

Native Clovers and their Chemical Composition¹

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Native clovers, (*Trifolium* spp.), are found growing in all of the Western states. About 300 species are reported to be widely distributed throughout the world. The native clovers play an important role in soil conservation and furnish large quantities of nutritious pasturage for livestock and game animals. Ten species have been found growing in Wyoming. Six of these species were collected in Wyoming for this study. One additional species was collected in Montana, 1.4 miles north of the Wyoming-Montana state boundary. Two species previously collected from Wyoming were also found at the Montana location. A total of 117 samples representing seven species were collected. Two clovers, Montana (*Trifolium montanense* Rydb.) and brandege (*Trifolium brandegei* Wats.), previously collected in Yellowstone National Park, were not collected in this study. Some botanists believe that Montana clover represents dwarf high-altitude plants of *T. Parryi* Gray and should not be considered a distinct species. Sierra clover (*Trifolium wormskjoldi* Lehm.) was discovered growing on a small area in western Wyoming. Sierra clover is apparently a recent introduction into Wyoming and was not collected for this study.

Nearly all of the native clovers found in Wyoming are low-growing leafy plants frequently occupying rough and rocky mountainous areas. In many locations the plants appear to be growing under extremely adverse conditions. Because of small size, they

are often overlooked or bypassed. Interest in them and in their chemical composition resulted from numerous observations of the immediate and complete cropping of clovers in certain areas, by sheep and game animals. On numerous occasions difficulty or failure in obtaining samples was encountered if sheep were allowed to graze or had been trailed over the areas where the collections were to be made. The native clovers are especially valuable as range plants, because many of them grow on areas where few other palatable plants grow. Native clovers supply a large amount of extremely palatable and nutritious food for livestock and game animals.

Native Clovers Studied

The following species were collected and analyzed: Andean (*Trifolium andinum* Nutt.), whiproot (*T. dasyphyllum* Torr. and Gray), hollyleaf (*T. gymnocarpon* Nutt.), Hayden (*T. hay-*

deni Porter), longstalk (*T. longipes* Nutt), (dwarf *T. nanum* Torr.), and Parryi (*T. parryi* Gray). The native clovers are perennials, and most of them have comparatively fibrous roots. Most of them are small plants of the Alpine and sub-alpine zones with three-foliolate compound leaves and multiple flowers arranged in heads. In many areas the amount of seed produced is extremely small.

Andean

Andean clover has been found growing in various areas of the state, usually on dry, rocky hillsides, at elevations of 4,500 to 8,000 feet. Samples were collected from a rocky hillside in southwestern Wyoming. This is an early and fast maturing plant. Its seed usually matures before the rocky hills become too dry to permit further growth. The leaves remain green throughout the dry, hot summer months except under extreme drought conditions. The deep-rooted plant has a depressed, cespitose, dense habit of growth. The flowers are yellowish-white to pale purple in color with two bract-like sheathing leaves at the base.



FIGURE 1. Whiproot and dwarf clovers growing on a rocky mountainous area in Southern Montana.

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FIGURE 2. Hayden clover growing on a rocky ledge.

Whiproot

Whiproot clover grows in numerous areas of the state. It was collected from eight locations in Wyoming and one in Montana. Collections were made in the mountains east and west of Laramie, along the Continental Divide in southern Wyoming, and southern Montana. The elevations of these locations range from 8,000 to 12,000 feet. This clover grows in dense clumps, sometimes as dense mats, usually on rocky areas. The plants vary in height from one-half to seven inches. Whiproot clover, in bloom, in the foreground, and dwarf clover growing directly back and to the right, are shown in Figure 1.

The leaf petioles are rather long and the leaflets are usually linear-lanceolate and $\frac{1}{2}$ to $1\frac{1}{2}$ inches in length. The flowers, grouped in a typical clover head, are quite variable in color, ranging from whitish-yellow to pink to purple and are usually bicolored.

Hollyleaf

Hollyleaf clover is common on Wyoming ranges and is scattered over the southern half of Wyoming including the Red Desert. It was collected from numerous

locations in the southern part of the state. Hollyleaf clover is extremely palatable and one of the first plants on the range eaten by sheep. It has a tough root system and often grows on cutbanks, along streams or drainage ditches, and along roadsides. This clover matures seed fairly early and remains green during the hot and dry summer months. It is often found growing beneath sagebrush, especially black sage, *Artemisia nova* A. Nels., and big sagebrush *A. tridentata* Nutt.

The leaf stems are 3 to 6 cm. long and the base of the stems are covered with brown stipules. The leaflets are 5 to 10 mm. long, oval or elliptic-oblong, sharply serrated, and bluish-green in color. The heads are globose or hemispheric with 5 to 12 flowers. The flowers, whitish-yellow, are often rose tinted. The fruits are 1 to 2 seeded.

