Rings on The Range[1]

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Circular patterns in native vegetation excite the imagination of most observers. Such rings are not uncommon on North Dakota prairie, where explanations for their causes are many and often legendary.

This paper deals separately with each of four entirely different kinds of rings and their causes. The purpose is to consolidate information on the various types observed, to record some quantitative data from this area concerning such rings, and to report additional literature on each type.

Fungus Fairy Ring

Rings of much local interest are circular bands of fleshy fungi. The fruiting bodies of the fungi, in this climate are irregularly produced, ephermal, and easily missed by the casual observer.

Such rings have a different appearance at different seasons, according to the amount of precipitation and the amount of grazing they have received. When sufficient moisture is available the circle is often detected by more luxuriant growth and by a darker green color. Shantz and Piemeisel (1917) explained this deeper color as greater chlorophyll content of the plant. They sometimes appear as a circle of grass seed heads when few seed heads occur on unaffected areas. When ungrazed, the circles may show as lighter colored bands of foliage in the fall. When grazed by livestock they are often marked by dark closely grazed bands (Figure 1).

Fungus fairy rings are most evident in the western part of the state. On the highlands along the Yellowstone River several fungus fairy rings can frequently be seen in one pasture. Two local explanations are frequently given for their origin. In some instances they have been reported as places where Indian war parties danced. Others have considered them caused by buffalo (bison) cows circling their calves to ward off attack by wolves.

Shantz and Piemeisel (1917) wrote, "The term 'fairy ring', generally used to describe the arrangement of plants in an approximately circular form, originated in the belief that these circular growths marked the paths of dancing fairies." They also described, in great detail, the legends and superstitions associated with the appearance of fungus fairy rings in Holland, France, Sweden, England and Germany.

Effects on vegetation differ with different species of fungi. There are two major groups; those which kill the vegetation and those which stimulate the vegetation (Shantz and Piemeisel, 1917). The species treated in this article is of the second group.

Study Area

This study was made in Sections 27 and 28; T. 26, R. 59, on the John Cayko ranch in Richland County, Montana. This location was chosen because of the different grazing practices associated with each of three different fungus fairy rings.

One ring was in unfenced, natural grassland, long protected from domestic livestock. Occasional droppings indicated that cows sometimes got into the area but grazing by such strays was slight. Range condition was classed as "Excellent" (Dyksterhuis, 1949). A visit there on December 18, 1959 showed some removal of forage by rabbits from the stimulated band but foraging outside of the band was not evident. A second ring was located in an area closely grazed by sheep during a short period

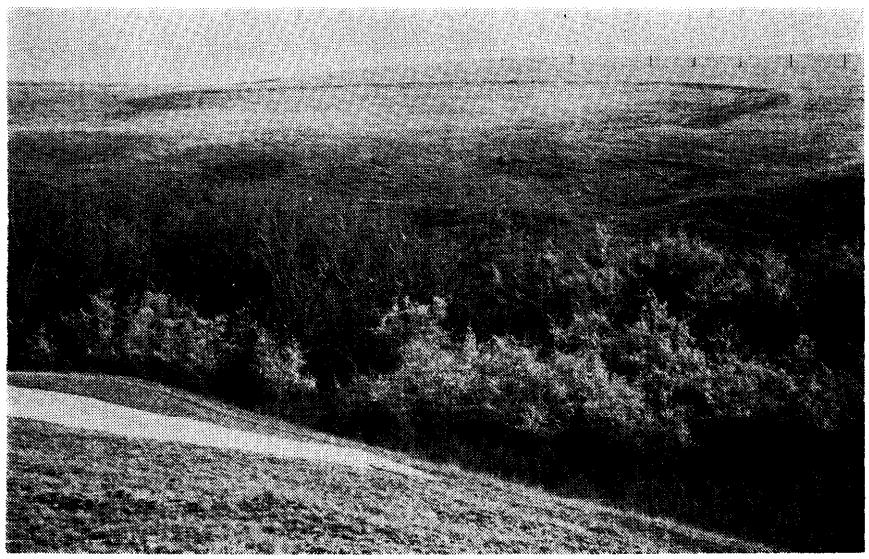

FIGURE 1. Fungus fairy ring caused by *Marasmius oreades* on sheep range grazed summer long.

