

SURVEY AND TAXONOMIC STUDY OF  
ASTRAGALUS SHULTZIORUM (SHULTZ'S MILKVETCH)

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## INTRODUCTION

Astragalus shultziorum, Shultz's milkvetch, is a narrowly endemic plant species restricted to subalpine calcareous habitats in the Salt River and Teton Ranges of western Wyoming (Figure 1). It was first collected in 1923 by E.B. Payson and G.M. Armstrong, from a "stony hilltop" in the mountains near Cottonwood Lake, in the Salt River Range (Barneby 1981). The specimen was not satisfactorily identified until more material became available--specimens collected from the same area in 1980 by John and Leila Shultz, and R.D. Dorn and R.W. Lichvar. Based on these collections, Barneby described Astragalus shultziorum in 1981, placing it in Section Minerales. It was thought to be most closely related to A. molybdenus, which it resembles in general aspect and ecology. A. molybdenus, the Leadville milkvetch, is restricted to a small area of alpine habitat in the vicinity of Leadville and Aspen, Colorado (Figure 2).

In 1982, a similar milkvetch was collected in flower in Teton Co., Montana, on Mt. Wright (Lackschewitz et al. 1984). In the absence of ripe pods, it was identified as Astragalus molybdenus, as it looked quite different from A. shultziorum material from Wyoming (R.C. Barneby, pers. comm. to K. Lackschewitz).

Isely (1985, 1986) followed Barneby's treatment of the two taxa. Dorn (1988) combined the two under A. molybdenus. However, past taxonomic decisions have been based on morphological studies involving relatively little material. Fruiting material especially has been lacking.

In 1989, Bridger-Teton and Targhee National Forests contracted on a cost-share basis with the Wyoming Natural Diversity Database (WNDDDB) of The Nature Conservancy to gather basic taxonomic and ecological data for Astragalus shultziorum. The species was a Category 2 candidate for Federal listing (USFWS 1985), and was ranked G1S1--extremely vulnerable to extinction--by The Nature Conservancy prior to this study. Shultz's milkvetch is a Sensitive species for Region 4 of the Forest Service, with Medium Priority management sensitivity (USDA Forest Service 1989). For Sensitive species, it is Forest Service policy to provide "...special management emphasis to ensure their viability..." (FSM 2672.1). However, for Shultz's milkvetch, the knowledge base has been inadequate for determining appropriate management. Even information as basic as distribution and abundance has not been available.

Figure 1. Distribution of *Astragalus shultziorum*.

