ALPINE FLORA OF THE WASSUK RANGE, MINERAL COUNTY, NEVADA

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ABSTRACT

The peak of Mt. Grant, 3426 m elevation, in the Wassuk Range of Nevada is one of a number of small alpine islands in the Great Basin. In this study, the alpine zone was defined to be the zone above the highest areas dominated by shrubby *Artemisia* species. Its total area on Mt. Grant was about 2.6 km^2. The alpine flora consisted of 70 species. Of these, 12 species are found in the Sierra Nevada, 13 in the Sierra Nevada and Great Basin, two in the Great Basin only, one in the Great Basin and Rocky Mountains, 30 are widespread in western North America, and 12 are widespread arctic-alpine species. There were no endemic species. Most species are not restricted to alpine habitats.

The alpine areas of Great Basin ranges consist of a number of small islands that have probably never formed continuous habitat. Their isolation raises questions about the source of their floras. Billings (1978) suggested that migration into Great Basin alpine zones was generally from north to south. He also has described endemics as contributing significantly to alpine floras only in the southwestern portion of the interior drainage area.

Data for testing these ideas can currently be derived from descriptions of relatively few alpine floras. Extensive species lists are available for the White Mountains of California (Lloyd and Mitchell, 1973), the Ruby and East Humboldt Ranges in Elko Co., Nevada (Loope, 1969; Lewis, 1971), and the Deep Creek Range of Utah (McMillan, 1948). Less complete lists exist for the Toiyabe and Snake Ranges of Nevada (Linsdale et al., 1952; Lewis, 1973), the Raft River Range in Utah (Preece, 1950), and the Sweetwater Mountains of California (Major and Taylor, 1977). These ranges make up most of the larger alpine areas in the Great Basin. Billings (1978) points out that almost no information is available on the floristics of small alpine areas. Yet these small areas, which may be expected to have the most depauperate floras, are likely to yield useful information for understanding the differential abilities of alpine species to migrate and survive.

As part of a study comparing the floras of Great Basin alpine areas, we here report the composition of the alpine flora of one small island, the Wassuk Range in Mineral County, Nevada. The alpine zones

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nearest the Wassuks are in the Sweetwater Range 48 km to the west, the White Mountains 88 km to the south, the Toiyabe Range 125 km to the east, and the Carson Range (Mt. Rose) 125 km to the northwest. The alpine zone of the Wassuk Range is restricted to Mt. Grant, 3426 m elevation.

The physical environment of the upper reaches of the Wassuk Range is poorly known. The range lies in the rain shadow of the Sierra Nevada and Sweetwater Mountains. A storage rain gauge installed at 2740 m on Mt. Grant from March, 1952, to May, 1954, measured 48.3 cm of precipitation over that period; summer precipitation slightly exceeded that of winter (U.S. Weather Bureau, 1958). On Mt. Grant, no surface snowdrifts persisted past early July in 1976 and 1977, although snow and ice buried among boulders high on the eastern slope continued to melt after 15 July 1977. No information on alpine temperatures is available.

The Wassuk Range is composed of pre-Tertiary intrusives, primarily granites of the Sierra batholith (Ferguson and Muller, 1949). Soils are poorly developed in the alpine zone, with no organic horizons except under scattered grass tussocks. Slopes are predominantly talus or scree, much of which is unstable. Flat ridges and shallow depressions are gravelly. There is no evidence of frost features such as sorted polygons, sorted stripes, or stone-banked terraces.

Access to Mt. Grant has been restricted since about 1938, and grazing on the mountain has been minimal for about 40 years.

A Definition of the Alpine Zone

Because we wish ultimately to compare alpine floras across the Great Basin, a definition of the lower limit of the alpine zone on Mt. Grant should be widely applicable throughout the region. Many authors have commented on the difficulty of defining an alpine zone in the absence of continuous subalpine forests (Loope, 1969; Mooney, 1973; Höllermann, 1973; Major and Taylor, 1977; Billings, 1978).

