

A FLORISTIC STUDY
OF THE
FESTUCA MEADOWS
IN THE
GUNNISON NATIONAL FOREST
COLORADO

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A FLORISTIC STUDY OF THE FESTUCA
MEADOWS IN THE GUNNISON NATIONAL FOREST

During the summer of 1946 a study was made of the floral composition of Festuca meadows in the Gunnison National Forest. These meadows are within the subalpine formation and are broad expanses of Festuca, in most cases bordered by aspen. Occasionally the adjacent vegetation is a spruce-fir forest on the upper edge of the meadow with sedges and willows frequently appearing along drainage channels where the soil is too wet for the aspen to grow. The average annual precipitation for the area varies from 25 to 30 inches, and the snowfall from 4 to 6 feet. The soil beneath all of the meadows is a rocky lateral moraine composed of a mixture of granitic and sedimentary rocks resting on dark gray shale.

Seven meadows in the East River valley and two meadows in Slate River valley near Kebler pass were selected for this study.* These meadows ranged in altitude from 9,400 feet to 11,800 feet which is the timberline in this area. Each meadow in which collecting was done was called a station. These stations were classified into four areas and numbered as follows: (1) west exposure, (2) east exposure, (3) south exposure, and (4) high altitude areas. The letters A, B, and C were used to identify different meadows selected for study in each area. These meadows were visited several times during the summer to obtain information on plant distribution.

DESCRIPTION OF SUBALPINE STATIONS IN EAST RIVER VALLEY

Station 1A was a broad, rolling area with a west exposure, 3.5 miles south of Gothic, Colorado. The slope varied from 5° to 15° due to the irregular

* Additional specimens were collected at a high altitude station near Cumberland Pass by Dr. Harriet G. Barclay.

character of the moraine. The altitude ranged from 9,500 to 9,800 feet.

Station 1B was also an area with a west exposure about 2.5 miles south of Gothic, Colorado. This meadow was surrounded by aspen groves. The altitude ranged from 9,800 to 10,000 feet. The topography was less steep than station 1A.

Station 1C was a broad area with west exposure one mile south of Gothic, Colorado. The altitude ranged from 9,600 to 9,700 feet. The topography was rolling with an average slope of approximately 10° . The upper edge of this meadow was bordered by a large aspen grove. Seepage water from this grove and from two streams which flowed across the meadow maintained a high moisture content in the soil of the lower areas adjacent to the drainage channels. In places it was so moist that the Festuca was replaced by False Helibore or Willow Savannah. Three line transects and one belt transect were made to show the relative abundance of different species in different parts of this meadow.

Station 2A had an east exposure with an elevation of 9,600 to 9,700 feet and a slope of about 10° . This area was 3.5 to 4 miles south of Gothic, Colorado. It was generally not so dry as the west exposures but had no wet depressions as occurred at station 1C.

Station 2B was located about 3.5 miles north of Crested Butte, Colorado. The major portion of this meadow was nearly level. The north edge had a steep north facing slope of about 15° in one place. The altitude ranged from 9,500 to 9,600 feet.

Station 2C had an east exposure about one mile south of Gothic, Colorado. It was on a broad gentle slope with no depressions. The altitude was 9,500 feet.

DESCRIPTION OF SUBALPINE STATIONS IN SLATE RIVER VALLEY

Station 3A was an area with a south exposure about 6 miles west of Crested Butte, Colorado, on the road to Kebler pass. This area had a slope of approxi-

mately 20°. The soil was very rocky and dry. The presence of *Vaccinium* indicated that the soil was acid. The altitude varied from 9,500 to 9,600 feet.

Station 3B was about 1.5 miles west of station 3A and also had a south exposure. This station was much broader than station 3A and had a gentle slope of 3 to 5°. The soil was dry and stony, and the presence of *Vaccinium* indicated that the soil was acid. The altitude was approximately 9,700 feet.

DESCRIPTION OF HIGH SUBALPINE STATIONS

Station 4A was a high altitude meadow where the trail to Virginia Basin crosses the first "Avery Bench" about a mile northeast of Gothic, Colorado. The altitude ranged from 10,925 to 11,000 feet. The lower part of the meadow was nearly level and very moist. The upper part had a slope of approximately 15 to 20°. It was dry and very rocky, and the stand of *Festuca* was very thin. As a whole, however, the soil on this meadow was more moist than on any of the west exposures occurring at lower elevations.

Station 4B was a southwest exposure on a ridge above the road to Cumberland Pass. This station was approximately 35 miles southwest of Gothic, Colorado. Soil moisture conditions were about the same as in station 4A. The average altitude was 11,800 feet.

METHOD OF PLANT COLLECTION AND IDENTIFICATION

The plants were collected mainly by field press. Each plant was identified by number, station, and date of collection. When it was inconvenient to carry a press to the field, a vasculum was used, and only the plants from one station were placed in it. These plants were numbered and put into a press after returning to camp. All numbers, dates of collection, and stations were recorded in a field notebook.

Grasses were identified by using Hitchcock's Manual of Grasses of the United States. Other plants were identified by using either New Manual of Rocky Moun-

tain Botany by Coulter and Nelson, or Rocky Mountain Flora by Rydberg. A preliminary check of questionable identifications was made in the herbarium at the Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma. All plants were checked in the herbarium of the Missouri Botanical Garden in St. Louis, Missouri. Difficult groups were sent to the following individuals for rechecking: grasses, to Dr. Jason R. Swallen at the U. S. National Museum; Cruciferae, to Dr. Reed C. Rollins at Stanford University; Umbelliferae, to Dr. Lincoln Constance at the University of California; and Compositae, to Dr. J. M. Greenman of the Missouri Botanical Garden.

ANALYSIS OF PLANT COLLECTION

After the plants were identified, they were arranged according to their phylogenetic relationships by listing the individual plants according to families, the stations at which they occurred, and the dates of collection.

Dominant and Seasonal Aspects

The dominant plant in these meadows is *Festuca Thurberi*. It covers the whole meadow leaving little space for other plants to come in except where it dies out or is disturbed. It reproduces vegetatively by developing new culms on the outer portion of the bunch. It occasionally reproduces by seeds in the absence of severe competition.

In these meadows three seasonal aspects were observed from June 23 to August 21, 1946. The plants collected and classified according to seasonal aspects are given in table 1. The vernal aspect in some of the meadows was that of the blue lupine. In other meadows this vernal aspect was dominated by *Ligusticum Porteri*. Eleven species appeared in the vernal aspect that died out before August. Thirty-nine species bloomed early but remained green during the growing season.

The aestival aspect of the meadow was dominated by *Campanula*, *Calochortus*, and composites such as *Erigeron*, *Solidago*, and *Agroseris*. Six species appeared only in July. Seventy-five bloomed in July but remained green after the blooms disappeared.

The serotinal aspect was that of the *Gentiana Parryi*, with the composite *Machaeranthera aspera*. Numerous grasses were collected along with the serotinal aspect since they were mature at that time. Many of the grasses grow in the meadow all season. Nine grasses and seven dicotyledonous plants were collected during this period.

Subdominants

The subdominants at all stations for the whole season were *Bromus anomalus* Rupr., *Agropyron trachycaulon* (Link.) Malte., *Polygonum Douglasii* Greene, *Vicia americana*, *Lathyrus leucanthus*, *Artemisia aromatica*, *Castilleja sulphurea*, *Linum Lewisii*, *Potentilla gracilis*, *Ligusticum Porteri*, *Androsace septentrionalis* L. var. *diffusa* (Small) Kunth, *Collomia linearis* Nutt., *Pseudocymopterus montanus* (Gray) C. & R., and *Achillea millefolium* L.

The subdominants arising in July and observed the rest of the season at all stations were *Galium boreale* L., *Agroseris glaucum* (Nutt.) Greene, and *Erigeron macranthus* Nutt.

Table 1. Plants Collected and Classified According to Seasonal Appearances

Vernal (Die before August)

Allium reticulatum Fraser
Delphinium Nelsonii Greene
Lepidium ramosissimum A. Nels.
Draba stenoloba Ledeb. var.
 nana (Schulz) Hitchc.
Phacelia heterophylla Pursh
Mertensia ciliata (Torr.) Don
Mertensia fusiformis Greene
Mertensia alpina (Torr.) G. Don
Antennaria speciosa
Senecio sphaerocephalis Greene
Taraxacum officinale Weber

Vernal (Appear all season)

Arenaria congesta Nutt.
Berberis aquifolium Pursh
Thlaspi arvense L.
Barbarea orthoceras Ledeb.
Arabis Drummondii Gray
Erysmium amoenum Greene
Dasiophora fruticosa (L.) Rydb.
Fragaria americana (Porter) Brit.
Potentilla gracilis Dougl.
Potentilla hippiana Lehm.
Lupinus Bakeri Greene
Lupinus humicola A. Nels.
Astragalus flexuosus Dougl.

Vernal (Appear all season) cont.

Vicia americana Muhl.
Lathyrus leucanthus Rydb.
Geranium Richardsonii F. & M.
Linum Lewisii Pursh
Viola bellidifolia Greene
Viola erectifolia A. Nels.
Pseudocymopterus montanus
 (Gray) C. & R.
Washingtonia occidentalis
 (Nutt.) C. & R.
Ligusticum Porteri C. & R.
Lomatium dissectum (Nutt.)
 Math. & Const. var.
 multifidum (Nutt.) Math. & Const.
Androsace septentrionalis L.
 var. *diffusa* (Small) Kunth
Collomia linearis Nutt.
Gilia aggregata (Pursh) Spreng.
Hydrophyllum Fendleri (Gray) Heller
Lappula floribunda (Lehm.) Greene
Pentstemon strictus Benth.
Castilleja linearifolia Benth.
Castilleja sulphurea Rydb.
Lonicera involucrata Banks
Valeriana acutiloba Rydb.
Valeriana certophylla (Hook.) Piper
Dugaldia Hoopesii
Achillea millefolium L.

