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About the Institute

The Hunt Institute for Botanical Documentation, a research division of Carnegie Mellon University, specializes in the history of botany and all aspects of plant science and serves the international scientific community through research and documentation. To this end, the Institute acquires and maintains authoritative collections of books, plant images, manuscripts, portraits and data files, and provides publications and other modes of information service. The Institute meets the reference needs of botanists, biologists, historians, conservationists, librarians, bibliographers and the public at large, especially those concerned with any aspect of the North American flora.

Hunt Institute was dedicated in 1961 as the Rachel McMasters Miller Hunt Botanical Library, an international center for bibliographical research and service in the interests of botany and horticulture, as well as a center for the study of all aspects of the history of the plant sciences. By 1971 the Library's activities had so diversified that the name was changed to Hunt Institute for Botanical Documentation. Growth in collections and research projects led to the establishment of four programmatic departments: Archives, Art, Bibliography and the Library.



Colorado. 1919

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Boulder

- July 26. Boulder, ev.
" 27 Mt. Sanitas
" 28 Bluebell Canyon
Gunbarrel Hill, ^{Whiterock}
" 29 Flagstaff Mt.
" 30 Plains grassland, Boulder
Tolland.
" 31. AM. Boulder to Tolland, auto
P.M. S. Boulder Park.
Aug. 1 Teller Lake
" 2. AM. S. Boulder P., + Aspen thicket
P.M. Upper S. Boulder
3 Mesophytic forest Boulder
" 4 Forest Lakes (10900)
" 5 Park Lake
" 6 Corona
" 7 James Peak (13253)
" 8
" 9 Park, Filled, + East Lakes
" 10 (plants)
" 11 AM 2 1/2 mi. down
" P.M. Dry grassland
" 12 Echo + James Peak Lakes
" 13 -
" 14 Tolland to Boulder to Ward

Ward

- Aug. 15 Stapp's Lake
" 16 Red Rock, Brainerd, +
Long Lake.
" 17 (Sunday)
" 18 Mt. Audubon
" 19 White Raven Mine
" 20 Duck + Mud (or Echo) Lake
" 21 AM. En Route
Stewer. Kirkwood Inn
" 21. Woods
" 22 Twin Sisters
" 23 Chasm Lake
" 24 AM Long's Peak Inn
" 24 PM Timberline Cabin
" 25 Long's Peak 14255 ft
" 26 High Drive + Fall River rd
" 27 Loch Vale
" 28 En Route, Big Thompson
" 29 Berlake, Colo. + Sargent

Back of Notebook

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~~711~~
~~319~~
3.92

Aug. 1, 1919. Tolland, Colo. I

General Divisions of Vegetation

I. Plains - char. by grass ass.
incl. lower mesas

3000 or 3500 up to 5000

A region of ters. or semi-arid
cond. w. rainfall of 10-12 or
less up to 15 in.

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Quantity and diversity of soil
1. Fine loam (as seen at Ulerons,
works of Briggs + Shantz)

In plains, soil moisture the
limiting factor in veg.

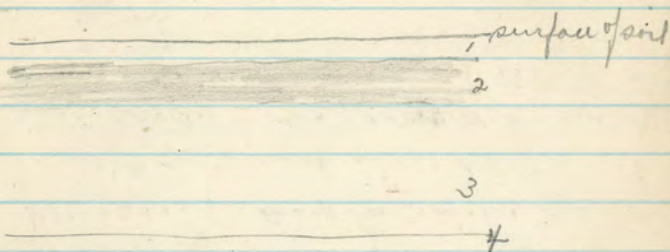
The cond. of this moisture in
the soil - Shantz + Always
(in det.)

Soil so close that consid. run-off
in torrential rain, + moisture
penetrates very slowly.

Moisture wh. affects veg. not
in any way in contact with

The water table.

Water supply in plains:—



1. quite dry
2. some moisture

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4. surface of water table

Lower limit of 2 raised by transp. of crops

Adv. of lying fallow—open in cond. for water to soak in

(2) no plants to use water

Once the water is in the soil it comes out only as plants take it out. Evaporation only effective thro the upper few in. + soons so dry that it isolates the moist below

Wannec. stress prob. laid on
stirring of soil in dry farm-
ing. Here imp. in distr.
plant growth + to prevent run-off

Why the dry space (3) ?