Examination of high elevation vegetation on Mt. Grant showed several zones, in many places separated by indistinct boundaries. In order of increasing elevation these were: (1) A community dominated by *Artemisia tridentata* generally occurred up to 3050 m and in relatively protected sites up to 3325 m. This community was clearly subalpine following definitions of Billings (1951) and Mooney (1973). (2) Above the *A. tridentata,* up to about 3375 m, and on south slopes and exposed ridges as low as 2850 m, were *A. arbuscula* communities with the physiognomy of an alpine fellfield. Many species that were abundant in this fellfield also grew at higher elevations as well, including *Koeleria cristata, Sedum lanceolatum, Astragalus calycosus, A. whitneyi, Leptodactylon pungens, Erigeron clokeyi,* and *Hymenoxys cooperi.* (3) Above the *A. arbuscula* communities lay a narrow zone

lacking woody *Artemisia* species and characterized by the dominance of several subshrub species, including *Ribes cereum, Leptodactylon pungens, Chrysothamnus viscidiflorus,* and *Haplopappus macronema.* Some herbaceous species (e.g. *Poa fendleriana, Stipa pinetorum,* and *Lewisia rediviva*) reached their upper limits in this zone; most, however, were also found above the subshrubs. (4) At the highest elevations (above about 3350 m) and at somewhat lower elevations on steep north slopes, vegetation was dominated by herbaceous forms. On gravelly ridges, prostrate or cushion forms were most common, including *Arenaria kingii, Draba densifolia, Astragalus calycosus,* and *Erigeron clokeyi.* Scree slopes were dominated by grasses. *Cystopteris fragilis, Festuca brachyphylla, Oxyria digyna,* and *Arabis lemmonii* were the most common plants on steep rocky north slopes. Total vascular plant cover in this zone was rarely above 25 percent.

The lower boundary of the alpine zone on Mt. Grant could be drawn in at least four different positions: (a) above some elevational limit (after Billings, 1978), (b) at the upper edge of *Artemisia tridentata* (after Billings, 1951; and possibly Mooney, 1973), (c) at the boundary between the *A. arbuscula* and subshrub communities, or (d) at the upper limit of woody plant dominance.

Elevation alone, while easily and repeatably determined, has relatively little biological significance. Where trees are present in other ranges, wind exposure, aspect, latitude, and snow cover greatly influence the position of a krummholz treeline. Distribution of high elevation shrubs and herbs is often similarly affected.

The absence of *Artemisia tridentata* appears to be the most widely used definition of Great Basin alpine. But use of this boundary would include the relatively low elevation *A. arbuscula* fellfields in the alpine zone. These are clearly not alpine because they extend as much as 475 m below the upper limits of *A. tridentata* on south-facing slopes. In addition, we have seen similar communities on ridges in pinyon-juniper forests in the Sweetwater Range of California.

The exclusion of all woody vegetation from the alpine zone is probably too stringent a definition in that alpine floras of the Sierra Nevada and Rocky Mountains contain such woody genera as *Salix, Kalmia, Ribes,* and *Dryas* (Marr, 1967; Major and Taylor, 1977).

We have, therefore, chosen to include high elevation subshrub communities in the alpine zone of Mt. Grant and to classify *A. arbuscula* fellfields as subalpine. Following this definition, about 2.6 km^2 of the Wassuk Range is alpine.

To ensure that the definition of the alpine zone on Mt. Grant can be used widely in the Great Basin, we have made preliminary observations in nine other ranges: the Sweetwater Mountains (Mono Co., California), the Toiyabe Range (Nye and Lander Cos., Nevada), the Humboldt Range (Pershing Co., Nevada), the Santa Rosa Range (Humboldt Co., Nevada), the Independence and Jarbidge Ranges

(Elko Co., Nevada), the Schell Creek and Snake Ranges (White Pine Co., Nevada), and the Raft River Range (Box Elder Co., Utah). The definition of alpine used on Mt. Grant appears applicable to these ranges as well. Where a krummholz treeline is present, the upper limit of trees generally coincides with the upper limit of shrubby *Artemisia*.

Collections were made on Mt. Grant on the following dates: 26–30 June and 4–6 August 1976, 11–15 July 1977, and 15–16 August 1979. Nomenclature and descriptions follow Munz (1959) except where authorities are listed. Voucher specimens are deposited in UNLV and WS.

Alpine Plants of the Wassuk Range

Geographical distributions are summarized as follows: SN—Sierra Nevada, including the White and Sweetwater Mountains of California (Lloyd and Mitchell, 1973; Major and Taylor, 1977; Munz 1959; Sharsmith, 1940); GB—Great Basin, excluding the White and Sweetwater Mountains (Bell and Johnson, unpubl. data; Cronquist et al., 1972, 1977; Lewis, 1971, 1973; Linsdale et al., 1952; Loope, 1969; McMillan, 1948; Preece, 1950); Ro—Rocky Mountains (Harrington, 1964; Weber, 1976); Ar—Arctic (Polunin, 1959).

Lepidophyta

Selaginellaceae

Selaginella watsonii. Common among rocks in snow accumulation areas. SN, GB

Pterophyta

Aspidiaceae

Cystopteris fragilis. Locally abundant on north-facing slopes, especially among rocks. SN, GB, Ro, Ar.