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each year. The third was in an area regularly grazed season-long. In this area rings commonly lie on moderate slopes with runoff water consequently draining from the higher ground across the lower edge of the circle. Circle boundaries are generally less distinct on the low side.

Average annual precipitation in the area approximates 13.5 inches, with about 10.5 inches occurring in the period April through September.

Methods

Relative coverage by species of seed plants was determined by a mechanical arrangement of points designed to sample the area inside of the stimulated band and the area around the outside of the entire fungus fairy ring. At each point the plant hit was identified and tallied. Weight of foliage was determined by clipping circular 9.6 square foot plots. These were located inside the circle, in the stimulated band, and outside of the area affected by the fungus. Procedure in clipping, segregating, and naming materials followed that described by Dyksterhuis and Schmutz (1947). The fungi were identified by Dr. K. W. Kreitlow, Agricultural Research Service, USDA.

Results

The fungus, identified as *Marasmius oreades,* was described by Shantz and Piemeisel (1917) as a type causing fairy rings marked by stimulated vegetation.

On ungrazed range the ring was prominently marked by seed heads on western wheatgrass *(Agropyron smithii)* in October of 1958 and 1959. Seed heads were not in evidence outside of the stimulated band. Fungi fruiting bodies, when present, were in the outer zone of the stimulated band. The dried fruiting bodies were numerous in the ungrazed ring in October 1959. The average width of the fruiting zone was about 4 feet.

The ungrazed ring occurred on Williams loam, thin solum phase. The soil had a 3-inch very dark brown A_1 horizon. The B_2 horizon averaged about 4 inches in thickness. The pores of the B_2 horizon were filled and the natural ped surfaces covered with white mycelium. The C horizon was highly calcareous loam glacial till. The soil is considered typical of the "silty range site" being mapped by several agencies in range classification.

Within the study area the noncalcareous part of the solum varied from 7 to 16 inches in thickness but the distinguishable hyphae were consistently in the upper B_2 horizon, from 3 to 5 inches below the surface (Figure 2). They apparently had clogged all large pores and even capillaries of this horizon so that almost no moisture penetrated to the subsoil. A drop of water placed on the face of a broken ped took more than five minutes to penetrate while a similar noninfested ped absorbed the water instantly. No effect on soil structure or on normal soil profile development was observed.

The soil outside of the area affected by fungus was wet to a depth of 18 inches on October 29, 1959. In the band occupied by the fungus mycelium the soil was moist above the mycelium but not below.

The diameter of the circles, measured at the outer perimeter of the stimulated band, was 195 feet on the ungrazed area, 170 feet on the periodically grazed