Alway's answer -

When the amt of water in the
dry area is the amt of the
hygroscopic coefficient [the

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amt. present in soil. The
soil is eq. to sat. atm. + always
the leaves of plants eq. water]

got into this cond. because in the
plains veg. a certain % of
plants with very long roots +
they extracted the water.

One of great diff. between plains
+ prairie - in prairie 2 reaches
to 4, 3 not present.

Over large portion of this area
veg. reaches its climax in

short grass. ass. (see Shantz
on abandoned rds., in Jour. Ecol.)
Variations

2. Sandy areas - runoff less,
water holding cap. less. Dry
isolation stratum not present,
surplus of r. f. goes down to
water table.

Streams diff. in 2 areas. - those
in fine soil area intermittent,
in sandy area, permanent due
to cont. movement of water thro

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R. J. Poole - Minn. Plant Studies,
sandy areas in Neb.

Here grass coarser, taller. -
the "wire grass ass", *Stipa*
Andropogon, *Agropyron*, &

Bunch grass }
Short grass } the 3 grass
Wire grass } ass. of plains.
Short grass s. to Ariz. & north of Cal.

II Foot hills or mt. Front.

5000 - 7000 ft.

This essentially a region of
spr. forest.

Rainfall - 15 in, var. locally
because of hills

For this part of Colo, a yellow
pine forest, *Pinus ponderosa*,
sometimes called bull pine.

P. ponderosa

P. arizonica

P. jeffreyi ?? its use ind.
diff. ass.

An open park-like forest w.
consid. interval, this covered
w. sparse shrub or grass
veg. The limits of density
of forest quite certainly water
supply, because forest is
denser in topog. positions
wh. tend to get water supply
here & toward upper part
of its range, as with

Pseudotsuga.

III Montane. -

The position of a mountain that is most mesophytic, it goes up to the height where trees of very much affected in ht. & devel. by cond. of temp. etc. 7000 ft. - 9500 ft.

Rf. - 30 in. in this part of Colo. not evenly dist. , much more in winter months. Consid. in

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Lower montane + upper Foothill, growth of yellow pine dependent on winter rainfall.

The forest region -

The climax - the spruce-fir forest. Engelmann spruce + prince tree, + or it,

Abies lasiocarpa, + some *Picea pungens*. [Mammoth

Summ. gulch, s. Boulder canyon (up)]
Burn of spruce-fir (not too much
or too freq. - a pioneer forest of

aspen, + invading aspen,
+ lodgepole pine forest (*P. murrayana*)

Some diff. of opinion as to
whether lodgepole pine ever
climax. May be a temp. climax
in some areas of poor soil.

Grassland - In the montane,
certain areas of grassland.

One of the problems, whether any
of this gr. land is climax. No
question but that it will endure
for a very long time, but Fuller
doubts whether ever really
permanent.

IV Sub-alpine

9500 - 10500 or 11000 ft.

Begins where there is a
very decided infl. of alt.
shown in the dwarfing
of tree growth.

limber pine one of commonest
of sub-alpine, but may come
down into montane, as
in Mammoth Gulch.

The sub-alpine the region of
deformed forest, from " "
def. dwarfing up to krumholz.
A consid prop. of shrub (willow
spp.) + grassland. Subalpine
meadows more mess. than
montane grassland.

Trees - Limber pine, P. flexilis
foxtail pine P. aristata

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V. Alpine region

11000 ft +

The falling out of tree species
the best limit, & yet in
that def. consid, alpine there
is some krumholz.

1. Alpine shrub-ass.

2. " Herbarious ass.

very difficult to draw line
between because many plants
hard to place as Dryas.

Alpine meadows of herb. plants
& some grasses. - On the
whole, char. by a comp.
small no. of sp. Sometimes
consid. areas covered w
one sp. as alpine clover, or
slyas, or willow.

The Extent of glaciation at Tolland.

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up to Tolland. base of valley
valley very compl. filled w.
ice sheet.

Mammoth gulch & region of
max. moraine dep. & of course
made when gl. scarcely reached
Boulders part. Region around
Teller lake wiped out & ferns.
At lower end more subsequent
water action

Aug. 5, 1919. L. II

III Montane

Montane Forest. 8000 - 11000

Climax - char. by comparatively few tree species - Engelmann Spruce & Abies lasiocarpa.