Hayden

Hayden clover has been observed growing in Yellowstone National Park, in central Wyoming, and west of Cody. The samples analyzed were collected west of Red Lodge in southern Montana. The plants were growing in rocky soil among rock

ledges on a southern slope near the mountain top. Hayden clover plants with one blossom are shown in Figure 2.

The plant has creeping habits of growth similar to white clover. The leaflets are obovate, obtuse or abruptly pointed, and sharply toothed. The flower stem usually has two leaves, one large and one small, located a short distance below the head. The flowers are yellowish-white with a tinge of purple and reflex with age.

Longstalk

Longstalk clover is widely distributed in Wyoming. In habits of growth, appearance, and habitat it is similar to alsike clover. It may be identified by botanists as *T. longipes* Nutt., *T. Rydbergi* Greene, (Rydberg clover), *T. longipes* var. *rushbyi* Greene, and *T. rushbyi* Greene. Longstalk clover grows in meadows, moist valleys, pine forests, aspen stands, along roads, and beside streams. A clump of longstalk clover is shown in Figure 3.

The stems are 8 to 40 cm. tall and erect or ascending. The leaflets are usually over 2 cm. in length, lanceolate, oval to oblong-lanceolate, and sharply serrate. The flowers are white-yellow-pink-rose in color, sessile, and reflex with age.

Dwarf

Dwarf clover was collected from two areas, one in northern Wyoming and the other in Montana, 1.4 miles north of the Wyoming-Montana state line. It grows on rocky soil, in mountain areas at elevations up to 12,000 feet. This low-growing plant forms a dense mat and is easily seen when the flowers are in bloom. The plants are caespitose, 2 to 6 cm. tall, and grow erect or spreading from woody-branched crowns of roots. The petioles are slender and longer than the leaflets, which are 6 to 15 mm. long. The leaflets are narrowly obovate, linear-oblongate to oblong, and sometimes slightly serrate. The flowers occur in groups of 1 to 3, the majority

Table 1. Common Name, Number of Samples, Number of Collection Sites, and Composition, Mean and Range, of Certain Native Clovers.¹

Common name		Samples Sites	Carotene mcg./g.	(Percent)								Phosphorus	Magnesium
				Ash	Crude protein	Ether extract	Crude fiber	Nitrogen-free extract	Calcium				
Andean ²	M ⁴	3 1	239.4	14.25	18.91	3.60	22.64	40.60	3.84	0.20	0.49		
Andean ²	R ⁴	3 1	215.4-271.3	13.97-14.67	13.61-22.12	3.53-3.70	21.43-23.48	38.29-44.54	3.83-3.85	0.18-0.23	0.40-0.56		
Dwarf ³	M ⁴	6 2	243.4	12.85	20.16	3.52	18.15	45.32	2.72	0.26	0.67		
Dwarf ³	R ⁴	6 2	168.0-284.3	11.10-14.60	18.81-21.57	2.70-3.92	16.06-22.55	43.92-48.28	2.21-3.10	0.23-0.32	0.55-0.76		
Hayden ³	M ⁴	4 1	253.3	11.99	23.88	3.73	17.69	42.71	2.18	0.31	0.46		
Hayden ³	R ⁴	4 1	216.0-254.6	11.10-13.55	23.24-24.46	3.32-3.93	16.04-18.56	39.87-44.20	2.06-2.38	0.26-0.33	0.45-0.47		
Hollyleaf ²	M ⁴	13 7	267.5	13.92	17.77	3.52	18.23	46.56	3.25	0.30	0.44		
Hollyleaf ²	R ⁴	13 7	209.6-323.2	11.88-17.46	11.80-21.72	2.30-4.38	16.92-21.69	42.18-50.45	2.41-4.83	0.21-0.39	0.34-0.58		
Hollyleaf ³	M ⁴	11 6	315.9	11.12	21.98	4.10	17.08	45.72	2.57	0.33	0.51		
Hollyleaf ³	R ⁴	11 6	253.8-382.9	8.55-14.59	19.36-25.28	3.48-4.66	15.34-18.55	41.11-48.45	2.00-3.49	0.24-0.41	0.35-0.70		
Longstalk ³	M ⁴	26 9	246.7	10.46	20.97	3.34	20.78	44.45	1.73	0.35	0.45		
Longstalk ³	R ⁴	26 9	196.4-314.7	8.73-18.00	16.11-27.57	1.98-4.33	15.95-27.69	38.83-52.15	1.39-2.19	0.26-0.45	0.27-0.57		
Parry ³	M ⁴	22 6	299.5	10.10	23.35	3.91	14.16	48.48	3.11	0.32	0.65		
Parry ³	R ⁴	22 6	223.4-376.6	7.44-15.66	17.61-27.36	2.66-4.43	9.22-19.67	41.30-57.34	1.75-5.40	0.22-0.40	0.35-0.99		
Whiproot ³	M ⁴	32 9	244.7	9.89	21.11	3.84	21.03	44.13	2.02	0.32	0.46		
Whiproot ³	R ⁴	32 9	185.7-360.9	6.75-13.35	15.11-24.96	2.31-4.79	16.20-28.90	37.98-49.25	1.31-3.26	0.25-0.40	0.21-0.80		

