

USDA-ARS-PPRL

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Plant Environment Interactions

Biotic Stresses-

Bacteria, Fungi, Insects, Small Animals, Large Animals

Abiotic Stresses-

Temperature, Water Availability, Nutrients

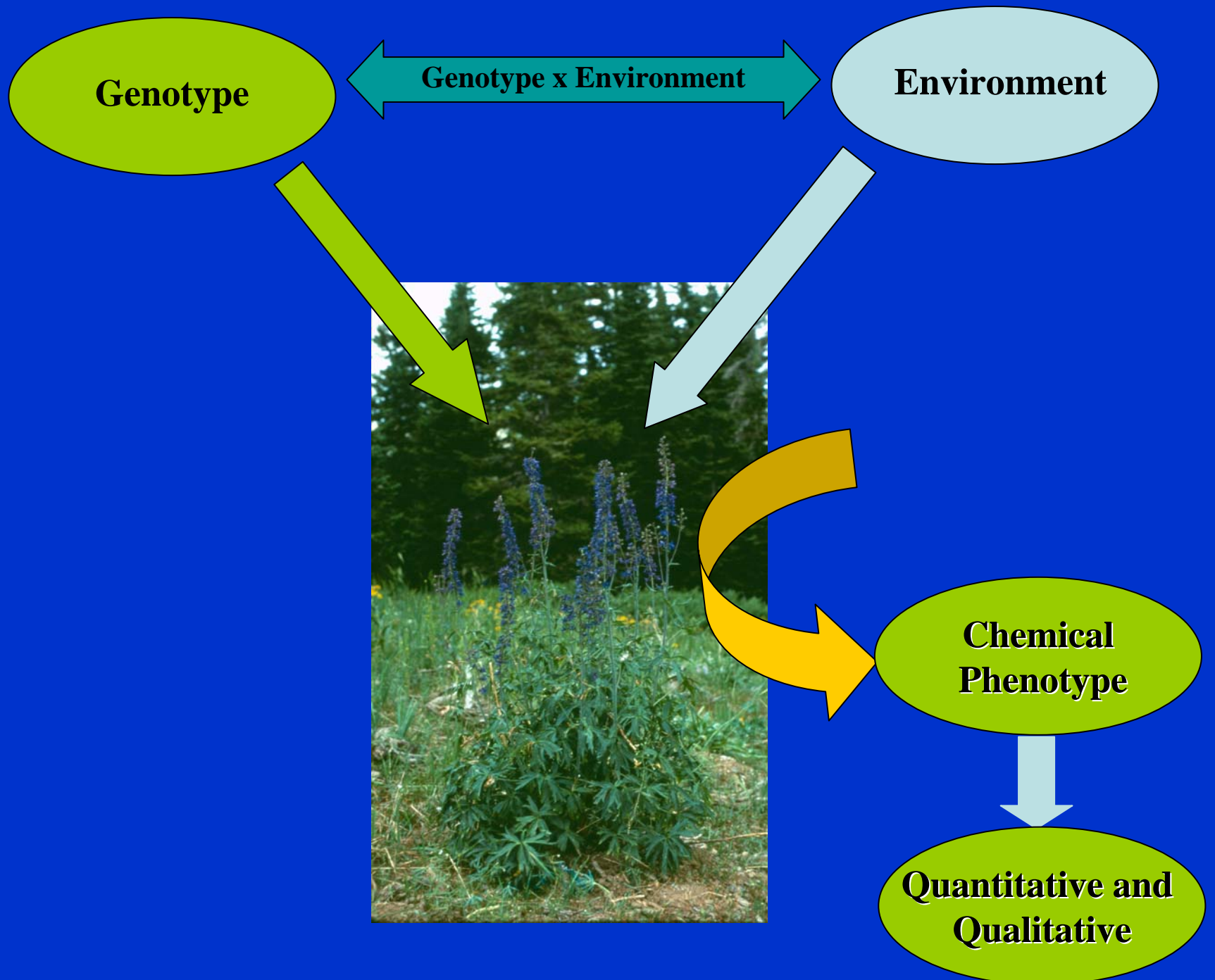
Coevolution – mutual evolutionary influence between two species
example: chemical changes in response to herbivory lead to compensatory metabolic changes in herbivores to adapt to the new plant chemistry, ultimately leading to further changes in plant chemistry

Chemical Defenses – chemicals produced by the plant that deter herbivory or invasion by other organisms

examples: alkaloids, terpenes, tannins

Physical Defenses – physical characteristics of the plant that deter herbivory or invasion by other organisms

examples: spines, thorns, lignified tissue, leaf hairs, leaf waxes



Questions

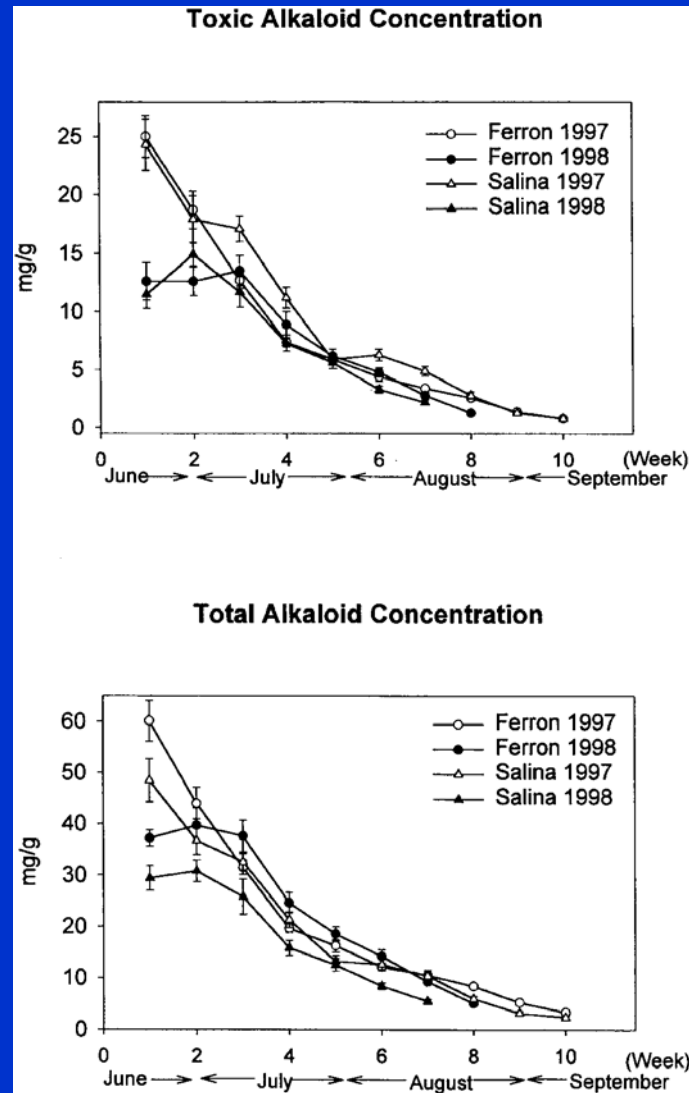
Can plant toxins vary seasonally?

Can plant toxins vary as a function of plant growth and development?