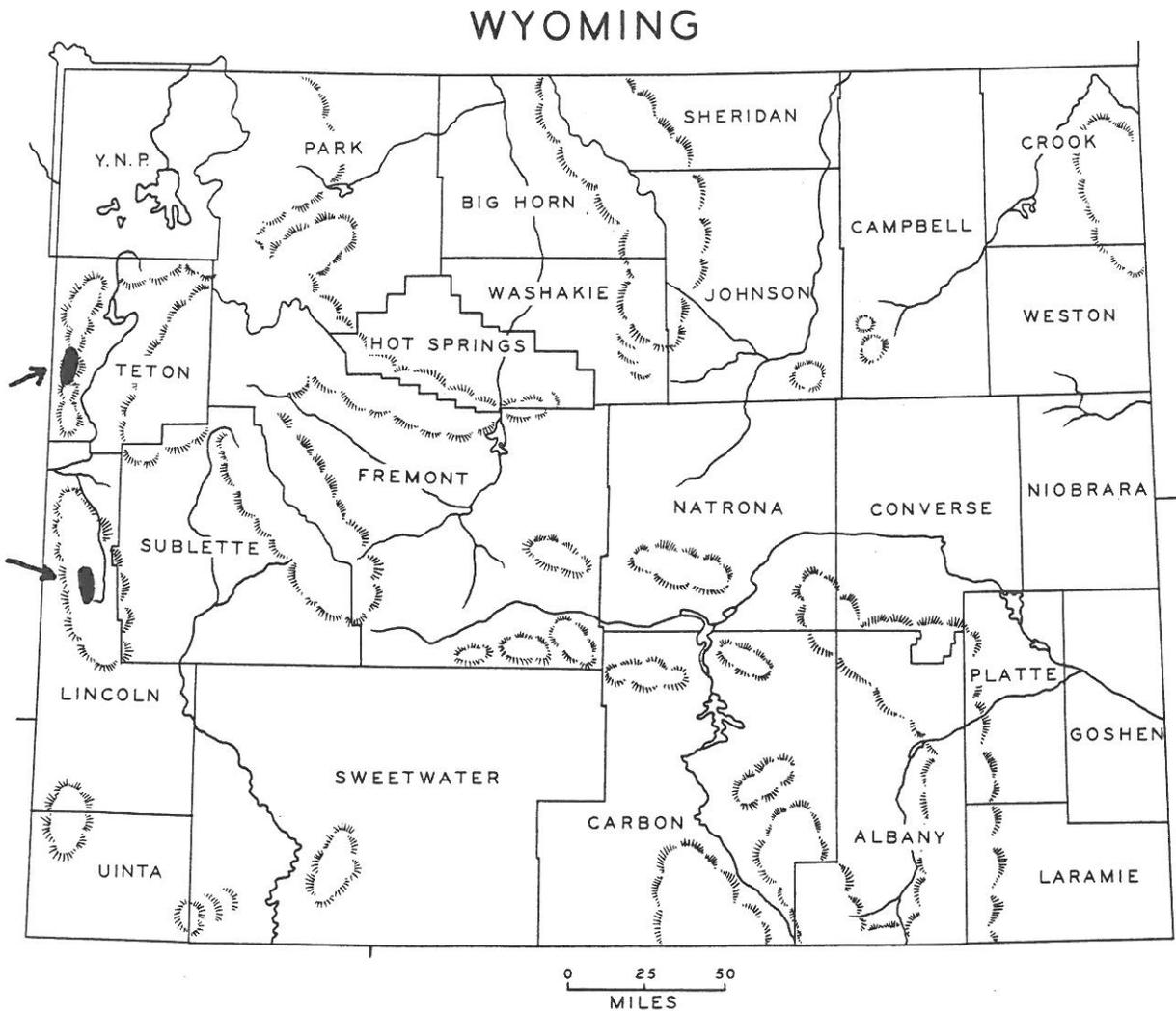


Figure 2. Distribution of Astragalus molybdenus in Colorado.

