Ca: ^{40}Ca) than at sites where Ca^{2+} concentrations were lower. Additional research using Ca^{2+} stable isotopes should further develop this technology into a powerful tool for monitoring both spatial and temporal patterns in Ca^{2+} availability and for clarifying linkages between Ca^{2+} and changing climate, atmospheric deposition and species composition.

Key words: Adirondack, calcium, catchment, isotope, litter, nitrate, nitrogen, soil, stream, vegetation, watershed

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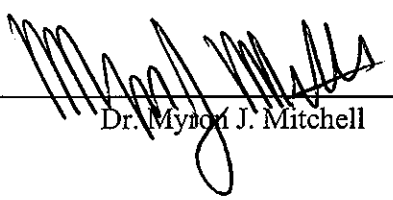
Signature of Major Professor 
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