

Limiting Factors of Mushroom Growth  
in the San Juan Mountains

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## Abstract

In this study the number of fungal fruiting bodies was counted and compared at two sub-alpine locations. The locations, Lizard Head Pass and Bridal Veil Basin (residing in the San Juan Mountains of south western Colorado) were selected based on several varied factors. Both were alike in they had a west aspect, sub-alpine forests with spruce and fir trees, and running surface water near by. The differences were comprised of the slope angle, the canopy cover, and the soil moisture. It was due to these factors that it was predicted that the Lizard Head plot, having higher statistics in all differing factors, (ie. denser canopy cover, higher soil moisture etc.) would yield more mushrooms fruiting. The end result showed 38 fruiting mushrooms at Bridal Veil, and 252 at Lizard Head. While analyzing the data, it was concluded that a prolific amount of decaying material at Lizard Head contributed immensely to the staggering statistics. The data showed six times as many mushrooms at Lizard Head, than at Bridal Veil.

## Introduction

“More than 465 million years ago we shared a common ancestry [with fungus]. ... one evolutionary branch of fungi led to the development of animals.”(pg 2 Mycelium Running).

A great deal of research has been taking place concerning the fungal kingdom recently, but the enormity of this research is only surmounted by the lack of understanding of fungus. A study done by Paul Stamets of *Fungi Perfecti* showed that in a cubic inch of top soil, there are enough fungal cells to stretch more than 8 miles if placed end to end. Mushrooms seem to represent the unknown, a mysterious denizen of the underworld growing seemingly out of nothing. The truth is that the fungal network serves as a sort of guardian for ecosystems. Mycelium supports weakened plants assisting them through the hard times, and they recycle the wastes of all living things so the nutrients can be reused. As new information comes to light, the fungal kingdom proves more and more fascinating and mystifying.

This leads us to the town of Telluride, where some basic questions regarding the growing habits of mushrooms in a western montane climate are examined. The study was set to explore some basic questions regarding the growth habits of mushrooms. Two sites were chosen to exemplify certain differences in the environments. The sites were Lizard Head Pass and Bridal Veil basin. The hypothesis was to verify that the mycelial mats in

the Lizard Head area would yield more fruit than those in the Bridal Veil area due to increased runoff and less decaying material in Bridal Veil. The postulation was that Lizard Head has a gradual slope and extensive canopy cover whereas Bridal Veil has steep slopes and limited cover contributing to a lack of both organic material to decompose and, residual water.

This study was conducted in the San Juan mountain area. The climate is semi arid with harsh winters. Most of the sub-alpine area is moist with spruce/fir forests. In each of the sights chosen, a plot was set up. The locations are at approximately the same elevation, and are both West facing. Bridal Veil is an alpine/ sub-alpine valley with steep sometimes rocky sides. The herbaceous plants are prodigious there. Lizard Head is more of a sub-alpine forest, sprawling out between peaks. Here the fauna is more wooded, trees and the like. The trees in both areas consist of Sub-alpine Firs and Engelmann Spruce. The abiotic differences are mainly in regard to the slope and its effects. In Bridal Veil, above the plot, there is an extremely steep slope, bare rock in places. This caused a thinner duff layer and lower soil moisture. In Lizard Head, surrounding the plot, are rolling forested hills. The soil is pungent and fertile with a thick shield of duff. The canopy was also dissimilar with substantially more shade at Lizard Head. These sites are extremely different from each other while still being in the same general community.

## Methods

Site selection was made according to two separate factors; elevation and aspect. The general areas were chosen at the two locations, both the same approximate elevation. The aspect of the plots was to the west providing the least complications, because the rising and setting sun would affect it, but mildly.