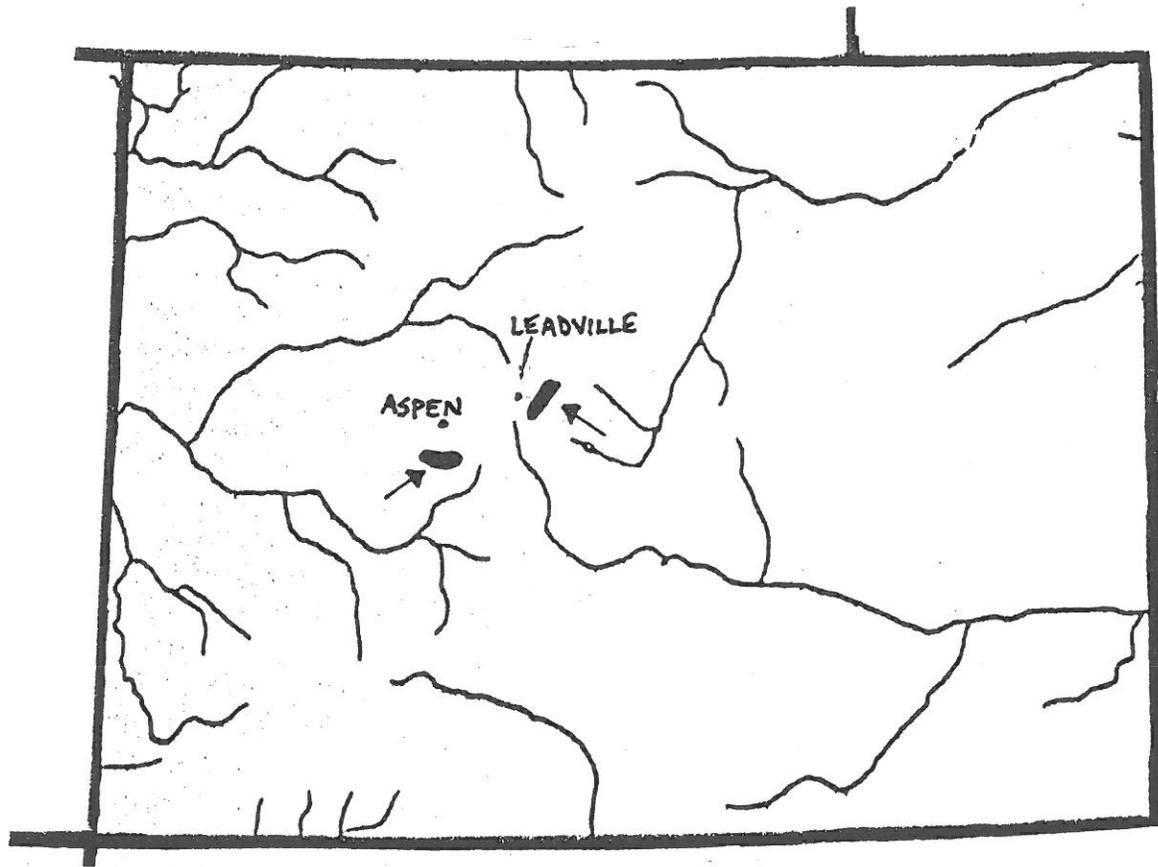


Figure 3. Distribution of Astragalus molybdenus in Montana.



## METHODS

This project consisted of two parts: 1) survey to determine distribution, abundance, habitat and threats for Astragalus shultziorum; and 2) taxonomic study to determine the relationship between A. shultziorum and A. molybdenus.

### Survey

Information for known Astragalus shultziorum sites was obtained from secondary sources, including WNDDDB manual and computer files, the Rocky Mountain Herbarium at the University of Wyoming, the literature and knowledgeable individuals. The small herbarium maintained at the Bridger-Teton NF Supervisors Office was also checked. Field survey began with relocation and survey of previously reported sites. Based on habitat characteristics of these sites, other areas with potential habitat in the Teton, Salt River and Wyoming Ranges were searched for additional populations. Search routes are shown in Appendix A. Information on biology and management needs was collected using the standard field forms of The Nature Conservancy (Appendix B).

Three Astragalus molybdenus sites in Colorado were surveyed briefly during the 1989 field season, while collecting material for taxonomic study.

This report includes results of surveys carried out by the WNDDDB in 1987 and 1988, as well as the work funded by Bridger-Teton and Targhee NFs in 1989. All surveys reported for Wyoming and Colorado were done by Hollis Marriott, WNDDDB Botanist. Field survey took place August 17-30, 1987, September 9-12, 1988, and August 28-September 13, 1989. This report also includes information from a survey of Astragalus molybdenus in Montana funded cooperatively by the Montana Natural Heritage Program and Lewis & Clark National Forest (Shelly and Schassberger 1990).

### Taxonomic Studies

Several approaches were used to assess the taxonomic relationships among the Wyoming, Colorado and Montana populations of Astragalus shultziorum and A. molybdenus. Material was collected from three sites in Colorado, six sites in Wyoming, and five sites in Montana. Specimens were examined by the author, by S.J. Shelly of the Montana Natural Heritage Program, and by Drs. Rupert Barneby of the New York Botanical Gardens and Duane Isely, Iowa State University, both experts on the genus Astragalus. Material was provided to Dr. Matt Lavin, Montana State University, for chloroplast DNA analysis, and to Dr. Greg Brown, University of Wyoming, for isozyme electrophoretic studies.