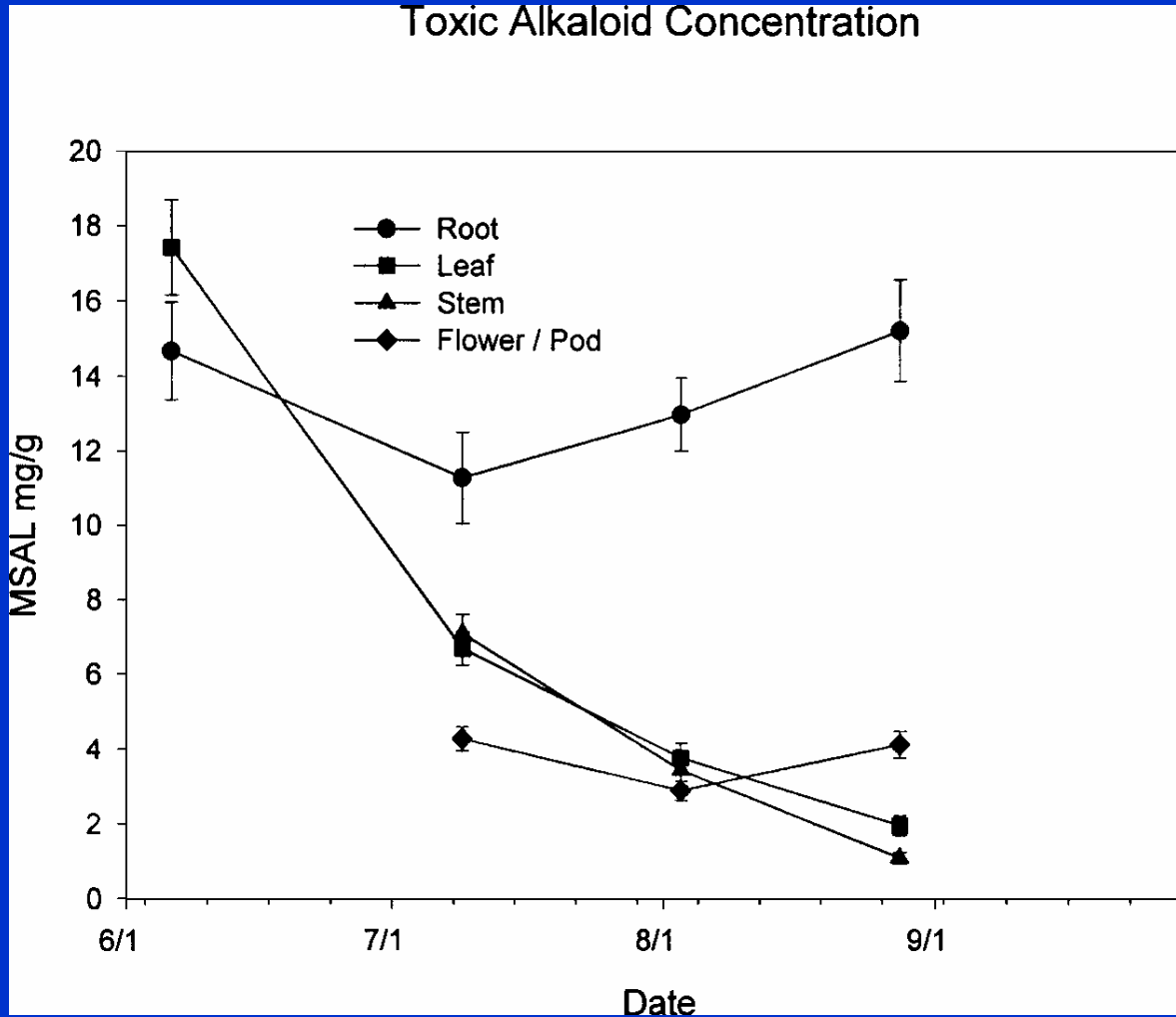
Can plant toxins vary as a function of time of day?

Are all plants of the same species toxic?

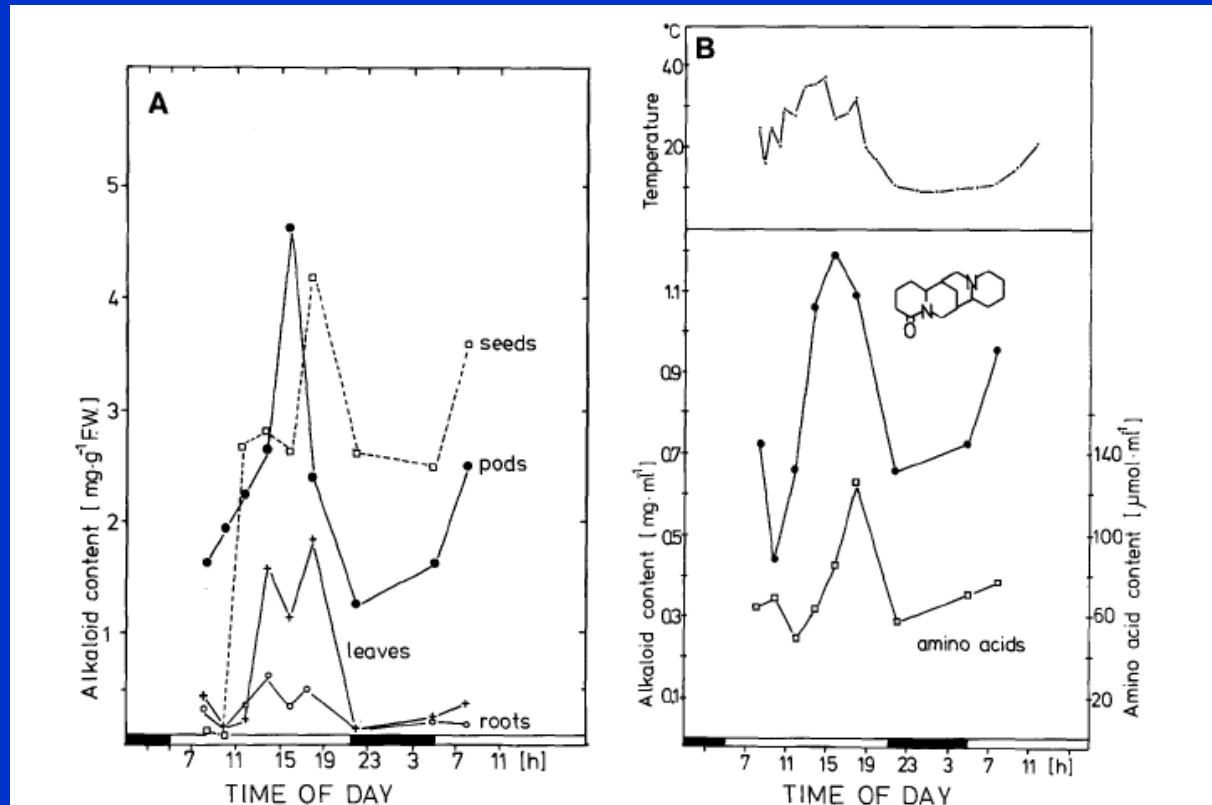
Larkspur Alkaloids Vary as a Function of the Time of Year



