The alpine flora of Montana
by Pliny H Hawkins

A THESIS Submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE IN BOTANT at MONTANA STATE COLLEGE
Montana State University

Abstract:
no abstract found in this volume

THE ALPINE FLORA OF MONTANA

by

PLINY H. HAWKINS

A THESIS

Submitted in partial fulfillment of the requirements

for the degree of

MASTER OF SCIENCE IN BOTANY

at

MONTANA STATE COLLEGE

Approved:

J. W. B. (J. W. Blankenship)
In Charge of Major Work

Bozeman, Montana
June, 1903

THE ALPINE FLORA OF MONTANA

by

PLINY H. HAWKINS

Sources of Data

The data for this thesis is gleaned from many sources. The herbarium of the State College of Agriculture and Mechanical Arts has been carefully canvassed. For many of the ideas advanced I am indebted to Dr. J. W. Blankenship who has given me free access to his private note books and much personal assistance. The excellent libraries of the College and Dr. Blankenship have been carefully reviewed, and are often referred to in the following pages.

During the last nine years, I have visited many of the highest peaks in person. The summer of each year being spent as follows:

1894 in the Yellowstone Nat. Park
'95 " " Bull Mountains and Little Belt-range
'96), " " Little Belt and Judith ranges
'97)
'98 in the Big Belt and Crazy Mts.
'99 " " Big Belt chain, and
1900), 1901), 1902) in the Bear Tooth range between Wyoming and the Yellowstone River.

Not all of this time has been given up to botanical work. Many days have been spent in geological studies and prospecting. Some have been given up completely to hunting and fishing or exploring the uninhabited portions of the mountains; others have been devoted to ethical and aesthetical pleasures toward which the mountains always draw one so irresistably. For these latter days I have no excuse to offer. They are the alpine summits of human existance.

The public lands are now settled far into the canyons. Wherever there is abundance of grass, stockmen have summer ranges easily accessible by wagons. The occupants are always hospitable to people who do not interfere with their business, so that the botanist can often reach a height of 7000 ft. without inconvenience.

Means of travel

From this altitude the ascent can be made on foot in a day, or if one does not mind hardship by taking a blanket and a supply of food one evening and the following morning can be spent on the mountain top.

Even with rain and snow accompaning such trips, I have never suffered, always finding shelter in dense timber or under overhanging cliffs where a fire can be built. The interest and novelty always repay one richly for any inconvenience. But in these trips it is only a few hours until you must begin your decent to reach camp and food. To avoid this I have always taken two small horses well shod, one to ride and one to pack, making permanent camps upon the summits.

Crazy Mts. impassable to horses

The Crazy mountains are impassable, on account of the great slide rock peaks which crown the whole chain. After taking the horses nearly to the summit we were obliged to return with them. There was no grass and it was with utmost difficulty the next day that we made the ascent and journey along the range on foot.

In my pack I always carry the following list

Equipment

Presses, dryers, papers, etc.,
a poncho and three blankets,
frying pan and granite sauce pan,

a tent 7 x 7 with jointed pole and iron tent pins,
An ax to cut the trail,
A sack of good bread,
bacon,
jelly, - (this takes the place of fruit.)
meat if game is out of season,
cheese and nuts.

With such an outfit one can be gone a week or two with perfect safety and comfort.

Before July 1st and after Sep. 1st Alpine climbing is at the risk of being snowed in. In the Little Belts June 9, 10, 11, the snow fell continuously for three days. At the end of the third day the snow was up to my arm pits and men and stock were perfectly helpless. Three days later the snow thawed so that we could roll snow balls and the horses got their noses to grass. In their hunger they had eaten each other's mains and tails so that our train was an object of derision the remainder of the summer. This was at 8000 ft. At 11000 ft. our stock might have perished. The fourth day after the storm we went down the mountain. In three hours travel the snow had entirely disappeared and there stood the tall June grass nearly ready for harvest. Here the famished ponies insisted on camping and we lay down to enjoy the restful green after the perpetual glare of the sun upon the snow. Where the snow drifted it was nearly three weeks before the vegetation was uncovered. Flowers just in bud when the snow came were past their prime when uncovered yet it did not seem to affect their fertility (Anemone patens Nuttaliana).