Table 1 (cont.)

Vernal (Appear all season) cont.

Artemisia aromatica Rydb.
Artemisia tridentata Nutt.

Aestival (July only)

Calochortus Gunnisonii Wats.
Smilicina stellata (L.) Desf.
Draba spectabilis Greene
Arabis glabra (L.) Bernh.
Heuchera parvifolia Nutt.
Antennaria aprica Greene

Aestival (July and August)

Stipa columbiana Macoun.
 var. *Nelsonii* (Scribn.) Hitchc.
Phleum alpinum L.
Phleum pratense L.
Trisetum spicatum (L.) Richt
Koeleria cristata (L.) Pers.
Melica spectabilis Scribn.
Poa Fendleriana (Steud.) Vasey
Poa interior Rydb.
Poa pratensis L.
Festuca Thurberi Vasey
Bromus anomalus Rupr.
Bromus polyanthus Scribn.
Agropyron subsecundum (Link.) Hitchc.
Agropyron trachycaulon (Link.) Malte.
Sitanion hystrix
Carex Egelstonii
Eriogonum subalpinum Greene
Eriogonum umbellatum Small var.
 tectum A. Nels.
Polygonum Douglasii
Lychnis Drummondii S. Wats.
Delphinium barbeyi (Huth) Huth
Aconitum columbiana Nutt.
Thalictrum Fendleri Engelm.
Anemone globosa Nutt.
Corydalis aurea Willd.
Lepidium virginiana L. var.?
Descurainia californica (Gray) Schulz
Erysimum capitatum (Dougl.) Greene
Ribes leptanthum
Ribes leptanthum var. *brachyanthum* Gray
Potentilla arguta Pursh
Sieversia ciliata G. Don
Rosa Fendleri

Aestival (July and August) cont.

Astragalus alpinum L.
Chamaenerion angustifolium (L.) Scop.
Gayophytum ramosissimum T. & G.
Vaccinium caespitosum Michx.*
Gentiana heterosepala Englem.
*Frasera speciosa**
Agastache urticifolia (Benth.) Rydb.
Dracocephalum parviflorum Nutt.
Pentstemon procerus Dougl.
Pentstemon glaucus Graham var.
 stenosepalus Gray
Pedicularis Grayii A. Nels.*
Orthocarpus luteus Nutt.
Galium boreale L.
Symphoricarpos rotundifolius Gray*
Campanula rotundifolia L.
Campanula Parryi Gray
Chrysopsis villosa Nutt.
Chrysothamnus nauseosus (Pall.) Brit.
Oreochrysum Parryi (Gray) Rydb.
Solidago corymbosa Nutt.
Solidago decumbens Greene
Aster Canybi Vasey
Erigeron Coulteri Porter
Erigeron elatior
Erigeron macranthus
Antennaria parvifolia
Antennaria rosea
Helianthella quinquenervis (Hook.) Gray
Viguiera multiflora Blake
Artemisia frigida Willd.
Artemisia gnaphaloides Nutt.
Senecio crassulus Gray
Senecio Bigelovii Gray
Senecio crocatus Rydb.
Senecio Fendleri Gray
Senecio eremophilus Rich.
Senecio glaucescens Rydb.
Senecio integerrimus Nutt.
Senecio serra Hook.
Carduus Nelsonii Pammel*
Agoseris glauca (Nutt.) Greene

Serotinal (August only)

Stipa columbiana Macoun.
Stipa Lettermannii Vasey
Stipa robusta Scribn.
Blepharoneuron tricholepis (Torr.) Nash

* Blooming and fruiting period

Table 1 (cont.)

Serotinal (August only) cont.

Dechampsia caespitosa (L.) Beauv.
Poa macroclada Rydb.
Poa stenantha Trin.
Bromus ciliatus L.
Bromus marginatus Nees.
Chenopodium atrovirens

Serotinal (August only) cont.

Gentiana Parryi Engelm.
Gentiana plebeja
Chrysothamnus lanceolatus
Aster adscendens Greene
Machaeranthera aspera Greene
Machaeranthera rubricaulis Rydb.

The plants which were subdominant at special stations included *Blepharion neuron tricholepis* and *Vaccinium caespitosum* on the south exposures, *Taraxacum officinalis* on the west exposures, and *Delphinium Nelsonii* and *Aconitum columbianum* in the wet draws of the west exposures.

In some of the meadows wet depressions were caused by an accumulation of surface drainage or seepage. All plants that grew on these areas were larger and more luxuriant than those on the drier locations. Some of these depressions were too wet for *Festuca*; consequently *False Helibore* or *Salix* were dominant.

Ligusticum Porteri usually occurred on the east exposures and only in the moist depressions on the west exposures. *Bromus polyanthus* grew best and most frequently in the more moist depressions and sometimes even displaced the *Festuca*, but it occurred on all slopes in limited numbers.

Certain species occurred only at one station. This may be due to several factors. Cattle have weakened the *Festuca* by overgrazing in some meadows; consequently remnants of subclimax plants have gained a firmer hold in places. In some meadows wet areas occurred which favored the invasion of species preferring a moist environment. Dry, rocky knolls encouraged the persistence of the pioneers because of the shallow character of the soil.

The main pioneers which were quite common are *Chrysopsis*, *Eriogonum*, *Antennaria*, *Pentstemon*, *Erysmium*, *Gilia*, and *Chrysothamnus*. There were also pioneers that persisted only at one or two stations where conditions were favor-

able for them. It was observed that the pioneer plants nearly always occurred on the upper one-third of the knolls in these meadows where the soil was less deep and lower in average moisture content. Pioneer plants which were observed at only one station were as follows:

Plants	Station
<i>Berberis aquifolium</i> Pursh.	3A
<i>Chaenactis Dugaldii</i>	4B
<i>Artemisia tridentata</i>	2B
<i>Artemisia frigida</i> (Willd.) A. Nels.	1A
<i>Antennaria speciosa</i>	1A
<i>Artemisia gnaphaloides</i>	1C
<i>Corydalis aurea</i> Willd.	1A
<i>Castilleja linearifolia</i> Benth.	1A
<i>Orthocarpus luteus</i> Nutt.	1A

Quadrat and Line Transect Analysis

Several quadrat studies and two line transects were made in the meadow at station 1C to determine the dominant species and the plant succession from the tops of knolls to the base of the slopes. The data showed that *Festuca Thurberi* was dominant. Line transects, which extended from the top to the bottom of two knolls, showed that there was a definite succession from the dry, rocky top, which was covered with pioneers, down to the bottom of each knoll where a *Festuca* meadow climax had developed. The plants which appeared along the line transects from top to bottom of two slopes are given in Table 2 according to genera.

Table 2. Plants Appearing on Line Transects From Top to Bottom of Two Slopes At Station 1C

Stage No.	Transect, west side (56 Meters)	Transect, north side (45 Meters)
1. (top of slope)	<i>Eriogonum</i> <i>Antennaria</i> <i>Chrysothamnus</i> <i>Artemisia</i> <i>Pentstemon</i>	<i>Eriogonum</i> <i>Artemisia</i> <i>Antennaria</i> <i>Taraxacum</i> <i>Pentstemon</i> <i>Potentilla</i> <i>Galium</i> <i>Achillea</i> <i>Troximon</i>

Table 2 (cont.)

Stage No.	Transect, west side (56 Meters)	Transect, north side (45 Meters)
1. (top of slope) (cont.)		Bromus* Poa* Trisetum*
		* Occasionally
2.	Lupinus Eriogonum Arabis Poa Potentilla Artemisia Ligusticum Trisetum Bromus	Troximon Gentiana Bromus Antennaria Androsace Pentstemon Polygonum Potentilla Collomia Artemisia Dasiophora Senecio Poa
3.	Poa (different species) Vicia Lathyrus Agropyron Polygonum Potentilla Eriogonum Dugaldia Achillea Troximon	Taraxacum Troximon Collomia Androsace Bromus Polygonum Galium Eriogonum Achillea Dugaldia Potentilla Poa? Trisetum Sitanion?
4.	Polygonum Trisetum Achillea Sieversia Senecio Eriogonum Agropyron Dugaldia Potentilla Galium Taraxacum Troximon	Gentiana Trisetum Taraxacum Troximon Fragaria Sieversia Bromus Polygonum Agropyron Solidago Deschampsia

Four stages were observed in these transects. Festuca appeared in all stages but was thicker on the lower part of the slope. There was also definite self-perpetuation of the Festuca in these meadows, mostly by vegetative methods. A few seedlings were found. In nearly all of these meadows the Festuca coverage amounted to over 75%, and in the climax meadows it was 90% or higher.* There were no obvious signs of forest invasion or any other invasion in any of these meadows. The surface soil was dark brown in color to a depth of 12 to 15 inches which is a characteristic of grassland soil in a temperate climate.

A COMPARISON OF PLANT COMPOSITION AND
GENERAL CHARACTERISTICS OF MEADOWS

Variations in Meadows with a West Exposure

Meadows with a west exposure were the broadest areas from which collections were made, because the lateral moraine was more extensive on the east side of the valley. These meadows, except for station 1C, were generally drier than any of the others studied; consequently plants such as the more drought resistant species of Senecio, numerous species of Antennaria, Eriogonum, Chrysothamnus, Gilia, and Pentstemon were present. All of the stations with west exposure had a very irregular topography consisting principally of small and medium-sized knolls or hillocks. Most of the species that preferred a more nearly xeric condition persisted the longest on the tops of the knolls due to the fact that less opportunity occurred for the absorption of runoff water. The soil was also less deep on or near the top of the knolls because of a more rapid loss of erosion.