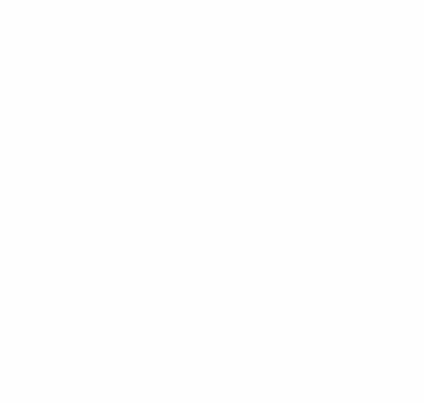
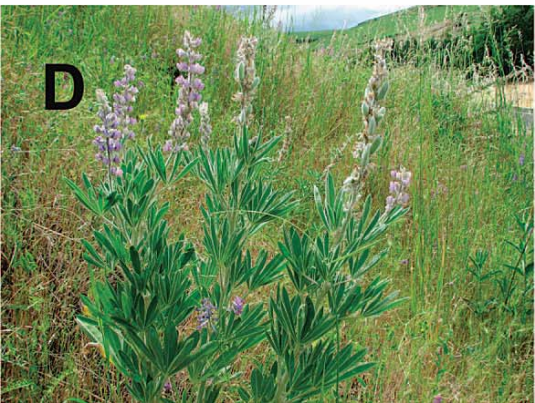
Larkspur Alkaloids Vary as a Function of Plant Part and Time of Year



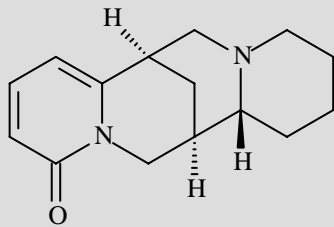
Lupine Alkaloids Vary as a Function of the Time of Day



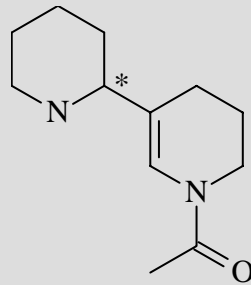
Lupine Species



Teratogenic Alkaloids



Anagryne

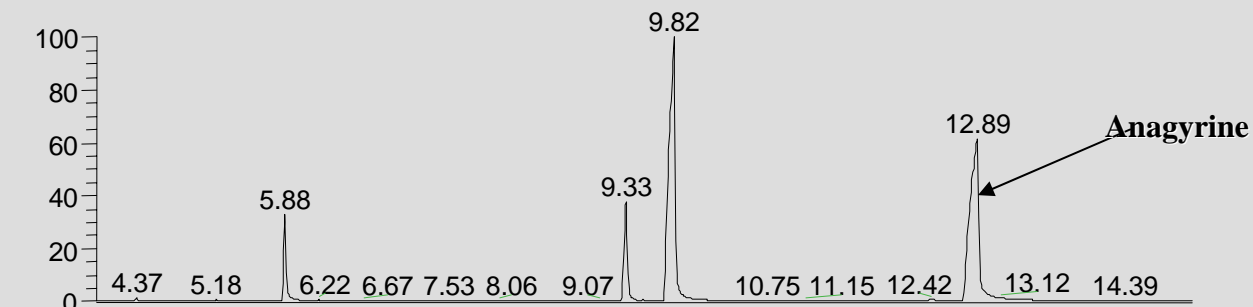


Ammodendrine

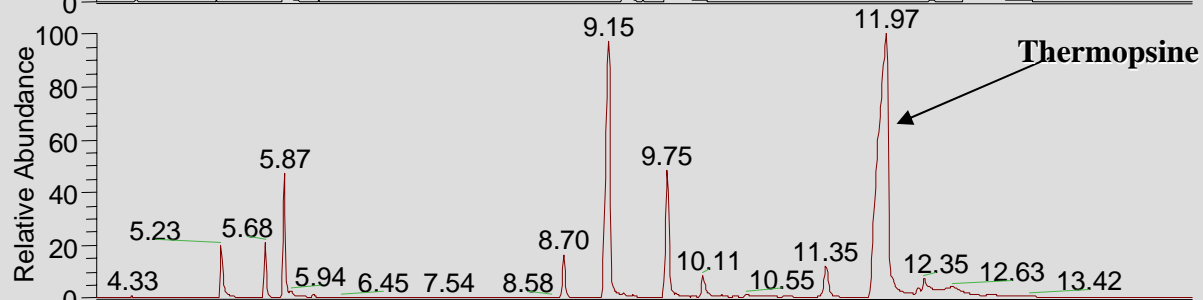


Lupinus sulphureus

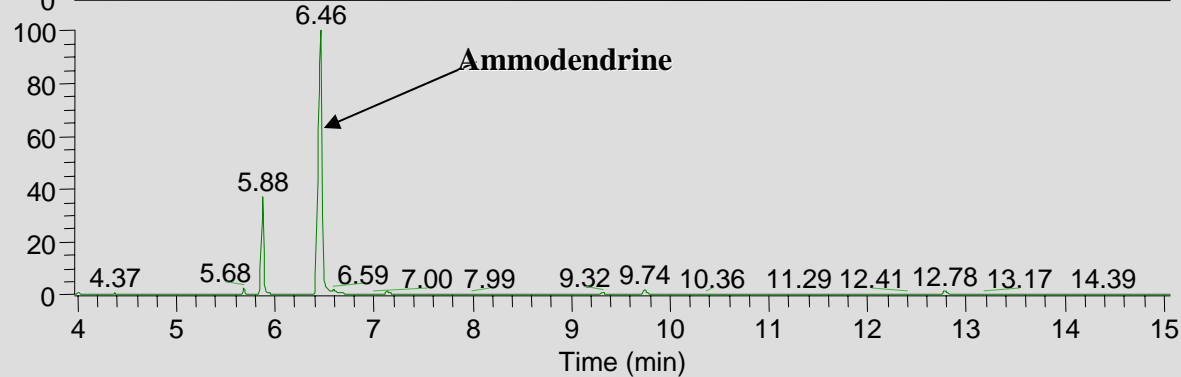
Quinolizidine and Piperidine Alkaloids



Pendleton, OR



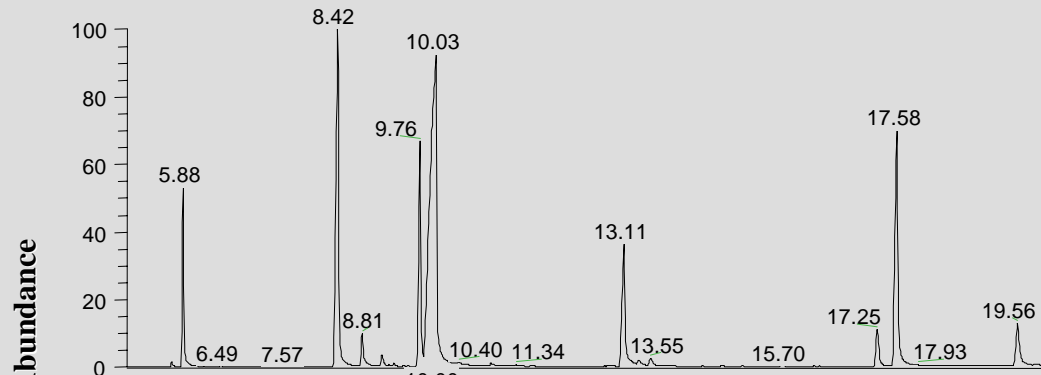
Clarkston, WA



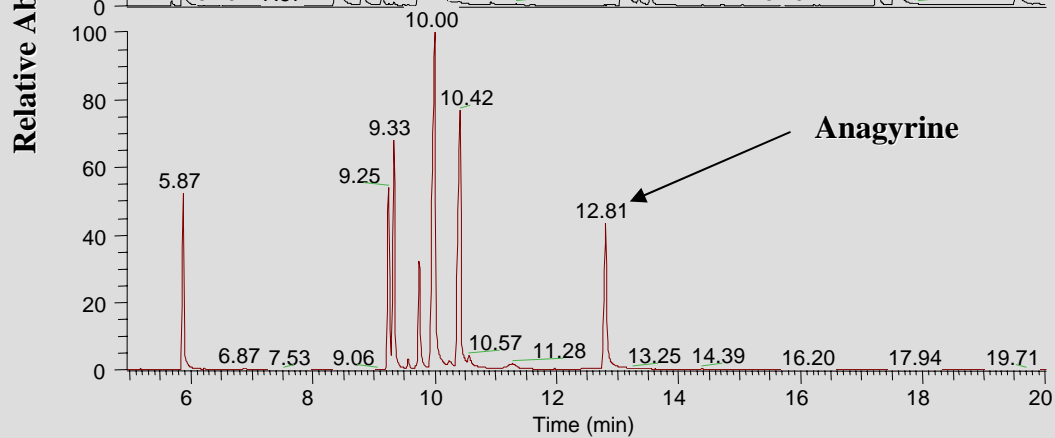
Ritzville, WA

Lupinus leucophyllus

Chemical Fingerprint (Quinolizidine Alkaloids)