Time for Alpine travel

Snow

There is no time in the summer when snows and frosts may not visit the alpine peaks. One of the worst blizzards I ever experienced was the fourth of July in the little Belts at 8000 ft. and the same year (1897) we had a foot of snow August the twentieth. Any plant which cannot withstand these vicissitudes of Climate is barred from Alpine regions.

Vicissitudes of Alpine flora

Not often are these higher regions visited by flying insects. Therefore they do not play an important part in cross fertilization as they do in lower altitudes. One of the most annoying things to the insects, and to the collector as well, is the powerful wind which is always blowing at the summits. Sometimes for days together there will not be a lull. If there were insects they could not rise from the ground. The wind is simply terrific with occasionally a spot of rain or a flake of snow from an apparently cloudless sky. In twenty minutes a storm will gather wetting everything and in as many more not a cloud can be seen. Only an experienced botanist will leave the summits with a good collection for the elements usually prove more than a match for an amateur as I can testify to my sorrow.

wind

Difficulty in Collecting

Even the most casual observer has noticed the belts of vegetation. The mountains tabulate them in gigantic letters. First there are the plains covered with cactus and other xerophytic plants, scattering trees, and rich grasses extending to the broken foothills of the mountains. This belt runs up to about 5800 ft. From 5800 to 5000 ft. is a more grassy moister region known as the foothills. Many of the plants of the plains are

Belts or Zones of vegetation

Plains

Foothills

common here and some of the mountain vegetation strays down but on the whole it is a distinct belt.

From 5000 ft. to 9000 ft. is the subalpine or black timber belt, characterized by abundance of moisture, heavy timber which gradually dwindles down to prostrate shrubs, and a flora entirely distinct. Then comes another transformation belt from 9000 ft. to 10000 ft. in which alpine and subalpine forms are about equally dispersed and highest of all the strictly alpine zone from 10000 ft. up. I had always reasoned by analogy that the alpine species were simply depauperate forms of lower altitude species, that time had made these changes more or less permanent but that by taking the seeds to lower altitudes they would gradually return to their old form. One hour in alpine heights will dispel that illusion forever. First if these higher species would grow in lower altitudes they have every opportunity to do so. Avalanches and land slides occur continuously taking seeds, roots and soil below. Seeds naturally roll down hill, every gust of wind takes them to lower levels; birds fly up and down the season through yet all of these powerful agents of distribution fail to scatter even a few of the alpine plants down the mountain side. There is nothing to lead one to believe that they are the unfit, crowded to this inhospitable region of wind and snow because they could not compete in the struggle for existance with lower forms; but are rather the fittest which have the strength and hardihood to withstand the uncongenial climate and invironment.

Sub-alpine

Alpine

Alpine forms distinct

The journey from subalpine to alpine regions is often but ten minutes travel. It is the most striking change in zone life. On leaving the timber and coming out on one of these bare ridges, the first impression is that there is not a sign of vegetable life, nothing but bare rocks, that all vegetable and animal life have decended to a more congenial climate. As one looks more closely, however, the rocks are found to be covered with lichens, around the springs in little, dwarfed, isolated bunches are grasses and sedges while in shelter of rocks a hardy set of plants are ekeing out a very comfortable living.

Apparent barrenness of Alpine Peaks

The most striking characteristic of these alpine plants is their size. In leaf and stem the most rigid economy is practiced. But while small, they are well formed and do not resemble depauperate forms of lower altitudes. The leaves are finer flowers smaller and stems tougher than lower plants. Examined under a microscope the leaves show a thicker cuticle and fewer stomata. The stomata are not flush with the leaf and stem but are set in little depressions or follow the grooves. In times of drowth and exposure these are almost entirely closed like the Xerophytic plants of the deserts.

Characteristics of Alpine flora

The roots are strikingly large, mostly perennials, covering an underground surface many times the size of the branches. Nearly all, are fibrous roots. Then as a further means of securing moisture most plants grow by large rocks sending their branches underneath. Often a root an inch in diameter will be crowned by a little stem no larger than a knitting needle and

only a few inches high. By means of ample roots the plant is able to stand drowth in summer, to store up sufficient food for a quick growth in the few summer days, to withstand the enormous pressure of the snow in winter, and to obtain the largest surface possible for absorption which must often be very much retarded by ice cold water and freezing.

Very few alpine plants are glabrous. There is a tendency toward becoming hispid or hairy. This is likely a protection against moisture or drowth in excessive quantities.

