

# Niwot Ridge LTER Research Workshop

21 August 1998

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## Agenda

0900 Coffee; Poster Set-ups

0915 Introductions and Workshop Overview (Seastedt)

### Investigator Presentations:

0930 Christopher G. Meloche and Pamela K. Diggle. Developmental Preformation of *Acomastylis rossii* (Roseaceae) in Contrasting Alpine Tundra Sites.

0945 Pamela K. Diggle. Developmental Constraints on Plant Response to Environmental Change: Experimental Analyses of the Alpine Perennial *Polygonum viviparum*.

1000 Steven K. Schmidt, David A. Lipson, Paul D. Brooks, and Mark W. Williams. Under-Snow Peaks in Microbial Biomass and Activity in the Colorado Alpine.

1015 Timothy R. Seastedt, and Gina Adams. Effects of Tree Islands on Soil Characteristics of Alpine Tundra.

1030 *Coffee Break*

1045 Connie A. Woodhouse. Report on the 9th Annual Dendroecological Field Week.

1100 Heidemarie Steltzer, and William D. Bowman. Influence of Plant Species on Community Structure Through the Control of Spatial Heterogeneity in Nitrogen Cycling in Alpine Tundra.

1115 Timothy R. Seastedt, and Lynn Vaccaro. Effects of Enhanced Snowpack and Nutrient Additions on the Productivity and Diversity of Alpine Tundra.

1130 Herman Sievering, John Calanni, Erik Berg, Matthew Wood, Deborah Mangis, Rick Boyce, and Walt Weathers. Atmospheric Nitrogen Deposition at C1: Response of Free Amino Acids in Engelmann Spruce Needles.

1145 Greg P. Asner, Jon Carrasco, Alan R. Townsend, and Carol A. Wessman. Functioning of Aspens-Remote Sensing of Structure Experiment (FARSSE).

1200 *Lunch*

1300 Elyse Ackerman, and Scott A. Elias. Arthropods in Sediment Cores from Sky Pond, Rocky Mountain National Park

### LTER 1998-2004 Action Items and Discussion:

1315 FYI Updates and New Science Initiatives

- Herman Sievering. Working towards an N budget for the forest at C1 in vicinity of Ameriflux tower.
- Mark Williams. Protecting headwater catchments from N deposition: critical loads and land use codes.

- Nick Pepin and Mark Losleben. Examination of climate and NADP data along the NWT LTER meteorological station transect.
- Diane McKnight. MRS Science Discovery.
- Grizelle Gonzalez. Asian LTER.
- Tim Seastedt leads a discussion: Life After the Walkers: a) mechanisms to cover plant community ecology questions: orphaned datasets? b) mechanisms to cover landscape/GIS activities c) the politics of replacing TEAML at CU: LTER vested interests and role in faculty recruitment

1700 (or sooner) HAPPY HOUR.

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- **Additional LTER Abstracts and Presentations at Outside Meetings, 1997-1999**

- Snowpack Controls on Nitrogen Cycling and Export in Seasonally Snow-Covered Catchments

- Hydrologic Sources, Flowpaths, and Residence Times Along a Longitudinal Gradient in the Green Lakes Valley, Colorado Front Range, USA

Selectivity of Chemical Weathering in High Elevation Catchments of the Colorado Front Range

Oversampling of Snow and Overestimation of Inorganic Nitrogen Wetfall Using NADP Data,  
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Data for Snowmelt Model Development, Calibration, and Verification at an Alpine Site, Colorado  
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Critical Loads for Inorganic Nitrogen Deposition in the Colorado Front Range, USA

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## Abstracts for 1998 Workshop Niwot Ridge LTER Workshop

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### Arthropods in Sediment Cores from Sky Pond, Rocky Mountain National Park

Elyse Ackerman

*NWT LTER Research Experience for Undergraduates Program*

Scott A. Elias

*Institute of Arctic and Alpine Research, CB 450, University of Colorado, Boulder, CO 80309-0450*

*Talk Abstract.* Fifty-two taxa of insects and arachnids (including one oribatid), from 20 families (mostly beetles and ants) have been identified from sediment cores taken from Sky Pond, Rocky Mountain National Park. This is relatively rich for an alpine fossil fauna. Twenty seven species of beetles and ants have been identified, which is about par for North American studies (ca. 50% success rate at identifying Quaternary beetle fossils to the species level). The relative abundance of arthropods varied considerably over the time period of the collection, indicating substantial changes in climate during the study interval. Relationships between fauna and climate will be identified.