## RESULTS

### Survey

**Distribution.** Astragalus shultziorum is now known from ten sites in the Salt River and Teton Ranges in Lincoln and Teton Cos., Wyoming (Figure 1). Detailed information for these sites is contained in the WNDDDB computer printouts and maps in Appendix C. Populations are concentrated in two areas: the Salt River Range from the upper Swift Creek drainage south to the upper Smith's Fork drainage; and the Teton Range from Alaska Basin south to the upper Moose Creek drainage and Rendezvous Peak (see **Unsurveyed potential habitat.** in DISCUSSION below). All known populations occur within an area of less than 700 square miles. Populations are clustered in two areas: an area of approximately 45 square miles in the Teton Range, and an area of approximately 20 square miles in the Salt River Range.

All documented Astragalus shultziorum habitat is on Federal land. Sites in the Teton Range are managed by Bridger-Teton and Targhee NFs, and Grand Teton National Park. Much of the habitat in this area is within the Jedediah Smith Wilderness. Sites in the Salt River Range are managed by Bridger-Teton NF, and the population on Swift Creek is included, at least in part, in the Swift Creek Research Natural Area approved in 1989 (USDA Forest Service 1989) (see Management Recommendations in DISCUSSION below).

**Abundance.** Astragalus shultziorum populations are large, ranging from several thousand to tens of thousands of plants estimated. However, population size is difficult to estimate, due to the habit of Shultz's milkvetch. Above ground stems arise from an underground caudex and rhizomes, and one plant may be represented by numerous stems over an area of 400 cm<sup>2</sup> or more. The milkvetch is occasionally a co-dominant in suitable habitat.

In spite of its abundance, flowering and fruiting material of Shultz's milkvetch is often rare, especially in the Salt River Range populations. In these situations, plants with mature pods are found only in small, localized areas, and probably represent a more reproductively-fit genotype. Fruit production appears to be much higher in populations in the Teton Range, based on surveys done in both 1987 and 1989, but even in these areas, an estimated 95-99% of above-ground stems exhibit only vegetative growth. Again, fruit production is localized.

**Habitat.** Astragalus shultziorum is almost always found in calcareous habitats. Populations have been found on soils derived from the Triassic Thaynes limestone and the Paleozoic Wells and Amsden Formations in the Salt River Range (Rubey 1973). In the upper Spring Creek drainage just north of Sheep Pass, the milkvetch is occasionally found on a fine red soil that may not be calcareous. In the Teton Range, it occurs on several Paleozoic

limestones and dolomites, including the Darby, Bighorn, Gallatin and Gros Ventre Formations (Love 1956, Reed and Love 1971). The milkvetch rarely grows on bare rock. It is most commonly found on somewhat-vegetated rocky soils. In the Salt River Range, it is often a co-dominant on vegetated talus/scree at the bases of slopes below calcareous cliffs. In the Teton Range, populations are especially well-developed on fine soils with calcareous pebbles, apparently derived from the Death Canyon member of the Cambrian Gros Ventre Formation. In this area, Astragalus shultziorum is found in abundance in bottoms and vegetated slopes of cirques, as well as on the broad, gently dipping slopes in the vicinity of Spearhead Peak and Death Canyon Shelf (along the Teton Crest Trail). Elevations range from 8800 to 10,500 feet above sea level, with most habitat between 9000 and 10,000 feet.

Astragalus shultziorum grows in subalpine habitat in the Salt River and Teton Ranges, although it occasionally extends close to or into the lowermost alpine zone. It almost always grows in open habitat, usually in subalpine forb communities. Achillaea millefolium, Aster alpigenus, Castilleja sulphurea, Salix glauca and Sibbaldia procumbens are common associates, but associated species vary greatly.

Slides of Astragalus shultziorum and habitat are included in Appendix E.

**Existing and potential threats.** Some Astragalus shultziorum habitat has been destroyed in the area around the ski lift towers above Teton Village (Rendezvous Mountain). At this site, plants are found in relic areas where native vegetation was not disturbed. Several populations in the Teton Range are crossed by hiking/horse trails, specifically those areas along the Teton Crest Trail from the Middle Fork of Granite Creek north to the rim southwest of Teton Creek. Habitat disturbance does not appear to extend beyond the trails. In the Salt River Range, hiking/horse trails cross populations in the Corral and Spring Creek drainages, as well as in the uppermost Swift Creek and Smith's Fork drainages. Again, habitat destruction appears to be limited to the trails themselves.