Scanty vegetation

The vegetation is very sparse. Perhaps 1/100 of the soil is covered with plant life, only the most favored spots are chosen, by the side of a rock for moisture and protection, or in a crevice or under an overhanging cliff for heat. North exposures may be too cold. South exposures too dry or slide rock may bury the whole country. In such a climate annuals have too much in way of unexpected frosts to contend with so that 99% of the alpine plants are perennials which may be frozen down many times but will eventually produce seed in some favorable year. A severe frost 12° below freezing Fahr. will not wilt a leaf. I have often seen the plants covered with solid ice and come out without a wilted leaf.

Of course some plants can withstand much more frost than others and young shoots show tenderness to freezing sooner than mature branches. The mountain flora throughout the state is practically the same in alpine regions. In N. W. Montana the line drops from 9000 to 8000 ft. due perhaps to moisture and

Universality of Alpine Flora

latitude but there is but little to distinguish the flora of one mountain from that of another while the lower plant life is extremely variable.

The time of blossoming depends on slope and latitude. One thousand feet or five hundred miles latitude make about a week in difference of time of blossoming. There is on an average about ten days between a north and south slope. On very steep inclinations the difference is more.

Just as snow line gradually decends as you go north, so the region of Alpine plants which at the equator is near 15000 ft. drops to sea level in arctic America. The same species are found in Greenland and across into Europe showing a common origin. This led to the theory that during the glacial age the plant life of the North was forced south by the intense cold then as it receded these same forms ascended the mountains. During this migration plants in the large continents would be thrown into all kinds of company. The hardier native stock would sometimes meet, and cross with alpine forms making new species and many varieties. In Greenland this would not occur. The entire flora would be crowded to the sea by glaciers but could not go south. This would leave one to expect some remarkable things in Greenland flora and we are not disappointed. All but eleven of the two hundred seven species found in Greenland are European. Of two hundred thirty European species common to America not one is found in Greenland. Some few species are common to all three countries. Greenland species are on the

Forming new species

whole most nearly like those of Lapland in Europe. The similarity of the flora of America, Europe, Greenland, and Asia is a remarkable thing. Nothing like it being found elsewhere. It is the only flora which is cosmopolitan.

Age of Species

All of these facts prove that species are very old, many of them antedating the glacial period. Changes may be brought about very gradually by environment and intergrading with other plants.

The species on our mountain tops today are similar to those found in similar environment thousands upon thousands of years ago.

Species are not artifical distinctions made for man's convenience but are a part of Nature's plan. Plants undergoing rapid changes are not properly species but variations, or varieties. A species is stable as compared with the age of man. Greenland has a scantier vegetation than either continent because no continental forms traveled back after the glacial period.

Limit of phanerogamous plants

Of the 762 phanerogamous plants found in Northern latitudes 612 have traveled south to latitude 40° , 50 are native of alpine regions in the tropics and 105 inhabit the south temperate zone. Seventy phanerogams are found in Spitzbergen. About 81° is the northern limit. On islands 15 miles north of Spitzbergen none were found.

Saxifraga oppositifolia is the most ubiquitous plant of the artic regions. Pleuropogon is the only genus peculiar to it.

Where mountain chains run in a northerly or southerly

direction as the Ural and Rocky Mts. the flora is distributed much further south and contains many more similar genera.

Mts. are bridges

Species of more than 50 genera which grow in the alps are unknown in arctic Europe. The great plains between the Alps and Arctic regions have been a barrier and factor in differentiation. Therefore Mountain chains radiating from the N. pole do not show endemic species to the extent that eastern and western chains do. This is proof again of glacial origin of Northern species. Of course it is not meant that glaciers carried the seeds but with the fall of temperature which accompanied them, the temperate plants were crowded south. The Arctic flora then took their places coming south a short distance each year. When the ice began to recede the opposite movement took place.

The high mts. connecting N. America and South America have probably formed the bridge by means of which arctic plants crossed the tropics.

It may be argued by some that a similar climate would tend to evolve the same species. A study of island flora will not bear out that conclusion. Where islands are slightly separated from the main land as Great Britain the flora resembles that of the continent but where far isolated as the Canaries, or St. Helena there are endemic varieties, species and even orders. Where island groups are far separated as the Galapagos Islands, each island has its peculiar species, though the climate is the same.