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### Functioning of Aspens-Remote Sensing of Structure Experiment (FARSSE)

Greg P. Asner and Jon Carrasco

*Cooperative Institute for Research in Environmental Sciences, CB 216, University of Colorado, Boulder, CO 80309-0216*

Alan R. Townsend

*Department of Environmental, Population and Organismic Biology, and Institute for Arctic and Alpine Research, CB 450, University of Colorado, Boulder, CO 80309-0450*

Carol A. Wessman

*Department of Environmental, Population, and Organismic Biology, and Cooperative Institute for Research in Environmental Science, and Institute of Arctic and Alpine Research, CB 216, University of Colorado Boulder, CO 80309-0216*

*Talk Abstract.* We are developing a tower radiometry-biogeochemistry project to explore links between aspen canopy structure, phenology and ecosystem processes, with a special emphasis on remotely sensed signatures. Previous work suggests that the timing of critical biogeochemical processes, such as CO<sub>2</sub>, N gases, and soil water and nitrogen fluxes, can be linked to changes in vegetation structure, especially in deciduous canopies. We have found that both hyperspectral and multi-angle remote sensing signatures can be highly indicative of seasonal changes in aboveground carbon allocation. The goal of the aspen project is to: (1) improve our quantitative understanding of how forest canopy phenology affects these two remote sensing signatures, (2) seek links between seasonal changes in biogeochemical fluxes and aboveground carbon allocation as inferred from remote sensing measurements, and (3) explore potential lags between aboveground and belowground processes. The aspen communities near Niwot Ridge provide an ideal setting in which to address these issues, and they have regional importance in assessment of the role of phenology and land-cover change on biogeochemical processes using remotely sensed data.

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## **Developmental Constraints on Plant Response to Environmental Change: Experimental Analyses of the Alpine Perennial *Polygonum viviparum***

**Pamela K. Diggle**

*Department of Environmental, Population and Organismic Biology, CB 334, University of Colorado,  
Boulder, CO 80309-0334*

**Talk Abstract.** Development of the alpine perennial *Polygonum viviparum* (Polygonaceae) is characterized by extreme preformation. Four years are required for each leaf and inflorescence to progress from initiation to functional maturity. Such extreme preformation may inhibit or delay developmental and morphological responses to environmental change. This prediction was tested in natural populations using experimental defoliation. Results demonstrate that vegetative phenotypes are more constrained than reproductive phenotypes. Whereas defoliation did not appear to induce any change in vegetative phenotype during the year of defoliation, reproductive phenotypes were adjusted via abortion. Vegetative structures developing below ground, within the apical bud, did respond developmentally. These responses, however, were only manifest in the following year when fewer and smaller leaves were matured. Reproductive allocation was also depressed in the year following the defoliation treatment. Leaf production returned to control levels two years following defoliation while inflorescence production remained below control levels. Morphological plasticity is fundamentally the result of developmental plasticity. Thus, developmental patterns can constrain or limit plastic responses. Understanding properties of development facilitates the formulation of mechanistic explanations for observed patterns of plant responses.

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## **Sublimation from a Seasonal Snowpack at a Continental, Mid-Latitude Alpine Site**

**Eran W. Hood and Mark W. Williams**

*Department of Geography and Institute of Arctic and Alpine Research, CB 450, University of Colorado,  
Boulder, CO 80309-0450*

**Don Cline**

*National Hydrologic Remote Sensing Center, National Weather Service, Chanhassen, MN*

**Poster Abstract.** Sublimation from the seasonal snowpack was calculated using the aerodynamic profile method at Niwot Ridge in the Colorado Front Range. Past studies of sublimation from snow have been inconclusive in determining both the rate and timing of the transfer of water between the snowpack and the atmosphere, primarily because they relied on one-dimensional measurements of turbulent fluxes or short term data sets. We calculated latent heat fluxes at ten minute intervals based on measurements of temperature, relative humidity and wind speed at heights of 0.5m, 1.0m and 2.0m above the snowpack for nine months during the 1994-5 snow season. The meteorological instruments were raised or lowered daily to maintain a constant height above the snow surface. At each ten minute time step, the latent heat fluxes were converted directly into millimeters of sublimation or condensation. Total net sublimation for the snow season was 195 mm of water equivalent, or 15% of maximum snow accumulation at the study site. The majority of this sublimation occurred during the snow accumulation season. Monthly losses to sublimation during the fall and winter ranged from 27 to 54 mm of water equivalent. The snowmelt season from May through mid-July showed net condensation to the snowpack ranging from 5 to 16 mm of water equivalent. Sublimation was sometimes episodic in nature, but often showed a diurnal periodicity with higher rates of sublimation during the day.