In the Salt River Range, sheep were seen in Astragalus shultziorum habitat in the Spring Creek drainage just north of Sheep Pass (August 30, 1989) and near the head of Swift Creek (September 5, 1989). The palatability of Shultz's milkvetch is not known. Because the plant appears to favor vegetative reproduction by underground stems, soil compaction by livestock may adversely affect population vigor.

**Comparisons with Colorado and Montana sites.** It is generally agreed that Astragalus shultziorum is closely related to A. molybdenus, which is restricted to a limited area of alpine habitat in the vicinity of Leadville and Aspen, Colorado, and possibly Teton Co., Montana (see Taxonomic Studies in DISCUSSION below). Dorn combines

the two under A. molybdenus (1988). However, prior to this study, taxonomic decisions were made based on limited field survey and little material--ripe pods especially were lacking. In 1989, the author visited three sites in Colorado to collect material for taxonomic study. The following habitat features were noted as well.

In Colorado, Astragalus molybdenus is clearly alpine in habitat, in contrast with the predominantly subalpine A. shultziorum. Elevational range for sites surveyed was 11,900 to 12,500 feet above sea level. It has been collected as high as 13,000 feet. It was found on somewhat-vegetated talus/scree reminiscent of Astragalus shultziorum sites in Wyoming. However, the Leadville milkvetch also occurs in "lusher" alpine tundra communities with 100% cover, on well-developed soils. Slides of A. molybdenus and habitat are included in Appendix E.

No estimates were made of population size, as only portions of populations were surveyed at each site. However, sexual reproduction was clearly more prevalent in Astragalus molybdenus populations in Colorado than in A. shultziorum populations in Wyoming. On Hoosier Ridge and at the North London Mine, it was estimated that approximately half the population was in flower or immature fruit (July 21, 1989). At Taylor Pass, approximately 30% of the population was in bud or flower (July 22, 1989).

Material very similar to Astragalus shultziorum and A. molybdenus has been collected from the Front Range Mountains in Teton Co., Montana. In 1984, a specimen in flower was identified as A. molybdenus. Populations were surveyed by botanists with the Montana Natural Heritage Program in 1989, and material was collected for taxonomic study in coordination with this project. Habitat and population descriptions are presented in detail in the final report from the Montana survey (Shelly and Schassberger 1990). In Montana, A. molybdenus grows in alpine and subalpine habitat on calcareous substrates. It often occurs interwoven in dense Dryas octopetala mats, occasionally spreading onto adjacent sparsely-vegetated scree. In 1989, very few flowering or fruiting individuals were seen at most sites. Vegetative spreading was extensive.

Comparisons of morphology for Wyoming, Colorado and Montana populations are presented in Taxonomic Studies below.

#### Taxonomic Studies

**Morphology.** Consistent differences in vegetative and reproductive morphology were observed in material from the three widely-separated areas where Astragalus shultziorum and A. molybdenus occur (Colorado, Wyoming and Montana). With adequate material now available for comparison, it is clear that populations from the three areas represent three distinct entities (Marriott

and Shelly in prep.), rather than two or one, as was previously reported (Lackschewitz et al. 1984, Dorn 1988). For the purpose of this discussion, the three entities are referred to as "Astragalus shultziorum" (Wyoming populations), "A. molybdenus (CO)" and "A. molybdenus (MT)."

In all three areas, plants exhibit similar growth form, spreading by slender underground stems. Individual plants are difficult to distinguish for this reason, and it is possible that "populations" of plants at given sites are really collections of clones representing single or a few genotypes that have colonized the area through vegetative propagation. Morphological characters in plants within a site are quite consistent, with the exception of fruit production in Astragalus shultziorum. Good fruit production in the Wyoming populations occurs only in occasional local areas within sites.