Pteridaceae

Pellaea breweri. Locally abundant on north-facing cliffs and stable talus. SN, GB, Ro.

Anthophyta—Monocotyledoneae

Amaryllidaceae

Allium parvum. Uncommon on flat ridges or gentle south slopes in fine, stable scree. SN.

Cyperaceae

Carex phaeocephala. Common in snow accumulation areas. SN, GB, Ro.

Carex rossii. Locally abundant only in fine-textured soils of some snow accumulation areas. SN, GB, Ro.

Gramineae

Calamagrostis purpurascens. Abundant and dominant on rocky, north-facing slopes; uncommon elsewhere. SN, GB, Ro, Ar.

Festuca brachyphylla. Common on north-facing slopes; uncommon in all other alpine habitats. SN, GB, Ro, Ar.

Koeleria cristata. Abundant to common on north- and east-facing slopes except talus. SN, GB, Ro.

Leucopoa kingii (S. Wats.) Weber. Uncommon on rocky, east-facing slopes in subshrub communities. SN, GB, Ro.

Muhlenbergia richardsonis. Locally abundant and dominant only in fine-textured soils in snow accumulation areas. Generally non-flowering. SN, GB, Ro.

Poa epilis. Abundant in all habitats except snow accumulation areas and north-facing slopes. SN, GB, Ro.

Poa fendleriana. Uncommon in flat, grassy meadows. SN, GB, Ro.

Poa rupicola. Very common in all habitats except cliffs. SN, GB, Ro.

Sitanion hystrix. Abundant and dominant on south-facing slopes and in some disturbed areas. SN, GB, Ro.

Stipa pinetorum. Rare, in shrubby meadows. SN, GB, Ro.

Trisetum spicatum. Uncommon, on east- and north-facing slopes; probably under winter snow. SN, GB, Ro, Ar.

Anthophyta—Dicotyledoneae

Boraginaceae

Cryptantha humilis. Common on ridgetops, uncommon to rare elsewhere. GB.

Caryophyllaceae

Arenaria kingii var. *glabrescens*. Common on ridgetops and in subshrub communities. SN, GB.

Arenaria nuttallii subsp. *gracilis*. Rare on ridgetops and in loose, east-facing talus. SN, GB.

Chenopodiaceae

Monolepis nuttalliana. Uncommon, restricted to disturbed areas along roads. SN, GB, Ro, Ar.

Compositae

Antennaria corymbosa. Rare, in snow accumulation areas. SN, GB, Ro.

Antennaria rosea. Uncommon on rocky slopes, mostly in probable snow accumulation areas. SN, GB, Ro.

Antennaria umbrinella. Uncommon in snow accumulation areas and on north-facing slopes. SN, GB, Ro.
Artemisia ludoviciana subsp. *incompta*. Locally forming dense stands in rocky drainage areas near the lower edge of the alpine zone. SN, GB, Ro.
Chrysothamnus viscidiflorus subsp. *pumilus*. Common to uncommon in subshrub communities on slopes of all aspects. SN, GB, Ro.
Crepis nana. Rare, on scree slopes. SN, GB, Ro, Ar.
Erigeron clokeyi. Common in subshrub communities and on gravelly ridges. SN.
Erigeron compositus. Abundant and ubiquitous. SN, GB, Ro, Ar.
Eriophyllum lanatum var. *monoense*. Uncommon, in snowbeds. SN.
Haplopappus macronema. Uncommon on rocky slopes. SN, GB, Ro.
Hymenoxys cooperi var. *canescens*. Common on gravelly south-facing slopes; rare elsewhere except absent from snowbeds. SN, GB.
Senecio canus. Uncommon on gravelly slopes. SN, GB, Ro.
Senecio multilobatus. Uncommon in subshrub communities. SN, GB, Ro.
Senecio pattersonensis Hoover. Rare on north-facing talus slopes. SN.
Taraxacum officinale. Rare, in roadbeds. SN, GB, Ro, Ar.

Crassulaceae

Sedum lanceolatum. Rare, in snow accumulation areas. SN, GB, Ro.

Cruciferae

Arabis holboellii var. *pendulocarpa*. Rare, on a rocky south-facing slope at the upper edge of a snow accumulation area. SN, GB, Ro.
Arabis lemmonii var. *depauperata*. Abundant and ubiquitous. SN, GB, Ro.
Draba crassifolia. Uncommon, on rocky north-facing slopes. SN, GB, Ro, Ar.
Draba densifolia. Moderately common in all habitats except unstable slopes. SN, GB, Ro, Ar.
Erysimum perenne. Locally common on north-facing slopes or gravelly ridges, and in subshrub communities. SN, GB.
Lesquerella kingii var. *cordiformis*. Uncommon in snow accumulation areas. SN, GB.

