Habitat Relations of *Cercocarpus montanus* (true mountain mahogany) in Central Utah

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Abstract

True mountain mahogany (*Cercocarpus montanus* Raf.) and its habitats were studied in the canyons and foothills of the Wasatch Mountains of Central Utah. Twenty populations were selected and sampled for various biotic and abiotic environmental variables. All study sites contained true mountain mahogany as a dominant or subdominant plant. The communities are shrub dominated with other plant life forms contributing little to the total cover of the sites. The more northern exposed sites appear to be undergoing succession while the more southern exposures seem more stable.

Native shrubs common to the Intermountain Region are important to the livestock and wildlife resources of the region. Increasing demands upon our shrub resources by a growing human populace necessitate more efficient range management. The efficacy of rangeland policies relating to shrub species depends upon knowledge of the ecological requirements of the species. Such information can best be gained through study of the natural ecosystems that support the shrub species in question. True mountain mahogany (*Cercocarpus montanus* Raf.) is widely recognized as a useful forage plant (Plummer 1969, Young and Bailey 1975) and knowledge of its habitat relations is essential for productive management.

Martin (1950) revised the genus *Cercocarpus* and delimited 8 varieties. The species referred to in this present work is *Cercocarpus montanus* Raf. var. *montanus*. Martin described this variety and listed several synonyms. Members of this genus were first called mountain mahogany by early pioneers, but that name has since been restricted to the genus *Sweitenia* by the Federal Trade Commission. Following this ruling, the U.S. Forest Service check list has approved "Cercocarpus" as the common name (Hayes and Garrison 1960). Nevertheless, certain common names have become firmly entrenched in the literature: true mountain mahogany, birchleaf mahogany, and alder-leaf mountain mahogany.

True mountain mahogany is a widely distributed browse species in the western United States (Fig. 1). The mean habitat type is in the Great Basin and Rocky Mountains, along bluffs and mountain slopes between 1,070 and 3,050 m (Medin 1960, Martin 1950, Pyrah 1964, Greenwood and Brotherson 1978). The Soil Conservation Service (1971) reports that true mountain mahogany is found within the 240-550 mm rainbelt on sites having a June deficiency of moisture.

Medin (1960) found true mountain mahogany growing on sandstone and shale in Colorado and his data indicated that soil depth was the most important factor influencing annual shrub production. A soil conservation report for Utah indicated that true mountain mahogany was most abundant on sites with shallow soils and with 35% or greater coarse fragments. Other researchers have noted that the shrub can withstand high lime and prefers sandy soils, but it is occasionally found in shales or deep loams (Brotherson and Brotherson 1967, Plummer 1969, Ream 1964). True mountain mahogany is recorded on all aspects and in fertile canyon bottoms where the pH ranges from 6.8 to 7.7 (Plummer 1969, Ream 1964).

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Fig. 1. *Distribution map of* Cercocarpus montanus *var.* montanus *in the western United States (after Pyrah, 1964).*

The successional patterns of true mountain mahogany have been partially documented by several authors. Ream (1961) pointed out that this shrub community was once widespread, and has since decreased as a result of over-grazing. The true mountain mahogany—bitterbrush *(Purshia tridentata)* community is physiognomically related to the Gambel oak *(Quercus gambelii)* mountain mahogany community (Ream 1961) and may be evolving towards a white fir *(Abies concolor)* dominated community.

True mountain mahogany is rated from good to excellent as browse for livestock and deer (Young and Bailey 1975). The leaves are palatable throughout the growing season, and after leaf senescence in mid-October, the twigs remain palatable on through the year. Protein contents in twigs and leaves are higher than in most other browse shrubs (U.S.F.S. 1937, Medin 1960, Plummer 1969, Soil Conservation Service 1971). Mineral concentration patterns in true mountain mahogany and associated soils were studied by Brotherson and Osayande (1980). Mineral concentrations in the twigs also indicated good forage value.

There is a general lack of information on the structure, dynamics, and habitat requirements of true mountain mahogany and its communities in Utah. Our objective is to evaluate aspects of the community ecology and habitat requirements of true mountain mahogany with respect to its distribution in northcentral Utah.