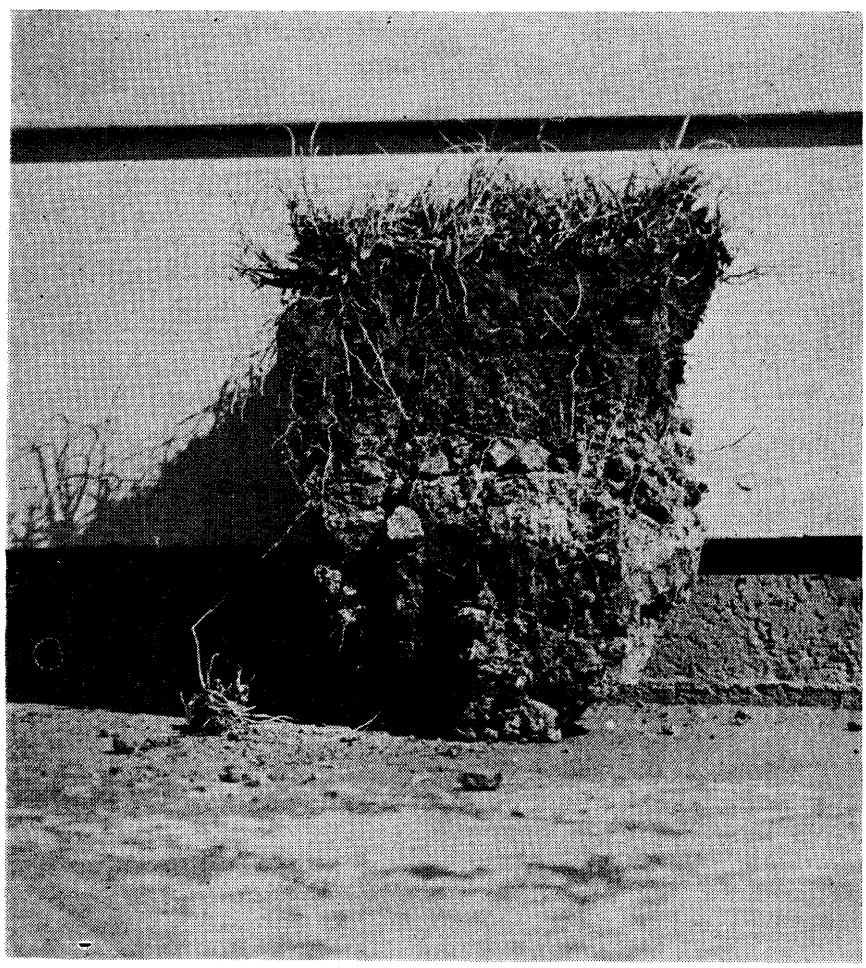

FIGURE 2. Soil sample from a fungus fairy ring. The gray layer is caused by mycelium of the fungus *Marasmius oreades.*

area, and 188 feet on the continuously grazed area. The width of the stimulated band was 12 feet. Shantz and Piemeisel, 1917, state that "Bayliss (1911) found the maximum increase of a ring of *Marasmius oreades* to be 13½ inches per year, and the minimum increase 3 inches." From this, one would expect the age of these rings to exceed 100 years.

Fungus fairy rings caused by *Marsmius oreades* are numerous in native grass on a farmyard in Divide County. The land owner first noticed the effects on the grass after horses wintered in the shelter of the buildings during the winter of 1946-47. When the present renter moved to the farm in 1955 the rings were about the size of car tires. In late 1959 the diameter of one of these circles was 6 feet 7 inches and two others measured 8 feet 10 inches. These rings are apparently very young compared to those previously mentioned. According to the growth rate found by Bayliss, it seems likely that the owner may have observed the beginning of these rings.

Relative vegetative cover by species in each of three fungus fairy rings and inside and outside of each ring is shown in Table 1. The vegetative composition in the ungrazed area, unaffected by fungus, compares rather closely with climax composition on similar sites as reported by Larson and Whitman (1942) and Quinnild and Cosby (1958). Under the conditions of a climax type of cover and no grazing western wheatgrass showed a significant increase in the stimulated band with a corresponding decrease in blue grama *(Bouteloua gracilis)*. Rogler and Lorenz (1957), working near Bismarck, N. Dak., in a similar plant community, reported a similar increase in western wheatgrass from the addition of commercial nitrogen. The plant composition within the circle was not significantly different from that of the check area. This indicates that once the fungus has passed through the area the vegetation returns to normal.

In both grazed areas there was significantly more blue grama and less western wheatgrass, both within and outside the fungus affected areas. In the ungrazed area, winterfat *(Eurotia lanata)* was a very conspicuous part of the entire landscape. On each of the other two areas winterfat was not found. Green needlegrass *(Stipa viridula)* was not encountered in a relative cover determination but large, scattered bunches were noted on the ungrazed site. Clones of prairie sandreed *(Calamovilfa longifolia)* were conspicuous but were not important in the total vegetation.

As shown, a drouthy condition was created in the soil of the fungus affected zone, yet, with sufficient moisture there was a stimulation of growth. The darker green color can be noted regardless of the growth stimulation. The cause for the growth stimulation was studied and reported by Shantz and Piemeisel (1917), who wrote: ". . . the progress of the Fairyring fungus through the soil brings about the following chemical changes. The dead organic matter of the soil is utilized as a food supply for the saprophytic fungus. During the process the carboydrates are consumed or reduced and parts of the protein material consumed by the fungus and reduced to ammonia. This combines readily to produce ammonical salts, or is changed by bacterial action to nitrates which are in turn converted into nitrates. The chief effect, insofar as soil chemistry is concerned, is to change the protein portion of the organic matter of the soil into compounds of nitrogen which are readily available to higher plants."