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## **Microbial Functional Group Biomass and Maximum Growth Rate Along a Soil Developmental Gradient in High Elevation Talus Soils**

**Ruth E. Ley and Steven K. Schmidt**

*Department of Environmental, Population and Organismic Biology, CB 334, University of Colorado, Boulder, CO 80309-0334*

**Mark W. Williams**

*Department of Geography and Institute of Arctic and Alpine Research, CB 450, University of Colorado, Boulder, CO 80309-0450*

*Poster Abstract.* We estimated the biomass and maximum growth rate of two soil microbial functional groups along a soil development gradient in a high elevation talus slope in July and August 1997 (Colorado Front Range, Niwot Ridge LTER). The soils ranged from less than 0.6% to over 30% organic matter. The two functional groups we assayed were salicylate (a phenolic compound) and glutamate (an amino acid) mineralizers. We estimated biomass using the newly developed substrate induced growth response (SIGR) method and a most probable number (MPN) method, and maximum growth rate with the SIGR assay. We found a striking pattern in biomass distribution across the soil gradient. For both functional groups, biomass varied over several orders of magnitude in unvegetated soils (organic matter < 2%) and was highest and least variable in vegetated soils (organic matter 2-30%), such that biomass appears to plateau once vegetation colonizes soil. Salicylate mineralizers are more numerous, relative to glutamate mineralizers, in the unvegetated soils. Growth rates of the two groups changed along the soil gradient. Unvegetated soils had the slowest growing salicylate mineralizers, and the fastest growing glutamate mineralizers. The nature of the microbial communities is thought to be related to the nature of the C inputs (eolian vs. plant growth) to the soils.

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## **Continuous Measurements of Soil Moisture and Temperature in High Elevation Talus Soils**

**Ruth E. Ley and Steven K. Schmidt**

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*Poster Abstract.* In this poster we present a continuous record of soil moisture and temperature data from unvegetated and vegetated soils located on a south-facing talus slope at 3700m in Green Lakes Valley at 3700m. The record we show is from October 20th 1997 to July 20th 1998. We obtained the record with a Cambell Scientific CR10X datalogger equipped with TDR and thermistor probes for moisture and temperature measures respectively. It shows very clearly in the vegetated soil the rise in temperature from around -1 degrees C (the average winter temperature) to 0 degrees C that occurred when the snowpack started to melt, followed later by a transition to diurnal temperature fluctuations once the snow is gone from the soil. Soil moisture tracks soil temperature, showing an increase when the snow has started to melt, and a peak followed by a drop-off once the snow pack is gone. The unvegetated shows the same pattern except the snow-thaw period is longer: by July 22 1998 (end of record) the probes were still under snow.

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## **Links Between Microbial Population Dynamics and Plant N Availability in an Alpine Ecosystem**

**David A. Lipson, Steven K. Schmidt, and Russell K. Monson**

*Department of Environmental, Population and Organismic Biology, CB 334, University of Colorado, Boulder, CO 80309-0334*

***Poster Abstract.*** In this study, we examined the links between microbial population dynamics and plant N availability in an alpine dry meadow. We conducted a year-round field study, and performed experiments on isolated soil microorganisms. Based on the previous work in this ecosystem, we hypothesized that microbial biomass would decline before the plant growing season and release N that would become available to plants. Microbial biomass was highest when soils were cold, in autumn, winter, and early spring. During this time, N was immobilized in microbial biomass. After snowmelt in spring, microbial biomass decreased. A peak in the soil protein concentration was seen at this time, followed by peaks in soil amino acid and ammonium concentrations in late June. Soil protease rates were initially high after snowmelt, decreased to below detection limits by midsummer, and partially recovered by late summer. Proteolytic activity in soil was saturated early in the growing season, and became protein limited later in the summer. We concluded that the key event controlling N availability to alpine plants occurs after snowmelt, when protein is released from the winter microbial biomass. This protein pulse provides substrate for soil proteases, which supply plants with amino acids during the growing season. On average, microbial biomass was lower in the summer than at other times, although the biomass fluctuated widely during the summer. Within the summer months, maximum numbers of amino acid-degrading microorganisms and the maximum amount of microbial biomass coincided with the peak in soil amino acids, at the same time when plants are most active. All bacterial strains isolated from this summer community had the ability to grow rapidly on low concentrations of amino acids and to degrade protein. This explains the previously observed result that the soil microbial biomass can compete strongly with plants for organic N, despite the seasonal offset of maximum plant and microbial N uptake.

