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Using Age as a Predictor of Chemotypes for Low Sagebrush (*Artemisia Arbuscula*): Can Age Help Us Manage Sage-Grouse Foraging Habitat?

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Background

- There is a great need to identify parameters that contribute to habitat use by threatened wildlife
- Concentration of coumarins (selected for) and monoterpenes (selected against) in sagebrush influence diet quality and therefore habitat use by Greater Sage-grouse (*Centrocercus urophasianus*)[1] – a species being considered for endangered status
- Our goal is to identify how disturbance changes plant chemistry and therefore diet selection and habitat use by sage-grouse:
  - ✧ Browsing by herbivores may increase monoterpenes in sagebrush[2]
  - ✧ Increasing temperatures may increase chemicals in sagebrush[3]
  - ✧ New research: Does the age of plants influence chemistry of sagebrush?

Figure 1. A Greater Sage-grouse (*Centrocercus urophasianus*) hen taking cover in a low sagebrush (*Artemisia arbuscula*) at our study site on Jim Sage Mountain in southeastern Idaho.

Hypothesis

- We hypothesize circumference can predict annual growth by sagebrush (age).
- We hypothesize higher concentrations of coumarins and lower concentrations of monoterpenes in younger plants.

Methods

Predicting age of sagebrush

- Radio-telemetry was used to flush birds from foraging patches
- Even numbers of browsed and non-browsed low sagebrush (*Artemisia arbuscula*) were selected for analysis
- Age was determined by counting annual growth rings from cut sagebrush
- Circumference was measured around the base of each shrub

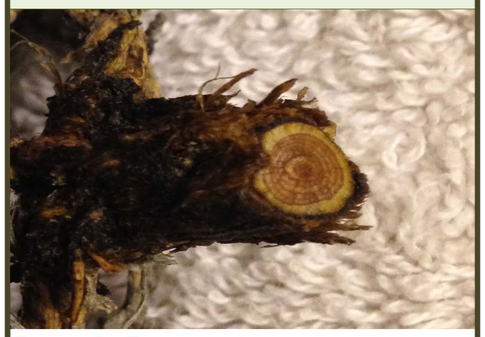

Figure 2. Example of a sagebrush plant that was used to compare annual growth rings (age) and the circumference. This plant has 7 annual growth rings.

Measuring chemicals in sagebrush

- Total monoterpenes were measured using gas chromatography.
- Total coumarins were quantified using a spectrometer and a scopoletin fluorescence assay.

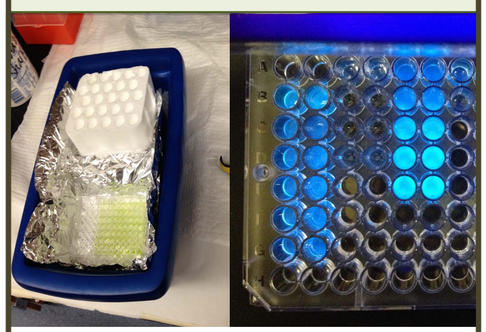

Figure 3. Example of a scopoletin fluorescence assay.

Statistics

- Regression analyses were used to determined relationships between age and circumference, monoterpenes and coumarins (JMP Pro 10, SAS Institute, Cary, NC).

Results

Age can be predicted from circumference (Fig. 4)

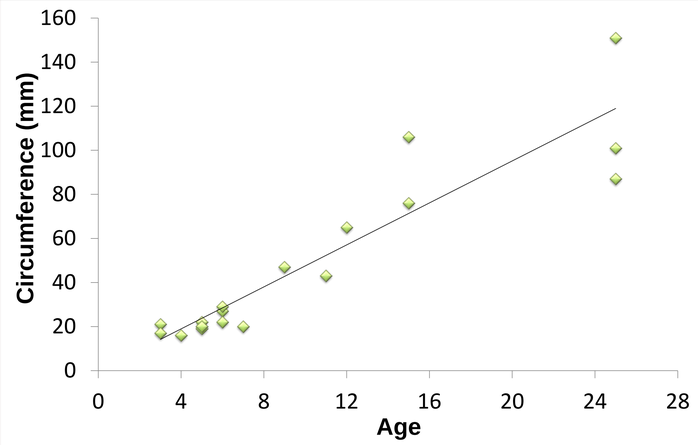

Figure 4. Annual growth rings (age) are strongly correlated with circumference of low sagebrush plants (R^2=0.84676, p-value<0.0001). The formula for the regression line is used to estimate ages for plants with circumference measures.

