A RELICT AREA IN THE CENTRAL OREGON JUNIPER ZONE

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Abstract. Vegetational and soil characteristics of two relatively undisturbed associations on a semi-isolated plateau in the central Oregon juniper zone were studied and related. *Agropyron spicatum* was the most abundant herbaceous perennial in both entities. *Artemisia tridentata* was specific to the *Juniperus/Artemisia/Agropyron* association. *Purshia tridentata* was specific to the *Juniperus/Purshia/Agropyron* association. The specificity of these species was related to the way soil characteristics affected the soil water regime and rooting resistance. *Purshia tridentata* occurred on coarse-textured stony soils overlying cracked bedrock. *Artemisia tridentata* occurred on finer textured nonstony soils with dense, clayey subsoils. Other differences in floristics, soils, and soil-factor effects between the two units were sufficiently great to warrant classification of the entities as individual ecosystems. The annual *Bromus tectorum* was a conspicuous part of the vegetational component of both units. *Juniperus occidentalis* was not abundant in either association. It occurred in small clumps or as individual trees unevenly distributed throughout the area. Wildfires appeared to have been a major factor controlling the distribution of the species.

Areas undisturbed by white man's influence probably no longer exist, but some places have been found where disturbance is negligible (Rummell 1951, Jameson, Williams, and Wilton 1962). Study of these locations has provided valuable information on conditions prior to domestic livestock grazing or other white-man-induced effects and has established bases for management on these and similar areas. During July and August of 1960 and 1961, data on vegetation and soils were obtained from a near virgin area in the central Oregon juniper zone. This area, known as The Island, is located approximately 10 miles southwest of Madras in Jefferson County, Oregon.

THE AREA

The Island (Fig. 1) is a semi-isolated plateau, approximately 250 acres in size, located between the Crooked and Deschutes River canyons in central Oregon. The top of The Island is nearly flat with an elevation of approximately 2,400 ft above sea level. Vertical cliffs 200-700 ft high surround it on three sides. The only means of access, excluding helicopters or ropes and pitons, is a crude trail on a steep talus slope on the south side of the area.

The Island is young geologically. Within recent times, between 10,000 and 15,000 years ago and after the two rivers excavated canyons 1,000 feet deep, vulcanism took place to the south. Accompanying lava flows occurred within and near the canyons, filling them with olivine basalt to within 200-300 ft of the top (Hodge 1942). These same lava flows cover much of the area adjacent to the canyon country, forming the primary bedrock of the landscape (Stearns 1931). Subsequent lakes filled partially with unconsolidated sediments before water cut the present day canyons and isolated The Island. In many places, including The Island, these sediments constitute the parent material of the present day soils.

The regional climate of The Island and the surrounding area is continental modified by marine air currents from the Pacific Ocean. It is semiarid characterized by low annual precipitation, dry summers with warm days and cool nights, and cool to cold winters relatively snow-free. No month of the year is entirely frost-free, although killing frosts generally do not occur during June, July, or August. At Madras, the nearest official U.S. Weather Bureau station, the average annual precipitation based on 40 years of record is 9.29 in. (U. S. Weather Bureau 1961). Approximately 88% of the annual precipitation occurs as rain and snow fairly evenly distributed from October through June. The summer months are characteristically droughty, frequently completely dry. Average monthly temperatures at Madras range from 29.7°F in January to 66.5°F in July. The lowest recorded was —45°F in December and the highest 112°F in July. Summer temperatures exceeding 100°F are not uncommon. Even with the high, summer day temperatures, nights are cool with low humidity.

The only known instance of planned livestock grazing on The Island occurred when a band of sheep, driven single file up and down the trail, grazed for two successive summers sometime between 1922 and 1928. Water for the stock was pumped from the Crooked River by a ramjet pump. This operation was terminated due to inaccessibility, aridity, and high losses caused by

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FIG. 1. An oblique aerial view of The Island looking southwest. The only access to this semi-isolated plateau is a crude trail on a steep talus slope on the south side. The *Juniperus/Purshia/Agropyron* association, approximately 35 acres in size, is restricted to sandy soils on the northeast edge of the plateau. The remainder of the area, approximately 215 acres, is occupied by the *Juniperus/Artemisia/Agropyron* association.