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## **Developmental Preformation of *Acomastylis rossii* (Roseaceae) in Contrasting Alpine Tundra Sites**

**Christopher G. Meloche and Pamela K. Diggle**

*Department of Environmental, Population and Organismic Biology, CB 334, University of Colorado, Boulder, CO 80309-0334*

**Talk Abstract.** Preformation, the initiation and early development of organs one or more growing seasons before maturity and function, is ubiquitous among alpine plants. This pattern of development is believed to allow plants to survive the short growing seasons found in alpine environments but few data have been presented to support this belief. The development of *Acomastylis rossii* (alpine avens) was studied in a moist meadow and a fellfield on Niwot Ridge (a Colorado alpine tundra site) to characterize the relationship between preformation and environment in alpine tundra. Moist meadow sites endure a longer snowpack and thus have a shorter growing season than adjacent fellfield sites. If preformation provides an advantage in shorter growing seasons, then a greater extent of preformation is expected in the moist meadow site. *A. rossii* plants in both communities have an extended period of preformation. Three years are required for each leaf and inflorescence to progress from initiation through structural and functional maturity. As a consequence, three cohorts of organs, initiated in successive years, are borne simultaneously on an individual plant. Plants extend an initial flush of leaves shortly after snowmelt after which no additional leaves are matured until the next growing season. Preformation proceeds below ground through the remainder of the growing season and into the period after aboveground structures senesce. Routine abortion of axillary inflorescences and vegetative shoots is observed. It appears that neither the extent nor the duration of preformation varies with environment in *A. rossii*. Evidence suggests that variation in mature structure among sites is due to variation in abortion of axillary shoots and variation in the growth rate of organs during preformation and during maturation.

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## **Phenotypic Plasticity in the Utilization of Nitrogen Pulses by an Alpine Bunchgrass, *Deschampsia cespitosa***

**Amy E. Miller**

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**William D. Bowman**

*Department of Environmental, Population and Organismic Biology, and Institute for Arctic and Alpine Research, CB 334, University of Colorado, Boulder, CO 80309-0334*

**Poster Abstract.** Soil nutrient availability may vary at fine scales, both spatially and temporally. The ability of plants to both maintain growth under conditions of low soil nutrient supply and exploit episodes of high supply may represent an important adaptation to an unpredictable nutrient environment. We examined the response of ten genotypes from two natural populations of *Deschampsia cespitosa* to variation in the timing and amount of nitrogen availability to determine the extent to which individuals were able to utilize a pulsed versus constant N supply. Plants were grown in a greenhouse and subjected to high N, low N (1/5 high N), or pulsed N treatments applied every 10 days (equivalent in concentration to the high N treatment, and total N delivered equivalent to that of the low N treatment). Genotypes of both populations showed marked plasticity in a number of vegetative characters (e.g., leaf length, root:shoot ratio, total biomass) in response to the nitrogen treatments. While high N treatment individuals accumulated the greatest biomass overall, plants receiving pulsed nitrogen showed 130-150% greater growth than plants receiving a low N supply (p

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## Soil Adsorption Characteristics of Amino-N in the Alpine/Subalpine

