An Important Lichen of Southeastern Montana Rangelands

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Abstract

The lichen *(Parmelia chlorochroa)* was most abundant in sagebrush and grassland vegetation associations, less so in the pine, and absent in riparian types. It was significantly associated with drier sites and bare ground. Lichens appear to have value in reducing erosion, as indicators of intensive grazing, and in contributing to the nutrient quality of soils.

Lichens (Lichenes) are often conspicuous and abundant on rangelands of the Western United States, yet have been ignored by most range managers and researchers when quantifying vegetation. Some published studies have presented cover and/or frequency estimates for lichens (Bear and Hansen 1966, Robinson 1969, Eastman and Jenkins 1970, Pendergast and Boag 1970, Mitchell and Smoliak 1971, Anderson et al. 1982), but failed to identify them by genus or species. Bear and Hansen (1966) later identified the lichen they encountered on southern Colorado rangelands as *Parmelia chlorochroa* (R.M. Hansen, pers. comm.). Most published studies about lichens deal with taxonomy and distribution (Wetmore 1967).

Lichens have been reported to be an important food of large ungulates (Bergerud 1972) and grouse (Ellison 1966) in northern regions. Reindeer lichens (*Cladonia* spp.) were considered a low quality food by Bergerud (1972) because they contained only 2–6% protein. Lichens have been reported in the diets of mule deer *(Odocoileus hemionus)* (Lovaas 1958, Anderson et al. 1965, Wallmo et al. 1972), pronghorn *(Antilocapra americana)* (Bayless 1969), and wild hogs *(Sus scrufa)* (Henry and Conley 1972) in small amounts. Livestock utilize temperate region lichens when vascular plants are heavily grazed. These lichens may be toxic or unpalatable to livestock because of the acids they produce (Durrell and Newsome 1939).

Lichens are an algae and fungus together in a mutualistic relationship. The fungus provides support, structure, and protection, while the algae produce food, and together they form a structure known as a thallus (Hale 1969). There are 16,000 known species of lichen worldwide. Reproduction generally occurs as lichen pieces are broken off and wind blown (Wilson and Loomis 1962). Lichens are also dispersed by floods and spring thaws. They can live for decades, possibly centuries (Hanson 1967). Lichens exist on many substrates including soil, rock and plant material.

Lichens are basic soil formers and the first step in primary succession. They can establish without soil and break down rock chemically and mechanically (Stoddart et al. 1975). Lichens also accumulate wind blown soil and organic matter (Daubenmire 1968), thus reducing erosion. They play a major role in cycling nutrients from the air and from rainfall (Hanson 1967, Smith 1980). Some lichen species have the ability to fix nitrogen through their blue-green algae component (Smith 1980). Many lichens can absorb and hold water, enabling them to exist under dry conditions. Lichens begin respiration at a low moisture content and require high light intensity (Looman 1964). They have also proven useful in monitoring levels of pollution from industry and nuclear weapons testing (Hanson 1967).

Gorham (1947) showed that lichens can be used successfully as indicator species and Looman (1964) suggested they were valuable in classifying vascular vegetation associations in grasslands. Looman (1964) also suggested that lichens and bryophytes could be valuable species in the evaluation of range management programs, especially in grassland types. Anderson et al. (1982) concluded the same for cryptogamic soil crusts made up of algae, lichens, and mosses in the Utah deserts.

The purpose of this paper is to present estimates of canopy cover, biomass, and frequency of occurrence for the lichen *Parmelia chlorochroa* (Fig. 1) in four vegetation associations of southeastern Montana.

Study Area and Methods

The study area was immediately west of the town of Alzada, Mont., Carter County, along the northern edge of the Black Hills. The area encompassed approximately 11,303 ha, with elevations ranging from 1036 to 1128 m. It included Black Hills and Northern