coyotes (*Canis lestes*)[2] and bobcats (*Lynx fasciatus pallescens*), either directly or by their causing the sheep to fall to their deaths over the high cliffs. Some domestic goats wandering from nearby early-day goat ranches probably grazed the area.[3]

Rocky Mountain mule deer (*Odocoileus hemionus hemionus*) are part of the fauna of The Island. A few shed antlers have been found indicating some use during the late fall-early winter period. Occasional does with spotted fawns have been seen during May. The latest summer date deer have been observed has been early July. Cottontail rabbits (*Sylvilagus nuttalli nuttalli*) are common. Other fairly common mammals are mice (*Microtus* sp.), chipmunks (*Eutamias* sp.), and ground squirrels (*Citellus* sp.).

METHODS

Two plant associations[4] which characterize The Island, *Juniperus/Artemisia/Agropyron* and *Juniperus/Purshia/Agropyron,* were delineated on an aerial photograph. The separation was based initially on the vegetational physiognomy of each unit. Five 50- by 100-foot macroplots were located in representative stands in each association taking care to avoid ecotones. Within each macroplot, four 50-foot combination line-belt transects were located in restricted random fashion. Along each transect, ten 1- by 2-foot observation plots were systematically placed. This sampling scheme has been discussed by Poulton and Tisdale (1961).

Percentage foliage cover of all herbaceous species, basal area of perennial herbaceous species, litter cover, and bare soil surface were ocularly estimated using the small observation plots. Foliage cover of shrubs was measured by the line intercept method (Canfield 1941) on the 50-foot

[2] Animal nomenclature from Anthony (1928).

[3] Personal interview with Mr. Harry Johnson, 45-year resident of Culver, Oregon, a small farming community 4 miles east of The Island.

[4] An association is ". . . the fundamental unit of phytosociology, being a plant community of certain floristic composition, of uniform habitat conditions and of uniform physiognomy" (Wildeman 1910). The term, as used here, is applied only to climax communities according to the polyclimax concept. The association names depict the climax aspect of perennial plant dominants of the various community layers.

line transects. Shrub density was obtained by counting all individuals rooted in a 4-foot belt transect bisected by each line transect. Average maximum heights of mature shrubs were determined by measuring all mature plants within the belt transects. Percentage foliage cover of trees was estimated over the whole of each association from an aerial photograph (Moessner 1960). Production of the selected perennial herbs was determined by clipping and air-drying current growth from 20 randomly located 24-square-foot plots in each association.

In addition, percentage constancy of all species was computed on the basis of presence or absence within the bounds of the macroplots. Percentage composition of perennial species was computed on the basis of total perennial foliage cover.

Soils data were obtained from pits dug immediately adjacent to each macroplot. Profile characteristics were described following standard procedures in the Soil Survey Manual (Soil Survey Staff 1951). In addition, samples of the A horizon and the finest textured part of the B horizon were collected and analyzed for (1) textural classes, (2) moisture equivalent, (3) 15-atmospheres tension, (4) bulk density, and (5) soil reaction (pH). In addition, percentages of organic matter and total nitrogen were determined for the A horizon. The results of analyses for moisture equivalent, 15-atmospheres tension, and bulk density were used to compute the total available water storage capacity in the 2- to 14-inch soil zone (Broadfoot and Burke 1958). All soil analyses were made by the Soil Testing Laboratory of the Oregon Agricultural Experiment Station at Corvallis.

Results

Juniperus/Artemisia/Agropyron *association*

The *Juniperus/Artemisia/Agropyron* association occupied approximately 215 acres. *Juniperus occidentalis*[5] had an average foliage cover of 10% (Table I). The trees were unevenly scattered, however, and occurred as individuals or small clumps. Wildfire appears to have been a major factor determining tree survival and distribution in this and the *Juniperus/Purshia/Agropyron* association. Charred stumps and logs on the surface and roots in the soil were fairly common.

A striking characteristic of this association was the wide spacing of *Agropyron spicatum,* the dominant herbaceous species (Fig. 2). The 9.2% foliage cover of *A. spicatum* provided nearly two-thirds the cover of all perennial herbs and more than one-fourth the cover of all perennial vegetation (Table I). The individual, robust grass plants excluded nearly all other species from the spaces between them.