Table 1. Relative coverage by species of seed plants in and adjacent to three fungus fairy rings caused by *Marasmius oreades*.

	Protected Area			Closely Grazed for Short Periods			Regularly Grazed Season-long		
	Stimulated band	Inside circle	Outside fairy ring	Stimulated band	Inside circle	Outside fairy ring	Stimulated band	Inside circle	Outside fairy ring
	(Percent)								
Agropyron smithii	56.25	31	34	20	22	18	31	27	27
Bouteloua gracilis	5.00	15	21	53	55	50	33	32	36
Stipa comata	18.75	31	17	18	19	20	12	8	10
Carex filifolia	3.75	7	13	7	1	5	7	14	13
Carex eleocharis	12.50	14	11	2	1	4	7	10	9
Artemisia frigida	1.25		2		1		8	9	2
Koeleria cristata						2	1		1
Muhlenbergia cuspidata						1	1		1
Opuntia polycantha		1			1				
Eurotia lantana	2.50		2						
Artemisia cana		1							
Sphaeralcea coccinea									1

Table 2. Pounds per acre, air-dry herbage, fresh mulch, and humic mulch associated with different positions in relation to fungus fairy ring on native range, October 1958 and 1959.

	1958			1959		
	Herb.	F.M.	H.M.	Herb.	F.M.	H.M.
Control: near ring	1200	1800	4300	900	1400	3900
Inside: encircled	1500	1600	2900	1100	1100	3900
On stimulated band	1900	1600	2900	1100	1400	2700

It may be noted (Table 2) that less herbage was produced outside the influence of the fungus ring than within its influence. This was the case both years. However, it is noteworthy that the dried remains of growth of previous years, segregated as fresh mulch and humic mulch, was greater outside the influence of the fungus ring. Therefore, the fungus was associated with greater current growth but less old growth. This might be explained by the more rapid decomposition of dead plant materials in the area influenced by the fungus. The lack of well-defined zones of influence makes herbage yield determinations difficult. More clippings over a longer period of time would increase the accuracy of the data on herbage yield and mulch accumulation.

Rings Originating From Firebreaks

Some circles on prairie land that at first seems inexplicable could later be accounted for by the plowing of firebreaks around haystacks. These may persist for decades and in areas where hay has not been cut within the memory of current land owners. In time the plow marks all but disappear, leaving a circle that is visible only because of the difference in vegetation. One such circle is on the Wayne Evans ranch along the Little Knife River in Mountrail County. It was first noticed in 1937. Hay has never been cut in the area to the owner's knowledge but the square inside the circle scarcely leaves room for any other explanation. The circle appeared the same to Mr. Evans in 1937 as when the picture was taken in May 1958, some 20 years later (Figure 3).