Study Site

Stands of true mountain mahogany were studied in northcentral Utah (Fig. 2). Study sites were located primarily in the canyons and foothills of the Wasatch Mountains between 1,750 and 2,200 m elevation (Table 1). Precipitation in the area generally falls within the 250-500 mm rainbelt with most of it occurring during the winter months (Bailey 1977). All exposures were represented, but they became increasingly southern in our sample as elevation increased. Soils varied from 8 to 48 cm in depth, and in texture from clay to sandy-clay loam. Soil pH ranged from neutral to

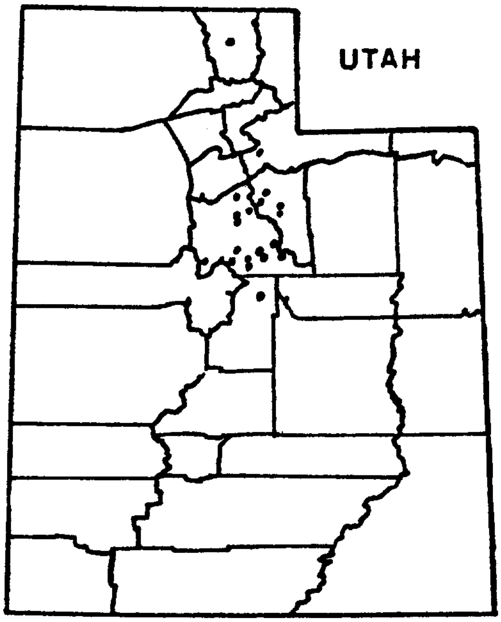

Fig. 2. *Map showing the location of the twenty* Cercocarpus montanus *study sites in north central Utah.*

slightly alkaline (Table 1).

Vegetation in the area is predominantly mountain mahogany brush, which exhibits a mosaic pattern of several dominant shrub species scattered across a constantly varying landscape of habitat types. On the xeric sites, the communities appear more stable,

Table 1. Site characteristics associated with stands of true mountain mahogany in northcentral Utah.

Physical factors	Low	High	Range	Mean	S.D.
Elevation (m)	1511.0	2196.0	685.0	1788.0	238.54
Percent slope	25.0	60.0	35.0	44.1	9.71
Exposure	0.0	330.0	330.0	204.0	105.95
Soil depth (cm)	8.1	48.3	40.2	24.5	11.59
pH	6.9	7.9	1.0	7.3	0.24
Soluble salts (ppm)	247.0	589.0	342.0	425.7	138.05
Percent clay	16.8	54.8	38.0	33.5	10.35
Percent silt	20.4	53.7	33.3	37.7	9.50
Percent sand	10.0	62.8	52.8	28.7	16.01
Percent rock cover	0.6	74.1	73.5	16.6	18.53
Percent bare soil	0.1	18.4	18.3	6.2	5.73

while successional changes are evident in more mesic areas. While usage by domestic and wild grazers varies widely among the habitat types, the community as a whole provides a valuable forage resource.

Methods

Field studies were conducted from August to October, 1973. Twnety plots measuring 20 × 20 m were selected and sampled. Each site was chosen on the basis of apparent true mountain mahogany dominance.

At all sites, data were taken for the following physical parameters: elevation, exposure, percent slope, soil depth, and number of deer pellet groups per plot (as a measure of browsing intensity). The following parameters of true mountain mahogany were also measured: shrub density, shrub height (to nearest 15 cm), average number of stems per plant, canopy cover, age class, and deer use (*Big Game Range Inventory Handbook* Utah Division of Wildlife Resources).

Twenty-five quarter-meter square quadrats were placed in rows of 5 at even intervals throughout each study plot. The presence of understory species and their canopy cover class (Daubenmire 1958) were recorded at each quadrat. Percent frequency and cover for each species present were calculated. Canopy cover values for rock, litter, and bare soil were also estimated. Total vegetative cover for each study plot was calculated by averaging cover values for rock, litter, and bare soil across all 25 0.25-m² quadrats, then summing these values and subtracting from 100%. Relative importance of shrub, forb, grass, and annual cover were individually calculated by summing the cover values of all species found in these categories across the 25 0.25-m² quadrats, summing those totals and then dividing each summation by the overall total. Shannon-Wiener diversity indices, (H'), were also computed for each site.

Soil samples were taken from randomly distributed sites within each plot. Each sample consisted of the upper 15 cm of soil, minus the litter layer. Texture was determined by the hydrometric method described by Bouyoucos (1936, 1951). Soil pH was determined with a Beckman glass electrode pH meter on a saturated 1:1 paste (Russell 1948). Total soluble salts were assayed with a Beckman electrical conductivity bridge.