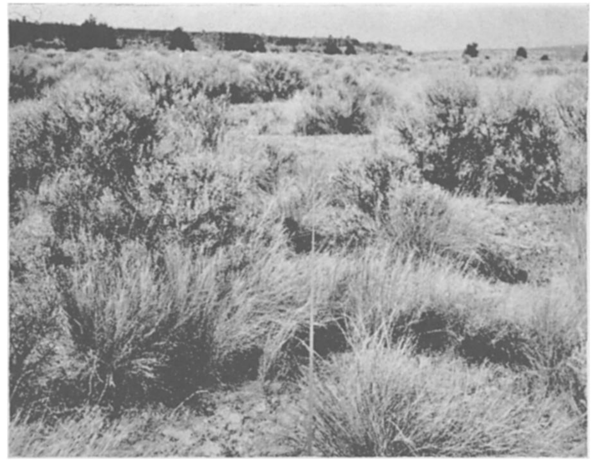

FIG. 2. Wide spacing between individual plants of *Agropyron spicatum* is characteristic of the *Juniperus/Artemisia/Agropyron* association on The Island. Note the paucity of vegetation in the spaces between the plants.

Stipa thurberiana was the next most abundant herb; although constancy of the species was only 80%, the foliage cover (2.0%) accounted for approximately 14% of the total herbaceous cover. *Poa secunda, Festuca idahoensis,* and *Sitanion hystrix* were the only other perennial grasses encountered in the sample units. The cover percentages of these species were 1.3, 0.4, and 0.1, respectively. *Festuca idahoensis* occurred mostly in the deep shade of shrubs or trees.

There was a paucity of perennial forbs. *Lomatium triternatum* was the most prevalent with 0.6% cover. Including this species, only eight forbs were identifiable when the association was examined.

Artemisia tridentata had a cover value of 8.5%, representing one-fourth of the total perennial cover (Table I). The average maximum height of mature plants of this species was 1.95 feet, and density of the species was approximately 1,300 plants per acre. Cover of *Chrysothamnus nauseosus,* the only other shrub measured in this entity, was 1.1%. Mature plant height was 2.03 feet, and density was 200 plants per acre.

Bromus tectorum was fairly abundant. It occurred throughout the area with 1.7% cover. Other annuals were present but not as conspicuous as this species.

Two uncorrelated soil series were associated with the *Juniperus/Artemisia/Agropyron* association. Both were nonstony, strongly developed

[5] Plant nomenclature for grasses from Hitchcock (1950), for trees from Little (1953), and for shrubs and forbs from Abrams (1940-1960).

TABLE I. Cover, composition, constancy, and production of species in two associations on The Island[1]

Species	Associations							
	Juniperus/Artemisia/Agropyron				*Juniperus/Purshia/Agropyron*			
	Cover (%)	Composition (%)	Constancy (%)	Production lb/acre)	Cover (%)	Composition (%)	Constancy (%)	Production (lb/acre)
Juniperus occidentalis	10.0	29.6	100	—	4.0	17.8	100	—
Agropyron spicatum	9.2	27.2	100	378	6.2	27.6	100	209
Artemisia tridentata	8.5	25.1	100	—	—	—	—	—
Purshia tridentata	—	—	—	—	8.7	38.7	100	—
Stipa thurberiana	2.0	5.9	80	95	1.1	4.9	100	88
**Bromus tectorum*	1.7	—	100	—	12.4	—	100	—
Poa secunda	1.3	3.8	100	35	.4	1.8	80	16
Chrysothamnus nauseosus	1.1	3.3	100	—	.6	2.7	40	—
Lomatium triternatum	.6	1.8	100	—	.1	.4	40	—
**Festuca octoflora*	.6	—	100	—	.3	—	80	—
Festuca idahoensis	.4	1.2	60	25	.5	2.2	60	35
Astragalus sp.	.3	.9	100	—	.1	.4	20	—
Agoseris sp.	.1	.3	60	—	—	—	—	—
Achillea millefolium	.1	.3	100	—	.6	2.7	100	—
**Collinsia parviflora*	.1	.3	100	—	.5	—	100	—
Sitanion hystrix	.1	.3	40	—	—	—	20	—
Phlox douglasii	.1	.3	20	—	.1	.4	20	—
**Cryptantha ambigua*	—	—	20	—	.6	—	100	—
**Linanthus harknessii*	—	—	20	—	—	—	—	—
Eriogonum umbellatum	—	—	20	—	—	—	—	—
Erigeron linearis	—	—	20	—	—	—	—	—
Zygadenus paniculatus	—	—	20	—	.1	.4	20	—
Total perennial herbs	14.2	42.0	—	—	9.2	40.9	—	—
Total shrubs	9.6	28.4	—	—	9.3	41.3	—	—
Total perennial vegetation	33.8	—	—	—	22.5	—	—	—
Total annual vegetation	2.4	—	—	—	13.8	—	—	—
Total all vegetation	36.2	—	—	—	36.3	—	—	—

