Title: M04D03-E: The effect of altitude on dung beetle community structure in a Honduran cloud forest.

Keywords: Biological indicators; biodiversity; climate change; data handling; deforestation; ecosystems; environmental monitoring; field techniques; human impact; rainforest; sampling; transects; species richness, species evenness, abundance

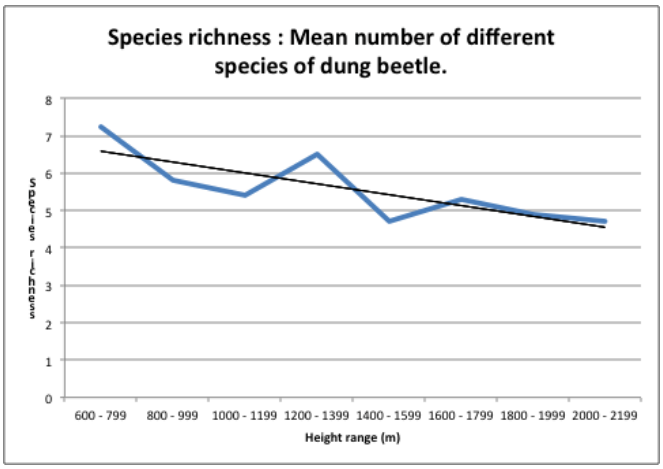
Skills: Correlation coefficients.

In tropical rainforests dung beetles are a conservation priority. As they move dung for feeding, nest building and the provision of nutrients to their larvae, the forest collaterally benefits as a result of soil fertilisation and aeration, nutrient recycling, seed dispersal, pollination, reduction in seed predation and the biological control of the eggs and larvae of mammalian parasites. As forest degradation continues apace, the survival of dung beetles, along with the important ecosystem services they fulfil, is threatened. The effects of global climate change are often first perceived when researchers notice alterations in the distributions of organisms. These distributional changes are most commonly associated with shifting latitudes as opposed to elevations. However, studies in dung beetle communities suggest that altitude affects species richness and diversity and therefore dung beetles can be useful biological indicators of disturbance and loss of biodiversity.

This study involves looking at the species richness of dung beetles within Cusuco National Park (CNP), Honduras. Species richness is calculated by simply adding up the number of different species of dung beetle found at each site. Seven areas were sampled across a range of altitudes (600-2200m) throughout the park and there are 127 sample points which have been continuously recorded for over many years.

Phanaeus endymion

The data below show the relationship between dung beetle species richness and altitude:



Sample location (m)	Species richness
600 - 799	7.25
800 - 999	5.8
1000 - 1199	5.4
1200 - 1399	6.5
1400 - 1599	4.7
1600 - 1799	5.3
1800 - 1999	4.9
2000 - 2199	4.7

Looking at the table and the graph the researchers suggest that there is a negative correlation between species richness and altitude, i.e. as altitude increase species richness decreases. They would like to know if this is a significant correlation and they therefore decide to calculate the Correlation Coefficient (*r*). The value of *r* (linear correlation coefficient) measures the strength and the direction of a linear relationship between two variables. The mathematical formula for *r* is found below but calculators/computers can normally determine this value for you!

$$r = \frac{n\sum xy - \left(\sum x\right)\left(\sum y\right)}{\sqrt{n\left(\sum x^2\right) - \left(\sum x\right)^2}\sqrt{n\left(\sum y^2\right) - \left(\sum y\right)^2}}$$

The value of r can range from -1 to +1. Positive values indicate a positive relationship between the two variables of interest, i.e. as the value of one increases the other does also. Negative values indicate a negative relationship between the two variables of interest, i.e. as the value of one increases the other decreases. If there is no correlation then $r = 0$, if there is a weak correlation then *r* will be close to 0. If there is a perfect correlation, then *r* will equal +1 or -1; this happens when all of the data points lie exactly on a straight line. The general rule is that if *r* is greater than 0.8 is described as strong, and less than 0.5 is weak.

Tasks and questions

1. The *r* value for the relationship between dung beetle species richness and altitude for the whole park was $r = -0.78$. What does this tell the scientist?
2. The scientist then looked at four different locations located across CNP and calculated their *r* values. Each site had its own altitudinal range.

Camp name	Height range in (m)	*r* value
Buenos Aires	700-1600	+0.31
Cantiles	1400-1700	+0.29
Corticeto	700-2100	-0.74
Dante	1300-2100	+0.03
All sites	700-2100	-0.78

Summarise his findings and suggest why some sites show no clear correlation.

3. When *r* was calculated the number of dung beetles found in each height range was averaged, e.g. on average 5.8 species were found between 800-999m. In one calculation *r* was determined using the actual number of species found at each altitude point. For some sites doing this gave a very different value, e.g. Cantiles *r* = -0.12 as opposed to +0.29. Which method is the most appropriate and why?