* Dr. Harriet G. Barclay of Tulsa University is of the opinion that these meadows are a climax in the subalpine formation. Her reasons for calling this vegetation a climax are

1. The meadows are end products of definite lines of succession.
2. Complete dominance in the community, and the limits coincide with the limits of the subalpine zone.
3. Self-perpetuation bunches enlarge and reseed.
4. No evidence of forest invasion or any other invasion is present.
5. The soil resembles a grassland soil.

Station 1C had more seepage areas and streambeds than any of the other stations; consequently there were more chances for the moist-mesic types of plants to invade. Two species, *Veratrum speciosum* and *Gentiana elegans*, were growing here but could not be considered a part of the meadow, because the environment which they preferred was usually too moist for the *Festuca*. These stations had the highest percentage of grass species of the west exposures and had a higher percentage of grass species than most of the east, south, and high altitude stations. This condition may be due to the fact that the cattle do not graze here as much as they do at station 1A, because there are natural ponds near this station where they congregate.

Table 3. Plant Species Collected in *Festuca* Meadows with West Exposures and Under Different Moisture Environments

Station 1A

Plants of Moist-Mesic Environment

Aconitum Fendleri
Pedicularis Grayi A. Nels.
Aquilegia caerulea
Phleum alpinum
Veratrum speciosum
Delphinium Nelsonii
Mertensia fusiformis
Mertensia alpinum
Valeriana acutiloba
Frasera speciosa
Bromus polyanthus

Plants of Xeric-Mesic Environment

Eriogonum subalpinum
Eriogonum umbellatum var. *tectum*
Polygonum Douglasii
Lynchis Drummondii S. wats.
Arenaria congesta
Corydalis aurea
Lappula floribunda
Pentstemon strictus
Orthocarpus luteus
Campanula Parryi

Plants of Xeric-Mesic Environment (cont.)

Chrysopsis villosa
Chrysothamnus lanceolatus
Chrysothamnus nauseosus
Antennaria aprica
Antennaria rosea
Antennaria speciosa
Viguiera multiflora
Artemisia frigida
Gilia aggregata
Castilleja linearifolia

Plants of Mesic-Mesic Environment

Stipa columbiana var. *Nelsonii*
Stipa Lettermanii
Trisetum spicatum
Koeleria cristata
Poa interior
Poa pratensis
Festuca Thurberi
Bromus anomalus
Agropyron trachycaulon
Carex Eggelstonii
Allium reticulatum

Table 3 (cont.)

Station 1A (cont.)

Plants of Mesic-Mesic Environment (cont.)

Calochortus Gunnisonii
Delphinium barbeyi
Lepidium ramosissimum
Thlaspi arvense
Barbarea orthoceras
Draba stenoloba
Draba spectabilis
Descurainia californica
Arabis Drummondii
Erysmium capitatum
Erysmium amoenum
Heuchera parvifolia
Dasiophora fruticosa
Potentilla gracilis
Potentilla hippiana
Sieversia ciliata
Rosa Fendleri
Lupinus Bakeri
Lupinus humicola
Astragalus flexuosus
Vicia americana
Lathyrus leucanthus
Linum Lewisii
Pseudocymopterus montanus

Plants of Mesic-Mesic Environment (cont.)

Ligusticum Porteri
Androsace septentrionalis var. *diffusa*
Gentiana Parryi
Collomia linearis
Phacelia heterophylla
Agastache urticifolia
Castilleja sulphurea
Galium boreale
Solidago decumbens
Aster adscendens
Machaeranthera aspera
Machaeranthera rubricaulis
Erigeron macranthus
Helianthella quinquenervis
Dugaldia Hoopesii
Achillea millefolium
Artemisia aromatica
Senecio eremophilus
Senecio Fendleri
Senecio serra
Senecio sphaerocephalis
Carduus Nelsonii
Agroseris glaucum
Taraxacum officinale

Station 1B

Plants of Moist-Mesic Environment

Phleum alpinum
Melica spectabilis
Delphinium Nelsonii
Aconitum columbianum
Thalictrum Fendleri
Geranium Richardsonii
Hydrophyllum Fendleri
Sambucus microbotrys
Bromus polyanthus
Washingtonia occidentalis

Plants of Xeric-Mesic Environment

Eriogonum subalpinum
Eriogonum umbellatum var. *tectum*

Plants of Xeric-Mesic Environment (cont.)

Polygonum Douglasii
Lappula floribunda
Pentstemon strictus
Campanula Parryi
Chrysopsis villosa
Viguiera multiflora
Chenopodium atrovirens

Plants of Mesic-Mesic Environment

Stipa Lettermanii
Stipa robusta
Festuca Thurberi
Bromus anomalus
Agropyron trachycaulon

Table 3 (cont.)

Station 1B (cont.)

Plants of Mesic-Mesic
Environment (cont.)

Calochortus Gunnisonii
Carduus Nelsonii
Taraxacum officinale
Delphinium barbeyi
Lepidium virginiana
Draba spectabilis
Descurainia californica
Arabis glabra
Arabis Drummondii
Erysmium capitatum
Vicia americana
Lathyrus leucanthus
Potentilla gracilis
Linum Lewisii
Lupinus Bakeri
Lupinus humicola
Pseudocymopterus montanus
Ligusticum Porteri

Plants of Mesic-Mesic
Environment (cont.)

Lomatium dissectum var. *multifidum*
Androsace septentrionalis var.
 diffusa
Collomia linearis
Agastache urticifolia
Dracocephalum parviflorum
Pentstemon procerus
Castilleja sulphurea
Galium boreale
Machaeranthera aspera
Erigeron Coulteri
Erigeron macranthus
Helianthella quinquenervis
Achillea millefolium
Artemisia aromatica
Senecio serra
Senecio sphaerocephalis
Agoseris glaucum

Station 1C

Plants of Moist-Mesic
Environment

Agropyron subsecundum
Phleum alpinum
Deschampsia caespitosa
Melica spectabilis
Poa Fendleriana
Gentiana heterosepala
*Gentiana elegans**
*Veratrum speciosum**
Delphinium Nelsonii
Aconitum columbianum
Thalictrum Fendleri
Mertensia ciliata
Pedicularis Grayi
Frasera speciosa
Valeriana certophylla
Valeriana acutiloba
Erigeron elatior
Senecio crassulus
Bromus ciliatus
Bromus polyanthus
Phleum pratense

Plants of Xeric-Mesic
Environment

Eriogonum subalpinum
Polygonum Douglasii
Gilia aggregata
Lappula floribunda
Pentstemon strictus
Campanula Parryi
Campanula rotundifolia
Viguiera multiflora
Chrysopsis villosa
Chrysothamnus lanceolatus
Chrysothamnus nauseosus
Antennaria aprica
Antennaria parvifolia
Antennaria rosea
Artemisia gnaphaloides

Plants of Mesic-Mesic
Environment

Stipa columbiana
Helianthella quinquenervis

* Plants preferring a very wet environment where *Festuca* does not grow.

Table 3 (cont.)

Station 1C (cont.)

Plants of Mesic-Mesic
Environment (cont.)

Stipa columbiana
 var. *Nelsonii*
Stipa Lettermanii
Trisetum spicatum
Koeleria cristata
Poa interior
Poa pratensis
Festuca Thurberi
Bromus anomalus
Agropyron trachycaulon
Sitanion hystrix
Carex Eggelstonii
Calochortus Gunnisonii
Delphinium barbeyi
Thlaspi arvense
Draba stenoloba
Draba spectabilis
Descurainia californica
Arabis Drummondii
Arabis glabra
Erysmium capitatum
Heuchera parvifolia
Desiphora fruticosa
Potentilla gracilis
Sieversia ciliata
Lupinus Bakeri
Lupinus humicola
Astragalus alpinum

Plants of Mesic-Mesic
Environment (cont.)

Vicia americana
Lathyrus leucanthus
Linum Lewisii
Pseudocymopterus montanus
Ligusticum Porteri
Androsace septentrionalis
 var. *diffusa*
Gentiana Parryi
Collomia linearis
Agastache urticifolia
Dracocephalum parviflorum
Castilleja sulphurea
Galium boreale
Solidago corymbosa
Solidago decumbens
Machaeranthera aspera
Machaeranthera rubricaulis
Erigeron Coulteri
Erigeron macranthus
Dugaldia Hoopesii
Achillea millefolium
Artemisia aromatica
Senecio crocatus
Senecio integerrimus
Senecio sphaerocephalus
Carduus Nelsonii
Agoseris glaucum
Taraxacum officinalis

Station 1A and 1B which are also west exposures had a lower percentage of grass species in relation to the total plant population than any of the other stations.

These stations do not seem to have reached the stage of a climax *Festuca* meadow due partly to the following facts: (1) the knolls are not leveled down by geological erosion, (2) cattle eat down the grass, weakening it so that other plants may come in, and (3) seepage areas and streambeds are favorable for the plants which prefer a moist-mesic environment.

The species of plants, collected from three *Festuca* meadows with west exposures classified according to soil moisture relationships, are given in table 3. At station 1A eleven species were found in a moist-mesic environment, fifty-nine species in a mesic-mesic environment, and twenty species in a xeric-mesic environment. Fifteen additional species were collected which were not found at other stations.

At station 1B ten species were found in the moist-mesic environment, fifty-six species in the mesic-mesic environment, and fifteen species in a xeric-mesic environment. Seven species were collected here which were not observed at any other station.

Variations in Meadows with East Exposures

The contrast in plant succession from the top to the bottom of the slopes in meadows with an east exposure was not so great as in meadows with a west exposure. This was due to a smoother topography than that of the meadows with a west exposure. The average moisture content of the soil in these meadows was higher than in meadows with a west exposure. There were no seepage areas; consequently a smaller number of plants which preferred a moist-mesic environment were present. The percentage of plants collected which preferred a moist environment was about the same as the percentage which can exist in a xeric environment. Few pioneers were found except at the top of the slopes.

