

## SOME BIOTIC DATA AT THE EDGE OF A SNOWSLIDE

MARY J. BROWN AND L. O. JACKSON,  
ROCKY MOUNTAIN BIOLOGICAL LABORATORY

## INTRODUCTION

Harshberger\* has called attention to the fact that there has been little investigation in America of the flora of snow patches which linger well into the summer, but European botanists especially in Switzerland have studied this subject more thoroughly. He also gives a historical statement and bibliography covering the subject.

The work which has been done in America has consisted chiefly in the enumeration of species of plants associated with snow patches in the White Mountains of New Hampshire, and the Mountains of Glacier National park and Mt. Ranier. Exact measurement of the growth of any of the plants of snow patches has not been made; the fauna in association with the plants has not been studied and meteorological observations have not been recorded. The author wishes to add some notes on these points as a contribution to the studies of the flora of American snow patches.

## LOCATION AND DESCRIPTION OF THE AREA UNDER OBSERVATION

The area under observation during the summers, 1928 and 1929 is at the Rocky Mountain Biological Station, Gothic, Colorado, which is thirty-five miles from Gunnison, Colorado. The station is located in a valley at an elevation of 9,474 feet, with snow capped mountains surrounding it on all sides. The winter of 1928-29 was an unusually cold one and there was an excessive snowfall. Upon the arrival of the writer at Gothic, June 25, 1929, there were still remains of snow slides in the valley. On June 27 one snow mass was selected for observation. This was located about one half mile south of the station on the east slope of Snodgrass Mountain. This mountain is continuous with Gothic Mountain, which has an elevation of 12,646 feet.

Snodgrass Mountain was formerly covered with a rich growth of Englemann spruce, *Picea Englemanni* the dominant plant of this region, but because of forest fires occurring about the year 1880 most of the forest was destroyed. On the top of the mountain there remains a fairly good growth of spruce trees from 50-100 feet in height with younger one, 5-15 feet in height beginning to appear. The lower slope of the mountain is covered with clumps of quaking aspen, *Populus tremuloides* which is usually the first tree following a forest fire in this region. The dominant herbaceous plant of the lower slope was false hellebore, *Veratrum speciosum*.

The purpose of this observation was to note the rapidity of *Veratrum* growth throughout the day; to note the seasonal growth; to correlate the growth with the environmental conditions; to note the animal seasonal succession in the soil and herb strata; and to correlate its succession with the plant succession and the environmental conditions.

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\*Harshberger, John W. 1929, Preliminary Notes on American Snow Patches and their Plants. *Ecology*, 10: 275-281.

## METHODS AND APPARATUS

A quadrat, eighteen by eighteen feet was staked off on the lower slope of the mountain and this in turn was divided into three foot quadrats. At the beginning of the observation the upper half of the quadrat was free from snow, while the lower half was entirely covered. This measured 18.25 inches in depth along the lower edge of the quadrat June 27. The quadrat was entirely free from snow on July 2.

Twelve *Veratrum speciosum* plants were selected in different three foot quadrats. These were measured in inches at different intervals during the day; at 5:30 A. M., at 11:30 A. M. and at 5:30 P. M., with few exceptions for four days, to compare the morning and afternoon rate of growth, and the nocturnal with the diurnal rate. These were then measured once each day for a period of about a week, then once each week for five weeks. The results of the observation are given in table one. Twelve other plants in the immediate vicinity, at the end of the period were measured to note the average height, when in full bloom, and twelve others to note the average height, when just beginning to bloom. These results are given in table one.

Weekly collections of animals were made at approximately the same time in the soil and herb strata in the immediate vicinity. In the soil stratum an area twelve inches square and four inches in depth was examined by digging. In the herb stratum twenty sweepings were taken through the air among the herbs from one to two feet in height with an insect net of the usual type.

The meteorological observations consisted of the wind velocity, maximum and minimum temperature and soil thermograph records. The maximum and minimum thermometer was suspended on one of the stakes in the quadrat, about eight inches from the ground. During the earlier part of the period it was fully exposed, but as the plants grew, during the later part of the period, it was protected from the direct sunlight, wind and rainfall, which accounts for the lower temperature. Hygrothermograph records were also obtained in a subalpine meadow region, at an altitude of 9,600 feet and about three-fourths of a mile from the snow slide. These results are shown in plate one. The hygrothermograph was placed on a wooden base on the ground and covered with a wooden box, which permitted free air circulation. The thermometer of the soil thermograph was buried in the soil four inches in depth. The wind velocity was taken about four feet above the ground.