Origin of Species

First plants to appear

Where volcanic islands have suddenly appeared in isolated parts of the ocean, ferns were first to appear, their anemophalous plants and those with seeds edible by birds.

Where mountain peaks are uncovered in a region covered by a continuous glacier as in Greenland and Labrador it is found that birds carry the first seeds. They have been an important factor no doubt in carrying alpine plants from one peak to another keeping species from becoming endemic.

While it is not the object of this paper to discuss origin of species, one can not collect the data without feeling that any barrier to free distribution and growth of seed will in time tend to produce variation and eventually change of species. Fossils of plants similar to our forest trees are found in Greenland and Spitzbergen. The tertiary fossil plants are the same throughout the N. hemisphere. Very few scientists doubt that our present flora has descended from them just as our horse came from the little five toed quadraped no larger than a dog.

Climate and flood are the great modifiers but they act very slowly. The Nut pine at an altitude of 5000 ft. is a large tree often over 50 ft. in height. At an altitude of 10000 ft. it is a prostrate shrub not a foot high. Yet it is strictly Pinus albicaulis, Englm. There is not the slightest opportunity to describe a new variety.

Moisture is as great a barrier as mountain chains. The swamp has out its sign board "No cactus allowed here" and the hills retaliate "No typha can cross here". Millions of seed try

to cross these barriers every year and perish according to the immutable laws of nature. This attempt has been going on since creation of plants and in the course of ages they may make some progress.

Sporting and Cross fertilization sometimes accomplish at a jump what would take ages of environment to attain but their influence is not great as is proved by the alpine plants holding their own for ages.

Nature's law is against crossing of species, and towards swamping sports. I believe if Linnaeus could come back to earth in 1000 yrs. from now he would recognize most of his genera practically unchanged.

In the following pages I will give a list of Arctic flora found in Central and southern Montana. "A" signifies Alpine strictly, "S" subalpine.

The plants are arranged according to Grays Manual with but few exceptions.

One species of Uredineae was found @ 10,000 feet, - Plants very light in color are marked white although some species in age may be tinted. Those with a liberal sprinkling of red and blue have been called purple. Individual plants of the same species differ so widely it is impossible to draw any hard, fast lines in color. Many white flowers turn pink in fading. It has often been hard to determine whether a plant was annual or perennial. Among the strictly alpine specimens it is a rare thing to find an annual root.

Annual or perennial

Where the flower differs little in color from the vegetation, I have marked it neutral.

Family		Genus species	Av. Elevation (feet)		Color	Remarks	Annual or Perennial
Ranunculaceae	1	Anemone Multifida, Pair	7-9,000	S	Red, Green, White	Found in Chile & Patagonia	P
	2	" Tetonensis, Porter	9-10,000	A	Purplish		P
	3	Caltha Uniflora, Ryd.	10,000	A	White		P
	4	" leptosepala, D. C.	8-10,000	S	White Bluish		P
	5	Ranunculus eximeur, Green	9-10,000	A	Yellow		P
	6	" glaberrimus, Hook	4-9,000	S	"		P
	7	" saxicola, Ryd.	10,000	A	"		P
	8	" Suksdorfii, Gray	10,000	A	"		P
Cruciferae	9	Arabis Columbiana, Macoun	9-10,000	A	White		P
	10	" stenoloba, Ledeb.	10,000	S	"		P
	11	" Lyalli, Wats.	10,000	A	Pink		P
	12	" Furcata, "	9-10,000	S	White		P
	13	" Lemmonii,"	10,000	A	Purple		P
	14	Draba Andina (Nutt) Nelson	7-10,000	S	Yellow		P
	15	" Crassifolia, Graham	9-10,000	A	Yellow White		P
	16	" densifolia, Nutt	9,000	S	Yellow		P
	17	" Fladnizensis, Wulf	10,000	A	"		P
	18	" glacialis, Adams	9-10,000	S	"		P
	19	" oliyosperma, Ryd.	9,000	S	"		P
	20	" mialis elongata, Wats.		S	"		P
	21	Erysimum Asperum, D. C.	9,500	Brib.	"		Bien.
	22	Smelowskia calycina	10-11,500		White		P
	23	Thaspi Alpestre L.	9,000	S	"		
Violaceae	24	Viola Atriplicifolia, Green	10,000	S	Purple		P
	25	" canina, L.	10,000	S	"		P
	26	" flavovirens, Pollard	9-10,000	S	Yellow		P