[1]Constancy computed on the basis of species presence or absence in five 50- by 100-foot macroplots. Cover recorded for species having at least 0.1% foliage cover Composition computed on the basis of total perennial vegetation cover.
*Annuals.

Brown loams but had formed from different parent materials. One series developed from hard-packed, river- and lake-laid sediments; the other developed from relatively loose loess and very fine sands. The parent material of both soils contained numerous, partially decomposed, small basalt fragments and was 26 and 13 inches, respectively, below the surface of the two soils. Discontinuous caliches occurred in the lower B horizons of the two soils. Small stones occupied 5% of the volume of the solum of both soils.

FIG. 3. The claypan in the B horizon of the soils occurring with the *Juniperus/Artemisia/Agropyron* association restricts root growth and reduces the effectiveness of the available soil moisture storage capacity.

A dense, nonstony clayey layer, which restricted root penetration and reduced the effectiveness of the available water storage capacity, was common to both soils (Fig. 3). In the first series, this horizon began approximately 15 in. below the soil surface, was 8 in. thick, and had clay texture. The same horizon in the second series started at an average depth of 8 in., was 2 in. thick, and had clay loam texture. No roots penetrated the thicker, heavier subsoil of the first series. Few roots penetrated the thinner, slightly coarser subsoil of the latter series.

Other characteristics of these two soils were the same. The available soil moisture storage capacity in the 2- to 14-inch soil zone was 2.31 in. (Table II). Organic matter and total nitrogen of the A horizon was 1.5% and 0.08%, respectively. The soil reaction ranged from slightly acid to neutral (pH 6.5 to pH 7.0) in the surface

TABLE II. Average values of selected surface and subsoil characteristics in two associations on The Island

Characteristic	Association	
	Juniperus/ Artemisia/ Agropyron	*Juniperus/ Purshia/ Agropyron*
Basal area—perennial herb (%)	6.6	7.2
Bare soil surface (%)	41.3	18.7
Litter cover (%)	30.7	62.3
Organic matter: A horizon (%)	1.50	1.43
Total nitrogen: A horizon (%)	.08	.07
Available soil moisture storage capacity: 2- to 14-inch zone (inches water)	2.31	1.67

horizon to mildly alkaline to moderately alkaline (pH 7.5 to pH 8.0) in the densest part of the B horizon.

The soil surface felt soft underfoot even though 41% of the soil surface was without living or dead plant material (Table II). Frost heaving, indicated by tipped-over clumps of *Poa secunda,* may have caused this characteristic. Pedestaled plants of *Poa secunda* and other species provided a micro-aspect of accelerated erosion, but this again was formed mostly by frost heaving. There was no evidence of other than normal geologic erosion on The Island.

Juniperus/Purshia/Agropyron *association*

The *Juniperus/Purshia/Agropyron* association occupied approximately 35 acres of The Island. Foliage cover of *Juniperus occidentalis* was only 4%. The trees were quite small and distributed mostly in scattered clumps throughout the area.

Purshia tridentata had a cover value of 8.7% which accounted for 39% of all perennial plant cover and 94% of all shrub cover (Table I). Individual plants were widely spaced with only 350 per acre. The plants were large, mature individuals, however, averaging 4.57 ft high with wide spreading crowns (Fig. 4).