## BIOTIC DATA

*a-Rate of growth of Veratrum speciosum*

The twelve plants which were selected for measurement, their location in the plot, their height at the beginning and end of the observation, and the total increase in growth is shown in the following table:

Quad No. (3 ft.)	Height at beginning 6-27-29	Height at end 7-10-29	Total increase in height
1	4 in.	46 in.	42 in.
2	5	37.5	32.5
3	2.5	44.5	42
7	.36	53	52.64
8	2.25	51	38.75
9	1.5	48	47.5
13	1.5	48.5	47
14	1.5	53.5	52
17	1.75	43.5	41.75
19	1	40	39
22	1.25	40.5	39.25
23	2.75	54	51.21
Average	2.09	46	51.25

Table one shows that the average rate of growth is greater during the six hour period from 11:30 A. M. to 5:30 P. M. than in the morning from 5:30 A. M. to 11:30 A. M. by .7 inches and that the average rate of growth during the twelve hour diurnal period from 5:30 A. M. to 5:30 P. M. is greater than the nocturnal twelve hour period from 5:30 P. M. to 5:30 A. M. by .61 inches. The average daily increase in height of each plant for the entire period of thirty-nine days was 1.19 inches.

The greatest increase in height as shown by the following table, occurred during the first week in July or the second week of growth. However the first week was incomplete, and if calculated on the basis of a complete week the greatest growth occurred during that week.

Date	Average height	Average increase in height
6-27-29	2.09	7.34
7-2-29	9.43	11.78
7-9-29	22.21	9.66
7-22-29	43.62	11.75
7-29-29	45.38	1.76
8-5-29	46.	.62

During the week of July 9 or the third week, there was a decline in rate of growth, followed by an increase during the fourth week, then a decline until maturity was reached.

This rate of growth can only partially be correlated with the meteorological observations. The first week, which showed a rapid increase in height was accompanied by an increase of temperature and increase in humidity; the third with a decrease in growth and an increase in temperature and humidity; the fourth with an increase in growth, an increase in temperature and a decrease in humidity and the fifth and sixth with a decrease in growth, a decrease in temperature and an increase in humidity. The average height when in full bloom was 73.1 inches.

The soil temperature was more constant than the air temperature, and during the first week showed an increase, correlated with the increase in growth. The record for the second week was incomplete, and during the remainder of the period it remained fairly constant, which indicated that the fluctuations in rate of growth were not due to the soil temperature. The wind velocity was taken at four different periods; July 15, which was 1.9 miles per hour; July 22, which was 1.18; July 29, .07 and August 5, which

was .06. This shows that the wind velocity was not of sufficient force to influence the growth of *Veratrum*.

The growth of some *Veratrum* was observed under a snow drift overhanging a stream bank at the edge of the quadrat on June 28. The tallest plant was 9 inches in height. It was entirely sheltered by the drift on this date. On the 29 it was twelve inches in height and only slightly exposed to the sun in the late afternoon. This indicates very rapid growth while yet covered with snow.

#### *b-Seasonal plant succession*

As stated before *Veratrum speciosum* was the dominant plant in the quadrat. Other plants which were most conspicuous are two species of Umbellifera, larkspur, *Delphinium subalpinum*, and bluebell, *Mertensia ciliata*. The abundance of these in the different quadrats were enumerated at different times throughout the period of observation, the results of which are shown in Table II. A number of other species were also observed in the different quadrats during the period, but determinations could not be made. At the end of the period a complete list of the species was made as far as could be determined. This list is as follows, and is given in order of their abundance;

Hellebore-*Veratrum speciosum* Rydb.  
 Umbellifera sp. (b)  
 Umbellifera sp. (b')  
 Larkspur-*Delphinium subalpinum* (Gray) A. Nels.  
 Blue bell-*Mertensia ciliata* (Torr.) Don.  
 Tall composite-*Erigeron* sp.  
 Meadow rue-*Thalictrum Fendleri* Engelm.  
*Geranium Richardsonii* F. & M.  
 Mallow-*Sidalcea candida* Gray.  
 Cruciferae sp.  
 Monks Hood-*Aconitum columbianum* Nutt.  
 Thistle-*Carduus* sp.  
*Ranunculus alpeophilus?* J. E. Smith  
 Composite-*Senecio* sp.  
 Legume-*Vicia* sp.  
 Fire weed-*Chamaenerion angustifolium* (L.) Scop.  
 Violet-*Viola retusa* Greene.  
 Strawberry-*Fragaria americana* (Porter) Brit.