Hydrophyllaceae

Phacelia hastata var. *compacta*. Uncommon to rare on slopes of all aspects; most abundant on disturbed soils and loose talus. GB.

Leguminosae

Astragalus calycosus. Locally abundant on gravelly ridgetops especially near the lower edge of the alpine zone. GB, Ro.

Astragalus purshii var. *lectulus*. Uncommon on gravelly ridgetops. SN.
Astragalus whitneyi. Uncommon in flat meadows. SN.
Lupinus alpestris. Locally abundant on gravelly soils in snow accumulation areas. SN.

Linaceae

Linum lewisii Pursh. Uncommon on both north and south slopes in gravel. SN, GB, Ro, Ar.

Onagraceae

Gayophytum racemosum. Uncommon on both north and south slopes in gravel. SN, GB, Ro.

Polemoniaceae

Ipomopsis congesta subsp. *montana*. Locally abundant on flat ridges and in loose gravel. SN.
Leptodactylon pungens subsp. *hallii*. Abundant on shrubby slopes and meadows. SN.
Phlox stansburyi var. *brevifolia*. Locally abundant on shrubby slopes near the lower edge of the alpine zone. SN, GB.

Polygonaceae

Eriogonum caespitosum. Rare, in gravel on flat ridges. SN, GB.
Eriogonum ovalifolium var. *nivale*. Uncommon, on north-facing rocky slopes and in gravel on flat ridges. SN, GB, Ro.
Oxyria digyna. Locally abundant on north-facing talus or boulder slopes; uncommon in fine-textured soils in snow accumulation areas. SN, GB, Ro, Ar.
Rumex utahensis. Rare in fine-textured mineral soil in a snow accumulation area. SN, GB, Ro.

Portulacaceae

Calyptridium umbellatum var. *caudiciferum*. Uncommon in disturbed soils, snowbeds, flat ridges, and rocky slopes. SN, GB.
Lewisia pygmaea. Uncommon, on rocky, north-facing slopes. SN, GB, Ro.
Lewisia rediviva var. *minor*. Uncommon, on gentle, south-facing slopes. SN, GB?

Primulaceae

Androsace septentrionalis subsp. *subumbellata*. Moderately abundant on gravelly or rocky north-facing slopes and in disturbed sites. SN, GB, Ro.

Rosaceae

Holodiscus sp., probably *H. microphyllus*. Very rare on east-facing rock slopes. Very reduced, non-flowering plants. SN, Ro.

Rubiaceae

Galium hypotrichium subsp. *hypotrichium*. Locally common among loose rocks, primarily on north- and east-facing slopes. SN.

Saxifragaceae

Heuchera duranii. Moderately common, on north- and east-facing rocky slopes. White, Sweetwater, Wassuk ranges only.

Ribes cereum. Common on rock outcrops and locally common on rocky slopes. SN, GB, Ro.

Scrophulariaceae

Castilleja nana. Locally common on gravelly ridgetops; rare elsewhere. SN, GB.

Mimulus coccineus. Locally common especially on south-facing slopes and ridges. SN, GB.

Mimulus suksdorfii. Locally common in fine-textured mineral soil. SN, GB, Ro.

Penstemon speciosus. Rare, on rocky slopes. SN, GB.

Umbelliferae

Cymopterus cinerarius. Uncommon in loose scree mostly on north-facing slopes SN.

Discussion

The alpine flora of the Wassuk Range was made up of 70 species of vascular plants. Harper et al. (1978) have developed a species-area curve for vascular plants on montane islands in the Great Basin. Their curve predicts that a montane island the size of the alpine zone on Mt. Grant (2.6 km^2) will contain 65 species, a number very close to that observed. The small number of species may be related to the lack of habitat diversity in the Wassuk Range alpine zone. Mt. Grant has no permanent snowdrifts; in 1976 and 1977, the largest snowbank had completely melted before 10 July. The lack of large, late-lying snowdrifts, persistent streams and moist soils results in the absence of important alpine habitats.