Chrysothamnus nauseosus was the only other shrub measured in this association. Foliage cover of the species was 0.6%, mature plant height was 2.50 ft, and density was only 50 plants per acre.

Agropyron spicatum was the most abundant herbaceous perennial when the association was examined. The 6.2% foliage cover of this species provided 67% of the cover of all perennial herbs and 28% of all perennial vegetation (Table I). Individual plants were more widely spaced than in the *Juniperus/Artemisia/Agropyron* association. *Stipa thurberiana, Festuca idahoensis,* and *Poa secunda* were other perennial grasses measured with 1.1%, 0.5%, and 0.4% cover, respectively.

Measurements were made of only five perennial forbs which could be positively identified at least to genera. *Achillea millefolium* was the most abundant with 0.6% cover representing only 7% of the total perennial herb cover. Individuals of the species were usually found intermingled with large clumps of grass or under the deep shade of shrubs.

Bromus tectorum was the most abundant species when the *Juniperus/Purshia/Agropyron* association was examined. This annual grass had 12.4% cover, approximately one-third the cover of all vegetation (Table I). It was very vigorous, occurring mostly within the peripheral crown area of *Purshia tridentata* (Fig. 4). In addition, the species was very abundant in other places all over The Island, mainly around individual juniper trees (Fig. 5).

The *Juniperus/Purshia/Agropyron* association was associated with a single uncorrelated soil series. This soil, a sandy loam Regosol, was very

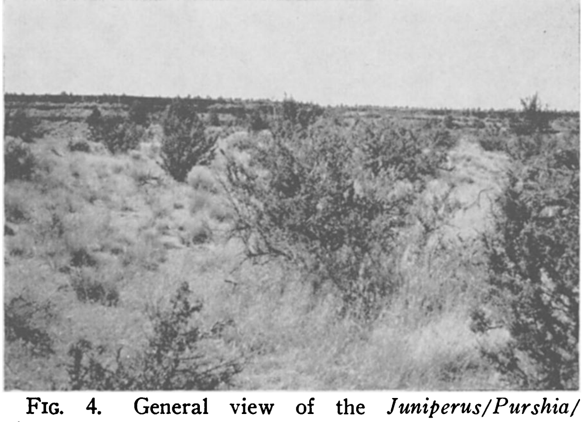

FIG. 4. General view of the *Juniperus/Purshia/ Agropyron* association on The Island. Density of *Purshia tridentata* is low, but individual plants are tall with wide crowns. *Bromus tectorum* forms a dense cover under the shrub crowns.

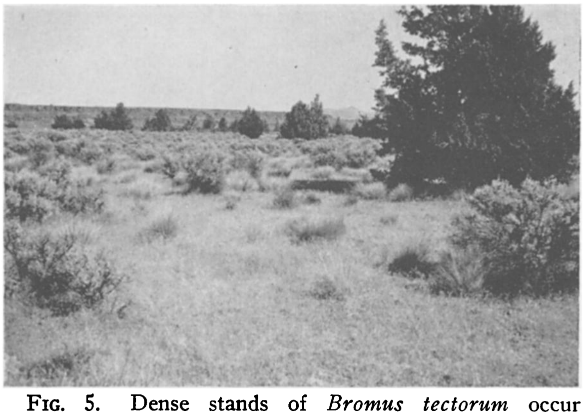

FIG. 5. Dense stands of *Bromus tectorum* occur around some trees on The Island. This could have been caused by sheep seeking shade when the area was grazed for two successive summers between 1922 and 1928.

shallow (8 in.), overlying a stony clay loam soil. The sandy parent material was of aeolian origin and contained about 30% pumice.

The buried soil has developed from alluvium of the same origin as the soils occurring with the *Juniperus/Artemisia/Agropyron* association. It was much stonier, with stones occupying 35% of the buried A horizon and 80% to 90% of the buried B horizon. At 18-20 in. below the soil surface, there was a discontinuous hardpan cemented by carbonates and silicates. Underlying the total soil was cracked bedrock with numerous plant roots within the cracks.