Pendleton, OR



Anagyrine

Ritzville, WA

Delphinium (Larkspurs)

- Diverse group
- Divided into three categories:
 - tall (*barbeyi*, *occidentale*, *ramosum*, *glaucum*)
 - low (*nuttallianum*, *andersonii*, *bicolor*)
 - plains (*geyeri*)
- Cause \$6-10 million in losses annually

Delphinium Spp.



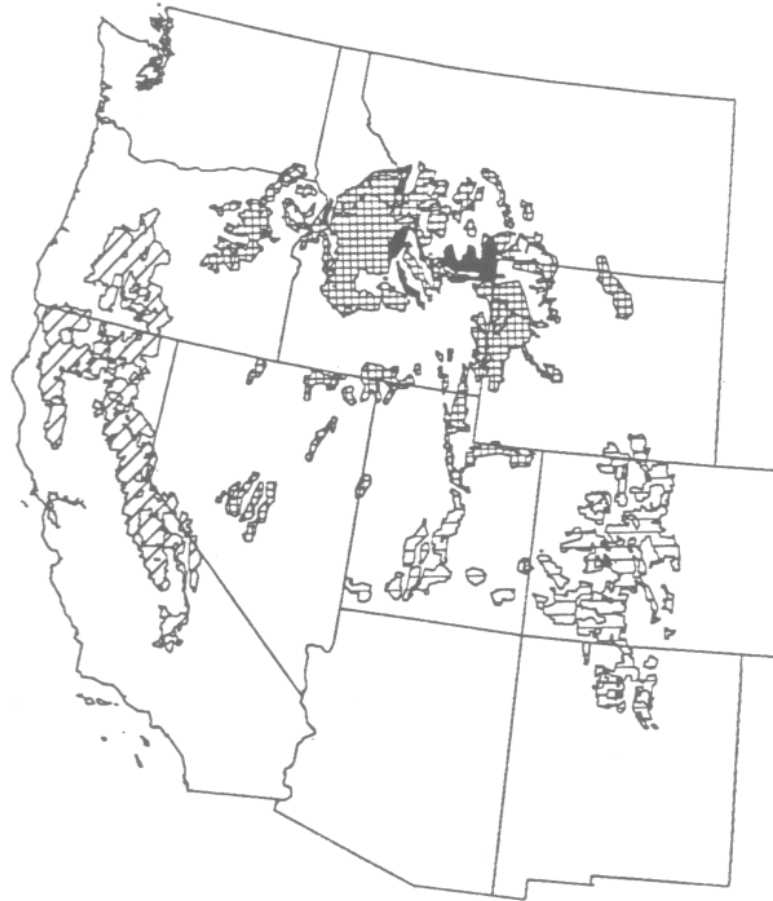
Larkspurs: Extent of the Problem





- Marsh (1913) stated that larkspurs kill more cattle on western ranges than any other plant (locoweed excepted)
- Tall larkspurs- serious problem on mountain rangelands
- Low larkspurs- problematic on foothill and mountain ranges.
- Plains larkspur- persistent problem on High Plains (particularly Wyoming & Colorado)

Tall larkspurs

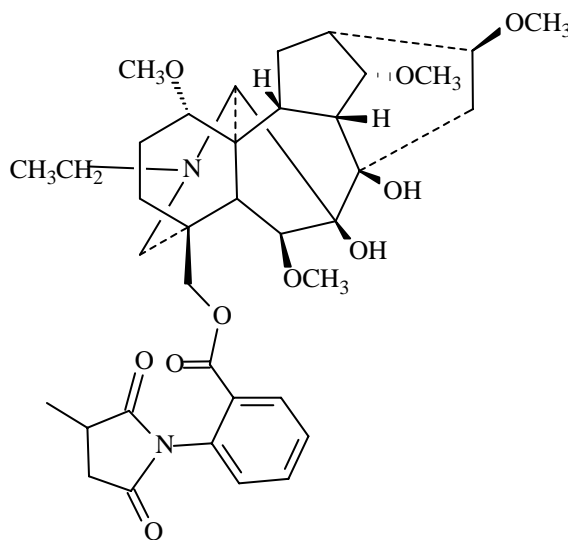
- Tall larkspurs: found in mountain habitat in the western U.S. - generally moist sites - 6,000 to 10,000 feet elevation
- Tall larkspur sites typically snow-covered during winter
- Tall larkspurs grow in forb-dominated sites; very nutritious forage and high carrying capacity

Distribution of Four of the Major Tall Larkspur Species in the Western United States

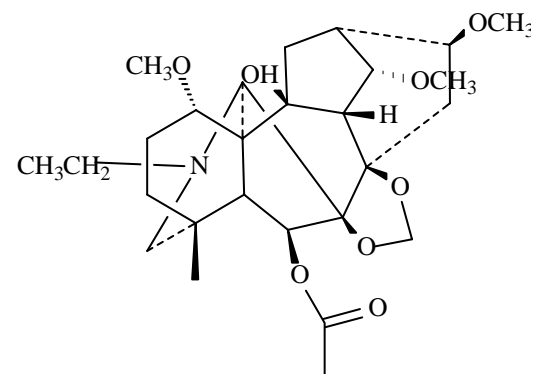


 *D. barbeyi*  *D. glaucescens*
 *D. glaucum*  *D. occidentale*

Larkspur Species contain Norditerpene Alkaloids that Differ in their Toxicity



Methyllycaconitine
(LD₅₀ ≈ 4 mg/kg)
MSAL-type alkaloid



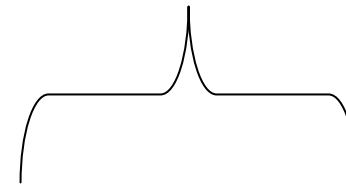
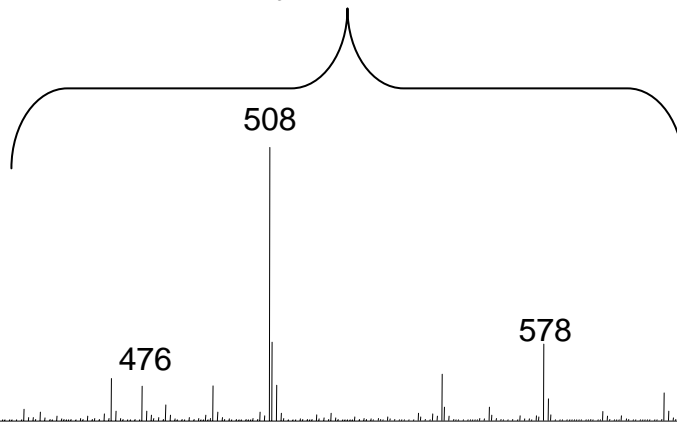
Deltaline
(LD₅₀ ≈ 120 mg/kg)
MDL-type alkaloid

