Lack of climate's influence on the degree curvature of *Centropogon cornutus* across Neotropical bioregions

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Introduction

- The South American Neotropical region is an extraordinary biodiversity hotspot, featuring tens of thousands of seed plant species as well as environmentally diverse bioregions (Antonelli & Sanmartin, 2011)
- *Centropogon cornutus* is a unique Neotropical species in that it differs from its close relatives.
- While other Eucentropogonids are high-altitude species pollinated by sicklebill hummingbirds and located primarily in the Andes mountains, *C. cornutus* is widespread throughout the Neotropics where it is pollinated by generalist hummingbirds (Powder-George, 2017).
- The morphology of *C. cornutus* also appears to vary across populations growing in different Neotropical bioregions.
- Understanding what allows *C. cornutus* to be widespread could aid in preserving Neotropical biodiversity and help to determine if *C. cornutus* is truly one species or multiple.

Research Questions/Hypotheses

- Does *C. cornutus's* degree curvature vary significantly across Neotropical bioregions?
- Do annual temperature and precipitation significantly impact degree curvature?
- **Degree curvature was expected to vary significantly across bioregions according to differences in temperature and precipitation. It was predicted that lower temperatures and higher precipitation would be correlated with more curved flowers.**

Methods

Sampling Methods

- 390 herbarium specimen images were downloaded from GBIF.org, and two flowers and two leaves on each specimen were measured (Figure 7).

Data Collection

- Morphological traits including degree curvature were measured using Image J. Shriveled or damaged flowers and leaves were not measured.

Data Cleaning

- Some specimens lacked location data and/or trait data and were excluded, leaving 151 specimens used in the analyses.
- Specimens were organized into bioregions based on their latitude and longitude coordinates.
- Annual precipitation and temperature data were obtained using R & World Climactic variables by our TA.

Data Analysis in JMP

- JMP Pro 16 was used to create scatterplots of degree curvature and bioclimatic variables of temperature (Figure 1) and precipitation (Figure 2). P-values and R^2 values were calculated.
- JMP Pro 16 was also used to create a box plot of degree curvature data across bioregions, and an ANOVA was run to obtain a p-value (Figure 3).

Results

Figure 5. *C. cornutus* found in Brazil (GBIF.org).

Figure 4. *C. cornutus* found in Colombia (GBIF.org).

Table 1. This table shows the means of flower length of the *C. cornutus* for each bioregion and the standard deviations of flower length for each bioregion.

Bioregion	Means	Standard deviation
Amazon	143.509	3.4109
Andes	141.055	2.7145
Central America	146.191	5.2566
Guiana Shield	144.690	3.5044