The water regime in this soil was much different from that in the soils occurring with the *Juniperus/Artemisia/Agropyron* association. The available soil moisture storage capacity in the 2- to 14-inch zone was 1.67 in. (Table II). Although this was 0.64 inch less than the former soils, the effectiveness is improved due to the stoniness and lighter texture.

The organic matter and total nitrogen contents in the A horizon were 1.43% and 0.07%, respectively. The soil reaction ranged from medium acid (pH 6.0) to slightly acid (pH 6.5) in the surface horizon to slightly acid and neutral (pH 7.0) down to the buried soil. The buried soil graded from neutral to mildly alkaline (pH 7.5) down to a depth of approximately 18 inches. The soil reaction below this soil zone was moderately alkaline (pH 8.0).

Other features of The Island

Numerous other species on The Island were vernal and not identifiable when the associations were measured or were so sparse they did not occur in the sample units.

Vernal species identified in the spring included *Allium douglasii, Castilleja applegatei, Descurainia* sp., *Orthocarpus tenuifolius, Erodium cicutarium, Coldenia nuttallii, Arabis sparsiflora, Orobanche uniflora, Crepis* sp., and *Delphinium* sp. Species with scattered and sparse distributions included *Balsamorhiza sagittata, Balsamorhiza terebinthacea, Penstemon* sp. (suffrutescent), *Ribes cereum, Erigeron* sp., *Holodiscus discolor, Eriogonum* spp. (herbaceous and suffrutescent), *Chrysothamnus viscidiflorus, Tetradymia canescens,* and *Artemisia tripartita.*

FIG. 6. A small community of *Cercocarpus ledifolius* occurs on the west edge of The Island on extremely shallow soils. Roots of the species are numerous in bedrock cracks.

Communities of *Elymus cinereus* occurred in two small spots where the soils were deep and sandy. A small community of *Cercocarpus ledifolius* was found on the west edge of The Island (Fig. 6). There was very little soil where this species had become established; its roots extended directly into cracks of the basalt bedrock where thin films of soil had formed.

Clearings made by colonies of the western harvester ant, *Pogonomyrmex occidentalis,* were conspicuous on The Island although they were not abundant. There was less than one clearing per 4 acres throughout the area.

Discussion

Plant communities relatively undisturbed by white man's influence show the integrated results of long-time environmental interactions. The floristics of these communities, particularly the dominants in the different community layers, character species, and sociability of species, provide clues to the classification of homogeneous ecological entities. Associated abiotic factors considered as independent and interacting influences on the communities provide additional evidence for separating the units. On this basis, each plant association described and their related soils represent component parts of individual ecosystems.

Presumably, germinals of all species have had sufficient chance to become established in all places on The Island. However, four perennial species, *Artemisia tridentata, Agoseris* sp., *Eriogonum umbellatum,* and *Erigeron linearis,* occur in the *Juniperus/Artemisia/Agropyron* association and not in the *Juniperus/Purshia/Agropyron* association. *Purshia tridentata* is specific to the *Juniperus/Purshia/Agropyron* association. Differences in the cover, constancy, and production of other species, including *Agropyron spicatum, Poa secunda, Chrysothamnus nauseosus, Lomatium triternatum,* and *Astragalus* sp., are striking between the two assocations.

The effectiveness of the available soil-moisture storage capacities and the ability of the soils occurring with the two associations to support certain species is different. The clayey, nonstony subsoils associated with the *Juniperus/Artemisia/Agropyron* association mechanically restrict root penetration and reduce the effectiveness of stored water. In comparison, the stony, coarser textured subsoils of the *Juniperus/Purshia/Agropyron* association allow roots to penetrate readily. Observation of soil profiles reveals few roots in this soil zone of the first association. Roots are abundant throughout the soil occurring with the second association and even extend into cracks in the bedrock.

The soil effects partially explain the specificity of *Purshia tridentata*. This species prefers habitats which provide minimum restriction to deep root penetration—either relatively coarse textured soils, finer textured soils with relatively high stone contents, or shallow soils with these characteristics and overlying loose or fractured material. In California, *Purshia tridentata* grows best on coarse textured soils excessively drained and rapidly permeable (Nord 1959).