The next step was to gather preliminary site data, and that began with the sectioning off of the plots. The Lizard Head Pass plot was the first to be set up, on 08/06/07 followed by the Bridal Veil on 08/06/07. The order in which the data was gathered was identical in both sites. A site was chosen, that looked optimal for fungal growth and with a West facing slope, (on the edge of a small valley, with many fallen severely degraded logs in the case of Lizard Head). A ten by ten square meter plot was then staked out with surveyor flags, a process completed through triangulation. The diagonal lines were adopted as the bases for four subplots. The quartering of the plot was followed by densitometer counts. To help explain the way in which the data was gathered view Figure 1.

The general slope of the plot was measured from the South East corner to the South West and from the North East to the North West, the average subsequently figured. Because mushrooms are mostly decomposers it was felt that the fallen trees should be recorded. Each tree was labeled, tree 1, tree 2 etc... then rated on a scale of degradation and a record of where they lay was kept. To examine the scale see Table 1-1.

Table 1-1  
Scale of Degradation

1	2	3	4	5
The tree was recently felled with bark intact.	Bark is absent with minimal visible rot	Rot easily visible on the outside of the tree	Rot has permeated the log causing a soft texture when stepped on but the original shape is still evident	The shape of the log has been lost decomposing into the ground, and in the case of the two sites analyzed was completely moss covered.

Following the categorization of the fallen trees, the depth of the duff below ground level was determined. The samples were taken outside of every sub plot, using a spade and meter stick. It was essential to know whether there was mycelium occupying the area to determine how prolifically it fruits. So, the next step was to establish percent mycelium presence through out the plot. Four samples of duff were taken, each in the center of the four subplots. A percentage was then derived using the results. The final pre-analysis data collected was the soil moisture. Samples were taken on the down slope side of the plot, just outside of the west side. This procedure was followed for both of the plots in the same order.

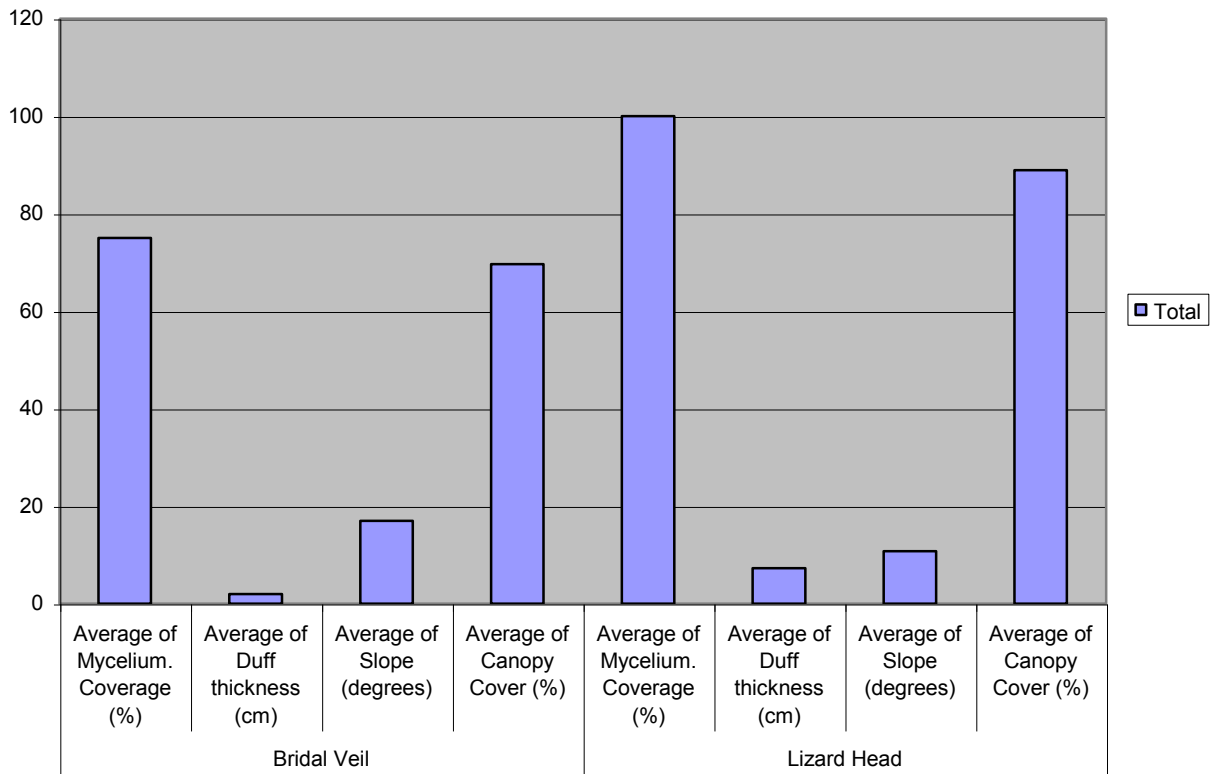
On the first and second of September 2007 the mushroom counts were completed at Bridal Veil and Lizard Head respectively. The counts were made by placing meter tapes along the 10 meter sides of the plot. The tapes ran from East to West and North to South, serving as x and y coordinates. Each mushroom patch with a mushroom cap size above 1.5 cm was given coordinates. The diameter of the cap and the color of the mushroom were noted along with the way it sporeulated and its habitat. Sporeulation is categorized by the way the mushroom releases its spores, such as gilled, polypore, puffball, club etc... Mushrooms under 1.5 cm were tallied and sorted into three categories: Tiny below 5mm, Little below 1cm, Medium below 1.5cm. Puffballs and slime molds were also counted. Before moving on, each patch was given a short description of its appearance, in case further information was needed.