The Two Chemotypes of Duncecap Larkspur

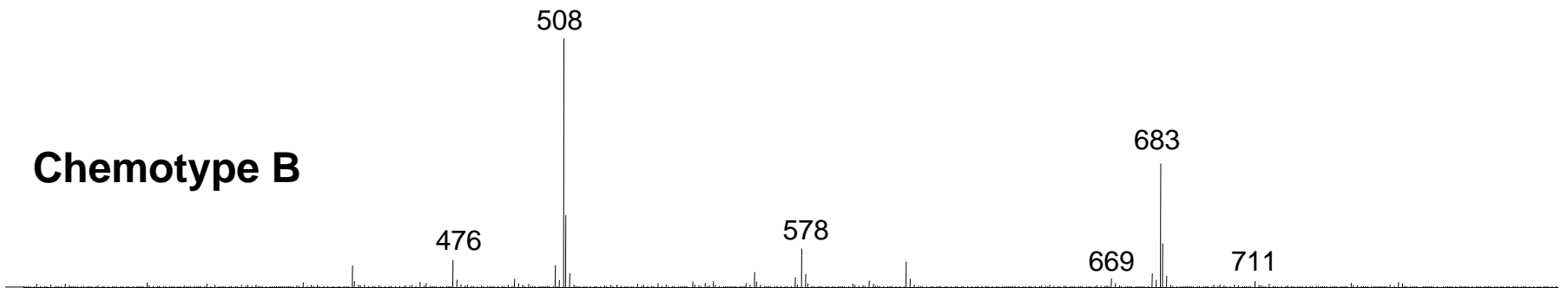
MDL-type alkaloids

MSAL-type alkaloids

Chemotype A



Chemotype B



Previous Research has Identified Larkspur Populations with Chemotypes A and B

Chemotype A

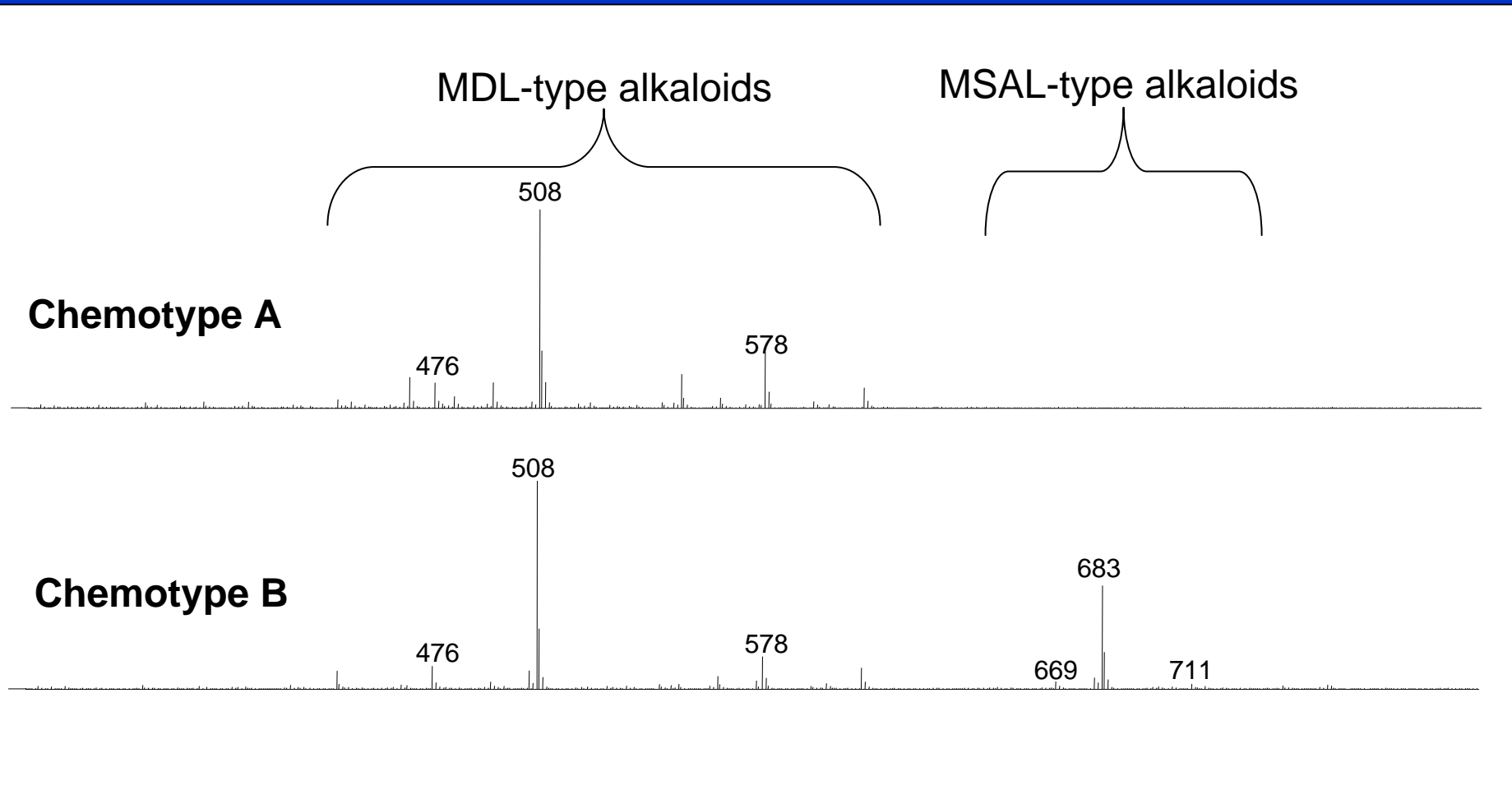
Logan, UT
Mendon, UT
Fairview, UT
Salina, UT
Yampa, CO