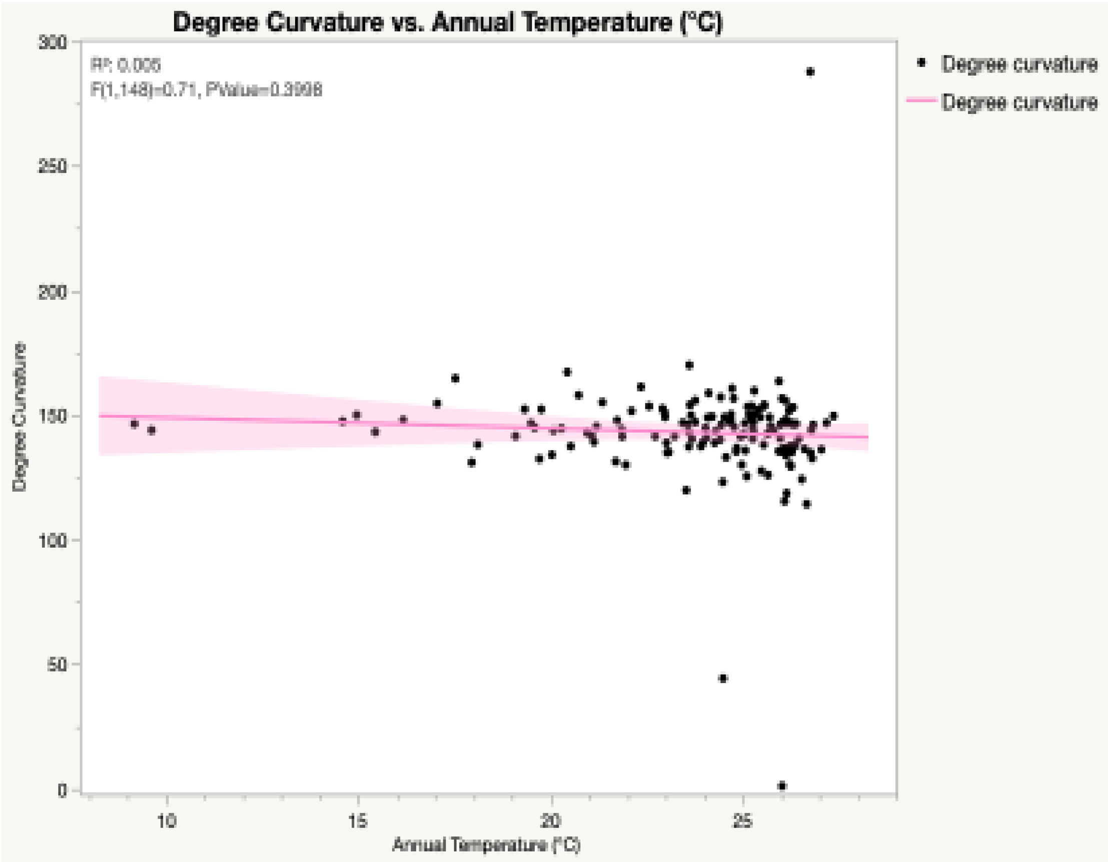

Figure 1. Scatter plot of Degree Curvature of *C. cornutus* vs Annual Temperature (°C). The graph represents the effect temperature has on the degree curvature of the plant. $R^2 = 0.005$, p-value = 0.3998, indicating that temperature has no effect on degree curvature.

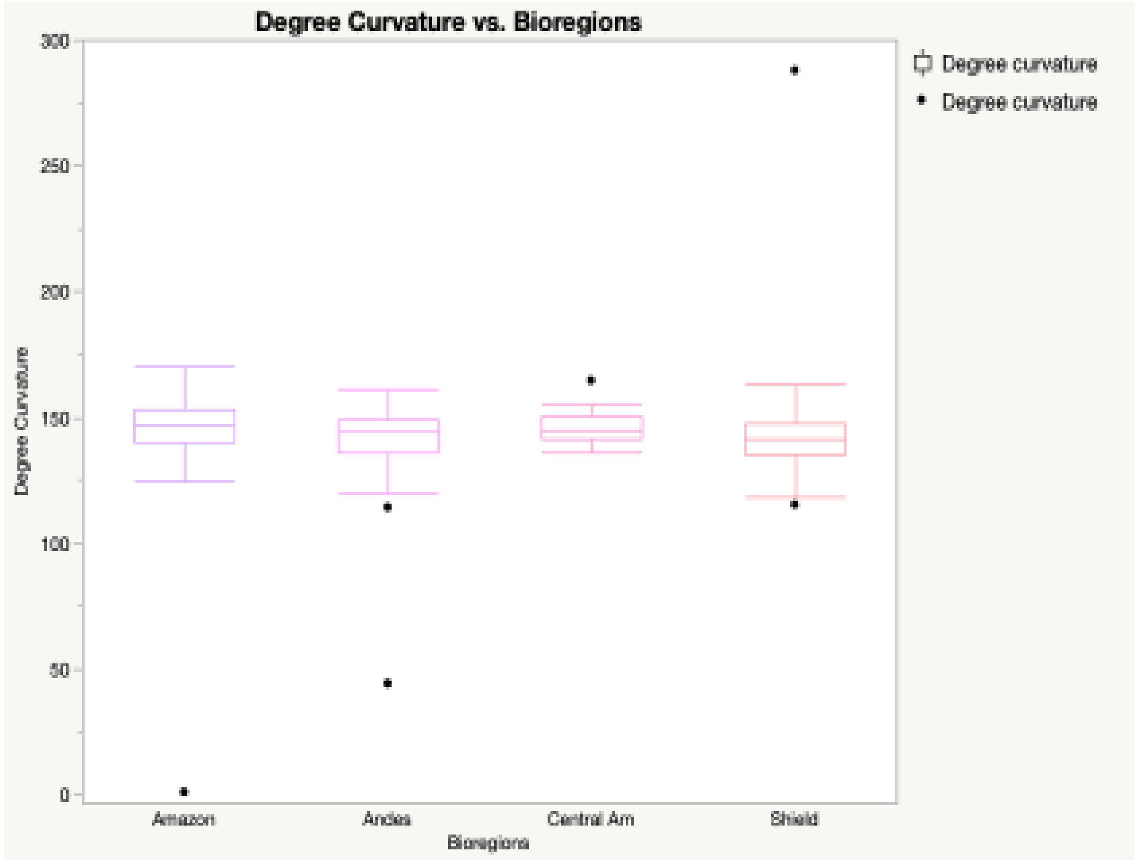

Figure 3. Box plot of Degree Curvature of *C. cornutus* vs. Different Bioregions. Measurements of degree curvature were separated by bioregion. The boxplot shows the differences in mean degree curvature between the bioregions. The bioregions are the Amazon (purple), the Andes (light pink), Central America (hot pink), and the Guiana Shield (red). The p-value and ANOVA was higher than 0.05, meaning there was no significant difference in degree curvature over the bioregions.