May add 2 others occurring less freq. but apparently within same ecol. range, v. e. Picea

mariana & Abies brucei

Question may arise as to whether this is a truly mesophytic forest or not. Has been stated by various writers than "conifers are xerophytes". Conifer leaves are xeromorphic; but some less so than others. But both spruce & fir have quite decidedly xeromorphic leaves.

Spruce fir forest here much same as in northern Rockies of Canada

There *Picea canadensis* + *Abies* -

Species that come in along with
these trees are much better local
indicators of mesophytism.

sp. *Phegopteris* - must be regarded
as ind. of mesoph.

Actaea

Thalictrum

and to a less extent + in a

different way the *Pyrolas.*

everg. forms + largely limited to
everg. forests.

Shrubs - not very dominant +
of comp. few sp. as in other mes.
forests.

Mt. Ash - *Sorbus scopulina*

Ribes sp.

Soil character - soil in mes.
montane forests has a high moisture
content. Have no records of range
of soil moisture thru the season.

But know that water holding capacity
very considerable. Humus in
masses, even high (in rock pockets)
In N. spruce-fir forests this very
part, so - there called "duff" by
foresters, & it is this that makes
them so liable to injury by fire.

Forest dense; evaporating power of
air in lower strata not high.

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Weaver (c. Wash) has found soil moist
& air cond. very similar to those
around Chi. in beech-maple forest.

Subdivisions according to altitude,
or of a more compl. & less compl.
mus. char. of forest.

Above 10000 ft. - trees shorter
taper more rapidly, branched
shorter; giving upper mountain form.
Undergr. less completely mesophytic

1. Forest of lower altitudes -
cf. Canyon of S. Boulder Creek.

Shrubs:

Sorbus

Lonicera involucrata

✓ *Ribes parvulum* + spp.

✓ *Vaccinium* spp.

(much less xeromorphic than leaves
of *Vaccinium* of east)

Sambucus microbotrys

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Herbs:

Lycopodium annotinum

Phegopteris Dryopteris

Helphium glaucescens

Aconitum columbianum

Actaea rubra

Thalictrum sp

✓ *Saxifraga arguta*

✓ *Mitella pentandra*

2. Forest of higher altitudes, above 10000
✓ of list before.

Pyrola chlorantha

Gaultheria humifusa (at forest edge)

Castilleja (one of very consp)

Erigeron

Aster

Hieracium gracile

Pentstemon (yellow)

Gentiana puberula

Podium (bracteatum)

Solidago

Aquilegia

Arnica parryi

Juniperus communis sibirica to
some extent but prob. more an
ind. of poorer conditions

Aug. 6, 1919

L. III.

Montane ponds

Most conspicuous thing the absence of some of the most consp. sp. + gen. wh. we are acc. to thinking of in con. or ponds, i.e. & emergent veg. largely lacking.

The reed ass. lacking, as

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(^{see} Ramaley - Red Rock Lake)

1. Aquatics (acide form. algae, wh. are not many)

Potamogeton alpinus

" sp.

Sparganium angustifolium

Myriophyllum (Park Lake)

Ranunculus depshinifolius

Sparse veg. doubtless due to short season + cold water.

2. Sedge moor or fen ass.

A zone in wh. 2 or 3 sp. of
sedge make up the bulk
of ass.

Carex utriculata (Perk) ^{Forest Lakes}
" *oxycarpis*

Juncus spp.

These in add. to other herb. plants

Caltha

Ped. groen.

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Saxifraga

2 a. A Shrub ass

Willows + dwarf birch sometimes
make an ass. coming to waters
edge instead of 2.

Heracleum lanatum

Pedicularis racemosa

Angelica

Formation of Forest Lakes, & others.

glacial action - either scooping out or damming back, or combination of these.

give rather abruptly sloping sides, quite diff. from Park Lake. Acc. change quickly.

3. Heath Zone - not always present on slope between sedges & forest - well developed about north + east Forest Lakes

needs abrupt rise or good drainage

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oreophyllum (blue)

Kalmia

Gaultheria humifusa

Sibbaldia

Solidago decumbens

Erigeron spp. (salsuginosus?)