The differences in floristics, soils, and soil-factor effects between the two units provide strong evidence that their natural biological potentials represent separate entities. Consequently, they must be classified as different ecosystems in which plans for use and management and the resultant effects will not be the same. For example, attempts should not be made to establish *Purshia tridentata,* a desirable deer forage, on clayey, nonstony soils. Criteria for evaluating range condition and trend in condition must consider each system as an entity.

Although two taxonomic soil units occur with the *Juniperus/Artemisia/Agropyron* association, their apparent biological effectiveness is the same. The variation in the position and thickness of the claypan and the nature of the parent material of the two soils compensate to provide equivalent soil environments. Few roots are present in the relatively deep, thick clayey zone of the first described soil, and no roots grow through it. In the second soil, few roots also occur in the shallower, thinner, slightly coarser clayey zone. However, some roots penetrate this soil layer and grow into the looser underlying material to take advantage of the growth-supporting potential in this soil zone. As a result, the plant-growth influences of the deeper, thicker, denser claypan of the first soil are equalized by the shallower, thinner, coarser claypan of the second soil. Consequently, the plant communities on both soils are similar.

Since the nonstony and clayey soils of the *Juniperus/Artemisia/Agropyron* association mechanically restrict root penetration (Veihmeyer and Hendrickson 1948) the stored water is not as available as it would be in coarser and stonier soils. In addition, the level aspect further reduces moisture effectiveness through increased water vaporization in the soil and evaporation from the soil created by intense insolation (Geiger 1957). These factors are primary reasons for the wide spatial distribution of plant species in this association.

The effectiveness of the available water in the soil occurring with the *Juniperus/Purshia/Agropyron* association is also reduced. The sandy topsoil, extremely stony, buried soil, discontinuous hardpan, and cracked bedrock allow for more rapid water infiltration and drainage, deeper water penetration, and greater evaporation from near the surface as compared with the soils occurring with the *Juniperus/Artemisia/Agropyron* association. Consequently, species such as *Purshia tridentata,* which characteristically roots deep in soils offering little restriction to root penetration, and *Bromus tectorum,* which takes advantage of moisture when it is available, are capable of maintaining abundant populations.

Bromus tectorum is fairly abundant in both associations. In the *Juniperus/Artemisia/Agropyron* association, it was fifth in percentage cover among all species and exceeded the amount of cover of nine perennials. *B. tectorum* was introduced from Eurasia about 1850 and spread profusely into the semiarid and arid western United States by 1900 (Warg 1938). Although many workers consider it indicative of disturbed conditions, *Bromus tectorum* should be regarded as part of either climax or well-managed vegetation within its range. Other workers have proposed the same concept (Daubenmire 1942, Robertson and Pearse 1945, Tisdale 1947, Hull and Pechanec 1947, Stewart and Hull 1949, Hulbert 1955). The adaptability of the species is such that it can compete successfully for niches not occupied by perennial species in relatively undisturbed habitats. It begins growth and matures earlier in the spring than most perennials. In addition, *Bromus tectorum* is a prolific seed producer, seed germination is extremely high (nearly 99.75%), sprouting is very rapid (complete within 5 days), and seedling development is strong (Warg 1938, Hulbert 1955). These characteristics favor successful competition by the species in climates similar to central Oregon where soil moisture in the surface horizons is usually abundant in the early spring.

The cause of the prevalence of *Bromus tectorum* in the *Juniperus/Purshia/Agropyron* association and around some individual *Juniperus occidentalis* trees throughout the area (Figs. 4

and 5) is speculative. The entity is probably in a semiarrested state of recovery from grazing in which *Bromus tectorum* is successfully competing for space previously used by perennial herbs. It is not unlikely that the sheep concentrated in this ecological unit because of their preference for *Purshia tridentata* browse and tree shade. With few exceptions, *Bromus tectorum*-dominated patches of vegetation occur immediately to the north and east of the trees, areas shaded from the afternoon sun. These animal concentrations reduced the perennial plant cover and allowed the annual plant to become firmly established. Once these disturbed areas were occupied by *Bromus tectorum,* competition was so intense that perennial species could not reestablish easily. Warg (1938) and Piemeisel (1951) also concluded that the species tenaciously maintained itself once established. The longevity of stands of *Bromus tectorum* is not known but Stewart and Hull (1949) reported that in intermountain *Artemisia* vegetation, it persisted for 30 to 40 years.