Results

Prominent species in the type along with their importance values are listed in Table 2. The importance values (P × C Index) indicate

Table 2. Prevalent species list and associated importance index values for the major species in the true mountain mahogany communities of northcentral Utah. Figures represent percent presence (P) times average percent cover (C).

Species	P × C Index
Cercocarpus montanus	3060
Agropyron spicatum	413
Artemisia tridentata	243
Quercus gambellii	213
Bromus tectorum	111
Symphoricarpos oreophilus	76
Amelanchier alnifolia	48
Mahonia repens	40
Alyssum allysoides	26
Machaeranthera canescens	21
Poa sandbergii	20
Chrysothamnus viscidiflorus	17
Xanthocephalum sarothrae	16
Oryzopsis hymenoides	12

the relative abundance of these plants within the true mountain mahogany community. Life form data (Table 3) clearly show that shrubs predominate on the study sites with grasses a distant

Table 3. Life form data of true mountain mahogany stands along with summation of index values (P × C). Values were summed across all species in twenty study sites. The percent contribution of the individual life forms to the vegetation of the areas are given.

Life form class	P × C	Percent of P × C
Sum of shrubs	3727.85	84.9
Sum of grasses	457.85	10.4
Sum of annuals	144.25	3.2
Sum of forbs	64.45	1.5
Sum total	4393.55	100.0

second. The community, therefore, consists largely of true mountain mahogany and associated shrubs.

Seventy plant species were found on the true mountain mahogany sites. The occurrence of the less common shrubs, grasses, annuals and forbs varied considerably between the sites; however, a number of species had average cover values greater than 1%. These were true mountain mahogany, Bluebunch wheatgrass *(Agropyron spicatum),* cheatgrass *(Bromus tectorum),* Oregon grape *(Mahonia repens)*, big sagebrush *Artemisia tridentata)*, snowberry *(Symphoricarpos oreophilus)*, gambel oak *(Quercus gambelii)*, and serviceberry *(Amelanchier alnifolia)*. Of these, only cheatgrass, oregon grape, and snowberry were significantly correlated with percent cover of true mountain mahogany (Table 4).

Table 4. Least squares regression data. Correlation coefficients of the most abundant species cover data with that of true mountain mahogany cover data.

Species	Number of plots	Average % cover	S.D.	R	Significance
Agropyron spicatum	15	7.33	7.57	-.039	NS
Bromus tectorum	14	2.27	3.13	.542	$P<.05$
Mahonia repens	5	6.44	5.20	.829	$P<.05$
Artemisia tridentata	12	6.75	7.51	-.147	NS
Symphiocarpos oreophilus	7	6.17	6.03	-.686	$P<.05$
Quercus gambelii	10	8.50	10.23	-.155	NS
Amelanchier alnifolia	9	2.36	2.25	-.432	NS

Cheatgrass is a weedy species which often invades open areas characteristic of shrub habitats; oregon grape is shade-tolerant and grows well beneath the dominant true mountain mahogany overstory; while snowberry, another large shrub, is likely to compete for space with true mountain mahogany on more mesic sites.

Table 5 lists the summary statistics for the vegetative parameters sampled on the 20 sites. Linear regressions of the individual site data were run against density per acre of true mountain on each site. The data points were widely scattered and no significant correlations were found.

Table 5. Biological factors associated with stands of true mountain mahogany in northcentral Utah.

Biological factors	Low	High	Mean	S.D.
Total vegetative cover	23.9	77.0	60.3	14.5
Total shrub cover	13.1	67.6	44.3	16.6
Total forb cover	0.8	16.8	6.4	5.5
Total grass cover	0.8	28.1	9.8	8.2
Total litter cover	6.1	92.2	56.4	21.1
Total no. species/plot	4.0	23.0	12.6	5.1
Species diversity (H')	0.06	1.09	0.7	
Pellet groups/acre	0.0	340.0	84.5	81.1
Parameters for True Mountain Mahogany:				
Percent frequency	12.0	100.0	68.0	22.7
Density/acre	230.0	1750.0	868.5	363.9
Percent cover	7.4	65.9	30.6	19.1
Average height (m)	1.1	1.99	1.5	0.2
Stems/plant	14.0	41.4	23.0	6.7
Form class[a]	1.0	4.0	1.8	
Age class[b]	Y	D		

[a]Relates to deer use: 1 = all available, lightly hedged; 2 = all available moderately hedged; 3 = all available, heavily edged; 4 = largely available hedged.
[b]Relates to prevalent age class: S = seedling; Y = young plant; M = mature plant; D = decadent plant.