Zones dependent on char. of shores - West Lake, abrupt + rocky - pockets between rocks w. *Senecio* + *Aquilegia*

The heath var. - most unique etc

acc. of a mt. Lakes. Others
connected with most lakes

4. Forest

may succeed either leach
zone or shrub zone + ^{sedge zone} sometimes
Is the forest already discussed¹
i.e. the spruce-fir.

Alpine

1. Factors of altitude.

a. Low air pressure

eff. ind. are that low air pressure results in stem elongation. no manifestation in alpine vegetation

b. Intense light

(Zon - Bull U.S. Forest Service, on influence of light - -)

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1000 ft up. av. temp. decr. $3^{\circ} F$.
Minimums decr. much more rapidly.

In alpine regions always a comp a low temp.

\therefore for many hrs of day metal. proceeds at low rate. Would account to some extent for decr. size.

Sun + shade temp. very diff.,
30 or 50 $^{\circ} F$. difference.

d. Humidity -
rel. humidity low.
Tolland, 10.

Chicago 60-80
e. Temperature - soil.
of water of pools + streams
∴ soil low.

f. Short season
growing season 3 months
at most

g. Increased rainfall

prob. no Colo mts on
wh. r. f. on summit
is less than in montans

Denver 14, 15 in

Boulder 17-18 "

Tolland 28-30 "

Corona 40 "

Higher mts, storms
may be below tops.

h. High Winds

Winds begin to incr.
in Sept + Oct + reach

max. in Dec. & Jan.
rate. - 40-60 mi. per hr
not uncommon in
alpine & montane.

Influence clearly shown
in response of wind timber,
esp. well shown on James Park
trail.

i. Poor soil

very little humus
few bacteria &
soil protozoa
no earthworms

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Humus may collect
in a few prot. spots

2. Alpine vs. Arctic conditions

In arctic regions (outside
of snow covered,

growing season longer,
larger % of light during
growing season

Humidity usually gr. in Arctic
Atm. pr.

Still, have much in same
forms & often same sp. ex-

Dryas octopetala - in alpine
& arctic

3. Origin of Alpine Flora

Many sp. arctic & believe
they occurred at lower levels
during glacial epoch.

Evidence that many alpine
genera or even sp. were
formerly on plains

P. flexilis is found on plains

in few places in Colo.

Phlox spp.

Upward postglacial migr.

One element from north farther
south that came w. recession
of glaciers

Alpine flora of Colo. & alps sim.

Arctic remarkably uniform

4. Growth Forms

a. Cushion forms.

(shaded on cushion plants)
on rocky slopes, large prop.
of cushions

Silene aca
Paronychia
Trifolium
Arenaria

b. Mat plants

Dryas - a thin mat
Willows

c. Large rooted plants

Claytonia megorrhiza

d. Rosettes

Saxifrages

e. Bulbous plants

not numerous in

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alpine but some in
sub-alpine

Lloydia

f. Prostrate shrubs

willows

Dryas (?) stems

woody or partially so

In all growth forms

a. reduced leaf size

b. thick cuticle

c. very considerable density
of tissues; strong develop-
ment of palisade

Aspen grasses
and *Chamaedryas*

- d. leaves crowded
- e. in a, b, d. + f, shortening of internodes of stems
- f. profuse branching
- g. flower size little reduced (flowers relatively larger, not abs.)

5. Duration of Alpine Plants
 nearly all perennials, a few biennials but very few

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many repr. veg.
 " do not

6. Plant Associations

1. Sedge moor or Fen - in wet places.

Here in Colo. v alpine not much below 11000 ft.

Sedge moor much like sedge moor of montane

ex. Saddle on James Pk., sedges, v. small, few other plants

2. Willow scrub.

In good development very little but willow

3. Meadow

4. Mat "Cushion meadow"

374 not easily separated larger prop. of grasses + sedges in prop. to mats + cushions make 3.

Ex. of both at Corona.

Where soil finer + deeper meadow; in rockier

situations - mat ass.

meadow passes into sedge mat.

5. Wind Timber or Krummholz.

Slopes of Kingston Hill, on

James Pk. trail.

James Pk. lake.