¹All results on a moisture-free basis²Collected at seed stage of growth³Collected at bloom stage of growth⁴M—Mean; R—Range

being in groups of 2 or 3, the flowers extending above the leaves and being comparatively large and showy. The corolla varies from 16 to 20 mm. in length. The flowers are reddish-purple to rose-purple in color and the fruits are 5 to 10 seeded.

Parry

Parry clover grows in the mountain areas of Wyoming and has been found in nearly all parts of the state. It prefers a habitat similar to whiproot clover and both were collected from 5 common locations. The sixth collection was made in Wyoming near the high point of the Red Lodge-Cooke City Highway. It is a showy plant and is extremely palatable to sheep and some game animals. Montana clover and *T. salictorum* Greene are believed by some botanists to be similar and possible dwarf alpine forms of Parry clover. The leaves are rather large, mostly radical, and are 2 to 12 cm. long. The leaflets are 10 to 25 mm. long, obovate, and oval to oblanceolate. Small leaf serrations are usually present but may be absent. The numerous flowers

extend above the leaves and form a typical clover head which is large and fragrant. The flowers are rose-purple or reddish-purple in color and the fruits are 3 to 7 seeded.

Review of Previous Work

Carpet Clover (*Trifolium monanthum* Gray) was collected in Nevada and analyzed by Dinsmore, Wilson, and Kennedy (1906).

The compositions of whiproot and Parry clovers were reported by Knight, Hepner, and Nelson (1908) and (1911). The present study was the result of preliminary work that indicated the high calcium levels present in some collections of Parry clover.

Methods and Procedures

The clovers were collected at the bloom stage, when possible, and samples were collected from the same site for two or three successive seasons. The samples were hand sorted, air-dried in the laboratory, and ground in a Wiley mill. Carotene determinations were made immediately after grinding. Analytical methods used were the A.O.A.C.

official methods (1950). All values were calculated using moisture-free sample weights.

Discussion of Results

The common name, Kelsey and Dayton (1942), number of samples, number of collection sites, stage of growth, mean composition, and range of individual samples values are given in Table 1. Samples of early-maturing clovers were collected at the seed stage, and the compositions of these samples were grouped together.

Hollyleaf and Parry clover had the highest mean carotene values, 315.9 and 299.5 mcg./g. respectively. The values of the other clovers were somewhat lower. The levels of carotene found in Andean and hollyleaf clovers 239.4 and 267.5 mcg./g. collected at the seed stage; when scant precipitation resulted in decreased soil moisture content, were equal to those present in some clovers collected at the bloom stage. It is evident that clovers are excellent sources of carotene for a considerable period of time after maturity.



FIGURE 3. Longstalk clover growing on a gray-clay cutbank near Togwotee Pass (Elevation 9,658 feet) in western Wyoming.

The ash content of the individual samples of clover was variable with an over-all range of 6.75 to 18.00 percent. Growing conditions and nature of the soil influenced the ash content as evidenced by an individual sample range of 8.73 to 18.00 percent with a mean value of 10.46 percent for longstalk clover.

The mean crude protein content of the samples, at bloom stage, varied from 20.16 to 23.88 percent. The level of protein in these native clovers compared favorably with the mean protein content, 22.86 and 21.21 percent, for white and alsike clover collected from identical and similar locations at bloom stage. The range of values for Andean and hollyleaf clover samples collected at seed stage was 11.80 to 22.12 percent. These lower values are to be expected since the protein content of most plants decreases gradually as the plant approaches maturity and decreases rapidly after seed is matured. Most of the clover samples collected several weeks after seed maturity contained a level of protein that would have supplied the nutritional require-

ments of animals consuming these plants.

The mean ether-extract value of the clovers varied from a low of 3.34 percent for longstalk to a high of 4.10 percent for hollyleaf. The crude-fiber contents of most of the clover samples were low with a range from 9.22 to 28.90 percent. This is a reflection of the leafy character of these plants. These clovers are satisfactory energy sources for livestock and game animals. The range of nitrogen-free extract varied from 37.98 to 57.34 percent.