Figure 3 is a plot of the density per acre of true mountain mahogany against the number of sites. There is an increase in shrub density, with several inflection points occurring as the rate of density increase changes. Sites with approximately equal densities per acre are presumed to have somewhat similar vegetational conditions. Therefore, data from the twenty plots were grouped in the following manner (6,9), (3,4,14), (5,10,11,20), (8,18,19), 1,7,12, 13,17), and (2,15,16) in an attempt to see if general patterns might not emerge.

Using group averages, least-squares regressions were again run on the major physical and vegetative parameters against density per acre of mountain mahogany. The correlation coefficients (r values) are shown in Table 6. True mountain mahogany density correlated positively with total vegetative cover, total shrub cover, percent clay and silt in the soil and negatively with (H') and percent sand in the soil.

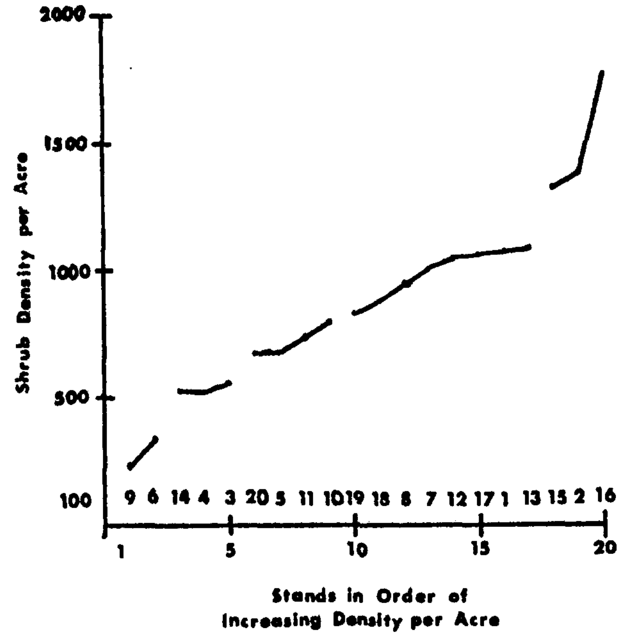

Fig. 3. *Increase in the density per acre of true mountain mahogany. The line has been broken to indicate the groupings done for the analyses.*

As shrub density increases community diversity declines, tending towards a monotypic stand. This is also evident in the weakly negative correlation of shrub density with total grass and total forb cover. Grasses are locally important but the overall pattern in the community as true mountain mahogany increases is to exclude grasses and shade-intolerant shrubs (Table 6).

Medin (1960) found that mountain mahogany productivity increased in sandstone relative to shale derived soils. The present results indicate that in our area, true mountain mahogany prefers moist, slightly more organic soils to sandy ones, and is displaced by other species on less optimal sites. The amount of mineral salts in the soil, pH, and actual soil depth seem to have little effect upon true mountain mahogany.

A shrub height profile of all individual mahogany plants was constructed for all sites sampled (Fig. 4). Approximately half of the total potential forage is above 1.5 m. This roughly coincides with the average maximum browse height for deer (J.T. Flinders and B. Welsh, personal communication). Since true mountain mahogany has no central trunk for the deer to brace against, only about 50% of the total potential forage is actually available for browse. Thus, many of the larger shrubs are essentially inaccessible, and useless for game maintenance.

Discussion

Climax plant communities are the product of long-term physical, biological and climatic influences and interactions. Such interactions, recent or historical, often influence the successional patterns of established systems. The purpose of this study was to assess the relative relationships of interacting physical and vegetative factors present in communities where true mountain mahogany is dominant or codominant.

Moisture conditions within the habitat and factors affecting them (i.e. silt and clay content of the soil, exposure, and elevation) appear significant in the development of true mountain mahogany

Table 6. Least-squares regression data. Correlation coefficients of various biological and physical parameters against the average density per acre of true mountain mahogany. Groups represent sites of approximately equal density per acre of true mountain mahogany (Fig. 3).