Family		Genus species	Av. Elevation (feet)		Color	Remarks	Annual or Perennial
Caryophyllaceae	27	Lychnis apetala, L.	10,000	A	G-purple		P
	28	Silene Acaulis	9-10,000	A	Purple		P
	29	Stellaria borealis, Bigel	10,000	A	White		P
	30	" longipes laeta, Wats.	10,000	A	"		P
	31	Cerastium Alpinum	9,500 to 10,000		"		P
	32	" arvense laetifolium, Frenzl.	8-10,000	S	"		P
	33	Arenaria Nuttali, Pax	9-10,000	S	"		P
	34	" Sajanensis carulora, Rob.	10-11,000	A	"		P
	35	" " , Wild	9-10,000	A	"		P
	36	" " rigidula, Rob.	9-10,000	A	"		P
	37	" Congeste	10,000	S	"		P
Leguminoseae	38	Astragalus hypoglottis, L.	9,000		Purple	All Altitud.	P
	39	" acauleatus (Nelson) Ryd.	10-11,000	A	"		P
	40	Lupimus monticola, Ryd.	9-10,000	A	"		P
	41	Trifolium Haydenii, Porter	8,500 to 10,000	S	" ish		P
	42	" Montaneuse	9-10,000	A	White		P
	43	" nanum, Torr	8-10,000	S	Purple		P
Rosaceae	44	Potentilla decurreus (Wats.) Ryd.	10,000	S	Yellow		P
	45	" glaudulosa Nevadensis, Wats.	10,000	S	"		P
	46	" quinquefolia	10,000	A	"		P
	47	Geum Rossi, Seringe	10-11,000	A	"		P
	48	" turbinatum, Ryd.	9,000	S	"		P
	49	Ivesia Gordonii, Hook	9,000	S	"		P
Saxifragaceae	50	S. Oppositifolia	10,500	A	Purple	More ubiquitous plant	P

Family		Genus species	Av. Elevation (feet)		Color	Remarks	Annual or Perennial
Saxifragaceae (cont'd)	51	Saxifraga bronchialis, L.	9,000	S	Purplish		P
	52	" flagellaria, Willd	11,000	A	Yellow		P
	53	" caespitosa, L.	9,000	S	White		P
	54	Sax. Nivalis, L.	9,500	A	White		P
	55	" Jamesii, Torr	10,000	S			
Crassulaceae	56	Sedum stenopetalum, Pursh	9,000	S	Yellow	Yellow	
	57	" rhodanthum, Gray	9,000	S	Yellow	"	
Onagraceae	58	Epilobium alpinum, L.	10,000	A	Purple		
	59	" anagallifolium, Lam.	11,000	A	Purple		
	60	" clavatum, Trealease	10,000	A	"		
Umbelliferae	61	Musenium divaricatum, C&R	9,500	S	Yellow		
	62	Peucedanum cercumdatum, Wats	10,000	S	"		
	63	Bupleurum ranunculoides, L.	10,000	S	Purple		
Compositae	64	Hulsea Carnosa, Ryd	9,500	A	Yellow		P
	65	Erigeron Compositus, Pursh	9,000	S	White		
	66	" saluginosus, Gray	9,000	S	Purple		P
	67	" debilis (Gray) Ryd.	10,000	S	Neutral		P
	68	" simplex, Green	10,000	A	White		P
	69	" radicatus, Hook	10,000	S	"		P
	70	Chaenactis Donglasii	10,000	A	"		P
	71	Solidago muluradiata, Ail.	10,000	A	Yellow		P
	72	Arnica latifolia, Bong	9,000	S	"		P
	73	Taraxacum officinale scopulorum, Gray	10,000	A	"		P
	74	Troximon gracileus, Gray	8,000	S	"		P
	75	" aurantiatum, Hook	9,000	S	Purple		P
	76	Antennaria Umbrinella, Ryd.	8,000	S	White		P
	77	" Alpina	10,000	A	"		P