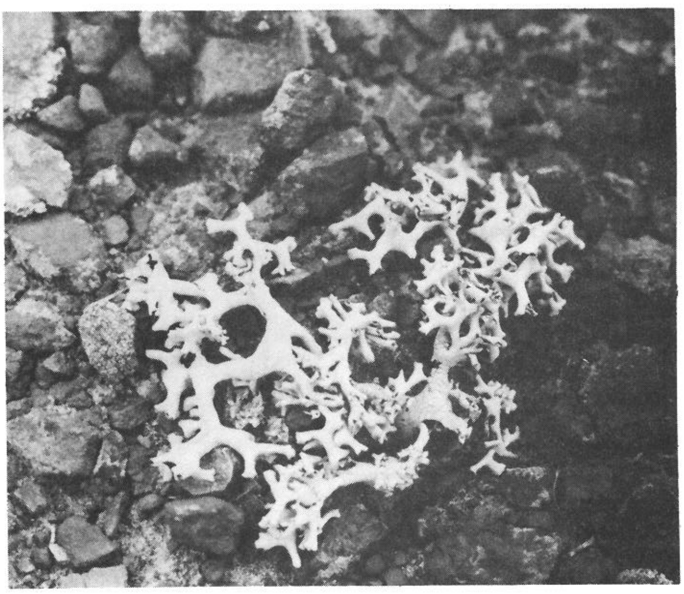

Fig. 1. *Photograph of* Parmelia chlorochroa *illustrating life form and bare ground habitat.*

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Great Plains vegetation types. Wetmore (1967) described this as the prairie-forest border zone.

Four major vegetation associations were recognized on the study area. Mapping vegetation associations on the study area showed that the sagebrush type covered 74% of the area. The most abundant vascular plants in this type were big sagebrush *(Artemisia tridentata),* western wheatgrass *(Agropyron smithii),* buffalograss *(Buchloe dactyloides),* needleleaf sedge *(Carex eleocharis),* and common yarrow *(Achillea millefolium).* Riparian areas made up 14% of the study area. Major plants there were box elder *(Acer negundo),* green ash *(Fraxinus pennsylvanica),* snowberry (*Symphoricarpos* spp.), western wheatgrass, smooth brome *(Bromus inermis),* kentucky bluegrass *(Poa pratensis),* common dandelion *(Taraxacum officinale),* and curly dock *(Rumex crispus).* A pine forest type accounted for 8% of study area, and included ponderosa pine *(Pinus ponderosa),* bur oak *(Quercus macrocarpa),* Rocky Mountain juniper *(Juniperus scopulorum),* western wheatgrass, blue grama *(Bouteloua gracilis),* buffalograss, needleleaf sedge, common yarrow, and starry cerastium *(Cerastium arvense).* Another lichen species *(Argrestia hispida)* also occurred in this type, but only in trace amounts. Open grassland comprised 0.2% of the area, consisting of western wheatgrass, needleleaf sedge, blue grama, prairie sandreed *(Calamovilfa longifolia),* and plains pricklypear *(Opuntia polyacantha).* The rest of the study area (4%) was classified as disturbed lands under the influence of bentonite mining. Plant names follow those of Scott and Wasser (1980) and Wetmore (1967).

Four areas of approximately 0.5 ha were selected for study in both the sagebrush and riparian areas. Two such areas were examined in both the pine forest and grassland types. In each of the 12 areas, percent canopy cover of *P. chlorochroa* and percent bare ground were determined following methods described by Daubenmire (1959). In each area, 3 parallel line transects were systematically established approximately 30.5 m apart. Each line transect was 50 m long. Estimates were taken in 50 quadrats (20 × 50 cm) systematically spaced at 1-m intervals along each transect. Frequency of occurrence estimates were taken at the same time.

Standing crop biomass of *P. chlorochroa* was determined for each area along two of the transect lines. Ten quadrats (20 × 50 cm) were spaced at 5-m intervals along each line transect. All lichens within a quadrat were harvested, air-dried for 14 days, then oven-dried at 60°C for 24 hours, and weighed. Data collections were carried out during summers of 1979 and 1980.

Differences in *P. chlorochroa* cover and biomass between years and vegetation types were examined using analysis of variance with mean values per transect. Duncan's new multiple range test was used to identify which factors produced differences. *P. chlorochroa* frequency was tested using chi-square contingency table and the relationship between *P. chlorochroa* canopy cover and bare ground was determined using rank correlation (Snedecor and Cochran 1967). Differences were considered significant at 0.05 level.