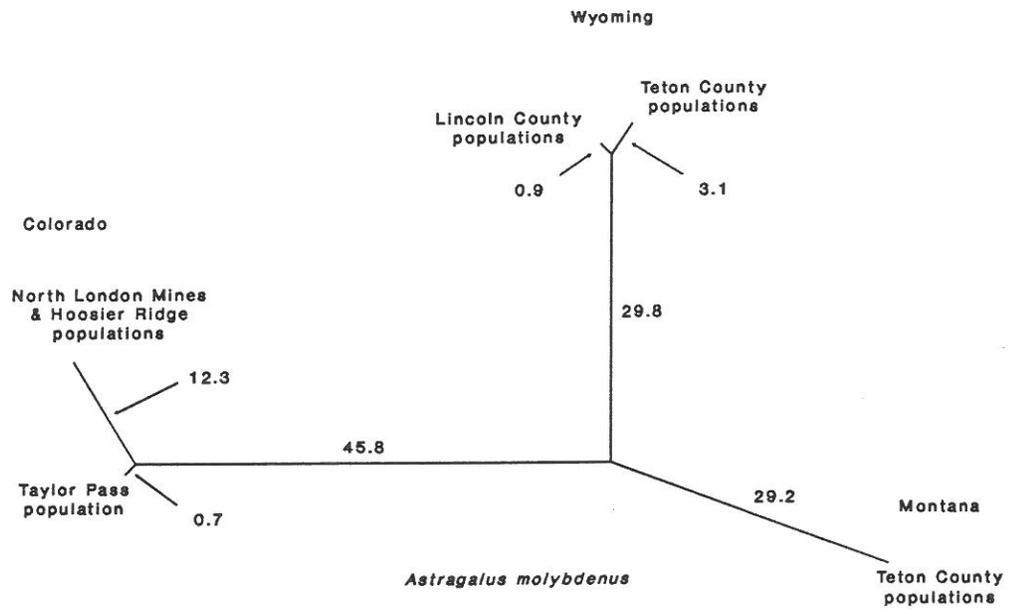
In general, plants from Montana and Colorado sites are more robust vegetatively than plants from Wyoming. Leaves are consistently larger, with more leaflets that are more closely and regularly arranged. The overall appearance of Astragalus shultziorum is more "open" and "loose."

In Astragalus shultziorum, flowers are consistently cream-colored, with pale purple striations on the banner, and a purple spot on the tip of the keel. A. molybdenus (CO) has petals that are creamy at the base and blue-purple at the tips. In A. molybdenus (MT), flowers are blue-purple.

Fruit morphology includes the most distinctive differences among the three entities. Fruit from Colorado populations are smallest, are shorter in relation to width, and have short beaks that contract abruptly from the main body of the legume. In Montana material, the fruits are larger, longer relative to width, arcuate in shape, and taper gradually into a longer beak. Astragalus shultziorum legumes (Wyoming) appear to be intermediate. They are intermediate in size, but approach Montana material in relation of length to width. Beaks are similar to Montana material, but the legumes are not at all arcuate.

**DNA analysis.** Partitioning of chloroplast DNA variation is consistent with patterns of morphological variation (Lavin et al. in prep.). Chloroplast DNA variation is considerable within the Astragalus shultziorum/molybdenus complex as a whole. Variation in cDNA among the three areas reaches levels observed for full species. However, cDNA is extremely consistent within sites. In addition, little variation is seen among sites within each of the three areas where populations occur (Colorado, Wyoming and Montana). Variation in nuclear ribosomal DNA is similar (Lavin et al. in prep.). Genetic distances in Astragalus shultziorum/molybdenus, based on cDNA variation, are shown in Figure 4.

Figure 4. An unrooted Fitch-Margoliash dendrogram showing genetic distances in *Astragalus shultziorum/molybdenus*. The genetic distances along each internode represent the number of nucleotide substitutions per 1000 sites (Lavin et al., in prep.).



**Isozyme analysis.** Preliminary results show little variation within sites. Variation among sites and among the three widely-separated areas has not yet been quantified. Final results of isozyme electrophoresis will be included as an appendix to this report (Appendix F).