## Results

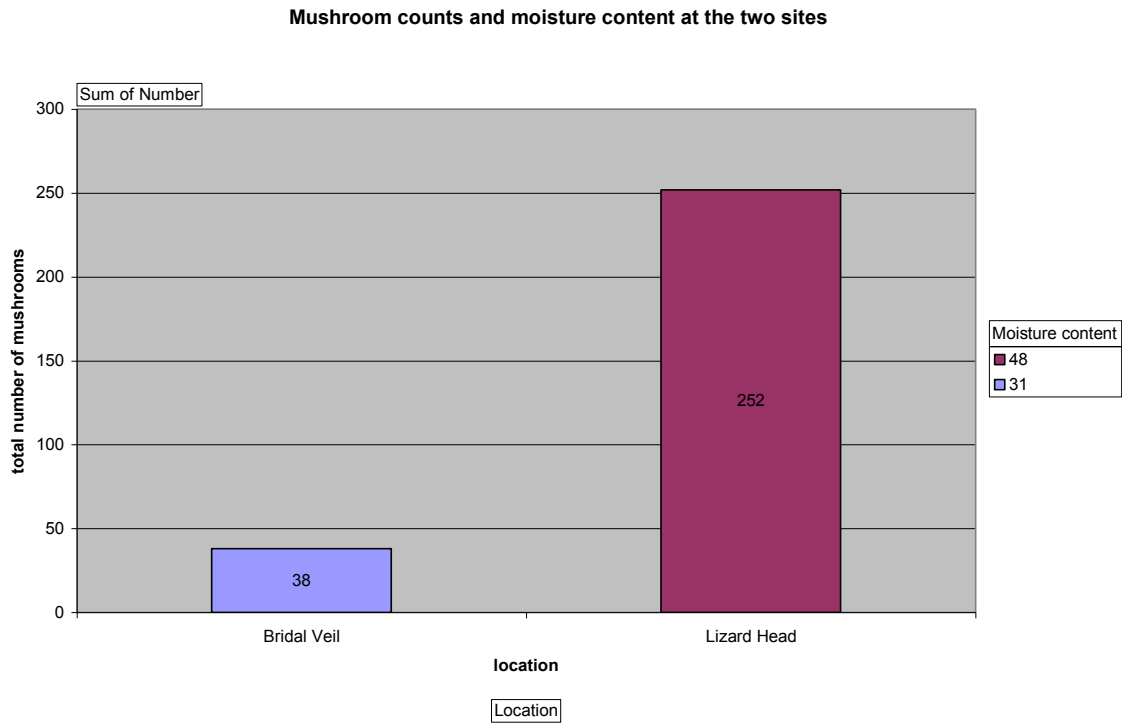
Many differences were blaringly apparent in the preliminary site comparisons. The canopy cover, the soil moisture and the average slope, were lopsided when comparing the two locales. The canopy cover, for example, of the Lizard Head site was 89 % coverage, deeply overshadowing the 69 % of Bridal Veil. Possibly related, the duff layers showed a discrepancy of 5.25 centimeters average depth between them, favoring Lizard Head. The soil moisture levels showed similar trends at 31% for Bridal Veil and 48% for Lizard Head. A final four-point test resulted in 75% (Bridal Veil) and 100% (Lizard Head) presence of mycelium throughout the plots. Additional data gathered at the two plots showed a significant difference between the masses of decaying material. Not only was the duff layer thicker at the Lizard Head plot but also there were more fallen logs. Bridal Veil had five fallen trees, Lizard Head seven trees. It should also be mentioned that around and in the Bridal Veil plot there was extensive herbaceous growth whereas Lizard Head had little to none. Also there was surface water moving very near to the Bridal Veil site and only a little farther away at the Lizard Head site. It also must be noted that the trees on the ground at the Lizard Head plot on average were more decayed. Below are charts of the differing data gathered.