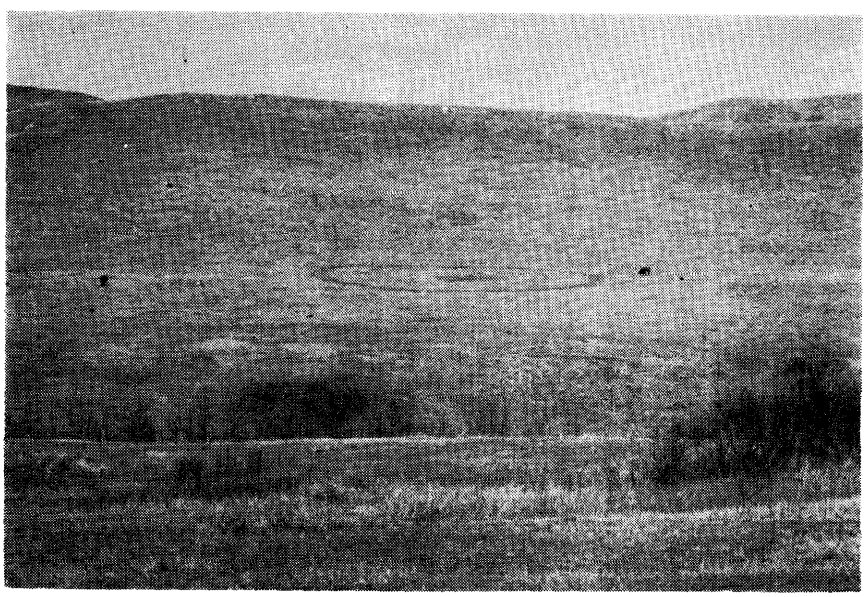

FIGURE 3. Circle in native range apparently caused by plowing a firebreak around a hay stack. The circle appeared the same to the land owner when he moved there in 1937. No history of haying could be established for this site.

The circle is vivid in the spring but becomes less apparent each month until it is difficult to see, even under close inspection. Relative coverage data were obtained by the same method used for relative coverage on fungus fairy rings to determine the vegetative characteristics which caused the change in appearance by seasons. Table 3 describes the vegetation in the circle and outside of the mechanically disturbed area on May 14, 1959.

Needleleaf sedge was 48 percent by count of the vegetation in the disturbed band, while blue grama made up only 7 percent. In the undisturbed area blue grama made up 52 percent of the plant cover while 16 percent was needleleaf.

Western wheatgrass and thickspike wheatgrass (*Agropyron dasystachyum*) are shown together on the table because of the difficulty of identification when not in head and because of their similar growth habits. It was thought that thickspike wheatgrass comprised about 2 percent of the total cover.

Firebreak rings provide evidence that blue grama has been extremely slow in returning to bared areas even though these are but a few feet across. On abandoned fields in western North Dakota, Whitman, Hanson and Larson (1943) found that fields abandoned 25 to 35 years had only about one-sixth as much blue grama as native sod. They also remarked that needleleaf sedge became established somewhat faster than blue grama.

Clones

Many interesting circular patterns of vegetation are formed from clones, i.e., single plants which propagate vegetatively. Prairie sandreed (Figure 4) propogates almost entirely by rhizomes and commonly forms clones, Weaver and Albertson (1956). During secondary plant succession, rhizomes frequently

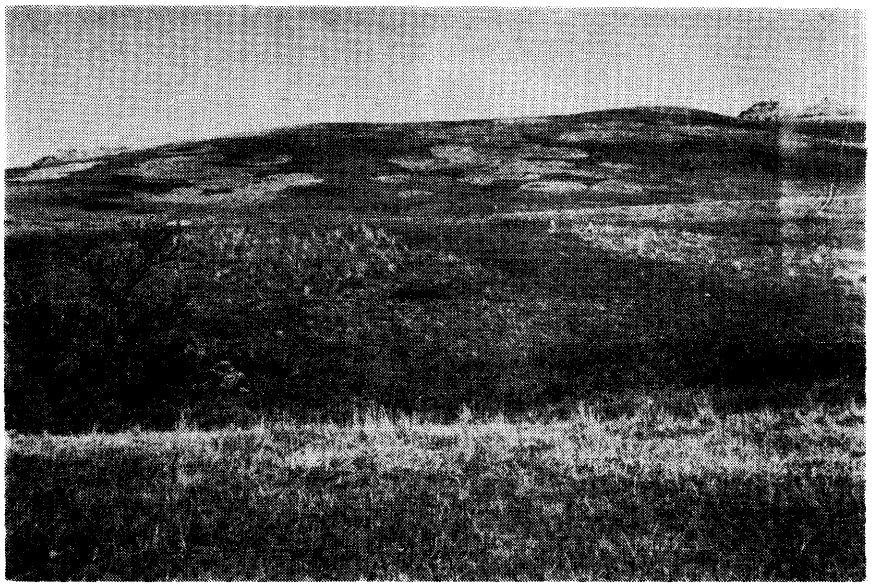

FIGURE 4. Clones of *Calamovilfa longifolia* making circular patches indicating spread by rhizomes rather than by seed.

radiate out from a surviving plant or one newly established. The rate of spread is often equal in all directions providing symmetry to the clone. The advancing edges of such clones are marked by more vigorous growth and more seed heads than the older central part. Central portions of old clones may die, leaving rings. Quinnild and Cosby (1958) reported this type of vigor along the edge of an advancing western wheatgrass community.

