Moth Wingspan Lengths Trend Upwards Alongside Elevation

Noah Dotson

BIO 461 – Evolution

May 1st, 2020

**Introduction**

The relationship between temperature and size of ectotherms has been well documented throughout the past as showing that lower temperature environments tend to lead to slower growth, but larger fully-matured adult sizes (Kingsolver\* & Huey, 2008). This is commonly referred to as the temperature-size rule (TSR). Many other factors are incorporated into this as well, such as social behaviors and elevation (Guevara & Avilés, 2007). Elevation is one of the environmental aspects of the equation that is much less understood and there seems to be somewhat conflicting information on the subject. Some studies seem to suggest that size tends to have a negative correlation with elevation (Guevara & Avilés, 2007), while others have found evidence that there is a positive correlation (Brehm et al., 2019). Strictly terrestrial species of ectotherms have shown primarily negative correlations (Guevara & Avilés, 2007). The relationship between elevation and size of airborne species of ectotherms seems to be more questionable with the current research. A recent study has shown evidence that moths may actually increase in mass as elevation increases (Brehm et al., 2019). Getting a better insight into whether flying ectotherms have a reverse correlation with altitude compared to non-flying ones has interesting potential reasonings. Is it because they live longer due to less predators? Does flying simply allow them to reach higher altitudes more readily and interfere with the data? These factors aren’t able to be tested until we get a solid idea on what kind of correlation flying ectotherm size (specifically moths in this case) have with As a result, this research was done with that premise in mind. This study aims to analyze the wingspan and elevation of various genera and species of moths from Costa Rica, in an attempt to find correlations between the two (if any). The hypothesis for this particular study is that moth wingspan will increase as the elevation increases.

**Methods**

Data for a large variety of moth genera and species was gathered from a similar study (Brehm et al., 2019), over a 2690 meter gradient (40m – 2730m above sea level) of elevations in Costa Rica. The moths were captured using light traps (which are essentially large baskets illuminated in order to attract the moths) across 12 sampling sites. Each site was sampled at least twice between April and June of 2003, as well as at least twice between February and March of 2004. The moth wingspans were measured in millimeters, and the elevation was recorded in meters. Genus/Species names were also recorded. There data points range across 250 genera and 250 species. All analysis was done in R with standard packages and functions. The dataset was originally multiple datasets within a folder, but aspects of multiple spread sheets (primarily the genus and species of the moth specimens) were compiled together into a single sheet for easier access and analysis. This study ended up with a total of 897 data points containing the same range of elevation as the original data (40m – 2730m). Standard plotting methods were used to compare the elevation and wingspans of all moths. Statistical tests were performed within RStudio with built-in functions, specifically the cor(), abline(), and summary() functions.

**Results**

By constructing a plot in RStudio, the discovery of a suggestible visual correlation was found between the two parameters. The correlation coefficient between the elevation and moth wingspan was found to be 0.5 (found using standard cor() function in RStudio). The plot has many overlapping dots as the specimens were gathered using the aforementioned light traps. There is a stair step-like pattern to the dots as they go up, but there is notably the most diversity in size of the wingspan size closer to the 1000m in elevation.



**Figure 1.**

Blue points represent moth specimens in the study. The red line indicates the trend following the average pattern between the elevation and wingspan values. The y-intercept is located at y = 2.6. A correlation coefficient of 0.5 was found.

A second figure was created to illustrate the frequency of moths within 500-meter intervals of elevation. Interestingly, 1001m-1500m showed the highest frequency at 233. 0m-500m and 2001m-2500m also had higher frequencies at 210 and 190, respectively. 2501m-3000m showed the lowest frequency at 36. 501m-1000m and 1501m-2000m were also on the lower side at 115 and 110, respectively.



**Figure 2.**

Vertical blue lines indicate frequency of moths. X-axis tick labels indicate 500m elevation ranges at which the moths were grouped for this figure.

**Discussion**

The first thing that should be discussed is the potential issues that are in the methods, data, and analysis. Human error for measurements, identification, etc... are always a potential issue in research. The method used in capturing the moths for identification/measurements is also a potential flaw. The traps being set at a certain elevation for a long period of time could give somewhat biased results opposed to searching and picking them out individually. It is not particularly easy to determine whether the elevation where a moth is found is where it spends most of its time. This would be a potential issue regardless of the capturing method, unless each moth gathered was followed for an extended period before being captured (which seems somewhat unfeasible). Only using a single study for data points is also a potential issue. The study itself is large and extensive in many ways, but only covers regions of Costa Rica over the span of about a year. As previously stated, this is a somewhat less researched topic, meaning that available data is harder to find and come by.

The data and analysis of said data seems to implicate that there is a moderate positive correlation (0.5) between moth wingspan length and elevation. Elevations around 1000m-1500m seemed to have the highest frequency of moths. This could potentially be due to some sort of ecological sweet spot that the moths are able to take advantage of in that given altitude. The 0m-500m range has the longest range of wingspan sizes according to this data/analysis, potentially suggesting that lower altitudes are more hospitable to moths of all sizes, while certain higher elevations are more suited for specifically larger ones. It isn’t clear that all ectotherms behave in this manner, but this bit of evidence helps us understand more about the elevation and size relationship of moths, and to a smaller extent ectotherms at large.

**Cited Literature**

Brehm, G., Zeuss, D., & Colwell, R. K. (2019). Moth body size increases with elevation along a complete tropical elevational gradient for two hyperdiverse clades. *Ecography*, *42*(4), 632–642. https://doi.org/10.1111/ecog.03917

Guevara, J., & Avilés, L. (2007). Multiple Techniques Confirm Elevational Differences in Insect Size That May Influence Spider Sociality. *Ecology*, *88*(8), 2015–2023. https://doi.org/10.1890/06-0995.1

Kingsolver\*, J. G., & Huey, R. B. (2008). Size, temperature, and fitness: Three rules. *Evolutionary Ecology Research*, *10*(2), 251–268.