Total monoterpenes were not significantly influenced by the plant's age (Fig. 5)

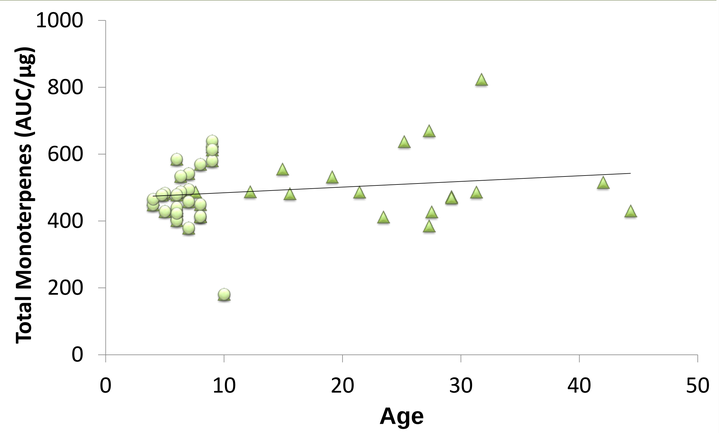

Figure 5. Total monoterpenes (AUC/µg dry weight), a group of plant secondary metabolites, were measured using gas chromatography. There was no correlation between age and total monoterpene concentration (R^2=0.034776, p-value=0.2255). The circles represent exact ages and the triangles represent samples that are age estimates using the formula for the regression line shown in Fig. 3.

Total coumarins showed no significant correlation to age (Fig. 6)

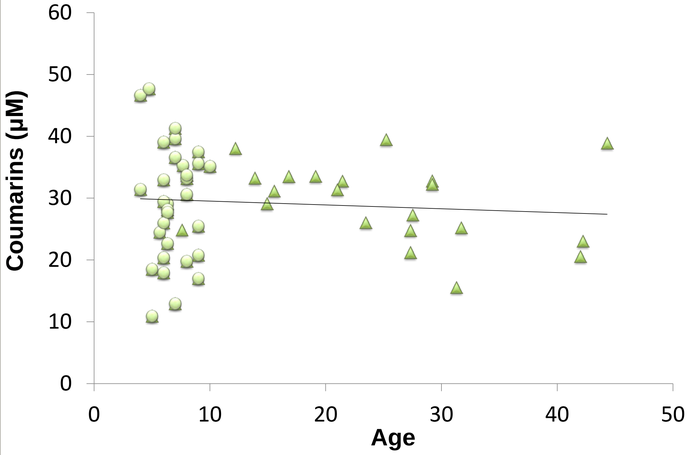

Figure 6. Coumarins, a general measure of palatability, were measured using a scopoletin fluorescence assay. There was no correlation between age and total coumarin concentration (R^2=0.006871, p-value=0.5591). The circles represent exact ages and the triangles represent samples that are age estimates using the formula for the regression line shown in Fig. 3.

Among the small (<15cm tall) plants coumarins were not influenced by exact age (Fig. 7)

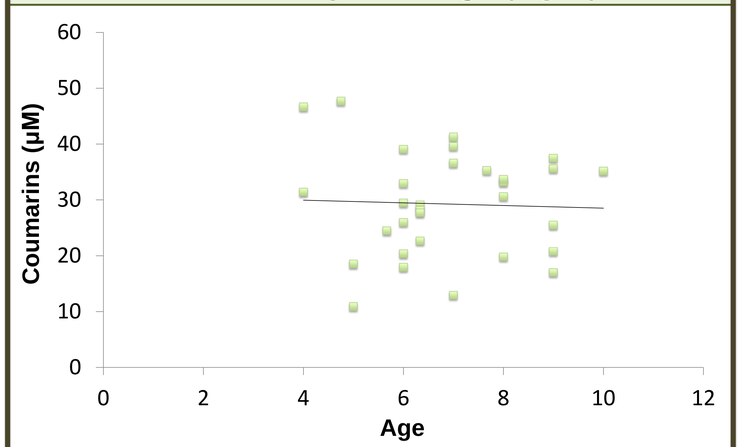

Figure 7. Coumarins, a general measure of palatability, were measured using a scopoletin fluorescence assay. Comparing this graph to Figure 6. shows the comparison between using just annual growth rings (R^2=0.00157), and including the estimates from the formula (R^2=0.00687). A t-test showed there was no significant difference between the age/coumarin correlation that included estimates versus the ones that only used exact age (p=0.9971).

Discussion

Aging sagebrush

- Measuring circumference is a non-destructive approach to determine age of low sagebrush within a habitat (Fig. 4)
- This approach needs to be validated in other habitats for other species of sagebrush
- Ageing sagebrush could be used to determine reestablishment of sagebrush after fire or other disturbances

Chemistry and age

- Total monoterpenes and coumarins are correlated with age in low sagebrush within a habitat (Fig. 5, Fig. 6)
- Other factors may be stronger influences of plant chemistry within age: Habitat quality, plant density, water accessibility[4]
- Concentration of individual coumarin or monoterpene compounds, rather than total concentrations, could be related to age
- Age could influence protein content which can predict diet selection[5]

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