Serratia Marcescens Mutations in the Elevated Ultraviolet Radiation Conditions of the Stratosphere

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ABSTRACT

Serratia marcescens grown on agar plates were transported to the stratosphere in a high altitude balloon in order to view mutations resulting from elevated exposure to ultraviolet radiation. A control was left on the ground collecting a moderate amount of UV radiation. S. marcescens was used because it changes pigment when there is a mutation present. Since the ultraviolet radiation is greater in the stratosphere than in our control at ground level, then the plates being sent with the balloon should have a higher mutation rate than the plates located on the ground.The scientific research conducted resulted in the bacteria sent in the balloon not producing as many colonies as well as the control. This could have been due to the harsh conditions of the stratosphere.

MATERIALS AND METHODS

Serratia marcescens is a rod shaped, gram negative, facultative anaerobe bacteria. It was discovered in 1819 and was first thought to be non pathogenic. However, in the 1960's it was classified as a human pathogen. It is commonly found in many environments including water, soil and plants. It can contaminate petri dishes in the laboratory and thrive in hospitals. S. marcescens was used in the experiment due to the fact that it produces a red pigment known as prodigiosin. Prodigiosin is made by pyrrole rings, which are aromatic organic compounds. When S. marcescens mutates, it does not produce the red color that the wild type holds. Instead, the mutated bacteria is white in color.

Agar plates were plated with Serratia marcescens using the aseptic technique. The plates that were traveling on the high altitude balloon were fastened on a foam pod. They were attached using zip ties and plastic wrap to the outside of the pod. The control plates were located on the roof of a building where they would get an ample about of UV radiation. The control plates were covered with plastic wrap as well. They were left on the roof until the experimental plates were located and returned. All of the plates were then placed in the incubator at 37 degrees Celsius for five days in order to obtain an adequate amount of growth.

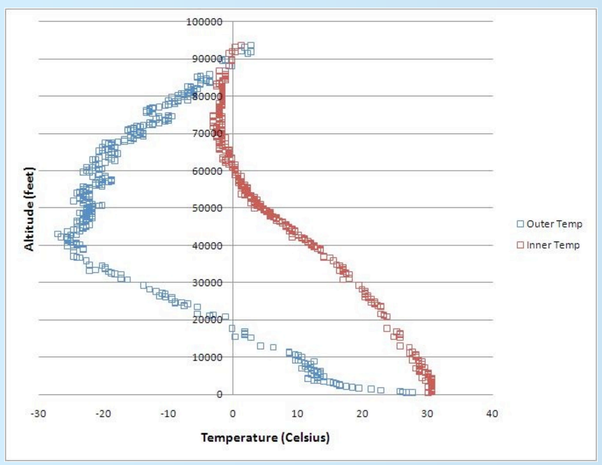

Figure 1: Temperature inside (red) and outside (blue) the pod as the altitude increases

RESULTS

The experimental plates had a harder than expected landing back on Earth. The agar plates had been jolted. However, when placed in the incubator they still grew bacteria. As stated before, S. marcescens turns white when it is mutated. Once all of the bacteria were incubated, the colonies were counted. When compared to the control located on the roof, the plates sent into the stratosphere had more mutations (Table 1). On our flight, the balloon reached 93,674.54 ft (Figure 2) and temperatures down to -42.19 degrees Celsius (Figure 1). The pressure ranged from 0.989 atm to 0.009 atm (Figure 3).

Table 1: Total number of colonies from the control and experimental S. marcescens and the number of mutated colonies

Location of S. marcescens	Total number of colonies	Number of mutated colonies
Roof (control)	49	0
Balloon (experimental)	2	2

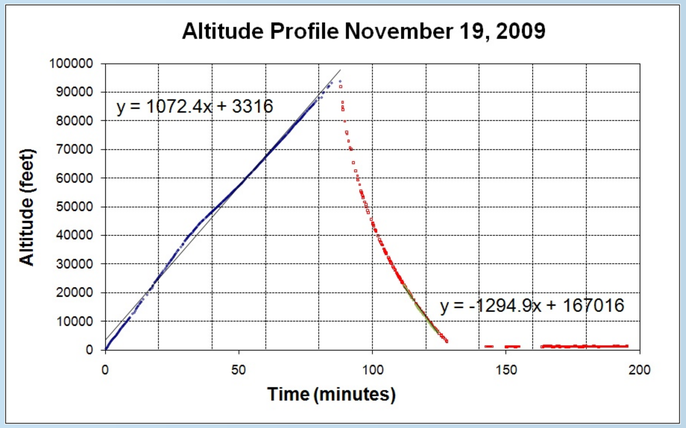

Figure 2: Altitude of the flight ascending (blue) and descending (red)

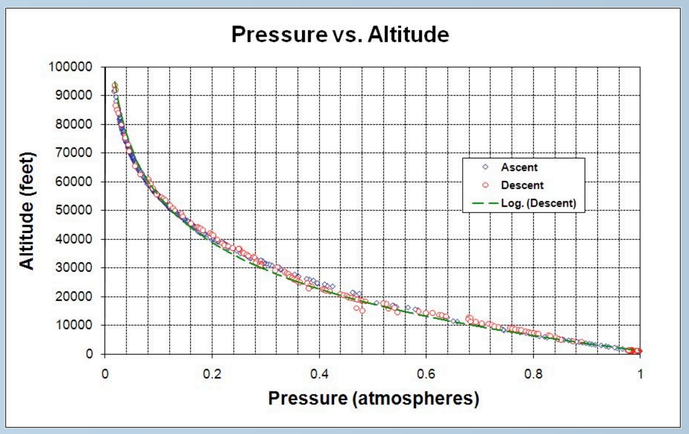

Figure 3: Pressure of the flight ascending (blue) and descending (red)

DISCUSSION

After reviewing the flight data, including the temperature (Figure 1) and the pressure (Figure 3) there is sufficient evidence that the bacteria was stunted in its growth. S. marcescens' optimal temperature to thrive is from five to forty degrees Celsius. The temperatures in the stratosphere are much lower than that. This could have either caused the bacteria to completely die from the cold or mutate so much that it died. It can not be determined by this single flight.

FUTURE RESEARCH

This was the first launch of a high altitude balloon that Trevecca Nazarene University had ever conducted. Since then we have had many successful flights and learned from them all. For future research it may be helpful to secure the plates onto the pods better. It may also be useful to perform this experiment with more plates. On this flight we did not have an ultraviolet radiation sensor so we are unsure of the exact exposure that the bacteria had. Since this experiment was conducted in November it may be helpful to have flights at different times of the year when the UV index is greater.

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