The species of plants collected from the three meadows with an east exposure classified according to soil moisture relationships are given in table 4. Eight species were found at station 2A in a moist-mesic environment, thirty-six species in a mesic-mesic environment, and seven in a xeric-mesic environment. Two species were collected which were not observed at any other station.

Fourteen species were found at station 2B in the moist-mesic environment, forty species in a mesic-mesic environment, and eleven in a xeric-mesic

environment. Two species not collected at other stations were collected here.

Five species were found at station 2C in a moist-mesic environment, thirty species in a mesic-mesic environment, and seven in a xeric-mesic environment. The fact that there were no plants observed here that were not observed at other stations, and the fact that the *Festuca* was thicker and more continuous than at most of the stations, seems to indicate that this meadow was the most highly developed of any of the meadows studied.

More shrubby species were observed at stations 2A and 2B than at any of the other stations. About half of them were chaparral genera. Shrubby species collected at station 2A were as follows: *Rosa Fendleri*, *Symphoricarpus rotundifolius*, *Sambucus microbotrys*, and *Ribes leptanthum*. At station 2B there were *Ribes leptanthum*, *Rosa Fendleri*, *Sambucus microbotrys*, *Artemisia tridentata*, and *Dasiophora fruticosa*.

Table 4. Plant Species Collected on East Exposures of *Festuca* Meadows Under Different Moisture Environments

Station 2A

Plants of Moist-Mesic Environment

Thalictrum Fendleri
Hydrophyllum Fendleri
Mertensia ciliata
Sambucus microbotrys
Symphoricarpus rotundifolius
Valeriana acutiloba
Agropyron subsecundum
Bromus polyanthus

Plants of Xeric-Mesic Environment

Lappula floribunda
Eriogonum subalpinum
Eriogonum umbellatum
 var. *tectum*
Gilia aggregata
Campanula rotundifolia
Polygonum Douglasii
Viguiera multiflora

Plants of Mesic-Mesic Environment

Gentiana Parryi
Collomia linearis
Castilleja sulphurea
Machaeranthera aspera
Helianthella quinquenervis
Achillea millefolium
Agoseris glaucum
Stipa columbiana var. *Nelsonii*
Stipa Lettermanii
Koeleria cristata
Poa pratensis
Festuca Thurberi
Bromus anomalus
Agropyron trachycaulon
Calochortus Gunnisonii
Delphinium barbeyi
Arabis Drummondii
Erysmium capitatum
Heuchera parvifolia
Ribes leptanthum

Table 4 (cont.)

Station 2A (cont.)

Plants of Mesic-Mesic
Environment (cont.)

Potentilla gracilis
 Potentilla hippiana
 Rosa Fendleri
 Lupinus humicola
 Vicia americana
 Lathyrus leucanthus
 Linum Lewisii
 Pseudocymopterus montanus
 Washingtonia occidentalis

Plants of Mesic-Mesic
Environment (cont.)

Ligusticum Porteri
 Lomatium dissectum var. multifidum
 Androsace septentrionalis
 var. diffusa
 Agastache urticifolia
 Galium boreale
 Erigeron macranthus
 Achillea millefolium
 Artemisia arnatica

Station 2B

Plants of Moist-Mesic
Environment

Fragaria americana
 Mertensia ciliata
 Pedicularis Grayi
 Sambucus microbotrys
 Valeriana certophylla
 Erigeron elatior
 Phleum pratense
 Poa Fendleriana
 Valeriana acutiloba
 Agropyron subsecundum
 Thalictrum Fendleri
 Gentiana heterosepala
 Bromus polyanthus
 Aquilegia caerulea

Plants of Xeric-Mesic
Environment

Eriogonum subalpinum
 Polygonum Douglasii
 Arenaria congesta
 Gilia aggregata
 Lappula floribunda
 Pentstemon strictus
 Campanula rotundifolia
 Chrysothamnus nauseosus
 Antennaria parvifolia
 Antennaria rosea
 Artemisia tridentata

Plants of Mesic-Mesic
Environment

Stipa Lettermanii
 Trisetum spicatum
 Poa interior
 Festuca Thurberi
 Bromus anomalus
 Agropyron trachycaulon
 Calochortus Gunnisonii
 Delphinium barbeyi
 Thlaspi arvense
 Castilleja sulphurea
 Solidago corymbosa
 Aster Canybi
 Erigeron macranthus
 Dugaldia Hoopesii
 Artemisia aromatica
 Agroseris glaucum
 Erysmium capitatum
 Heuchera parvifolia
 Ribes leptanthum var. brachyanthum
 Dasiphora fruticosa
 Potentilla gracilis
 Sieversia ciliata
 Rosa Fendleri
 Lupinus humicola
 Vicia americana
 Lathyrus leucanthus
 Linum Lewisii
 Chamaenerion angustifolium
 Pseudocymopterus montanus

Table 4 (cont.)

Station 2B (cont.)

Plants of Mesic-Mesic
Environment (cont.)

Ligusticum Porteri
 Androsace septentrionalis var. diffusa
 Gentiana Parryi
 Collomia linearis
 Galium boreale

Plants of Mesic-Mesic
Environment (cont.)

Solidago decumbens
 Machaeranthera aspera
 Helianthella quinquenervis
 Achillea millefolium
 Senecio serra

Station 2C

Plants of Moist-Mesic
Environment

Frasera speciosa
 Valeriana certophylla
 Phleum pratense
 Thalictrum Fendleri
 Bromus polyanthus

Plants of Xeric-Mesic
Environment

Polygonum Douglasii
 Chenopodium atrovirens
 Gilia aggregata
 Campanula rotundifolia
 Campanula Parryi
 Vigiera multiflora Blake
 Eriogonum subalpinum

Plants of Mesic-Mesic
Environment

Stipa columbiana
 Stipa columbiana var. Nelsonii
 Stipa Lettermanii
 Koeleria cristata
 Poa pratensis

Plants of Mesic-Mesic
Environment (cont.)

Festuca Thurberi
 Bromus anomalus
 Agropyron trachycaulon
 Carex Eggelstonii
 Delphinium barbeyi
 Erysmium capitatum
 Dasiophora fruticosa
 Potentilla gracilis
 Sieversia ciliata
 Vicia americana
 Lathyrus leucanthus
 Linum Lewisii
 Pseudocymopterus montanus
 Ligusticum Porteri
 Androsace septentrionalis var. diffusa
 Gentiana Parryi
 Collomia linearis
 Castilleja sulphurea
 Galium boreale
 Solidago corymbosa
 Erigeron macranthus
 Helianthella quinquenervis
 Achillea millefolium
 Artemisia aromatica
 Agrosieris glaucum

Variations in Meadows with a South Exposure

The soil on the upper part of the slope at station 3A which had a south exposure was very thin and dry. Some of the plants which will grow on a dry, rocky soil and were found in this meadow were Berberis aquifolium, Arenaria congesta, Gayophytum ramosissimum, and Viola bellidifolia. A roadside ditch

near the base of this slope prevented the formation of an extensive moist-mesic environment.

The percentage of grass species was higher at station 3B than at 3A. The surface soil was deeper with fewer rocks. The slope was not as steep, and less runoff occurred; consequently some of the species which preferred a moist-mesic environment such as *Vaccinium caespitosum*, *Fragaria americana*, *Valeriana certophylla*, *Gentiana plebeja*, and *Phleum alpinum* were more abundant at this station.

Although burning was not evident, the presence of *Vaccinium caespitosum* indicates, according to Clements,* that these stations may have been burned during previous years, but no evidence of fire was observed in this study.

Station 3A had a large number of plants which did not occur at any other station. Apparently the meadow at station 3A is an earlier stage of succession than 3B. The number of plants collected and classified according to their most favorable moisture environment are given in table 5. Seven species were found in a moist-mesic environment, twenty-three species in a mesic-mesic environment, and nine species in a xeric-mesic environment at station 3A. Five species were observed here which were not found elsewhere.

Eleven species were found at station 3B in a moist-mesic environment, twenty-four species in a mesic-mesic environment, and nine species in a xeric-mesic environment. Three species were present here which were not observed at other stations.

Table 5. Plants Collected on South Exposures of Festuca Meadows Under Different Moisture Environments

Station 3A

Plants of Moist-Mesic Environment

Blepharineuron tricholepis
Vaccinium caespitosum

Plants of Moist-Mesic Environment (cont.)

Fragaria americana
Viola bellidifolia

* Clements-Plant Indicators. Carnegie Institution Washington Publication 290, 1920.

Table 5 (cont.)

Station 3A (cont.)

Plants of Moist-Mesic Environment (cont.)

Viola erectifolia
Senecio crassulus
Bromus polyanthus

Plants of Xeric-Mesic Environment

Arenaria congesta
Berberis aquifolium
Gayophytum ramosissimum
Gilia aggregata
Campanula Parryi
Campanula rotundifolia
Chrysopsis villosa
Eriogonum umbellatum var. *tectum*
Polygonum Douglasii

Plants of Mesic-Mesic Environment

Stipa Lettermanii
Trisetum spicatum

Plants of Mesic-Mesic Environment (cont.)