Fires have strongly influenced the abundance of *Juniperus occidentalis* in the two associations. The occurrence of burned wood on and in the soil suggests that the species was at one time more abundant and quite evenly distributed. No environmental differences, including soil characteristics within associations, were observed between places where trees were numerous and where there were none. The species is not rapidly reestablishing itself in the burned areas. In fact, in a few small areas, fires have eliminated both the tree and shrub strata with the herbaceous stratum virtually "closing" those portions of the systems to reentry of these species under present conditions. Individuals of *Juniperus occidentalis,* especially in the *Juniperus/Artemisia/Agropyron* association, are mature and the stands are even-aged.

Comparison of vegetation of the *Juniperus/Artemisia/Agropyron* association on The Island with that in comparable but disturbed habitats on the "mainland" close to The Island indicated that heavy livestock grazing greatly reduced the abundance of *Agropyron spicatum* (9.2% cover to 2.0% cover) and eliminated *Festuca idahoensis. Poa secunda* decreased from 1.3% cover to 0.8% cover, and *Stipa thurberiana* decreased from 2.0% cover to 1.0% cover. The space vacated by these species was occupied mostly by *Bromus tectorum,* which increased from approximately 2% cover to approximately 30% cover. Percentage cover of *Artemisia tridentata* increased from 8.5% to 15.1%, and the stand contained more young plants of the species.

General observations of a grazed representative of the *Juniperus/Purshia/Agropyron* association with the representative unit on The Island indicate that heavy grazing causes great reductions in the more important perennial plants and increases abundance of *Bromus tectorum. Purshia tridentata* is little affected except that the individual plants become tightly hedged by heavy grazing, and no young plants are present in grazed stands.

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CHAPARRAL SUCCESSION IN A SAN GABRIEL MOUNTAIN AREA OF CALIFORNIA

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Abstract. Succession in chaparral stands dating to wildfires of 1896 and 1919 was studied on the San Dimas Experimental Forest. Data from 20 pairs of one-hundredth acre plots were segregated by the Uppsala method into five plant associations, each having two or more species in common. Ceanothus and chamise were being eliminated from north-facing stands which then were dominated by scrub oak, holly-leaved cherry, and redberry. Given fire protection, a low oak woodland is expected to develop on these north sites. Although ceanothus had all but disappeared from older stands on south-facing slopes, chamise and black sage were increasing in numbers. A few mountain-mahogany, sugar bush, and redberry shrubs were competing successfully on these exposures and in the absence of fire they might prevail. The composition of future south slope stands, however, is expected to change very little. Future north slope stands will be dominated by plants which were infrequent in the long unburned community.

INTRODUCTION

Although successional patterns are well known for many North American plant associations, they are relatively unknown in southern California's chaparral, where detailed histories of the vegetation and land use often are lacking. Ecological studies at San Dimas Experimental Forest[3] on vegetation development form a basis for this study on the influence of age on chaparral stand composition.

To early settlers the chaparral was a troublesome brushland of little economic value or potential. Fire was used to clear homesites, expand agricultural land, and even to drive out game.[4] During the San Gabriel gold rush, miners used fire to open up the mountains for prospecting. This method of brush removal also was used in some areas by cattle and sheep herders seeking to improve grazing and to gain access to mountain meadows. All too often the fire escaped control, if any had been intended, and burned unchecked until extinguished by fall rains. Considerable evidence (Society of American Foresters, California Section 1931) shows that irresponsible and indiscriminate burning has expanded upward the limits of brushland at the expense of woodlands and forests formerly on this land. A few of the early naturalists recognized the watershed and flood control values of this unique plant formation but until near the turn of the century these men of vision spoke almost unheeded. By then the recurring pattern of mountain wildfire, diminished water supply, and increased flood hazard had become all too apparent (Plummer 1911). A need became recognized for more rational management of the increasingly important brushland

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[3] The San Dimas Experimental Forest is a 17,000-acre research laboratory located in the San Gabriel Mountains of southern California, maintained by the Forest Service, U. S. Department of Agriculture, in cooperation with the State of California, Department of Natural Resources, Division of Forestry.

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