Chemotype B

Jackson, WY
Alpine, WY
Park Valley, UT
Oakley, ID
Clifton, ID

Objective

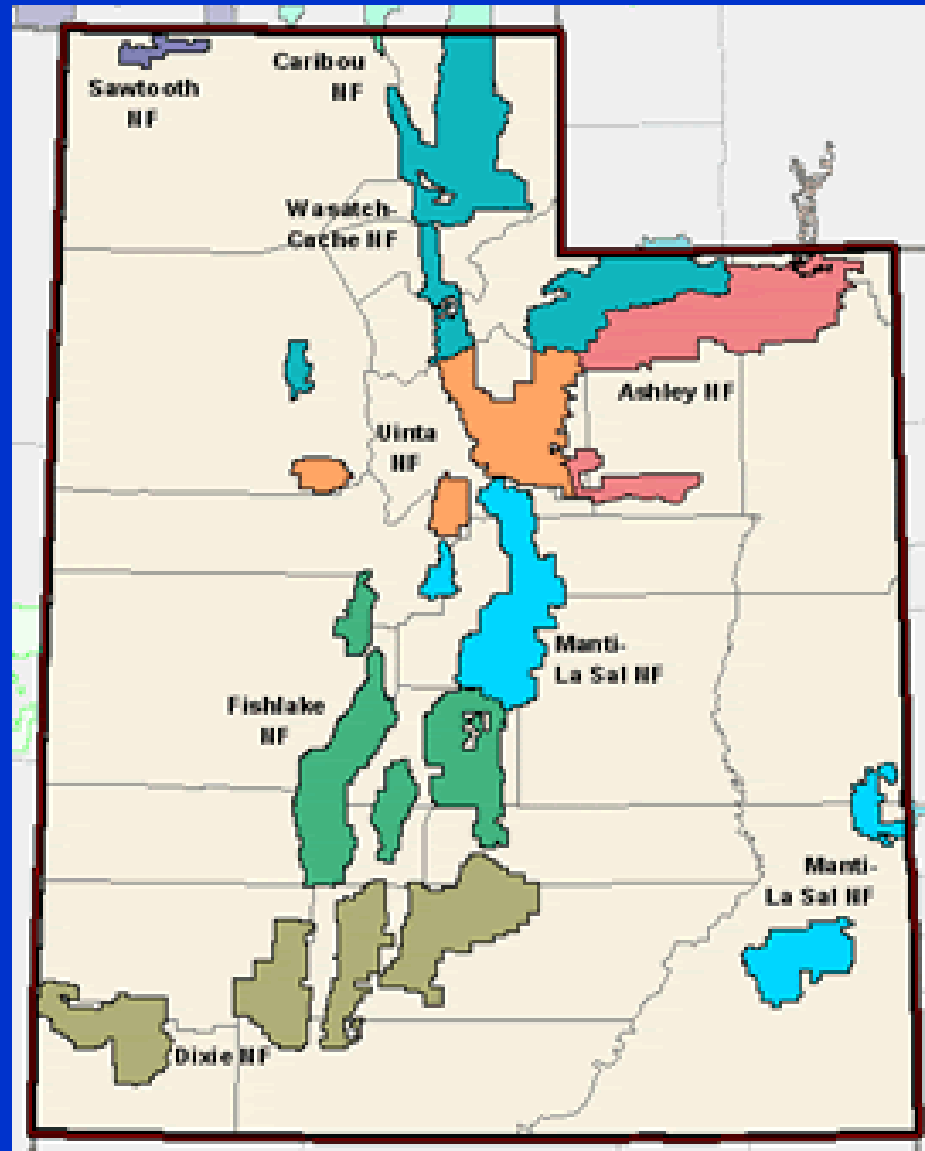
To determine if Chemotype A populations are more widespread geographically or if they are sporadic in nature



Duncecap Larkspur Plants that have Chemotype A (no MSAL type alkaloids) have a defined geographical distribution

Survey of Herbarium Specimens

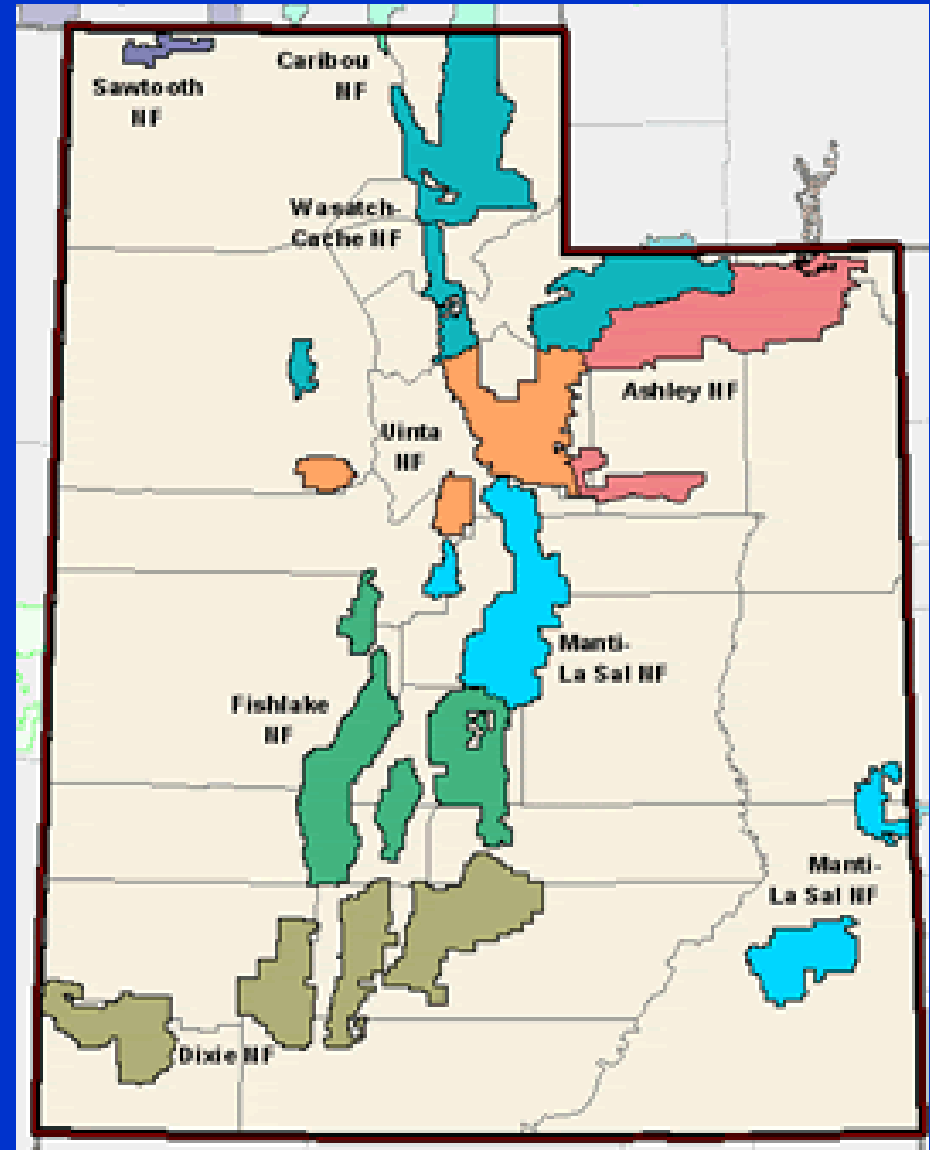
- 27 samples Cache County
- 12 of 15 samples Utah County
- 13 samples Wasatch County
- 10 samples Duchesne County
- 6 samples Rich County
- 5 samples Uintah County
- 5 samples Millard County
- 5 samples eastern Juab County
- 4 samples Salt Lake County
- 3 samples Tooele County
- 3 samples Weber County
- 2 samples Carbon County
- 1 sample Davis County
- 1 sample Dagget County
- 1 sample Emery County
- 1 sample Sevier County