Results

P. chlorochroa canopy cover ranged from 0% in riparian habitat to 5% on sagebrush sites. Biomass reached a high of 126 kg/ha on grassland sites in 1980, and percent frequency ranged from 0 on riparian sites to 53 on grassland sites (Table 1). Percent canopy cover of *P. chlorochroa* was greater ($P<0.01$) in grassland and sagebrush than pine and riparian types during both years (Table 1). There was no real differences ($P>0.05$) between grassland versus sagebrush or riparian versus pine types, or years in lichen cover.

However, lichen biomass was significantly higher ($P<0.01$) in 1980 than in 1979 in the grassland type (Table 1). No other vegetation associations had significant differences ($P>0.05$) in lichen biomass between years. Lichen biomass was also greater ($P<0.01$) on sagebrush and grassland types than on pine and riparian associations in 1980. There were no real differences ($P>0.05$) in lichen biomass between sagebrush versus grassland or pine versus riparian types.

Differences in lichen canopy cover and biomass between replications within a vegetation association were not significant ($P>0.05$).

Lichen occurrence was found to be significantly higher ($x^2 = 103.9$, $P<0.01$) in grassland and sagebrush types for both years than in pine and riparian types. Lichen canopy cover was significantly correlated with percent bare ground ($r_s = 0.88$, $P<0.01$) on the study area (Table 1).

Discussion

Wetmore (1967) stated that *P. chlorochroa* is a grassland species, scattered on soil in open prairies. It occurred loosely on soil surfaces, or slightly imbedded in soils on the study area. *P. chlorochroa* canopy cover, biomass, and frequency were highest on grassland and sagebrush vegetation associations supporting Wetmore's (1967) classification of *P. chlorochroa* as a grassland species.

Little published information on the ecology of *P. chlorochroa* as well as other lichens is available (Looman 1964, Anderson et al. 1982). Our findings confirm Looman's (1964), that *P. chlorochroa* favors xeric situations. 1980 was a drought year on the study area. *P. chlorochroa* biomass was higher during 1980 than 1979. Its absence from riparian areas also supports this conclusion. Looman (1964) ordinated lichen communities along a moisture gradient and stated that communities in which *P. chlorochroa* was a major species existed on very dry to dry grassland sites.

P. chlorochroa abundance may be related to grazing intensity. Other biologists have suggested the same relationship (S. Shusahan, pers. comm., Looman 1964). In Saskatchewan, Canada, Looman (1964) noted a decrease in *P. chlorochroa* in exclosures protected from grazing for a number of years. Anderson et al. (1982) reported that cover of lichens and mosses was 3 times greater on moderate-heavily grazed areas in Utah than in lightly grazed areas. The significant positive correlation between *P. chlorochroa* canopy cover and percent bare ground supports the conclusion that this lichen favors areas with reduced vascular plant cover. Certain areas in this sagebrush type were lacking herbaceous growth. *P. chlorochroa* canopy cover and frequency of occurrence was highest in areas were herbaceous cover was lacking. This species of lichen may be indicative of areas lacking in vegetation because of grazing in sagebrush and grassland habitats, and

Table 1. Mean (± SE) percent canopy cover, percent frequency of occurrence, and kilograms per hectare of *Parmelia chlorochroa* and percent bare ground of 4 vegetation types for 2 years in southeastern Montana.

	Parmelia chlorochroa							
	Cover		Biomass		Frequency		Bare ground	
Vegetation type	1979	1980	1979	1980	1979	1980	1979	1980
Grassland	2±1	5±2	*	126±49	53±18	52±13	27±2	18±2
Pine forest	1±0	*	*	11±4	13±5	3±2	11±2	13±3
Sagebrush	5±1	2±0	30±15	92±16	52±9	41±5	23±2	15±1
Riparian	0	0	0	0	0	0	5±1	10±2

*<1

undoubtedly is beneficial in the recovery of such areas by contributing organic matter and nutrients to the soil and by reducing soil erosion. However, lichen growth is extremely slow (1 mm/yr.); consequently, areas supporting *P. chlorochroa* would have a long history of conditions favorable to this lichen's growth.

Since *P. chlorochroa* favors areas of bare ground and grows rather slowly, its presence and size can be used to date erosion (see Looman 1964). The occurrence of mature pedesteled plants on bare ground sites indicates severe erosion. The presence of lichens on such a site with a thallus diameter of 25 mm would indicate that the site has been favorable to lichen growth for about 25 years and thus erosion can be traced back at least that far.