Theodore K. Raab and Russell K. Monson

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**Poster Abstract.** The adsorption/desorption of natural organic matter by soils has striking effects on the mobility of metals, mineral weathering, and other biogeochemical processes. Most studies to date have considered the reactivity of heterogeneous organic C, yet more information is needed on specific classes of compounds across the landscape. A case in point are the amino acids, recently shown to contribute to the nutrition of plants from arctic, alpine, boreal forest and subtropical ecosystems. We compared the adsorption properties of two important amino acids (gly and glu) with NH<sub>4</sub><sup>+</sup> over the alpine/subalpine ecotone. Soil adsorption isotherms of amino acids demonstrate stronger solid-phase partitioning than for NH<sub>4</sub><sup>+</sup> (solid-liquid partitioning  $K_d$ 's = 12 - 24 L kg<sup>-1</sup>) in alpine tundra A-horizons, with essentially none in lower soil horizons. Retention of amino acids decreases with altitude down to C-1, scaling with OM content of soils. Soil retention of all species is maximal near the natural pH of the soils, decreases slightly with increasing acidity, and disappears above neutral pH. Spectroscopic studies are underway to provide mechanistic information on amino acid adsorption/desorption from soils, and contribute to an understanding of their availability to plant communities.

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## Characterization of Three Dominant Ectomycorrhizal Fungi Associated with the Alpine Sedge *Kobresia myosuroides* (Cyperaceae)

Chris W. Schadt, Stacie Kageyama, and Steven K. Schmidt

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Monique Gardes

*CESAC/CNRS, Universite Paul Sabatier/Toulouse III, 31055 Toulouse Cedex 4, France*

**Poster Abstract.** *Kobresia myosuroides* is a common component of alpine and arctic tundra ecosystems throughout the Northern Hemisphere and is the only member of the Cyperaceae family that is known to form ectomycorrhizae. Despite the ecological importance of *K. myosuroides*, the identity or function of its fungal symbionts have not been determined. Three common morphotypes have been collected from the Front Range of the Colorado Rocky Mountains over the past two growing seasons. Of 19 root cores thus far examined, all contained *Cenococcum geophilum* and an unidentified symbiont with a white mantle. Eight of the 19 cores also contained an unidentified type with an orange mantle. These ectomycorrhizal morphotypes were characterized on the basis of mantle morphology and RFLP analysis of the Internal Transcribed Spacer (ITS) DNA region. Results of morphological analyses show these three ectomycorrhizal morphotypes have similar structural features to those reported for other Angiosperms. RFLP analysis performed on them confirmed that these three types are distinct from one another. In addition, each morphotype RFLP pattern was identical between sample cores. Progress toward the identification of the fungi forming the unidentified white and orange morphotypes will be presented.

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## **Under-Snow Peaks in Microbial Biomass and Activity in the Colorado Alpine**

**Steven K. Schmidt, and David A. Lipson**

*Department of Environmental, Population and Organismic Biology, CB 334, University of Colorado,  
Boulder, CO 80309-0334*

**Paul D. Brooks**

*US Geological Survey, Water Resources Division, Boulder, CO*

**Mark W. Williams**

*Department of Geography and Institute of Arctic and Alpine Research, CB 450, University of Colorado,  
Boulder, CO 80309-0450*

**Talk Abstract.** Many alpine sites are covered with snow for most of the year. Past research has shown that soils beneath moderate to deep snow packs can thaw to temperatures ( $> -7$  degrees C) that allow the proliferation of psychrophilic and psychrotrophic microorganisms. Over the past two winters, we have been following the population dynamics of three important microbial functional groups in soils from under willows (*Salix brachycarpa*), Subalpine Fir (*Abies lasiocarpa*) tree islands and in adjacent *Kobresia myosuroides* meadows. We have found that there are distinct peaks of microbial activity and biomass levels during the late winter and early spring before snow melt at our sites. This peak in activity is especially pronounced for microbial functional groups that mineralize phenolic compounds and are able to grow at 3 degrees C. The ecological implications of these findings will be discussed.

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## **Effects of Enhanced Snowpack and Nutrient Additions on the Productivity and Diversity of Alpine Tundra**

**Timothy R. Seastedt**

*Department of Environmental, Population and Organismic Biology, and Institute for Arctic and Alpine Research, CB 450, University of Colorado, Boulder, CO 80309-0450*

**Lynn Vaccaro**

*NWT LTER Research Experience for Undergraduates Program*

**Talk Abstract.** Increased snowpack and increased nitrogen inputs are likely occurring in alpine tundra of the Colorado Front Range. In 1993, a snowfence and nutrient amendment experiment was initiated to test vegetation responses to these inputs. A factorial experiment for N and P additions was conducted both within and adjacent to an area of enhanced snowpack. In summer 1997, productivity, species richness, and species diversity of these plots was assessed. Increased snowpack had only modest effect on characteristics studied here, and snowpack did not influence responses to nutrient additions. Both nitrogen and phosphorus additions resulted in increased foliage production (p