Seasonal plant succession was not conspicuous in this habitat because *Veratrum* completely dominated the area, and on account of its size and the time required to reach maturity only those forms were found intermixed with it which were able to survive in such a habitat, and even then many never reached maturity from lack of sunshine and because of the crowded conditions.

#### *c-The fauna*

Species determinations have not been made for these forms so the relative abundance of the different orders can only be given at present. In the soil stratum this is as follows:

Hemiptera—107
Myriapoda—12
Coleoptera—11
Mollusca—10
Acarina—7
Lepidoptera—4
Hymenoptera—4
Diptera—2
Orthoptera—1

The total abundances of these throughout the period is shown in Table III. It shows an increase in the animal population during the first, third, fifth and sixth week, and a decrease during the second and fourth week. The result can only be partially correlated with the meteorological observation and the *Veratrum* growth. This is given in the following table:

First Wk.	Sec. Wk.	Third Wk.	Fourth Wk.	Fifth Wk.	Sixth Wk.
A—increase	A—decrease	A—increase	A—decrease	A—increase	A—increase
V—increase	V—increase	V—decrease	V—increase	V—decrease	V—decrease
T—increase	T—decrease	T—increase	T—increase	T—decrease	T—decrease
H—decrease	H—increase	H—increase	H—decrease	H—increase	H—increase and decrease

A refers to the animal population, V to *Veratrum* growth, T to the temperature and H to the humidity.

#### *Insects of the herb stratum*

Due to a prolonged spell of rainy weather the insect collections from the herb stratum were irregular and incomplete but in spite in this handicap it is believed that several significant points may be noted from the collections that were obtained.

Only one specimen of Miridae was obtained June 28, eleven were taken June 30, one on July 8, and three on July 15, all adults. On August 5, fifteen adults and seven nymphs (probably Miridae) half grown, were taken. The late appearance of nymphs would seem to indicate that there are two generations a year, with the second one hibernating in the nymph stage.

There was a constant and fairly uniform increase in the number of parasitic Hymenoptera up to July 8, when a constant number was reached. The species differed from date to date but the total number present at any one time apparently followed the distribution mentioned above.

As a matter of speculation it is interesting to note that the Chalcids and very small Ichneumonids were the first to appear, apparently coinciding with the egg stage of the Miridae. On August 5, there was a very definite increase in size, coincident with the appearance of the half grown Mirid nymphs, and Chalcids were entirely lacking. There was no direct evidence that these wasps were parasitic on the Miridae, but the implication seems not beyond possibility.

There is also to be noted an increase in the total number of Diptera, increasing rapidly after July 15. With the exception of the Thysanoptera, this order was dominant in all collections, yet the sudden increase until August 5 seems to indicate that this order is also prolific during the summer months. The species differ considerably in the various collections, but the total number of flies present was markedly greater after July 15. One

species present in large numbers, but rare in the collections was a blood sucking member of the Leptidae, probably *Symphoromyia kincaidii*.

The sudden increase in the Coleoptera on August 5, is not so inexplicable as it might seem at first thought. It was not until this date that the plants in this locality (in the neighborhood of the plot began to flower. These beetles, twelve of one species, one of another are all flower loving forms. While the flowers in this immediate vicinity were not in bloom until this date, others of the same species had been open for a week or two, a short distance east of the plot. The implication seems strong that as the "plot flowers" bloomed, these beetles came in order to feed.

The specimens of Lepidoptera and Orthoptera and the five specimens of Bombidae were not obtained by sweeping, but were taken individually at or near the plot. In all cases similar species were seen at the plot. The curves of abundance as given in plate three do not picture accurately the presence of these orders.

The order Thysanoptera was well represented by one species occurring in tremendous numbers on *Veratrum* and perhaps accidentally, on one of the Umbelliferae. The number of specimens captured by sweeping gives no conception of their relative abundance. Over one hundred specimens were taken from three *Veratrum* plants, in a special collection. The rough corrugations of the *Veratrum* leaves, and the fact that many were found in the young, not fully unrolled leaves near the growing point, accounts for their not being so prominent in the sweepings. But even so, the collection of July 15 shows that they exceed the total of all other orders, in the proportion of forty to twenty-eight. Apparently by August 5 they had begun to decrease, and possibly another week or two would have shown a total disappearance for the year, as at that time they were scarce, even when special search was made for them.

These results indicate a much greater insect population in the herb than in the soil stratum and in each case there is an increase throughout the season. In general the increase in numbers of the insects can be correlated with the growth of *Veratrum* until July 22, when the rate of growth decreases, but the total number of insects had at that date not reached its maximum.