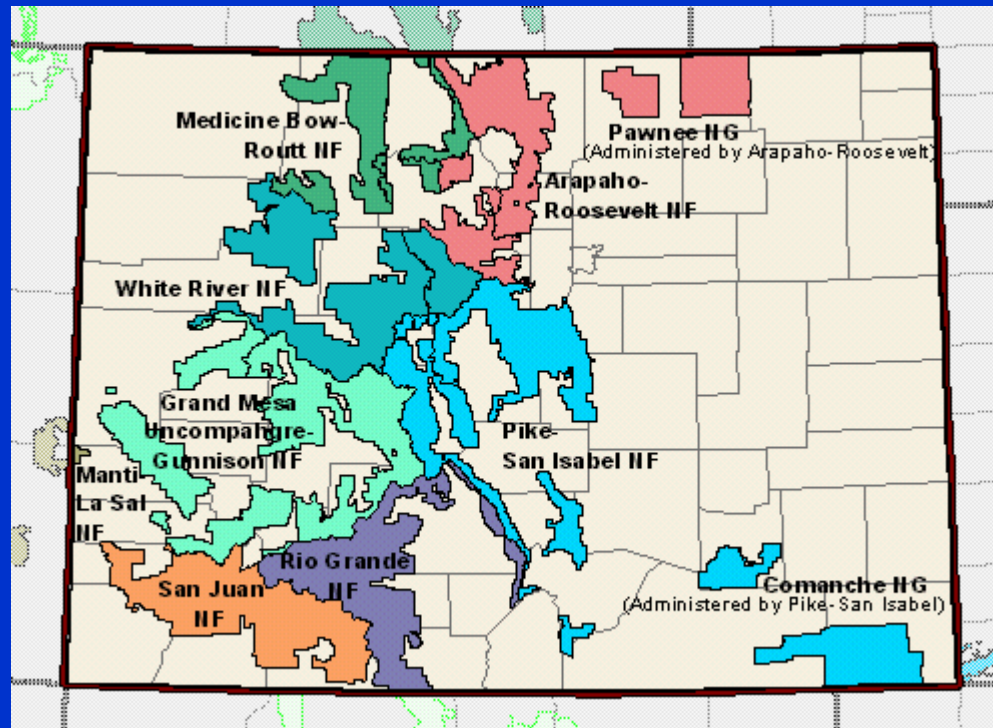
Duncecap Larkspur Plants that have Chemotype B (MSAL type alkaloids) have a defined geographical distribution

Survey of Herbarium Specimens

- 10 Samples Box Elder County
- 6 samples Western Juab County
- 3 of 15 samples Utah County
- 2 samples Sevier County

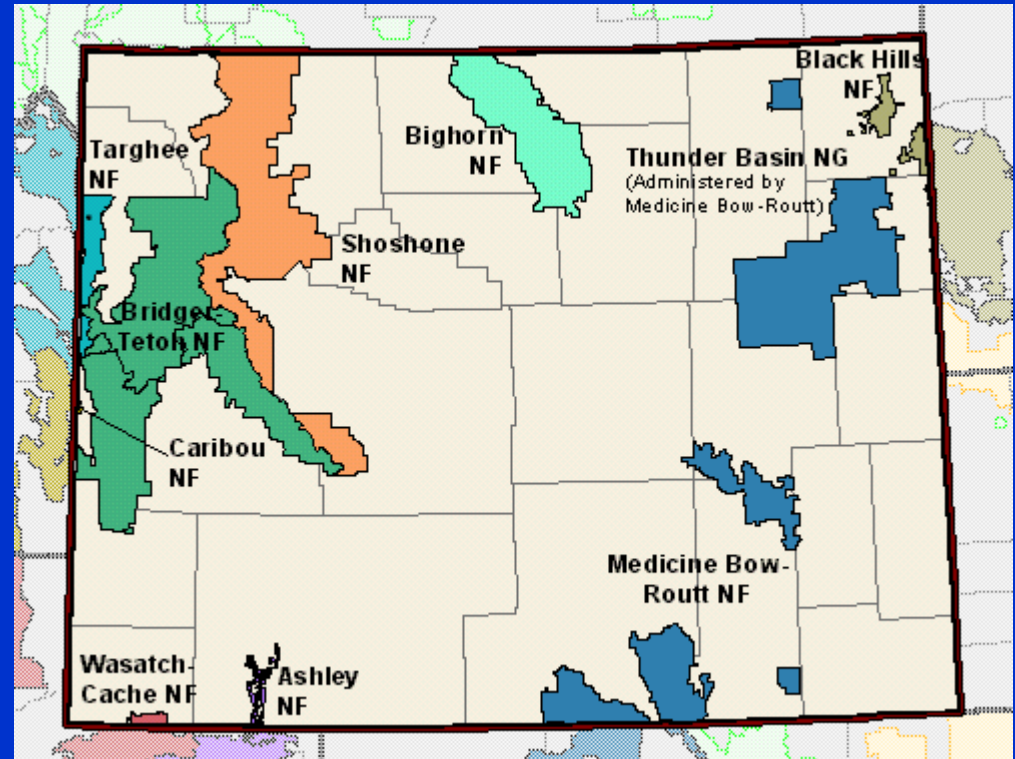
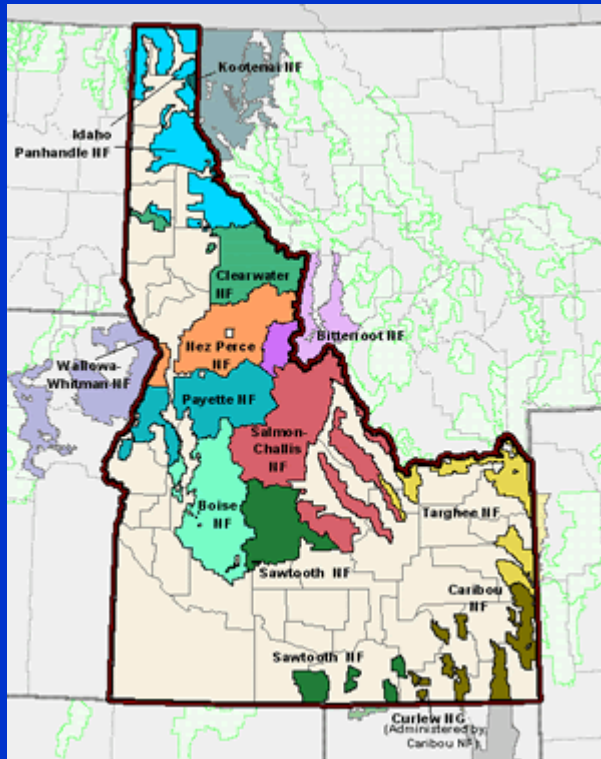


What chemotype(s) is/are found in the other states where Duncecap Larkspur may be found?