Family		Genus species	Av. Elevation (feet)		Color	Remarks	Annual or Perennial
Compositae (cont'd)	78	Senecio submudus, Gray	9,000	A	Yellow		P
	79	" purshianus, Nutt	6,000	S	"		P
	80	Eriophyllumn integrefolium, Green	10,000	A	"		P
	81	Hieracium, gracile	10,000	A	"		P
	82	Senecio Fredmontiocci, Gray	10,000	A	"		P
Ericaceae	83	Ledum glandulosum, Nutt	8,000	S	White S		P
	84	Kalmia glauca microphylla, Hook	9,000	A	Purple		P
	85	Bryanthus glanduliflorus, Gray	11,000	A	Pink		P
	86	" emfretriformis, "	8,000	S	"		P
	87	Gaultheria Myrsinites, Hook	9,000	A	White		P
	88	Vaccinum Myrtillus Microphyllum, Hook	8,000	S	Pink		P
	89	Pyrola chlorantha, Swartz	7,000	S	"		P
	90	Monotropa hypopitis, L.	6,000	S	White		Perasit.
	91	Cassiope Mertensiana	9,000	A	Pink		P
	92	Bryanthus intermedia	10,000	A	"		P
Primulaceae	93	Douglasia Montana, Gray	9,000	S	Purple		P
	94	Androsace subumbellata (Nelson) Small	9,800	A	White		P
	95	Dodecatheon media L. panuflorum Green	8,000	S	Yellow		P
	96	" uniflorum, Ryd.	9,000	S	"		P
Polemoniaceae	97	Phlox caespitosa, Nutt	9,000	S	Pink		P
	98	Gilia debilis, Wats.	10,000	S	Purple		P
	99	Polemonium parviflorum, Nutt	8,000	S	"		P
	100	" viscosum	10,000	A	Blue		P
	101	" confertium, Gray	9,000	A	"		P

Family		Genus species	Av. Elevation (feet)		Color	Remarks	Annual or Perennial
Scrophulariaceae	102	Veronica Alpina, L.	8,000	S	Blue		P
	103	Synthyris rubra, Benth	7,000	S	Purple		P
	104	" pinnatifida	9,000	S	"		P
	105	Penstemon Confertus caeruleo-purpureus, Gray	10,000	A			P
	106	" Menziesii	10,000	S	"		P
	107	Mimulus Alpinus, Gray	10,000		"		P
	108	Pedicularis cystopteridifolia, Ryd.	10,000	A	Cream		P
	109	" contorta, Benth	9,000	S	Yellow		P
	110	Castilleja occidentalis, Nutt	11,000	A	White		P
(Hydrophill)	111	Phacelia serica, Gray	9,000	S			P
	112	Castilleja lanceifolia	7,000	S	Red		P
	113	Mertensia lanceolata, D. C.	9,000	S	Blue		P
	114	Castilleja pallida septentrionalis	9,000	S	Neutral		P
	115	Mertensia Alpina, Don	9,000	S	Blue		P
	116	Pedicularis Groenlandica, Retz.	8,000	S	Cream		P
Orobanchaceae	117	Aphyllon fasciculatum, Gray	8,000	S	White		
	118	" uniflorum, Gray	6,000	S	"		
Polygonaceae	119	Polygonum unifolium, Small	10,000	S	Neutral		P
	120	" bistorloides, Pursh	8,000	S	White		P
	121	Oxyria digyna, Camp.	10,000	A	Neutral		P
	122	Eriogonium ovaliflorum, Nutt	11,000	A	White		P
	123	" subalpinum, Green	6,000	S	"		P
Liliaceae	124	Erythoronium grandeflorum	6,000	S	Yellow		P
	125	Lhoydia serotina	10,000	A			
Orchidaceae	126	Listera convallarioides, Nutt	8,000	S	Neutral		