The results indicate little migration between the two strata. There is also little correlation between the insect population and the meteorological data, except during the earlier part of the season, when with an increase of temperature there was an increase of the insect population, indicating perhaps the coming out of hibernation of the insects.

The insect population in the herb stratum is shown in Table III.

#### GENERAL CONCLUSIONS

- 1—The dominant plant at the edge of the snow slide in the region under observation was *Veratrum speciosum*.
- 2—The rate of growth was greater during the afternoon than in the morning.
- 3—The rate of growth was greater during the daytime than at night.
- 4—The average daily (24 hrs.) increase of growth per plant was 1.19 inches.
- 5—The greatest increase of growth occurred during the first and second week of the life of the plant.

6—A decline in rate of growth occurred after the fourth week.

7—The average height of *Veratrum speciosum*, when beginning to bloom was 50.4 inches with a daily growth of 1.29 inches.

8—The average height when in full bloom was 73.1 inches.

9—The rate in growth could only be partially correlated with the meteorological observations.

10—Some growth of *Veratrum speciosum* occurs above the soil when yet covered with snow.

11—The insect population of the soil and herb stratum of the plot increased with the advance of summer.

12—Thysanoptera, Diptera and Heteroptera dominated the early summer, followed by a reduction in numbers of Thysanoptera, and a noteworthy increase in Heteroptera, Diptera and Coleoptera in the herb stratum.

13—A period of abundance of the Miridae, followed by a marked decline in numbers with a later and greater increase, and the presence of nymphs seem to indicate two generations.

14—In general the increase in numbers of the insects could be correlated with the increase in growth of *Veratrum* until it reached its maximum rate of growth, about July 22.

15—There was a little correlation between the insect population and the meteorological data except during the earlier part of the season, when there was an increase in temperature and also an increase in the insect population, which indicated the coming out of hibernation of the insects.

TABLE I  
*Veratrum speciosum* growth

Date	Time—6 hr. morning	Increase in growth	Time—6 hr. afternoon	Increase in growth
6-29-29	5:30 A. M. to 11:45 P. M.	.7 in.	11:A. M. to 7:15 P. M.	.58 in.
6-30-29	5:30 A. M. to 11:30 A. M.	.83	11:30 A. M. to 5:30 P. M.	.44
7-1-29	5:30 A. M. to 11:30 A. M.	.45	11:30 A. M. to 5:30 P. M.	.81
7-2-29	5:30 A. M. to 11:30 A. M.	.41	11:30 A. M. to 5:30 P. M.	.84
Average		.59		.66
Date	Time—12 hr. night	Increase in growth	Time—12 hr. day	Increase in growth
6-29-29	7:15 P. M. to 5:30 A. M.	.42 in.	5:20 A. M. to 7:15 P. M.	.128 in.
6-30-29	5:30 P. M. to 5:30 A. M.	.93	5:30 A. M. to 5:30 P. M.	1.27
7-1-29	5:30 P. M. to 5:30 A. M.	.6	5:30 A. M. to 5:30 P. M.	1.26
7-2-29			5:30 A. M. to 5:30 P. M.	1.25
Average		.65		1.26

#### SOME OTHER AVERAGES

Average growth per day of twelve plants until setting of bloom -1.29 in.

Average growth per day of twelve plants until setting of bloom -1.29 in.

Average growth per day of twelve plants in full bloom -1.87 in.

Average height of twelve plants at beginning of first bloom -50.4 in.

Average height of twelve plants in full bloom -73.1 in.