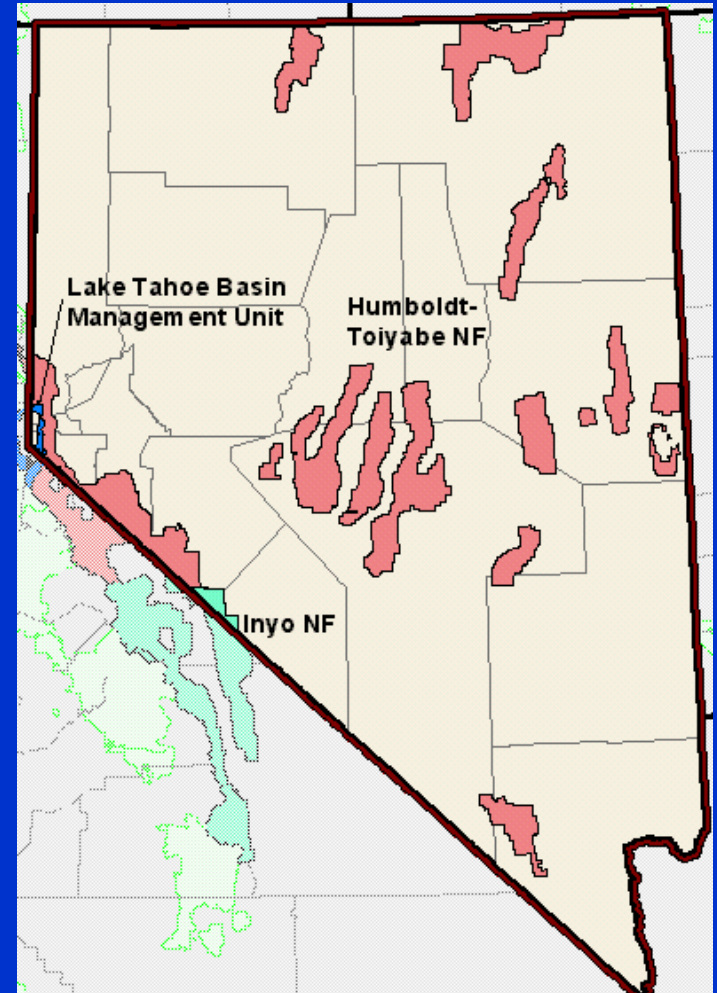
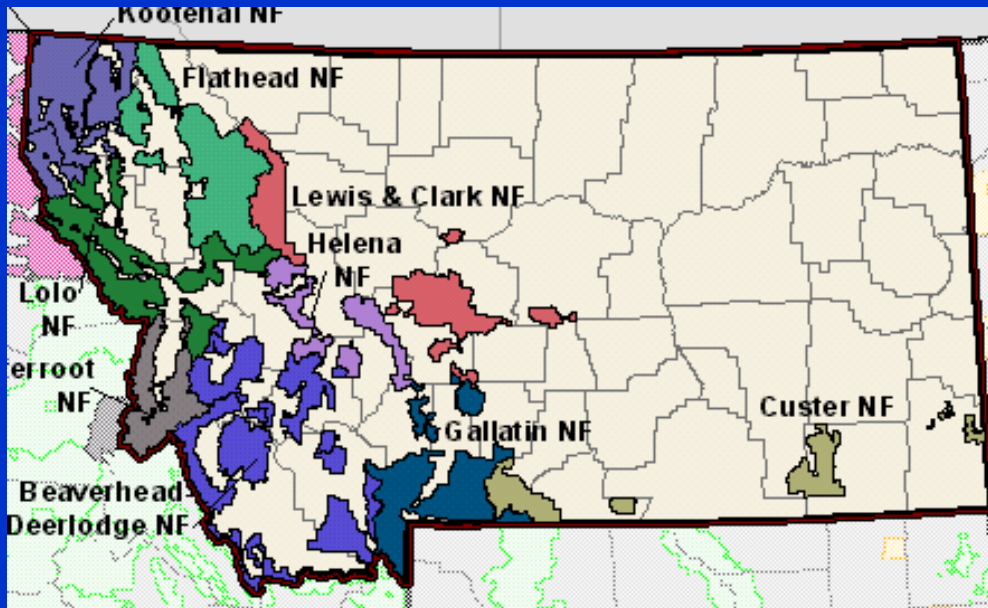
Only Chemotypes A is found in Colorado

What chemotype(s) is/are found in the other states where Duncecap Larkspur may be found?

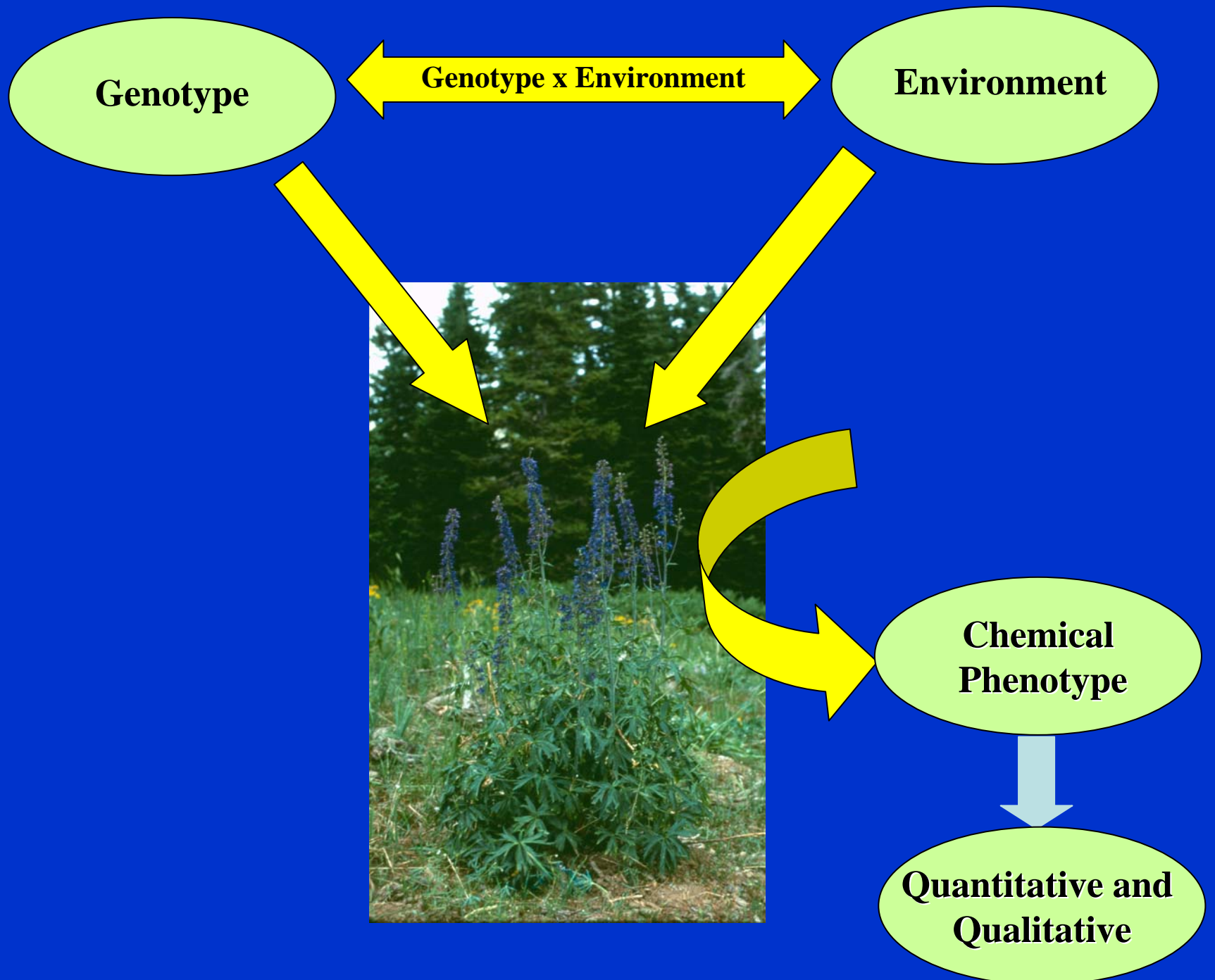


**Both Chemotypes A and B are found in Idaho and Wyoming
-populations of chemotype A overlap with Utah populations**

What chemotype(s) is/are found in the other states where Duncecap Larkspur may be found?



Only Chemotype B that contains MLA is found in Nevada and Montana



Conclusions

- Duncecap larkspur has two chemotypes that potentially differ in their toxicity
- The two chemotypes have defined geographical distributions
- The chemotypes are stable over multiple years suggesting that they are not influenced by the environment
- The biological mechanism responsible for this observation is unknown

Questions

Can plant toxins vary seasonally?

Can plant toxins vary as a function of plant growth and development?

Can plant toxins vary as a function of time of day?

Are all plants of the same species toxic?