Poa interior
Festuca Thurberi
Bromus anomalus
Agropyron trachycaulon
Arabis Drummondii
Dasiophora fruticosa
Potentilla arguta
Potentilla gracilis
Vicia americana
Lathyrus leucanthus
Linum Lewisii
Pseudocymopterus montanus
Ligusticum Porteri
Androsace septentrionalis
 var. *diffusa*
Collomia linearis Nutt.
Castilleja sulphurea
Galium boreale
Erigeron macranthus
Achillea millefolium
Artemisia aromatica
Agoseris glaucum

Station 3B

Plants of Moist-Mesic Environment

Blepharoneuron tricholepis
Vaccinium caespitosum
Poa macroclada
Fragaria americana
Valeriana certophylla
Senecio Bigelovii
Senecio crassulus
Gentiana plebeja
Phleum alpinum
Melica spectabilis

Plants of Xeric-Mesic Environment

Gilia aggregata
Campanula Parryi
Campanula rotundifolia
Chrysopsis villosa
Antennaria parvifolia

Plants of Xeric-Mesic Environment (cont.)

Eriogonum umbellatum var. *tectum*
Arenaria congesta
Polygonum Douglasii
Lychnis Drummondii S. Wats.

Plants of Mesic-Mesic Environment

Stipa columbiana
Festuca Thurberi
Bromus anomalus
Agropyron trachycaulon
Carex Eggelstonii
Potentilla gracilis
Potentilla hippiana
Vicia americana
Lathyrus leucanthus
Linum Lewisii
Pseudocymopterus montanus

Table 5 (cont.)

Station 3B (cont.)

Plants of Mesic-Mesic
Environment (cont.)

Androsace septentrionalis var. diffusa
 Gentiana Parryi
 Collomia linearis
 Castilleja sulphurea
 Galium boreale
 Solidago decumbens

Plants of Mesic-Mesic
Environment (cont.)

Erigeron macranthus
 Dugaldia Hoopesii
 Achillea millefolium
 Artemisia aromatica
 Agoseris glaucum
 Thlaspi glaucum

Variations in the High Altitude Meadows

Some succession of plants from the more nearly xeric to the moist-mesic environment appeared in the high altitude meadows, but it was not so obvious as on the drier slopes at lower elevations. Above an elevation of 10,000 feet many species, occurring at lower elevations are dwarfed or die out, and alpine species which invade from higher elevations become a part of the meadow. These species increase gradually, and at 11,800 feet make up more than one-fourth of the total plant composition.

At some locations plants such as *Poa stenantha*, *Lonicera involucrata*, and *Geranium Richardsonii*, which customarily grow in wet places at a lower elevation, invade these meadows at higher elevations due to the increased soil moisture arising from the combined effect of higher humidity, lower temperatures, and more rainfall.

Such plants as *Agropyron Scribneri*, *Carex chalicilepis*, *Luzula spicata*, *Sieversia turbinata*, *Anemone globosa*, *Pentstemon glaucum* Graham var. *stenosepalus* Gray, *Phacelia sericea*, and *Festuca brachyphylla* did not occur at lower elevations.

Station 4B was about 800 feet higher than 4A; consequently more alpine species were present. The percentage of grasses in relation to other species was between that of the meadows with a west exposure and those with a south

or east exposure. Very few shrubby species were present in the high altitude meadows. Plants collected from these meadows are given in table 6. Fifteen species were found at station 4A in a moist-mesic environment, thirty-one species in a mesic-mesic environment, and seven species in a xeric-mesic environment. There were five species present here which were not present elsewhere.

Nine species were found at station 4B in the moist-mesic environment, twenty-one species in the mesic-mesic environment, and six species in the xeric-mesic environment. Fourteen species occurred here which did not appear at other stations.

Table 6. Plants Collected from High Subalpine Festuca Meadows
Classified According to Moisture Environments

Station 4A

Plants of Moist-Mesic
Environment

Erigeron elatior
Poa Fendleriana
Geranium Richardsonii
Poa stenantha
Thalictrum Fendleri
Anemone globosa
Fragaria americana
Pentstemon glaucus var. stenantha
Lonicera involucrata
Senecio crassulus
Senecio Bigelovii
Agropyron subsecundum
Smilicina stellata
Bromus polyanthus

Plants of Xeric-Mesic
Environment

Arenaria congesta
Polygonum Douglasii
Campanula Parryi
Campanula rotundifolia
Oreochrysum Parryi
Antennaria parvifolia
Chrysopsis villosa

Plants of Mesic-Mesic
Environment

Trisetum spicatum
Festuca Thurberi
Bromus anomalus
Agropyron trachycaulon
Carex Eggelstonii
Delphinium barbeyi
Descurainia californica
Dasiophora fruticosa
Potentilla gracilis
Potentilla hippiana
Vicia americana
Lathyrus leucanthus
Linum Lewisii
Chamaenerion angustifolium
Pseudocymopterus montanus
Ligusticum Porteri
Androsace septentrionalis var.
diffusa
Gentiana Parryi
Collomia linearis
Castilleja sulphurea
Galium boreale
Solidago decumbens
Erigeron macranthus
Helianthella quinquenervis

Table 6 (cont.)

Station 4A (cont.)

Plants of Mesic-Mesic
Environment (cont.)

Dugaldia Hoopesii
 Achillea millefolium
 Artemisia aromatica
 Carduus Nelsonii

Plants of Mesic-Mesic
Environment (cont.)

Agroseris glaucum
 Ribes leptanthum var.
 brachyanthum
 Senecio glaucescens

Station 4B

Plants of Moist-Mesic
Environment

Poa Fendleriana
 Fragaria americana
 Sieversia ciliata
 Sieversia turbinata
 Gentiana plebeja var. Holmii
 Pentstemon glaucus Graham var.
 stenosepalus Gray
 Erigeron elatior
 Phacelia sericea
 Anemone globosa

Plants of Xeric-Mesic
Environment

Lychnis Drummondii S. Wats.
 Sedum debile
 Chrysopsis villosa
 Campanula rotundifolia
 Antennaria pulcherrima
 Chaenactis Douglasii

Plants of Mesic-Mesic
Environment

Trisetum spicatum

Plants of Mesic-Mesic
Environment (cont.)

Bromus anomalus
 Agropyron Scribneri
 Carex chalcilepis
 Luzula spicata
 Carex Egglestonii
 Arabis glabra
 Thlaspi alpestre
 Ribes leptanthum var.
 brachyanthum
 Potentilla gracilis
 Pseudocymopterus multifidus
 Rydb.
 Polemonium sp.?
 Mertensia Bakeri var. laterifolia
 (Greene) A. Nels.
 Castilleja sulphurea
 Erigeron macranthus?
 Achillea millefolium
 Taraxacum officinale
 Androsace septentrionalis L.
 var. diffusa
 Agropyron trachycaulon
 Poa interior
 Festuca ovine var.
 brachyphylla

RELATIVE ABUNDANCE OF FAMILIES IN THE FESTUCA MEADOWS

All plants collected were classified and the data tabulated according to families by stations. This information is given in table 7. Thirty-three families were represented. The highest average percentage of species occurring in the different families at all stations were the Compositae with 22.06%, Gramineae with 18.23%, and Rosaceae with 6.57%. Seventeen families varied from 1 to 5%, and thirteen families were less than 1% of the total species collected. The more moist a station seemed to be up to a certain point, the higher the percentage of the grass species present. This may be due to several factors such as depth and fertility of the soil and the character of the slope as it affected moisture accumulation. Grasses and composites made up approximately 30 to 50% of the total number of plant species collected.

Table 7. Percentage of Species Grouped According to Families Collected at Various Stations in Festuca Meadows

Family	1A	1B	1C	2A	2B	2C	3A	3B	4A	4B	Total
Gramineae	12%	13.6%	20.7%	17.6%	16.9%	23.8%	20.5%	22.7%	15.1%	19.4%	18.23%
Cyperaceae	1%	0	0	1.96%	0	2.4%	0	2.3%	1.9%	8.33%	1.79%
Liliaceae	3.3%	1.7%	1%	1.96%	1.54%	0	0	0	1.9%	0	1.14%
Polygonaceae	3.3%	5.1%	2.2%	5.9%	3.08%	2.4%	5.1%	4.5%	1.9%	0	3.35%
Chenopodiaceae	0	1.7%	0	0	0	2.4%	0	0	0	0	.4%
Caryophyllaceae	2.2%	0	0	0	1.54%	0	2.56%	4.5%	1.9%	2.8%	1.55%
Ranunculaceae	3.3%	6.78%	4.35%	3.9%	3.08%	4.76%	0	0	5.66%	2.8%	3.46%
Berberidaceae	0	0	0	0	0	0	2.56%	0	0	0	.26%
Fumariaceae	1%	0	0	0	0	0	0	0	0	0	.1%
Cruciferae	10%	10.17%	7.61%	3.9%	3.08%	2.4%	2.56%	2.3%	1.9%	5.56%	4.95%
Crassulaceae	0	0	0	0	0	0	0	0	0	2.8%	.28%
Saxifragaceae	1%	0	1%	1.96%	1.54%	0	0	0	0	0	.55%
Grossulariaceae	0	0	0	1.96%	1.54%	0	0	0	1.9%	2.8%	.82%
Rosaceae	5.5%	1.7%	4.35%	3.9%	7.69%	7.14%	10.3%	6.8%	7.55%	11.1%	6.57%
Leguminosae	5.5%	6.8%	5.4%	5.88%	4.62%	4.76%	5.13%	4.5%	3.77%	0	4.74%
Geraniaceae	0	1.7%	0	0	0	0	0	0	1.9%	0	.36%
Linaceae	1%	1.7%	1%	1.96%	1.54%	2.4%	2.56%	2.3%	1.9%	0	1.63%

Table 7 (cont.)