The calcium content of the clover samples was quite variable with a range of 1.31 to 5.40 percent. The lowest mean value was 1.73 percent for longstalk clover, which compares with a mean value for similar alsike clover samples of 1.67 percent. Longstalk and alsike clovers, as previously mentioned, preferred the same growing conditions and very frequently were found growing in close proximity. Samples of these two clovers collected from the same areas were comparable in regard to chemical composition. Andean and holly-

leaf clover, at seed stage, were collected from the same location, a rocky hillside in southwest Wyoming. Mean calcium content was 3.84 and 4.59 percent, respectively. These as well as other values mentioned in this discussion are means of samples collected from a definite location and are a part of the overall clover averages shown in Table 1. It is interesting to compare the mean calcium values of different clovers collected from the same location. Dwarf, Hayden, and whiproot clovers collected from the same location in Montana contained mean calcium levels of 2.59, 2.18, and 2.33 percent, respectively. Dwarf and Parry clovers collected from a location in northwestern Wyoming had mean calcium contents of 2.97 and 4.55 percent, respectively. Whiproot and Parry clovers collected from a site near Laramie had mean calcium values of 2.46 and 4.38 percent, respectively, while whiproot and Parry clovers collected approximately one mile distant had average calcium contents of 1.42 and 1.90 percent, respectively. A study of the calcium levels of the clovers collected indicates that the calcium content is strongly influenced by the species of clover and the soil upon which the clover grows. Clovers with above-average abilities to accumulate calcium are Parry, hollyleaf, and Andean.

Analysis of soil samples from the growing sites indicated that soil pH and the level of calcium in the soil influenced the uptake of calcium by the plant, but there appeared to be other factors or conditions which influenced calcium uptake.

The mean phosphorus values varied from 0.20 to 0.35 percent. The level of phosphorus decreased with increasing maturity of the plant, and this is reflected in the lower mean values of 0.20 and 0.30 percent in Andean and hollyleaf clovers collected at the seed stage. In most of the clovers

phosphorus level did not exhibit a wide variation among the several collection areas.

The magnesium levels of the individual clover samples varied from 0.21 to 0.99 percent with mean species values varying from 0.44 to 0.67 percent. Samples of whiproot and Parry clovers, growing on soil derived from dolomitic limestones, having a pH of 6.2 and a magnesium content of 1.27 percent, contained mean magnesium levels of 0.57 and 0.95 percent, respectively. It appears that dwarf and Parry clovers possess a greater ability to absorb and store magnesium than certain other clovers.

An over-all study of the chemical composition of the native clovers emphasizes the nutritional adequacy of these plants. The high palatability of these clovers, along with the high levels of essential nutrients in the plants and their growth in areas where other forage plants grow sparingly, make the native clovers valuable range plants.

Steps should be taken to encourage more widespread distribution and greater growth of these plants on our rangelands. Of the native clovers studied, only longstalk clover has possibilities as a hay producing plant, and it appears to have no qualities that render it superior to alsike clover.

Summary

Samples of Andean, whiproot, hollyleaf, Hayden, longstalk, dwarf, and Parry clovers were collected from numerous areas two or more successive seasons.

The chemical composition of these clovers, *i.e.*, carotene, ash, crude protein, ether extract, crude fiber, nitrogen-free extract, calcium, phosphorus, and magnesium, was determined. The levels of these components present in the clover samples varied within rather wide limits, but in nearly all samples the levels present indicated their high nutritional qualities. Parry and hollyleaf clovers contained the highest levels of carotene. Individual clover samples collected in Wyoming and near the state line in southern Montana, during tained widely varying levels of ash. Whiproot, Parry, and longstalk had the lowest mean ash content of those studied. The crude protein levels of Hayden and Parry clovers were highest, being above 23 percent.

Ether-extract and nitrogen-free extract levels in the native clovers compare favorably with the level of these components found in white, alsike, and red clovers. The crude-fiber contents of the individual clover samples were quite variable. Parry, hollyleaf, dwarf, and Hayden clovers contained the lowest mean crude-fiber contents.

The calcium contents of all samples of Parry, hollyleaf, and Andean clovers collected from certain areas were greater than 3.80 percent. Whiproot and dwarf clovers growing with Parry clover contained a much lower level of calcium than did Parry. Longstalk clover contained a much lower mean level of calcium than did the other native clovers studied.

Considerable variations existed between the phosphorus content of the individual samples. Only slight differences existed between the mean phosphorus values for all groups reported, except for dwarf and Andean clovers, which were somewhat lower. The phosphorus levels of hollyleaf and Andean clovers collected at seed stage were somewhat lower, as would be expected.

The magnesium contents of the individual clover samples varied over a considerable range. Samples of Parry clover, growing on soil derived from dolomitic limestone, contained levels of magnesium much higher than samples of the same clover from other areas or samples of whiproot clover from the same location. Dwarf clover from two locations contained a high level of magnesium.

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