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## Effects of Tree Islands on Soil Characteristics of Alpine Tundra

Timothy R. Seastedt

*Department of Environmental, Population and Organismic Biology, and Institute for Arctic and Alpine Research, CB 450, University of Colorado, Boulder, CO 80309-0450*

Gina Adams

*Natural Resource Ecology Laboratory, Colorado State University, Ft. Collins, CO*

***Talk Abstract.*** Soil characteristics, root productivity, and nitrogen flux in soils of tree islands and adjacent alpine meadow tundra were compared to test the hypothesis that tree island passage can significantly modify soil properties. We found significant reductions in amounts of soil organic matter (SOM) and KCl-extractable  $\text{NH}_4^+$  in soils influenced by tree islands. Cation exchange capacity was found to be correlated to SOM, but did not show a significant correlation with vegetation type. Soil texture was not changed by passage of tree islands. The soil carbon isotopic signature is only temporarily influenced by the passage of tree islands, suggesting that tree carbon is not stabilized in soils. Moreover, root ingrowth bags demonstrate very large reductions in fine root productivity (and presumably, carbon inputs) from trees. Resin bag nitrogen collections indicate that soils beneath trees have higher nitrogen losses than adjacent tundra soils. Tree island passage therefore has the tendency to reduce SOM and the nitrogen storage potential of former tundra soils, and contributes to increased heterogeneity of soils in the alpine regions.

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# **Atmospheric Nitrogen Deposition at C1: Response of Free Amino Acids in Engelmann Spruce Needles**

**Herman Sievering, John Calanni, Erik Berg, and Matthew Wood**

*Global Change and Environmental Quality Program, Departments of Environmental Sciences and Geography, and the Center for Environmental Sciences, CB 172, University of Colorado at Denver*

**Deborah Mangis**

*U.S. Environmental Protection Agency, National Exposure Research Laboratory*

**Rick Boyce**

*Department of Biology, University of Denver*

**Walt Weathers**

*U.S. Environmental Protection Agency, National Exposure Research Laboratory*

***Talk Abstract.*** Recent increases of nitrogen (N) deposition to forest ecosystems have had a variety of effects on plant species including mineral imbalance, growth disturbance and the accumulation of foliar free amino acids. The purpose of this study was to determine the existence and degree of correlation between variable atmospheric nitrogen deposition and the concentrations of foliar free amino acids (arginine, aspartic acid, and glutamic acid) in Engelmann spruce (*Picea engelmannii*). Needle samples were collected during July and August of 1996 from a site in the Colorado Rocky Mountains having large diurnal variations in atmospheric nitrogen deposition. Amino acid concentrations were quantified by means of HPLC and foliar % N was determined using a CHN analyzer. Atmospheric nitrogen concentrations of gaseous HNO<sub>3</sub> and NH<sub>3</sub>, as well as particulate NH<sub>4</sub><sup>+</sup> and NO<sub>3</sub><sup>-</sup>, were determined simultaneously with needle sampling and were subsequently converted to atmospheric N flux estimates. Foliar concentrations of arginine (July intensive) and glutamic acid (August intensive) in adult trees showed strong positive correlations with variations in atmospheric N flux, dominated by nitric acid, after a 4 +/- 2 hour time delay. The results of this study suggest that free amino acid concentrations in adult Engelmann spruce trees may eventually serve as indicators of atmospheric N deposition.

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# **Influence of Plant Species on Community Structure Through the Control of Spatial Heterogeneity in Nitrogen Cycling in Alpine Tundra**

**Heidemarie Steltzer**

*Department of Environmental, Population and Organismic Biology, CB 334, University of Colorado, Boulder, CO 80309-0334*

**William D. Bowman**

*Department of Environmental, Population and Organismic Biology, and Institute for Arctic and Alpine Research, CB 450, University of Colorado, Boulder, CO 80309-0450*