The clones of western snowberry *(Symphoricarpos occidentalis)* also often form almost perfect circles in this area. The colonies formed by the spreading rhizomes of this plant range from a meter to over 200 meters in diameter as described by Pelton (1955).

Creeping juniper *(Juniperus horizontalis)* has stems which creep over the ground and radiate in all directions from the central stem. Circles of this type usually result from one plant. When more than one plant or origin from both seeds and vegetative offshoots is involved, the circular pattern of advance is soon lost.

Other grasses, forbs and woody plants which reproduce by strong rhizomes may on occasion produce clones of nearly perfect circles. The more showy of these plants may add to the pattern of circles on the prairie.

Tepee Rings

Circles of surface stones, attributed to activities of Indians, are common on the undisturbed prairie throughout northwestern North Dakota (Figure 5). These man-made tepee rings sometimes show effects on the vegetation. There seems little doubt that tepee rings are man-made, but much speculation about the reason for the stones being placed in this manner is still heard. The name is derived from the Indian word *tipi* and is frequently referred to by this spelling. The name implies that the stones were placed around the base of the tepee for anchorage.

This belief is held by many. Others believe the stone circles have ceremonial significance and still others think they were constructed merely as recreation or diversion from tedium. Robert Cory related much of the legend associated with the tepee rings in "The Minot Daily News" of March 3 and April 18, 1959.

According to information in the Museum Review (1946) some rings of small boulders found on the prairie may have been used to hold down tepee walls but the following opposing reasons were also given. In size the rings range from 5 feet, too small for a tepee, to 90 feet, much larger than any known tepee, and average 15 to 20 feet in diameter. The rings are precisely circular, yet, when the tepees were removed the stones would have been moved and would have required replacing to maintain the carefully laid circles. In many cases the rings are on high ridges, fully exposed to wind, and are long distances from wood or water. The following statement appears in The Museum Review (1946): "The exact significance of the rings which were not used as tipi rings is problematical but due to their location it seems quite probable that they may have had a religious or ceremonial significance."

Table 3. Relative coverage by species of seed plants on circular firebreak, plowed once to protect haystack decades ago, and on surrounding range.

Species	Firebreak	Control
	(Percent)	
Bouteloua gracilis	7	52
Carex eleocharis	48	16
Agropyron smithii and *A. dasytachyum*	25	20
Stipa viridula	6	6
Stipa comata	5	1
Calamagrostis montanensis	4	
Artemisia frigida	3	3
Sphaeralcea coccinea		1
Unidentified forb	1	1
Poa pratensis	1	

FIGURE 5. Tepee rings. Such rings are commonly 15 to 20 feet across but may be much larger or smaller. There are commonly many within the same area. Such rings are widespread in undisturbed North Dakota prairie.

Washburn (1956), in a comprehensive article on patterned ground, has described the stone circles, nets, and polygons of cold climates. He also reviewed hypotheses of their origin such as ejection of stones from fines by multigelation. The circles of stones encountered by the author on North Dakota Prairie do not seem to conform with any of the types of frost-produced circles described by Washburn. Also unobserved were circles resulting from damage by white grubs as reported by Schumacher (1959).

Summary and Conclusions

Circular patterns in the vegetation are common on the range lands of North Dakota and Montana. The circles are of different types and have different origins. Data were obtained on two types in 1958 and 1959 and observations were made of these and other types over several years. Of the four types discussed the fungus fairy ring is probably the least widely distributed and is associated with the most mystery and legend.

Circles caused by plowing firebreaks around haystacks often persist long after marking by the plow is obliterated. Single plants which propagate vegetatively, commonly called clones, often form nearly perfect circles on the prairie. These form during periods of secondary succession following great loss of cover, and also during range degeneration when grazable species are kept low in vigor while very short or woody plants advance vegetatively.

Tepee rings are circles of surface stones. Their significance is unknown though it is generally agreed that they were placed by people at a time prior to the advent of white men.

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