Family		Genus Species	Av. Elevation (feet)		Color	Remarks	Annual or Perennial
Gramineae	127	Agropyron violaceum andinum, SFS	10,000	A	Neutral		P
	128	Calamagrostis purpurescens, R. Br.	10,000	A	"		P
	129	Agropyron Scibneri, Vasey	10,000	A	"		P
	130	Trisetum subspicatum	8,500	S	"		P
	131	Poa Buckleyana, Nash	7,000	S	"		P
	132	" Alpina	9,000	A	"		P
	133	" longipila, Nash Ryd.	10,000	A	"		P
	134	" longiligula, S. F. W.	10,000	A	"		P
	135	" purpurescens, Vasey	9,000	S	"		P
	136	" nemoralis	9,000	S	"		P
(Portulan)	137	Claytonia lanceolata, Pursh	6,000	S	White		P
	138	" megarrhiza, Parry	11,000	A	Neutral		P
	139	" Virginica	6,000	S	White		P
	140	Lewisia Nevadeusis, Rob.	10,000	A	Neutral		P
	141	" Pygmaea, Rob.	10,000	A	"		P
Equis.	142	Equisetum laevigatum	9,000	S	Neutral		P
	143	Selay innella rupestris, Spring	10,000	S	"		P
Juncaceae	144	Juncus mertensianus, Meyer	10,000	S	Neutral		P
	145	Luzula spicata L., Kuntze	10,000	S	"		P
	146	Juncus sublriflorus, Coville	10,000	A	"		P
	147	" Parri, Engelun	10,000	S	"		P
Filicis	148	Cystopteris fragilis, Beruh	10,000	S	"		P
	149	Cryptogramme achrostichoides	10,000	A	"		P
Salix	150	S. Dodgeana, Ryd.	10,000	A	"		P
	151	Salix arctica petraea	11,000	A	"		P
	152	" stricta, Ryd.	10,000	S	"		P
	153	" Nivalis, Hook	10,000	A	"		P

It seems to be an accepted fact that Alpine flowers are brighter in color than lower forms to attract insects for fertilization.

A careful estimate of colors in the Baltic flora of Europe is given as follows:

White	33% in Baltic	25% in Montana
Yellow	28% " "	24% " "
Red	20% " "	6% " "
Blue	9% " "	3% " "
Violet	8% " "	Reckoned with Blue
Brown	2% " "	0
		42% Neutral and Green

All the grasses have been considered neutral. In Montana, Alpine flowers do not seem more highly colored. With the exception of some very bright blues, the colors seem duller on the whole. In the North where the sun shines for 18 hrs. a day the colors would naturally be brighter than here owing to the excess of light, not the plan of cross fertilization.

Are Alpine flowers more highly colored

What time I have spent in Altitudes over 9,000 ft. lead me to doubt the presence of insects as factors at all prominent in fertilization. With the wind @ 30 miles an hour one does not feel like making extended observations on any one plant, nor can flying insects rise from the ground. Even creeping things like ants, etc. could be blown from the flower stalks. One can but wonder in this study of higher zones of life whether the line dividing the alpine and subalpine region is rising or falling.

Are Insects a factor?

Northern explorers often speak of peaks being recently uncovered which seem for ages to have been under glacial snows.

Is the strictly Alpine region rising

In the Mountains of Montana the terminal morain of the glaciers seem to be going further up the slopes each century.

On the other hand astronomers claim that our climate is gradually cooling, the mean annual temperature going lower each year.

My observations have been far too limited to hazard an argument. I am inclined to believe that the arctic flora is gradually going higher and higher and at some future age may be crowded from the rather low alpine summits where they have lived for so many ages in Montana.

P. H. Hawkins

Bozeman, Montana
June 1st, 1903

The Alpine Flora of Montana.

by

P. H. Hawkins.

[Thesis for M. S. June 1903.
J.W.B.]

The Alpine Flora of Montana.

by P. A. Hawkins.

The data for this thesis is gleaned from many sources. The herbarium of the State College of Agriculture and Mechanical Arts has been carefully canvassed. For many of the ideas advanced I am indebted to Dr. J. W. Blankinship who has given me free access to his private Note books and much personal assistance. The excellent libraries of the College and of Dr Blankinship have been carefully reviewed, and are often referred to in the following pages.

During the last nine years I have visited many of the highest peaks in person. The summer of each year being spent as follows:

1894 in the Yellowstone Nat. Park.
'95 " " Bull Mountains and Little Belt range.
'96 } " " Little Belt and Judith ranges.
'97 }
'98 in the Big Belt and Crazy Mts.,
'99 " " Big Belt chain, and
1900 }
1901 } in the Bear Tooth range, between
1902 } Wyoming and the Yellowstone River.

Not all of this time has been given up to botanical work. Many days have been spent in geological studies and prospecting. Some have been given

up completely to hunting and fishing
or exploring the uninhabited portions
of the mountains; others have been
devoted to ethical and aesthetical pleasures
toward which the mountains always draw
one so irresistibly. For these latter
days I have no excuse to offer.
They are the alpine summits of human
existance.