**Talk Abstract.** Nitrogen availability is an important control of productivity and species composition in the alpine. Plant species can control the spatial variability in N availability, by influencing rates of litter decomposition and mineralization. As a result, plant species can affect the spatial variability in species composition, which can be demonstrated through the spatial crosscorrelation of the relative abundances of dominant species to species diversity. In alpine tundra, soil beneath patches dominated by either of two abundant, codominant, species differ seven fold in net N mineralization rates, which is greater than variation associated with differences in soil microclimate. Three plant traits, phenolic:N ratio, C:N ratio, and fine root production vary between these two species. Variation in these traits accounts for 33% of the variability in soil N transformation rates among patches where one species or the other is dominant. Experimental results indicate that the phenolic:N ratio is a stronger control of N mineralized from litter than the C:N ratio. The spatial variability in the relative abundances of dominant species, which determine N availability by controlling quality of carbon inputs, thus has the potential to influence the spatial variability of other community characteristics such as plant and microbial species diversity.

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## **Effects of Temperature History on the CH<sub>4</sub> Metabolism of Alpine Soils**

**Ann E. West, R. S. Lai, and Steven K. Schmidt**

*Department of Environmental, Population and Organismic Biology, CB 334, University of Colorado, Boulder, CO 80309-0334*

**Poster Abstract.** In the *Carex* plant communities of Colorado Rocky Mountain alpine tundra, static-chamber measurements during the snow-free season indicated a temporal pattern of CH<sub>4</sub> fluxes: For several weeks after snowmelt, CH<sub>4</sub> fluxes were zero. After soils warmed to 4 degrees C, small, sporadic CH<sub>4</sub> emissions (less than 2 mg m<sup>-2</sup> d<sup>-1</sup>) were observed. Finally, late in the summer, net CH<sub>4</sub> oxidation occurred. These changes in field CH<sub>4</sub> fluxes did not correspond with changes in soil moisture but they did correlate roughly with soil temperature at 15 cm depth. Therefore, we performed laboratory incubations to examine the role of temperature in this temporal pattern. We observed some association between instantaneous temperature and CH<sub>4</sub> flux. However, the temperature response of CH<sub>4</sub> emission from soils collected in early spring was delayed by up to 4 weeks. Both methane emission and methane oxidation showed a similar delayed temperature response. These data indicate that CH<sub>4</sub> fluxes of these alpine soils can be influenced by not only the immediate temperature of the soil but also by the temperature history. Our results further suggest that net CH<sub>4</sub> flux of these soils may result from different sensitivities of methanotrophic and methanogenic activity to temperature.

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## Report on the 9th Annual Dendroecological Field Week

Connie A. Woodhouse

*NOAA Paleoclimatology Program, NGDC and Institute of Arctic and Alpine Research, CB 450  
University of Colorado, Boulder, CO 80309-0450*

***Talk Abstract.*** The 9th annual Dendroecological Field Week was held at the Mountain Research Station during the last week of June this year. Forty students and scientists attended, and the group included graduate students and faculty members from a number of institutions, and researchers from government agencies such as the USFS and the USGS. Attendees came from all regions of the United States as well as from Canada, Mexico, Norway, and Ethiopia. The group split up into five different project groups, lead by one or two group leaders, and each focussed on an aspect of dendroecology or dendroclimatology. During the course of the week, participants in each group took part in the full range of activities that are involved in a dendrochronological study, from the field work to the final analysis. On the last day, each group reported their findings in oral and graphical presentations. The five projects highlighted the following areas: 1) dendroecological studies of the subalpine forest above Cable Gate on Niwot Ridge, 2) tree-ring/climate relationships and potential for long reconstructions of climate from Douglas-fir and ponderosa pine located at the upper elevational limits of their ranges, 3) tree-growth/nitrogen relationships in ponderosa pine, 4) fire history in a Front Range ponderosa pine forest, and 5) dendroarcheological dates for the Albion townsite. In the span of a week's time, only preliminary results were obtained, but studies showed promise for further work. Some intriguing preliminary results suggest: 1) the fire above Cable Gate occurred in 1899, several years before previous estimates, 2) nitrogen may be inversely related to ponderosa pine growth in some areas, 3) fire in Front Range ponderosa pine forests burned at regular intervals until the period of Anglo settlement, but the fire regime change after the mid-1800s was not uniform in character across the Front Range, 4) Douglas-fir growing at the upper elevational limits of their range are very sensitive to June precipitation, and 5) very old ponderosa pine and Douglas-fir trees growing a few miles from the MRS may provide reconstructions of precipitation variability that date back to the 15th century.

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