TABLE II

Quad. no.	6-27-29	6-28-28	7-1-29	7-8-29	8-5-29
1	8v	10v	11v 8d 1m 9n	10v 14d 2m 9n	10v
2	11v	14v	14v 1m 12d 13n	14v 1b 1m 12d 12n	14v 1b'
3	15v	15v 1m	16v 20 m 6d 8n	16v 20m 4b 13d 9n	16v 4m 1b'
4	16v 1b	17v 1m	17v 21d kb 7n	19v 2b 22d 4m 7n	19v 1b'
5	7v	8v	8v 8d 8n	9v 29b 16d 8n	8v 5b'
6	17v	17v	17v 1b 13d 11n	17v 1b 13d 13n	17v
7	6v 4d 1b 1m	8v 4d 2m	8v 49d 5m 11n	7v 15m 48d 11n	7v 18d 3d 2m
8	7v 8m 1d	7v 9m 2d	8v 12d 8m 11n	9v 6b 15d 19m 10n	12v 2b'
9	15v	16v	15v 4d 10n	13v 9b 4d 10n	12v 2b'
10	11v 3d	11v 3d 1m	14v 15d 7n	13v 1b 18d 10n	13v
11	18v 1b 3d	20v 1b 6d	20v 12d 1b 8n	19v 1b 19d 8n	19v 4b
12	9v 1b	9v 1b 3d	9v 1b 16d 7n	9v 20d 11n	11v 3b
13	13v 1b 1d 1m	18v 1b 3d 4m	18v 1b 12d 11m 11n	17v 3b 18d 18m 12n	17v
14	11v 2b 1m	11v 2b 2m 3d	12v 2b 9m 9d 7n	12v 3b 9m 10n	13v 3b 1b'
15	12v 1b 2d	15v 2b 1d 1m	15v 2b 8d 3m 6n	13v 13b 14d 4m 9n	13v 1d 3b 1b' 1m
16	14v 3d 4m	15v 6d 8m	13v 22d 27m 3n	13v 50m 42d 4n	13v 10m
17	16v 5d	19v 8d	19v 40d 2m 6n	17v 52d 6n	16v
18	10v 2b 6d	10v 2b 7d	12v 2b 31d 8n	14v 4b 40d 7n	15v 1b 1b' 2d
19	3v 1m 1b	9v 1b 1m	10v 4d 1b 11m 5n	11v 3b 12d 12m 6n	14v 2b' 2m
20	7v 1b	17v 3b	21v 4b 2m 20d 5n	17v 3b 22d 2m 6n	12v 4b
21	8v	17v 3d 1m	13v 2m 2b 22d 3n	13v 4m 2b 30d 6n	16v 2b 2d
22	12v 3d	14v 4d	14v 20d 2b 6n	14v 3b 22d 6n	14v
23	14v 3b 1d	17v 3b 9d	14v 5b 21d 1m 4n	14v 5b 30d 6n	16v 1b'



24	7v 4d 2b	9v 2b 13d	10v 32d 3b 5n	9v 9b 36d 4n	8v 3b
25	snow	snow	5v 7m 9d 2n	8v 6b 8m 23d 2n	7v 7m
26	snow	snow	10v 2b 6d 1n	8v 2b 11d 4n	7v 1b
27	snow	4v 1b	12v 1b 17d 4n	17v 1b 16d 4n	11v 2b 1m
28	snow	2v 1d	7v 23d 1b 2n	7v 27d 1b 4n	10v
29	snow	12v 1b 4d	12v 1b 21d 4n	11v 2b 22d 5n	18v 4b
30	snow	9v 6d	13v 27d 5n	13v 2b 30d 6n	10v
31	snow	7v 1b 1d 2n	12v 3b 7d 3n	10v 4b	
32	snow	3v 1b 9d 2n	3v 2b 14d 4n	3v 1b 2b'	
33	snow	11v 16b 8m 20d 1n	13v 2b 30d 11m 4n	13v 3m 1d	
34	snow	14v 37d 2n 1b	14v 1b 38d 3n	13v	
35	10v 2c	16v 33d 4n	18v 35d 1b 6n	17v	
26	9v 1b 3d	7v 2b 31d 5m 3n	5v 3b 35d 5m 3m	4v 1b	

NOTE: v refers to *Veratrum speciosum*.  
 b and b' to *Umbellifera*.  
 M to *Mertensia ciliata*.  
 d to *Delphinium subalpinum*.  
 n to new species.

TABLE III

Date	Thysanoptera	Coleoptera	Orthoptera	Lepidoptera*
6-28-29	1	0	0	0
5-30-29	20	0	0	0
7-8-29	15	1 Staphylinidae	0	0
7-15-29	30	0	2 <i>Melanoplus</i> nymphs*	4 genera
8-5-29	0	13	0	0
Total	66	14	2	4
Date	Diptera	Heteroptera	Homoptera	Hymenoptera
6-28-29	5-4 families	1 Miridae	2 Chermidae	0
6-30-29	11-5 families	11 Miridae	0	1 Chalcioidea
7-8-29	10-3 families	1 Miridae	2 Cicadellidae	8
7-15-29	10-4 families	3 Miridae	1 Aphididae	9
8-5-29	33-5 families	15 Miridae	3 Cicadellidae	8
Total	69	31	8	26

	Diptera	69
	Thysanoptera	66
	Heteroptera	31
	Hymenoptera	26
	Colcoptera	14
	Homoptera	8
	Lepidoptera	4
	Orthoptera	2
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	Total	220
Total number	collected by dates.	
	6-28-29	9
	6-30-29	43
	7-8-29	37
	7-15-29	59
	8-5-29	72