Largely result of wind, but comb. w. wind + largely infl. by it, is snow cover

Timber Line -

a. snow

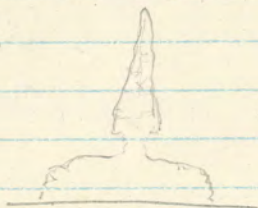
may be result of snow

(Examples on next page)

(snow a pist. factor if does
not lie too long)

if too much snow, that
will det. timber line

b. soil.



snow
infl.

c. length of growing season
not abs. ^{length} temp.

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Typical Plants of Alpine Ass.

1. Sedge moor

Carex

Caltha

Pedicularis groenlandica

Troillius

2. Willow scrub

Salix spp.

Betula sometimes

+ certain herbs -

Mertensia

Pedicularis

3. Meadow

Carex spp

Grasses

Trifolium - very
not. & covers large area

Sisirsia

Castilleja

Polygonum spp.

Mertensia

Pedicularis

4. Mat.

Selaginella densa

Polytrichum

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Silene acaulis

Cretichia

Paronychia

Primula

Saxifraga

Urtica

5. Wind timber

Picea engelmannia

Abies lasiocarpa

Pinus aristata -

Pinus flexilis

7 ass. with timber in

its shelter -
Polemonium
Mertensia

Aug 9, 1919

limits of alpine usually placed
at two genera; esp., genus Salix,
some of which are very abundant.

Salix pterophylla
" saximontana

Grasses poorly represented.

Sedges:-

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Carex alpina } dense dark heads
" atrata } + low habit.

Liliaceae

Lloydia serotina

Polygonaceae

Polygonum viviparum
" histortoides

Oxyria digyna

Portulacaceae

Claytonia megarrhiza

Lewisia pygmaea

Caryophyllaceae (many)

Silene acaulis

Lichnis montana
" *Drummondii* Corona
Stellaria laeta
Cerastium spp.
Arenaria sajanensis
" *Fendleri*
" (*aequecaulis*) ?
Paronychia sp.

Ranunculaceae (comp. few)

Caltha leptosepala
Aquilegia sajanmontana
Ranunculus adoneus
" — (*n. Primula*)

Cruciferae (comp. few)

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Thlaspi coloradense
Draba spp.

Crassulaceae

Sedum stenopetalum
" *integrifolium*
" *rhodanthum*

Sapifragaceae (very common alpine)

Sapifraga chrysantha
" *flagellaris*
" *debilis*
" (*nivalis*) *rhomboidea*
" *austromontana*

Heuchera sp.

Rosaceae

Sierersia turbinata

Bryas octopetala

Sibbaldia procumbens

Potentilla sp.

Leguminosae

Trifolium nanum

" *parryi*

" *dasyphyllum*

Violaceae

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Viola sp.

Onagraceae

Chamaenerion latifolium ^{subalp.}

Epilobium sp.

Umbelliferae

Oreopis humilis

Pseudocymopteris (?)

Primulaceae

Primula angustifolia

" *parryi* (+ subalpine)

Androsace subumbellata

Gentianaceae

- Gentiana parryi*
" *plebeja* + *G. p. Holmii*
" *Romanzovii* (*frigida*)
" *monantha*
Suertia palustris

Polemoniaceae

- Phlox* sp.
Polemonium confertum

Hydrophyllaceae

- Phacelia sericea*

Boraginaceae

- Critrichium argenteum*

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- Montanoa alpinus*
" *viridis*

Scrophulariaceae

- Chronophila Jamesii*
Syrthyris alpina
Pedicularis groenlandica
Castilleja

Campanulaceae

- Campanula rotundifolia*
" *uniflora*

Compositae

- Chrysopsis* sp.

Tomostus pygmaeus

Solidago sp.

Erigeron uniflorus

" *melanocephalus* ©

" spp.

Antennaria sp.

Chaenactis pedicularia

Rydbergia grandiflora

Actinella lanatus ?

Achillea millefolium ?

Artemisia scopulorum

" *papirula*

Senecio Soldanella

cothurnoides

" *petrocallis*

" *canus*

" spp.

Carduus hookerianus

var. *eriocephalus*

Aug. 13, 1919.

Sub-alpine

The region in which there is a trans. from montane to alpine

Best limits to be seen in char. of trees, from ht. at wh. trees become decidedly reduced in size due to cond. involved, up to ht. at wh. tree sp. drop out.