Family	1A	1B	1C	2A	2B	2C	3A	3B	4A	4B	Total
Violaceae	0	0	0	0	0	0	5.13%	0	0	0	.51%
Onagraceae	0	0	0	0	1.54%	0	2.56%	0	1.9%	0	.6%
Umbelliferae	2.2%	6.8%	2.2%	3.9%	6.15%	4.76%	5.13%	2.3%	3.77%	2.8%	4%
Ericaceae	0	0	0	0	0	0	2.56%	2.3%	0	0	.49%
Primulaceae	1%	1.7%	1%	1.96%	1.54%	2.4%	2.56%	2.3%	1.9%	2.8%	1.92%
Gentianaceae	2.2%	0	3.26%	1.96%	3.08%	4.76%	0	4.5%	1.9%	2.8%	2.45%
Polemoniaceae	2.2%	1.7%	2.2%	3.9%	3.08%	4.76%	5.13%	4.5%	1.9%	2.8%	3.23%
Hydrophyllaceae	1%	1.7%	0	1.96%	0	0	0	0	0	2.8%	.75%
Boraginaceae	3.3%	1.7%	2.2%	3.9%	3.08%	0	0	0	0	2.8%	1.7%
Labiatae	1%	3.4%	2.2%	1.96%	0	0	0	0	0	0	.86%
Scrophulariaceae	5.5%	5.09%	3.26%	1.96%	4.62%	2.4%	2.56%	2.3%	3.77%	5.56%	3.7%
Rubiaceae	1%	1.7%	1%	1.96%	1.54%	2.4%	2.56%	2.3%	1.9%	0	1.63%
Caprifoliaceae	0	1.7%	0	3.9%	1.54%	0	0	0	1.9%	0	.9%
Campanulaceae	1%	1.7%	2.2%	1.96%	1.54%	4.76%	5.13%	4.5%	3.77%	2.8%	2.94%
Valerianaceae	1%	0	2.2%	1.96%	3.08%	2.4%	0	2.3%	0	0	1.29%
Compositae	26.7%	22.03%	28.3%	13.7%	24.6%	16.7%	15.38%	22.73%	28.3%	22.2%	22.06%
Combined % of Gramineae and Composites	38.7%	35.6%	49%	31%	42%	41%	36%	45.4%	43.5%	42%	40.29%

SUMMARY

A study of the plant population in the Festuca meadows of the Gunnison National Forest was made in the summer of 1946. Ten stations were selected; three with an east exposure, three with a west exposure, two with a south exposure, and two high altitude stations. The altitude of these meadows varied from 9,400 to 11,800 feet.

Three seasonal aspects were observed from June 23 to August 21. The vernal aspect was dominated by *Lupinus* or *Ligusticum*. The Aestival aspect was dominated by *Campanula*, *Calochortus*, and composites such as *Erigeron*, *Solidago*, and *Agroseris*. The serotinal aspect was a combination of *Gentiana Parryi* and *Machaeranthera aspera*. The subdominants occurring at each station were *Bromus anomalus* Rupr., *Agropyron trachycaulon* (Link.) Malte, *Polygonum Douglasii* Greene, *Vicia americana*, *Lathyrus americana*, *Artemisia aromatica*, *Castilleja sulphurea*, *Linum Lewisii*, *Potentilla gracilis*, *Ligusticum Porteri*, *Androsace septentrionalis* var. *diffusa* (Small) Kunth, *Pseudocymopterus montanus* (Gray) C. & R., *Collomia linearis* Nutt., *Achillea millefolium* L., *Galium boreale* L., *Agroseris glaucum* (Nutt.) Greene, and *Erigeron macranthus* Nutt. The common pioneers were *Chrysopsis*, *Eriogonum*, *Antennaria*, *Pentstemon*, *Erysmium*, *Gilia*, and *Chrysothamnus*.

Plant variation within each station was greater from the top to the bottom of the knolls, than variation between the different exposures. South exposures, east exposures, and high altitude exposures seemed to be generally more moist than west exposures; however the topography of these exposures was less rolling than the west exposures. This condition may account for a greater variation in plant composition on the west exposures, where many pioneers still persisted on the dry, rocky slopes.

The high altitude stations contained many alpine species which had invaded from higher elevations. Some plants growing in wet places at lower elevations

Summary (cont.)

were found in the high altitude meadows due to increased soil moisture.

A quadrat and line transect analysis showed that there was a definite succession of plants from the dry, rocky top of each knoll, which was covered with pioneers, to the bottom where a *Festuca* meadow climax had developed.

The surface in these *Festuca* meadows, to a depth of twelve to fifteen inches, was dark brown in color, which is a characteristic of a well-drained grassland soil in a temperate climate.

Festuca coverage varied from seventy-five to ninety percent in the different meadows. Grasses and composites made up approximately thirty to fifty percent of the total number of plant species collected. Five hundred and sixty-six plants, representing 162 species and thirty-three families, were collected from the different stations.

APPENDIX

Annotated List of Plants Collected from Festuca Meadows in the Gunnison National Forest and Arranged Phylogenetically According to the Classification of Coulter and Nelson in Their New Manual of Rocky Mountain Botany.

<u>Family, Tribe, and Scientific Name</u>	<u>Date Collected and Station Number</u>
I. GRAMINEAE	
A. Agrostideae	
1. <i>Stipa columbiana</i> Macoun.	Aug. 15, 3B; Aug. 17, 1C; Aug. 20, 2C.
2. <i>Stipa columbiana</i> Macoun. var. <i>Nelsonii</i> (Scribn.) Hitchc.	July 23, 1C; Aug. 19, 1A; Aug. 20, 2A; Aug. 20, 2C.
3. <i>Stipa Lettermanii</i> Vasey	Aug. 15, 3A; Aug. 17, 1C; Aug. 19, 1A; Aug. 19, 1B; Aug. 20, 2A; Aug. 20, 2B; Aug. 20, 2C.
4. <i>Stipa robusta</i> Scribn.	Aug. 19, 1B.
5. <i>Phleum alpinum</i> L.	July 15, 1C; Aug. 15, 3B; Aug. 19, 1A; Aug. 19, 1B.
6. <i>Phleum pratense</i> L.	July 21, 2B; Aug. 17, 1C; Aug. 20, 2C.
7. <i>Blepharoneuron tricholepis</i> (Torr.) Nash	Aug. 15, 3A; Aug. 15, 3B.
B. Aveneae	
1. <i>Deschampsia caespitosa</i> (L.) Beauv.	Aug. 17, 1C.
2. <i>Trisetum spicatum</i> (L.) Richt	July 21, 2B; Aug. 14, 4A; Aug. 15, 3A; Aug. 17, 1C; Aug. 19, 1A; Aug. 23, 4B.
C. Festuceae	
1. <i>Koeleria cristata</i> (L.) Pers.	July 28, 1C; July 30, 2A; Aug. 19, 1A; Aug. 20, 2C.
2. <i>Melica spectabilis</i> Scribn.	July 23, 1B; July 28, 1C; Aug. 15, 3B.
3. <i>Poa Fendleriana</i> (Steud.) Vasey	July 21, 2B; Aug. 14, 4A; Aug. 17, 1C; Aug. 23, 4B.
4. <i>Poa interior</i> Rydb.	July 16, 1A; July 21, 2B; July 28, 1C; Aug. 15, 3A; Aug. 23, 4B.
5. <i>Poa macroclada</i> Rydb.	Aug. 15, 3B.
6. <i>Poa pratensis</i> L.	July 6, 1A; July 21, 2B; Aug. 19, 1C; Aug. 20, 2A; Aug. 20, 2C.
7. <i>Poa stenantha</i> Trin.	Aug. 14, 4A.
8. <i>Festuca ovina</i> L. var. <i>brachyphylla</i> (Schultes)	Aug. 23, 4B.
9. <i>Festuca Thurberi</i> Vasey	July 16, 1A; July 17, 2A; July 21, 2B; July 28, 1C; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 19, 1B; Aug. 20, 2C; Aug. 23, 4B.

10. *Bromus anomalus* Rupr. July 21, 2B; July 28, 1C; July 30, 2A; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 19, 1A; Aug. 19, 1B; Aug. 20, 2C; Aug. 23, 4B.
11. *Bromus ciliatus* L. Aug. 19, 1C.
12. *Bromus marginatus* Nees Aug. 15, 3B.
13. *Bromus polyanthus* Scribn. July 17, 2A; July 21, 2B; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 19, 1A; Aug. 19, 1B; Aug. 19, 1C; Aug. 20, 2C.

D. *Hordeae*

1. *Agropyron Scribneri* Vasey Aug. 23, 4B.
2. *Agropyron subsecundum* (Link.) Hitchc. July 21, 2B; July 28, 1C; July 30, 2A; Aug. 14, 4A.
3. *Agropyron trachycaulon* (Link.) Malte. July 16, 1A; July 21, 2B; July 30, 2A; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 17, 1C; Aug. 19, 1B; Aug. 20, 2C; Aug. 23, 4B.
4. *Sitanion hystrix* (Nutt.) J. G. Smith Aug. 17, 1C.

II. *CYPERACEAE*

1. *Carex chalicilepis* Holm Aug. 23, 4B.
2. *Carex Eggeltonii* Mackenzie July 16, 1A; July 28, 1C; Aug. 14, 4A; Aug. 15, 3B; Aug. 20, 2C; Aug. 23, 4B.

III. *JUNCACEAE*

1. *Luzula spicata* (L.) DC. Aug. 23, 4B.

IV. *LILLIACEAE*

1. *Allium reticulatum* Fraser June 28, 1A.
2. *Calochortus Gunnisonii* Wats. July 16, 1A; July 17, 2A; July 21, 2B; July 23, 1B; July 23, 1C.
3. *Veratrum speciosum* Rydb. June 28, 1A.
4. *Smilicina stellata* (L.) Desf. Aug. 14, 4A.