Parameters	Groups 1	2	4	4	5	6	S.D.	r	Significance
*Total shrub cover	23.2	40.6	43.6	54.8	40.2	59.3	12.7	.836	$P < .05$
Total forb cover	8.6	4.6	8.3	3.6	8.5	5.5	2.2	-.265	NS
Total grass cover	18.2	13.4	5.7	9.9	6.3	13.3	4.8	-.356	NS
Total vegetation cover	50.0	58.7	57.6	68.4	54.6	73.6	8.8	.781	$P < .05$
Species diversity (H′)	.94	.61	.89	.49	.68	.28	.25	-.833	$P < .01$
Percent clay	20.0	36.3	35.6	27.2	31.5	46.7	9.1	.750	$P < .05$
Percent silt	34.0	31.7	40.0	40.6	37.0	41.7	4.0	.730	$P < .05$
Percent sand	46.0	32.0	24.4	32.2	31.4	11.6	11.3	-.849	$P < .01$
Soil depth (cm)	13.4	19.0	35.1	18.5	30.2	20.6	8.0	.260	NS
Soluble salts (ppm)	247.0	457.7	508.8	384.0	439.0	421.7	89.7	.410	NS
pH	7.55	7.12	7.13	7.21	7.34	7.37	.20	-.040	NS

* Figures exclude cover of true mountain mahogany
** Explanation of group numbers: 1 = (6,9); 2 = (3,4,14); 3 = (5,10,11,20); 4 = (8, 18, 19); 5 = (1,7,12,13,17); 6 = (2,15,16)

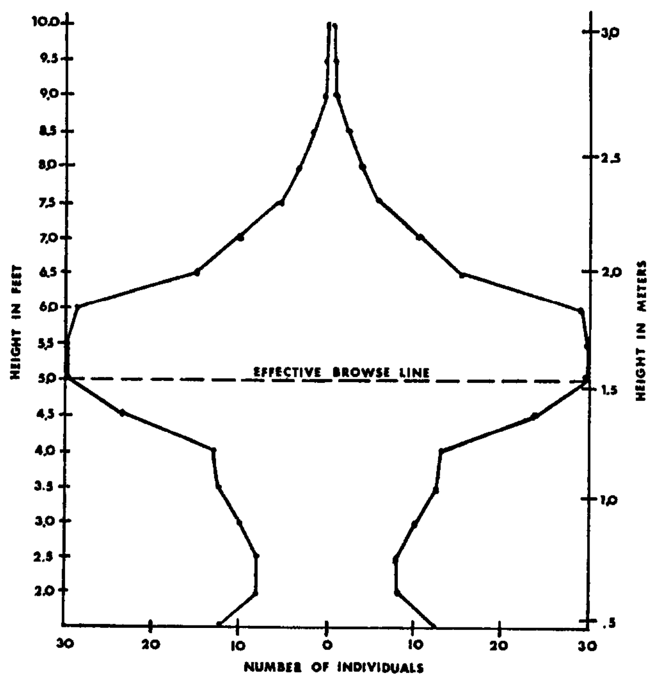

Fig. 4. *Height profile of true mountain mahogany from all stands sampled. The effective browse line is the average browsing height of deer.*

communities. Our data indicate the existence of moisture limitations as evidenced by the fact that communities on southfacing slopes are always higher in elevation than those on north-facing slopes. Also, optimum growth conditions for true mountain mahogany were most frequently encountered on north facing slopes of high elevation. This may have major successional consequences.

Stands of true mountain mahogany on slopes of northern exposure in Central Utah seem to be in transitional succession to other mountain brush types (Christensen 1964). Establishment of true mountain mahogany communities and the concurrent transformation of micro-environmental factors are not well understood. However, little build-up and increased shading of steep rocky sites will change the micro-environment. Such changes initially encourage more vigorous stands, but also prepare the site for the integradation and eventual establishment of other shrub types (Lepper and Fleschner 1977). The negative correlations with several major shrubs (Table 4) such as snowberry, big sagebrush, and gambel oak indicate such trends. On all sites sampled, these shrubs were the dominant or subdominant components of the surrounding vegetation. Succession appeared to be progressing more rapidly on north-facing slopes than on southern exposures. Therefore, on the southern more xeric sites, succession to the other shrub types may never occur.

Management policies for true mountain mahogany are difficult to formulate, although intense but not abusive browsing by deer seems to stabilize the communities. The sites studied provide a cross-section of diverse developmental stages of true mountain mahogany communities, and should stimulate further studies of successional dynamics, as well as the elucidation of significantly limiting ecological parameters.

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