The flora of the Wassuk alpine zone is a combination of widespread alpine elements and Sierran and Great Basin taxa. Sierra Nevada and Great Basin species make up 36 percent of the flora. The Sierran element contributes considerably less to the Wassuk flora (17 percent) than to the White Mountain flora (51 percent: Lloyd and Mitchell, 1973). One species, *Heuchera duranii,* is found only in the White,

Sweetwater, and Wassuk Ranges. Widespread species, occurring in both the Sierra Nevada and Rocky Mountains, form the largest single floristic group (60 percent). Of this group, 12 species are also found in the Arctic. There are no endemics.

The composition of the Wassuk Range flora supports two of Billing's (1978) generalizations about Great Basin alpine plant distributions. First, distinctly Sierran taxa have had relatively poor success in becoming established in ranges to the east. In this respect, alpine species act much like montane plants (Harper et al., 1978). Secondly, the Wassuk Range appears to represent a transition zone between the Sierra Nevada and Great Basin floras. Exact definition of the western boundary of Great Basin alpine floras will require more complete alpine species lists from the Sweetwater Range to the west and the Toiyabe Range to the east.

The lack of endemic taxa in the Wassuk alpine zone is unusual among ranges on the western perimeter of the Great Basin. Lloyd and Mitchell (1973) list six alpine endemics in the White Mountains, although *Heuchera duranii* and *Trifolium monoense* should not be considered endemic there (Munz, 1959); Major and Taylor (1977) cite two endemics in a partial alpine flora of 43 species in the Sweetwaters; and Billings (1978) notes four endemic species in an alpine flora of 39 species in the calcareous Spring Mountains. The absence of endemics in the Wassuk Range may be related to a reduced probability of their evolution in a very small area with little habitat diversity.

Harper et al. (1978) suggest that a low degree of plant endemism at mid-elevations in the Great Basin may result from a low degree of isolation of these areas. This explanation may also apply to Wassuk alpine plants because a large fraction of species in the range are not restricted to the alpine zone. Based on descriptions in Munz (1959), 65 percent of the taxa are presently found below 2440 m elevation in California, and only one species (*Poa rupicola*) is not reported below 3350 m. In the Wassuk Range, there is a relatively small group of species that appears restricted to the alpine zone, including *P. rupicola, Trisetum spicatum, Oxyria digyna,* and *Draba crassifolia.* Most species extend into the subalpine zone or lower. A migration path at 1950 m elevation is possible between the Wassuk Range and the nearest alpine area in the Sweetwaters. Under present climatic conditions, 36 percent of Wassuk alpine species could move freely between alpine areas in the two ranges. For an area about 100 km to the south, Wells and Berger (1967) have estimated that vegetation zones were depressed by 600 to 1000 m during Wisconsin glaciation. If a 600 m depression occurred along the East Walker River drainage, 74 percent of the Wassuk Range alpine flora could have migrated overland from the Sweetwater Range; with a 1000 m depression, all but four species could have moved across this route.

Wassuk Range plants that are generally restricted to very high el-

evations are all widely distributed arctic-alpine species. Thus, their identity can provide no clue as to the route by which they moved into the Wassuk Range.

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ANNOUNCEMENTS

Hunt Fellowship

The Hunt Institute invites applications for 1980–1981 research fellowships for those with a recent Ph.D. or other appropriate terminal graduate study. Tenure normally is limited to one year in the areas of history of botany, botanical biography and iconography, botanical bibliography, or history of botanical art and illustration. Fellows undertake research projects of their own choice, working closely with senior Institute faculty.

The fellowship will be awarded for the academic year with a stipend of $10,000. Applicants should submit a curriculum vitae, names of three references, copies of any published work, and a brief description of the proposed research project. Application deadline is 1 April 1980, with selection by 1 May 1980. Direct inquiries about possible projects and all application material to Dr. Robert W. Kiger, Director, Hunt Institute, Carnegie-Mellon University, Pittsburgh, PA 15213.

Nominations for Lawrence Memorial Award

The Award Committee of the George H. M. Lawrence Memorial Fund solicits nominations for the 1980 Lawrence Memorial Award. The purpose of the award is to support *travel for doctoral dissertation research* in systematic botany or horticulture or in their history. It is expected that the 1980 award will amount to $1000 for travel during the two-year period from date of award.

Major professors and other faculty are urged to submit letters of nomination for outstanding doctoral students who have achieved official candidacy for their degrees. A nomination may take the form of a letter that covers supporting materials prepared by the candidate. Submitted materials should describe briefly but clearly the candidate's program of research and how the travel enabled by the award would contribute significantly to its quality. They should be received no later than 1 April 1980. The awardee will be selected by 1 May 1980. All communications regarding the Fund and Award should be directed to Dr. Robert W. Kiger, Director, Hunt Institute, Carnegie-Mellon University, Pittsburgh, PA 15213.