V. *POLYGONACEAE*

1. *Eriogonum subalpinum* Greene July 9, 2A; July 16, 1A; July 21, 2B; July 23, 1B; July 23, 1C.
2. *Eriogonum umbellatum* Small var. *tectum* Avon Nelson July 6, 1A; July 9, 2A; July 23, 1B; Aug. 15, 3A; Aug. 15, 3B.
3. *Polygonum Douglasii* Greene July 16, 1A; July 21, 2B; July 28, 1C; July 30, 2A; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 19, 1B; Aug. 20, 2C.

VI. CHENOPODIACEAE

1. *Chenopodium atrovirens* Rydb. Aug. 19, 1B; Aug. 20, 2C.

VII. CARYOPHYLLACEAE

1. *Lychnis Drummondii* S. Wats. July 29, 1A; Aug. 15, 3B; Aug. 23, 4B.
 2. *Arenaria congesta* Nutt. June 28, 1A; July 21, 2B; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B.

VIII. RANUNCULACEAE

1. *Delphinium Nelsonii* Greene June 28, 1A; July 3, 1B; July 23, 1C.
 2. *Delphinium Barbeyi* (Huth.) Huth. July 15, 1C; July 17, 2A; July 21, 2B; July 23, 1B; July 29, 1A; Aug. 14, 4A; Aug. 20, 2C.
 3. *Aconitum columbianum* Nutt. July 23, 1B; July 28, 1C; July 29, 1A.
 4. *Thalictrum Fendleri* Engelm. July 9, 2A; July 15, 1C; July 21, 2B; July 23, 1B; Aug. 14, 4A; Aug. 20, 2C.
 5. *Anemone globosa* Nutt. Aug. 14, 4A; Aug. 23, 4B.

IX. BERBERIDACEAE

1. *Berberis aquifolium* Pursh Aug. 15, 3A.

X. FUMARIACEAE

1. *Corydalis aurea* Willd. July 16, 1A.

XI. CRUCIFERAE

1. *Lepidium virginicum* July 23, 1B.
 2. *Lepidium ramosissimum* A. Nels.? June 28, 1A.
 3. *Thlaspi alpestre* L. Aug. 23, 4B.
 4. *Thlaspi arvense* L. July 28, 1C; Aug. 19, 1A; Aug. 20, 2B.
 5. *Thlaspi glaucum* A. Nels Aug. 14, 3B.
 6. *Barbarea orthoceras* Ledeb. June 28, 1A.
 7. *Draba stenoloba* Ledeb. var. *nana* (Schulz) Hitchc June 28, 1A; July 23, 1C.
 8. *Draba spectabilis* Greene July 3, 1B; July 28, 1C; July 29, 1A.
 9. *Descurainia californica* (Gray) Schulz July 3, 1B; July 23, 1C; Aug. 14, 4A; Aug. 19, 1A.
 10. *Arabis Drummondii* Gray June 28, 1A; July 3, 1B; July 9, 2A; July 23, 1C; Aug. 15, 3A.
 11. *Arabis glabra* (L.) Bernh. July 15, 1C; July 23, 1B; Aug. 23, 4B.
 12. *Erysimum amoenum* Greene June 28, 1A.

13. *Erysmium capitatum* (Dougl.) Greene July 3, 1B; July 9, 2A; July 15, 1C; July 16, 1A; July 21, 2B; Aug. 20, 2C.

XII. CRASSULACEAE

1. *Sedum debile* S. Wats. Aug. 23, 4B.

XIII. SAXIFRAGACEAE

1. *Heuchera parvifolia* Nutt. July 21, 2B; July 22, 2A; July 28, 1C; July 29, 1A.

XIV. GROSSULARIACEAE

1. *Ribes leptanthum* Gray July 9, 2A.
 2. *Ribes leptanthum* Gray var. *brachyanthum* Gray July 21, 2B; Aug. 14, 4A; Aug. 23, 4B.

XV. ROSACEAE

1. *Dasiophora fruticosa* (L.) Rydb. (syn. *Potentilla fruticosa* L.) June 28, 1A; July 21, 2B; July 28, 1C; Aug. 14, 4A; Aug. 15, 3A; Aug. 20, 2C.
 2. *Fragaria americana* (Porter) Brit. July 21, 2B; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 23, 4B.
 3. *Potentilla arguta* Pursh (syn. *Drymocallis arguta* (Pursh) Rydb.) Aug. 15, 3A.
 4. *Potentilla gracilis* Dougl. June 28, 1A; July 3, 1B; July 9, 2A; July 15, 1C; July 21, 2B; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 20, 2C; Aug. 23, 4B.
 5. *Potentilla hippiana* Lehm. July 28, 1A; July 30, 1C; Aug. 14, 4A; Aug. 15, 3B.
 6. *Sieversia ciliata* G. Don. July 21, 2B; July 23, 1C; July 29, 1A; Aug. 20, 2C; Aug. 23, 4B.
 7. *Sieversia turbinata* (Rydb.) Greene Aug. 23, 4B.
 8. *Rosa Fendleri* Crepin July 6, 1A; July 21, 2B; July 23, 2A.

XVI. LEGUMINOSAE

1. *Lupinus Bakeri* Greene June 28, 1A; July 3, 1B; July 15, 1C.
 2. *Lupinus humicola* A. Nels. July 3, 1B; July 9, 2A; July 16, 1A; July 21, 2B; Aug. 17, 1C.
 3. *Astragalus alpinum* L. July 23, 1C.
 4. *Astragalus flexuosus* Dougl. June 28, 1A.
 5. *Vicia americana* Muhl. June 28, 1A; July 3, 1B; July 9, 2A; July 15, 1C; July 21, 2B; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 20, 2C.
 6. *Lathyrus leucanthus* Rydb. June 28, 1A; July 3, 1B; July 9, 2A; July 21, 2B; July 23, 1C; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 20, 2C.

XVII. GERANIACEAE

1. *Geranium Richardsonii* F. & M. July 3, 1B; Aug. 14, 4A.

XVIII. LINACEAE

1. *Linum Lewisii* Pursh June 28, 1A; July 3, 1B; July 9, 2A; July 15, 1C; July 21, 2B; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 20, 2C.

XIX. VIOLACEAE

1. *Viola bellidifolia* Greene Aug. 15, 3A.
2. *Viola erectifolia* A. Nels Aug. 15, 3A.

XX. ONAGRACEAE

1. *Chamaenerion angustifolium* (L.) Scop. (syn.) *Epilobium angustifolium* L. July 21, 2B; Aug. 14, 4A.
2. *Gayophytum ramosissimum* T. & G. Aug. 15, 3A.

XXI. UMBELLIFERAE

1. *Pseudocymopterus montanus* (Gray) C. & R. June 28, 1A; July 3, 1B; July 9, 2A; July 15, 1C; July 21, 2B; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 20, 2C.
2. *Pseudocymopterus multifidus* Rydb* Aug. 23, 4B.
3. *Washingtonia occidentalis* (Nutt.) C. & R. (syn. *Osmorhiza occidentalis* (Nutt.) Torr.) July 3, 1B; July 9, 2B.
4. *Ligusticum Porteri* C. & R. June 28, 1A; July 3, 1B; July 9, 2A; July 15, 1C; July 21, 2B; Aug. 14, 4A; Aug. 15, 3A; Aug. 20, 2C.
5. *Lomatium dissectum* (Nutt.) Math. & Const. var. *multifidum* (Nutt.) Math. & Const. July 3, 1B; July 9, 2B.

XXII. ERICACEAE

1. *Vaccinium caespitosum* Michx. Aug. 15, 3A; Aug. 15, 3B.

XXIII. PRIMULACEAE

1. *Androsace septentrionalis* L. var. *diffusa* (Small) Kunth June 28, 1A; July 15, 1C; July 21, 2B; July 30, 2A; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 19, 1B; Aug. 20, 2C; Aug. 23, 4B.

* Might be alpine variety of *Pseudocymopterus montanus*

XXIV. GENTIANACEAE

- | | |
|---|--|
| 1. <i>Gentiana Parryi</i> Engelm. | Aug. 14, 4A; Aug. 15, 3B; Aug. 19, 1A; Aug. 19, 1C; Aug. 20, 2A; Aug. 20, 2B; Aug. 20, 2C. |
| 2. <i>Gentiana plebeja</i> Cham. | Aug. 15, 3B. |
| 3. <i>Gentiana plebeja</i> Cham. var. <i>Holmii</i> Wettst. | Aug. 23, 4B. |
| 4. <i>Gentiana heterosepala</i> Engelm. | July 21, 2B; July 28, 1C. |
| 5. <i>Frasera speciosa</i> Griesb. | July 28, 1C; July 29, 1A; Aug. 20, 2C. |

XXV. POLEMONIACEAE

- | | |
|---|--|
| 1. <i>Collomia linearis</i> Nutt. | June 28, 1A; July 3, 1B; July 9, 2A; July 15, 1C; July 21, 2B; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 20, 2C. |
| 2. <i>Gilia aggregata</i> (Pursh) Spreng. | June 28, 1A; July 15, 1C; July 17, 2A; July 21, 2B; Aug. 15, 3A; Aug. 15, 3B; Aug. 20, 2C. |
| 3. <i>Polemonium</i> sp.? | Aug. 23, 4B. |

XXVI. HYDROPHYLLACEAE

- | | |
|---|--------------------------|
| 1. <i>Phacelia heterophylla</i> Pursh | June 28, 1A. |
| 2. <i>Phacelia sericea</i> (Graham) Gray | Aug. 23, 4B. |
| 3. <i>Hydrophyllum Fendleri</i> (Gray) Heller | July 3, 1B; July 30, 2A. |