Here in Colo. 9500 or 10000 to 11000.

Topog. cond., cond. of exp., may vary this

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Species:

In general, veg. a mixture of forms from all montane & from alpine
Comp. few sp. limited to subalpine
Of tree sp.

Pinus aristata - lim. to subalp.

" *flexilis* - down into mont.

Salix sp. - but prob. most of these also in m. + a.

Pinus } wide range

Abies }

2 types of veg. most prominent:

1. Forest

2. Meadow

+ possibly add

3. Scrub - mostly a willow scrub, sometimes w. birch + alder

2. Alpine meadows:-

Phleum alpinum + few others

Carex spp - incl. all v

montane spp. +

Carex alpina, *atrata*

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+ consid. var. of herb plants

Cattha very prominent

Trollius

+ others of montane spp

In dryer meadows,

clovers - as prom as in alpine

Erigeron superbus

Castilleja laeta +

Senecio spp

Delphinium

Aconitum

Aquilegia

1. Forest -

Undergrowth very much same
as below.

Vaccinium

Galium

Rubus

} not heavily shaded
slopes

Factors that lead to development
of this type of veg. comb. of factors
of montane + alpine

Rainfall consid.

Water - from above, making
many swampy + undrained

areas where dammed

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Seepage from snow of alpine

∴ consid. areas of subalpine have
abund. of soil moist.

Winds - very def. factor in
growth forms.

[Schrader's monog. on veg. of
Alps - tree forms]

Snow - comb. of wind + snow

tends to develop a peculiar
types of tree in wh. foliage

is distr. in 2 areas, crown
+ basal mat with an

interval between rep. about
snow level, at wh. most
foliage destr. by action of
wind on snow surface.

Absence of forest in most portions
of subalpine, due to limit +
duration of snow.

Position of late snow drifts
will be scrub or meadow

[Floristic - series of art. by
Rydb. about 1911, Bull.
Torrey Bot. Club]

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Subalpine species:

grasses

Liliaceae

sedges

Lloydia

Zyadenus elegans

Streptopus

Orchidaceae

Listera

Polygonaceae

Polygonum bistortoides

Saxifraga hypnoides
Portulacaceae

Lewisia pygmaea

Caryophyllaceae

Arenaria } more consp

Stellaria } alpine

Ranunculaceae - must better repr.
in subalpine than in alpine

Caltha

Trollius

Aquilegia

Delphinium

Aconitum

Ranunculus sp.

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Cruciferae

Cardamine cordifolia

Saxifragaceae

Saxifraga nivalis

" *arguta*

" *subcapitata*

Parnassia

Mitella pentandra

Rosaceae

Fragaria

Potentilla spp.

Sivversia

Sibbaldia

Leguminosae

Trifolium parryi

Astragalus alpinus + spp

Anagraceae

Epilobium spp

Umbelliferae

Apocynis fendleri

Ericaceae

Gaultheria humifusa

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Moneses

Pyrola secunda

Arctostaphylos

Vaccinium scoparium

" *oreophyllum*

Primulaceae

Primula Parryi

Gentianaceae

Gentiana chondrophylla

" *parryi* 2 spp

Sivertia

Polemoniaceae

Polemonium^{*pulcherrimum*} - very abund
under mixed timber

Hydrophyllaceae

Hydrophyllum ?

Boraginaceae

Erigeron *ciliata*

" *viridis* ?

Scrophulariaceae

Pentstemon

Pedicularis *groenlandica*

" *bracteosa*

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Veronica *alpina*

Castilleja *lurida*

" *sulphureum*

" spp

Caprifoliaceae

Sambucus *nigra* ?

Campanulaceae

Campanula *rotundifolia*

Compositae - strongly represented

Solidago spp

Asperula

Erigeron silperbus
" *melanocephalus* J. Ag.
" *uniflorus* J. Ag.
" *Coulteri*
" *elatus* v. sp.

Antennaria spp.

Artemisia scopulorum
" *saxicola*

Arnica cordifolia

" *Rydbergii*

" *Parryi*

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Senecio amplexicens

" *triangularis*

" spp.

Carduus scopulorum

Hieracium gracile