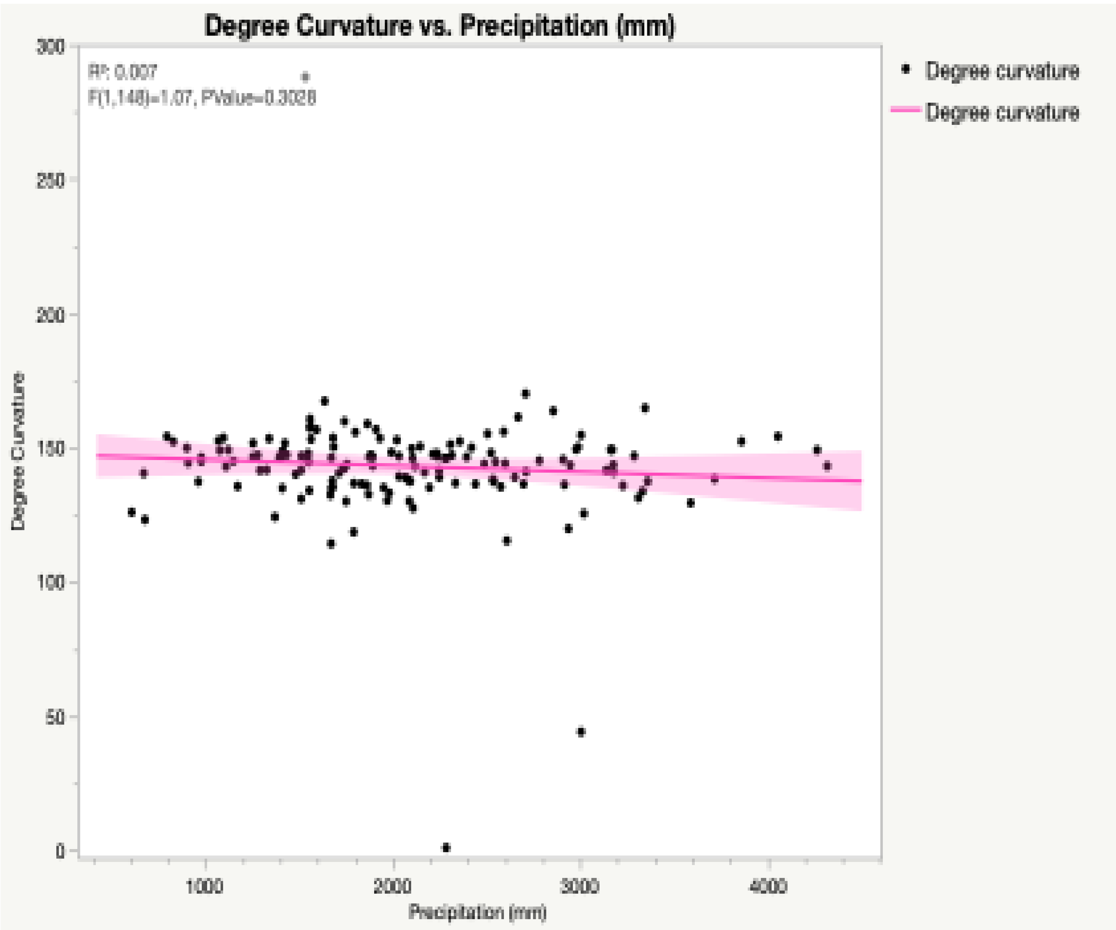

Figure 2. Scatter plot of Degree Curvature of *C. cornutus* vs. Precipitation (mm). The graph represents the effect the annual precipitation has on degree curvature of the plant. $R^2 = 0.007$, p-value = 0.3028, indicating that precipitation has no effect on degree curvature.

Figure 7. Herbarium specimen of *C. cornutus* used for morphometrics (GBIF.org).

Figure 6. Generalist hummingbird (*Phaethornis guy*) that pollinates C. cornutus (GBIF.org)

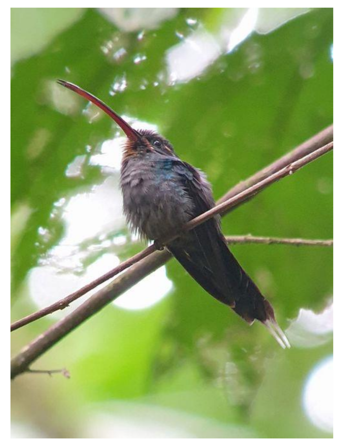

Figure 8. Generalist hummingbird (*Phaethornis guy*) that pollinates C. cornutus (GBIF.org)

Conclusions

- **The data from the results showed that there was no correlation between the degree of curvature of *C. cornutus* and the annual temperature and precipitation.**
- The p-values were all greater than 0.05 meaning that no significant difference was found in the data.
- The alternative hypothesis was rejected, and the predictions were not supported. The null hypothesis was accepted.
- Degree curvature is likely not a key factor to *C. cornutus's* widespread distribution
- One limitation to the study is that not all specimens had flowers or leaves that could be measured accurately.
- It is possible that pollinators might have a greater effect on the degree of curvature, but this study did not examine pollinator influence.
- It is possible *C. cornutus* is a cryptic species and that different populations may be genetically different

Future Directions

- Future studies could investigate if degree curvature is impacted by other environmental factors, such as humidity and soil nutrients.
- Future studies could determine if different generalist hummingbird pollinator species impact the traits of *C. cornutus.*
- Only four bioregions were included, and a significant difference may be found if more were included such as the Caribbean.
- Trait data could be compared to each other to see if correlation exists between certain *C. cornutus* traits.

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