Graph 1-1

Comparison of site differences



Graph 1-2



As is apparent in Graph 1-2 mushroom counts in Lizard Head Pass were far greater than Bridal Veil showing a direct correlation with the moisture content.

## Discussion

When the results were subsequently analyzed the outcome was both surprising and expected. The preliminary data gave a nominal impression being consistent with previous analysis. There were higher moisture levels in the soil at Lizard Head than Bridal Veil presumably related to the gradual slope. The canopy cover also showed similar trends, correlating directly with the duff layer and fallen tree count. Mycelium coverage was extensive at both locations indicating that there would be a bountiful flush. Indeed there was, the amount of mushrooms was stunning at both Lizard Head and Bridal Veil. Lizard Head however stole the show with more than six and a half times more mushrooms. These results connected directly with the hypothesis, but to a degree that was totally unexpected. According to this observation it would seem that the major limiting factors are; slope, canopy cover, moisture content, and a new addition, decaying material. The original hypothesis is greatly supported by the amassed data, but there seems to be not enough information. This outcome is a step in the right direction, but it is a long and fruitful journey ahead of us.

## Improvements

The study was extensive, with prolific data gathering, and many long hours of thinking. There were limits to how precise it could be however. To determine more solid findings one would have to extend the period in which the data is gathered. Mushrooms fruit in flushes, and the flushes occur at different times for different mushrooms. As a result a study conducted only a single time has the potential for error. In order to extract more defined results, mushroom counts should be made several times during the season. To refine the results even further the limiting factors could be isolated. This would allow for a more exact picture of their significance. Many would assume that when data is gathered and conclusions made, curiosity is sated. The truth however is quite the contrary; the more one learns the more questions arise. Do specific types of mushrooms prefer specific conditions? Does the time of year and temperature affect the fruiting of the mushrooms? How will global warming influence fungal populations? How much does fungus truly contribute to the health of an ecosystem? All of these are pertinent questions that deserve due consideration. It seems one is never finished when dealing with science.

The end result of the study was intriguing; it showed astonishingly more mushrooms at Lizard Head, than Bridal Veil. This leads to the suspicion that there are more factors contributing to these inflated results. The next logical step, in verifying the validity of the applicable hypothesis is to gather more, and more specific information.

## Bibliography

Stamets, Paul, *Mycelium Running*, Ten Speed Press, Berkeley California, 2005.

Lincoff, Gary, *The Audubon Society Field Guide to North American Mushrooms*, Alfred A. Knopf, Inc, 1931