## SUMMARY AND DISCUSSION

### Survey

Astragalus shultziorum is now known from ten sites in the Salt River and Teton Ranges in western Wyoming, all within an area of less than 700 square miles (Figure 1). Populations are large, with many thousands of plants estimated per site. However, population size (number of plants) is difficult to estimate. Individual plants can form extensive mats from underground caudices and rhizomes. Sexual reproduction appears to be uncommon in most years, with growth mainly vegetative. The milkvetch is found in subalpine calcareous habitats, usually in low forb communities with moderate to sparse cover. Soils are generally rocky.

**Unsurveyed potential habitat.** The cluster of sites in the Salt River Range may extend somewhat further south in the upper Smith's Fork drainage; this area was not completely surveyed. No populations were found in potential habitat immediately north of Swift Creek (Willow Creek and Rock Lake area). Subalpine limestone and dolomite cirques and drainages were searched further north in the Salt River Range, and on Deadline Ridge in the Wyoming Range, but no populations were found. However, additional populations may be discovered at unsurveyed calcareous subalpine sites in the Wyoming Range. In the Teton Range, it is likely that the cluster of sites extends at least a short distance further north on the slopes of Alaska Basin. Astragalus shultziorum does not occur on the limestone and dolomite that crops out in the northern part of Grand Teton NP, in the area of Moose Creek Basin and Survey Peak. The Teton Range sites may also extend a short distance further south than the area surveyed (upper Moose Creek and Rendezvous Peak), but no populations were found in the calcareous subalpine habitats around Phillips Pass, ca. 2 air miles southwest of Rendezvous Peak.

### Taxonomic Studies

Both morphological and chemical analyses show that populations from the three widely separated areas in Colorado, Wyoming and Montana vary significantly. Variation in morphology, chloroplast DNA and nuclear ribosomal DNA is significant among the three areas, with little variation among sites within each area, and virtually no variation within sites. This partitioning of variation suggests that populations in the widely-separated areas have been isolated for a significant time period, reproducing primarily by vegetative

propagation, and that "populations" are really clonal expressions of single genotypes (Lavin et al. in prep.).

The appropriateness of recognizing variants of clonal species as separate taxa has been questioned (Cronquist 1988). Lavin et al. (in prep.) suggest that Astragalus molybdenus be circumscribed in the broad sense to include A. shultziorum populations in Wyoming. Such circumscription results in a single species with marked variation among disjunct populations promoted by founder events and genetic drift.

The above discussion illustrates the difficulty of trying to fit our taxonomic system to the natural world. While it may be difficult to justify nomenclatural recognition of variation in the Astragalus shultziorum/molybdenus complex based on biology alone, some sort of recognition is desirable from a management perspective. In protecting biological diversity, it is necessary to identify elements of concern. The genetically and morphologically different entities of Astragalus shultziorum/molybdenus found in Colorado, Wyoming and Montana are clearly separate elements of concern. They should be so recognized both for the diversity they represent and for their value in understanding plant evolution, speciation and adaptation.

Although the issue of proper nomenclature remains unresolved, a final decision is not necessary for recommending management of Astragalus shultziorum in Wyoming, fortunately. Whether or not the Wyoming entity is recognized as a separate taxon, it is now known to be sufficiently abundant, widespread and unthreatened that special management is not required.

#### Management Recommendations

Surveys from 1987 through 1989 have shown Astragalus shultziorum to be significantly more abundant and widespread than was previously thought. Populations occur in relatively inaccessible areas, and no significant threats have been documented. For these reasons, the following management actions are recommended:

- 1) Astragalus shultziorum should no longer be considered Sensitive in Region 4. No special management is required at this time for continued viability.
- 2) The species should be maintained on Forest watch lists. Its restricted distribution might make it vulnerable to extinction should major changes in land use take place.
- 3) Federal status (US Fish and Wildlife Service) should be reduced to Category 3C [NOTE: Astragalus shultziorum is now a Category 3C candidate (USFWS 1990).]

- 4) Management of the Swift Creek Research Natural Area (Bridger-Teton NF) should follow Alternative 4 (Tuhy 1987). The proposed boundaries for this alternative would include all Astragalus shultziorum habitat in the upper Swift Creek drainage.

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