Durrell and Newsome (1939) stated that *P. molliuscula* had been reported to cause livestock poisoning. This may also be true of *P. chlorochroa*, but has not been documented. An aversion by livestock would insure *P. chlorochroa's* continued presence with associated benefits in intensively grazed areas.

Literature Cited

Anderson, A.E., W.A. Snyder, and G.W. Brown. 1965. Stomach content analysis related to condition in mule deer, Guadalupe Mountains, New Mexico. J. Wildl. Manage. 29:352-366.

Anderson, D.C., K.T. Harper, and R.C. Homgren. 1982. Factors influencing development of cyrptogamic soil crusts in Utah deserts. J. Range Manage. 35:180-185.

Bayless, S.R. 1969. Winter food habits, range use, and home range of antelope in Montana. J. Wildl. Manage. 33:538-551.

Bear, G.D., and R.M. Hansen. 1966. Food habits, growth, and reproduction of white-tailed jackrabbits in southern Colorado. Colorado State Univ. Agr. Exp. Sta. Tech. Bull. 90. 59 p.

Bergerud, A.T. 1972. Food habits of Newfoundland Caribou. J. Wildl. Manage. 36:916-923.

Daubenmire, R. 1959. A canopy-coverage method of vegetation analysis. Northwest Sci. 33:43-64.

Daubenmire, R. 1968. Plant communities. Harper and Row. New York.

Durrell, L.W., and I.E. Newsome. 1939. Colorado's poisonous and injurious plants. Colorado Exp. Sta. Bull. 455. Colo. State Univ., Ft. Collins 80523.

Eastman, D.S., and D. Jenkins. 1970. Comparative food habits of red grouse in northeast Scotland, using fecal analysis. J. Wildl. Manage. 34:612-620.

Ellison, L. 1966. Seasonal food and chemical analysis of winter diets of Alaskan spruce grouse. J. Wildl. Manage. 30:729-735.

Gorham, E. 1947. Bryophytes and lichens in the pastures of martime province. Proc. Nova Scotia Inst. Sci. 22:1-10.

Hale, M.E. How to know the lichens. W.C. Brown Company, Dubuque, Ia.

Hanson, C.W. 1967. Cesium-137 in Alaskan lichens, caribou, and eskimos. Health Physics. 13:383-389.

Henry, V.G., and R.H. Conley. 1972. Fall foods of European wild hogs in the southern Appalachians. J. Wildl. Manage 36:854-860.

Lovaas, A.C. 1958. Mule deer food habits and range use, Little Belt Mountains, Montana. J. Wildl. Manage. 22:275-283.

Looman, J. 1964. Ecology of lichen and bryophyte communities in Saskatchewan. Ecology 45:481-491.

Mitchell, G.J., and S. Smoliak. 1971. Pronghorn antelope range characteristics and food habits in Alberta. J. Wildl. Manage. 35:238-250.

Pendergast, B.A., and D.A. Boag. 1970. Seasonal changes in diet of spruce grouse in central Alberta. J. Wildl. Manage. 34:605-611.

Robinson, W.L. 1969. Habitat selection by spruce grouse in northern Michigan. J. Wildl. Manage. 33:113-120.

Scott, T.G., and C.H. Wasser. 1980. Checklist of North American plants for wildlife biologists. The Wildl. Soc., Washington, D.C. 20014.

Smith, R.L. 1980. Ecology and field biology. Harper and Row, N.Y.

Snedecor, G.W., and W.C. Cochran. 1967. Statistical methods. Iowa State Univ. Press, Ames.

Stoddart, L.A., A.D. Smith, and T.W. Box. 1975. Range Management. McGraw-Hill, New York.

Wallmo, O.C., W.C. Regelin, and D.W. Reighert. 1972. Forage use by mule deer relative to logging in Colorado. J. Wildl. Manage. 36:1025-1033.

Wetmore, C.M. 1967. Lichens of the Black Hills of South Dakota and Wyoming. Publ. Mus. Michigan State Univ., Boil Ser. 3:209-464.

Wilson, C.L., and W.E. Loomis. 1962. Botany. Holt, Rinehart, and Winston Inc.