XXVII. BORAGINACEAE

- | | |
|--|--|
| 1. <i>Lappula floribunda</i> (Lehm.) Greene | June 28, 1A; July 21, 2B; July 22, 2A; July 23, 1B; July 23, 1C. |
| 2. <i>Mertensia alpina</i> (Torr.) G. Don. | June 28, 1A. |
| 3. <i>Mertensia Bakeri</i> var. <i>laterifolia</i> (Greene) A. Nels. | Aug. 23, 4B. |
| 4. <i>Mertensia ciliata</i> (Torr.) G. Don. | July 15, 1C; July 17, 2A; July 21, 2B. |
| 5. <i>Mertensia fusiformis</i> Greene | June 28, 1A. |

XXVIII. LABIATE

- | | |
|--|--|
| 1. <i>Agastache urticifolia</i> (Benth.) Rydb. | July 3, 1A; July 23, 1B; July 28, 1C; July 30, 2A. |
| 2. <i>Dracocephalum parviflorum</i> Nutt. | July 23, 1B; July 28, 1C. |

XXIX. SCROPHULARIACEAE

- | | |
|--|---|
| 1. <i>Pentstemon strictus</i> Benth. | June 28, 1A; July 15, 1C; July 21, 2B; July 23, 1B. |
| 2. <i>Pentstemon procerus</i> Dougl. (syn. <i>Pentstemon micranthum</i> Nutt.) | July 23, 1B. |
| 3. <i>Pentstemon glaucus</i> Graham var. <i>stenosepalus</i> Gray | Aug. 14, 4A; Aug. 23, 4B. |

- | | |
|--|---|
| 4. <i>Pedicularis Grayi</i> A. Nels. | July 21, 2B; July 29, 1A; Aug. 19, 1C. |
| 5. <i>Castilleja linearifolia</i> Benth. | June 28, 1A. |
| 6. <i>Castilleja sulphurea</i> Rydb. | July 6, 1A; July 9, 2A; July 15, 1C; July 21, 2B; July 23, 1B; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 20, 2C; Aug. 23, 4B. |
| 7. <i>Orthocarpus luteus</i> Nutt. | Aug. 19, 1A. |

XXX. RUBIACEAE

- | | |
|-----------------------------|--|
| 1. <i>Galium boreale</i> L. | July 6, 1A; July 9, 2A; July 21, 2B; July 23, 1B; July 23, 1C; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 20, 2C. |
|-----------------------------|--|

XXXI. CAPRIFOLIACEAE

- | | |
|---|--|
| 1. <i>Sambucus microbotrys</i> Rydb. | July 17, 2A; July 21, 2B; July 23, 1B. |
| 2. <i>Symphoricarpos rotundifolius</i> Gray | July 9, 2A. |
| 3. <i>Lonicera involucrata</i> Banks | Aug. 14, 4A. |

XXXII. CAMPANULACEAE

- | | |
|-------------------------------------|---|
| 1. <i>Campanula Parryi</i> Gray | July 16, 1A; July 23, 1B; July 23, 1C; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 20, 2C. |
| 2. <i>Campanula rotundifolia</i> L. | July 17, 2A; July 21, 2B; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 17, 1C; Aug. 20, 2C; Aug. 23, 4B. |

XXXIII. VALERIANACEAE

- | | |
|---|---|
| 1. <i>Valeriana acutiloba</i> Rydb. | June 28, 1A; July 9, 2A; July 15, 1C; July 21, 2B. |
| 2. <i>Valeriana certophylla</i> (Hook.) Piper | July 17, 1C; July 21, 2B; Aug. 15, 3B; Aug. 20, 2C. |

XXXIV. COMPOSITAE

- | | |
|---|--|
| 1. <i>Chrysopsis villosa</i> Nutt. | July 23, 1B; July 28, 1C; July 29, 1A; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 23, 4B. |
| 2. <i>Chrysothamnus lanceolatus</i> Nutt. | Aug. 17, 1C; Aug. 19, 1A. |
| 3. <i>Chrysothamnus nauseosus</i> (Pall.) Brit. | July 21, 2B; Aug. 17, 1C; Aug. 19, 1A. |
| 4. <i>Oreochrysum Parryi</i> (Gray) Rydb. (syn. <i>Haplopappus Parryi</i> Gray) | Aug. 14, 4A. |
| 5. <i>Solidago corymbosa</i> Nutt. | July 21, 2B; July 23, 1C; Aug. 20, 2C. |
| 6. <i>Solidago decumbens</i> Greene | July 21, 2B; July 23, 1C; July 29, 1A; Aug. 14, 4A; Aug. 15, 3B. |
| 7. <i>Aster adscendens</i> Greene | Aug. 19, 1A. |
| 8. <i>Aster Canybi</i> Vasey | July 21, 2B. |

9. *Machaeranthera aspera* Greene July 30, 2A; Aug. 17, 1C; Aug. 19, 1A; Aug. 19, 1B; Aug. 20, 2B.
10. *Machaeranthera rubricaulis* Rydb. Aug. 17, 1C; Aug. 19, 1A.
11. *Erigeron Coulteri* Porter July 15, 1C; July 23, 1B.
12. *Erigeron elatior* (Gray) Greene July 21, 2B; July 28, 1C; Aug. 14, 4A; Aug. 23, 4B.
13. *Erigeron macranthus* Nutt. July 9, 2A; July 16, 1A; July 21, 2B; July 23, 1B; July 28, 1C; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 20, 2C; Aug. 23, 4B.
14. *Antennaria aprice* Greene July 29, 1A; July 28, 1C.
15. *Antennaria parvifolia* Nutt. July 21, 2B; July 28, 1C; Aug. 14, 4A; Aug. 15, 3B.
16. *Antennaria pulcherrima* (Hook.) Greene Aug. 23, 4B.
17. *Antennaria rosea* (Eat.) Greene July 6, 1A; July 21, 2B; July 23, 1C.
18. *Antennaria speciosa* A. Nels. June 28, 1A.
19. *Viguiera multiflora* Blake (syn. *Gymnolomia multiflora* (Nutt.) B. & H.) July 17, 2A; July 29, 1A; Aug. 17, 1C; Aug. 19, 1B; Aug. 20, 2C.
20. *Helianthella quinquenervis* (Hook.) Gray July 9, 2A; July 15, 1C; July 21, 2B; July 23, 1B; July 29, 1A; Aug. 14, 4A; Aug. 20, 2C.
21. *Chaenactis Douglasii* H. & A. Aug. 23, 4B.
22. *Dugaldia Hoopesii* (Gray) Rydb. (syn. *Helenium Hoopesii* Gray) July 15, 1C; July 21, 2B; June 28, 1A; Aug. 14, 4A; Aug. 15, 3B.
23. *Achillea millefolium* L. July 9, 2A; July 15, 1C; July 21, 2B; July 23, 1B; June 28, 1A; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 20, 2C; Aug. 23, 4B.
24. *Artemisia aromatica* A. Nels. July 16, 1A; July 21, 2B; July 22, 2A; July 23, 0B; July 28, 1C; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 20, 2C.
25. *Artemisia frigida* Willd. Aug. 19, 1A.
26. *Artemisia gnaphaloides* Nutt. Aug. 17, 1C.
27. *Artemisia tridentata* Nutt. July 21, 2B.
28. *Senecio Bigelovii* Gray Aug. 14, 4A; Aug. 15, 3B.
29. *Senecio crassulus* Gray July 28, 1C; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B.
30. *Senecio crocatus* Rydb. July 23, 1C.
31. *Senecio eremophilus* Rich. July 6, 1A.
32. *Senecio Fendleri* Gray July 6, 1A.
33. *Senecio glaucescens* Rydb. Aug. 14, 4A.
34. *Senecio integerrimus* Nutt. Aug. 17, 1C.
35. *Senecio serra* Hook. Aug. 19, 1A; Aug. 19, 1B; Aug. 20, 2B.
36. *Senecio sphaerocephalis* Greene June 28, 1A; July 3, 1B; July 23, 1C.
37. *Carduus Nelsonii* Pammel July 23, 1B; July 28, 1C; July 29, 1A; Aug. 14, 4A.
38. *Agroseris glaucum* (Nutt.) Greene July 16, 1A; July 21, 2B; July 28, 1C; July 30, 2A; Aug. 14, 4A; Aug. 15, 3A; Aug. 15, 3B; Aug. 19, 1B; Aug. 20, 2C.

39. *Agroseris montana* Osterh. Aug. 23, 4B.
(*Troximon montanum* (Osterh. A.
Nels.
40. *Taraxacum officinale* Weber June 28, 1A; July 15, 1C; July 23,
1B; Aug. 23, 4B.

BIBLIOGRAPHY

Barclay, Harriet G. Grassland Climax of the Subalpine Zone. Presented at AAAS meeting, Dallas, Texas, December 1940.

Clements, F. E. Plant Indicators. Carnegie Institution Washington Publication 290, 1920.

Clements, F. E. and Weaver, J. E. The Relation of Climax as to Climate. Carnegie Institution Washington Publication 335, 1924.

Clements, F. E. Nature and Structure of a Climax. Journal of Ecology 24: 252-284, 1936.

Hanson, Herbert. Prairie Inclusions in Deciduous Forest Climax. American Journal of Botany 10: 515-536, 1932.

Marvin, R. J. and Kincer, J. B., editors. Climatic Summary of the United States. USDA Weather Bureau, Sec 22, Western Colorado, pp. 11, 21, Washington, D. C.

Meserve, Mary Fleishman. Grasses of Colorado. Colorado Studies, University of Colorado, 27, 93-95, 1939.

Meserve, Mary Fleishman. Plant Succession on Subalpine Grasslands as Affected by Livestock Management. Northwest Science, 15 (I): 3-5, 1941.

Pickford, G. D. and Reed, Elbert H. Basis for Judging Subalpine Grassland Ranges of Oregon and Washington. USDA Agricultural Circular 625, pp. 1-38, 1942.

Shreve, Forrest. Influences of Slope and Exposure of Soil Temperature. Carnegie Institution Year Book 23: 141-142, 1942.

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