

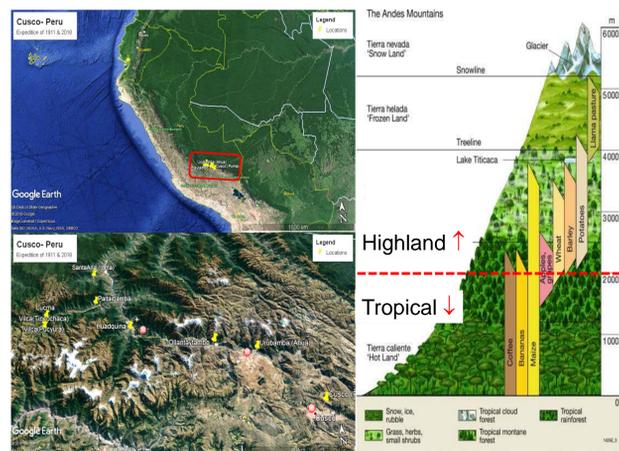
Diversity and Distribution of Spiders in Cusco, Peru: A survey and Comparison of the Yale-Peruvian Expedition of 1911

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INTRODUCTION

- Estimating the number of species is critical for setting conservation goals as it allows biologists to monitor wildlife populations worldwide and allocate resources accordingly¹.
- The tropical Andes in South America is one of the most biologically diverse regions on Earth², yet most species in this area remain undescribed and unknown to science.
- Peru is considered a biodiversity hotspot due to the large number of unique habitats. For example, 50% of Peruvian spider species can only be found in Peru³.
- In 1911, Yale University collected spiders from 11 remote locations in Cusco, Peru. This led to the discovery of 82 species and 12 genera new to science⁴.
- Despite the value of comparing populations after several decades, historical studies are seldom replicated, especially in remote locations such as the Peruvian Andes.
- For the first time in over 100 years, we replicated the Yale-Peruvian expedition, following a century of land use change.

Figure 1. Sites and altitudinal zonation in Cusco, Peru



Objective and Hypothesis

Our goal was to determine the diversity and geographic distribution of spiders in Cusco, Peru and compare our findings to the results of the Yale-Peruvian expedition of 1911.

The biodiversity-productivity hypothesis states that productive habitats enhance arthropod communities^{5,6}. Consequently, we hypothesized that spider communities will more diverse in the Tropical altitudinal zone (elevation < 2000 m) than in the Highland altitudinal zone (elevation > 2000 m) (Figure 1).

MATERIALS & METHODS

- The study took place in the department of Cusco, Peru where spiders were collected in January 2017 and July 2018 from ten locations visited by the Yale expedition (Figure 1).
- Locations ranged from 1300 to 3500 meters above sea level and were classified in two major ecological zones (Figure 2):
 - *Tropical < 2000 m*: Santa Ana (1300 m), Idma (1400 m), Paltabamba (1600 m), and Huadquiña (1700 m).
 - *Highland > 2000 m*: Lucma (2600 m), Ollantaytambo & Urubamba (2800 m), Tinochaca & Pucyura (2900 m), and Cusco (3500 m).

Figure 2. Tropical (left) and Highland (right) zones



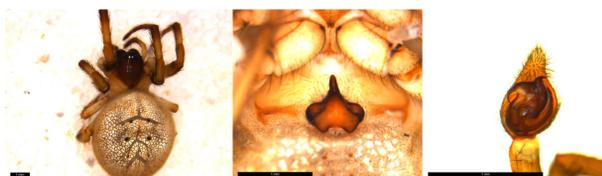
- During each 3-day expedition, two teams of 4 people collected spiders using pitfall traps and hand-sampling techniques (Figure 3).

Figure 3. Sampling methods



- Specimens were identified and classified using genitalia and unique morphological characteristics (Figure 4).
- Spider diversity and richness were estimated with presence/absence data via rarefaction and extrapolation using Hill numbers in the iNEXT package in R statistical software⁷.

Figure 4. Spider morphological characteristics



RESULTS

- A total of 140 spider species were reported in 2017-2018 while 90 spider species were found in 1911 (Figure 5).
- In 1911, spider richness and diversity were higher in the Tropical altitudinal zone than in the Highlands (Figure 6).
- **In 2017-2018, spider richness and diversity were similar in both Tropical and Highland altitudinal zones (Figure 7).**

Figure 5. Spider richness/diversity in 1911 & 2017-18

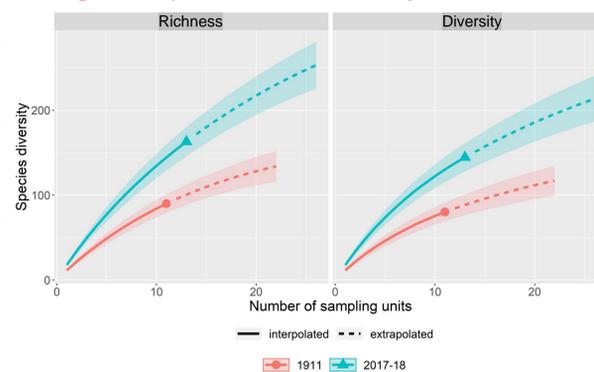


Figure 6. Spider richness and diversity in 1911

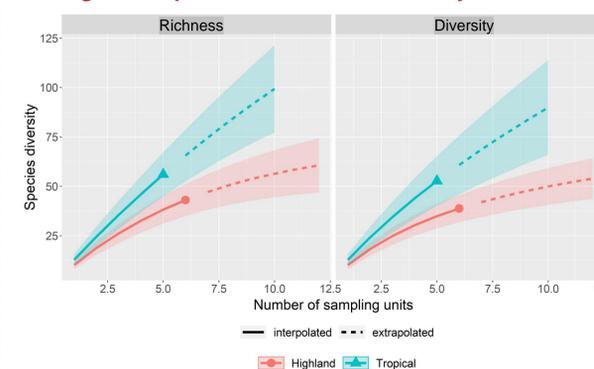
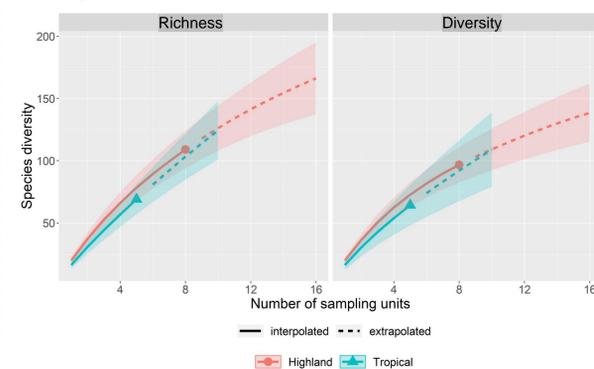


Figure 7. Spider richness and diversity in 2017-2018



CONCLUSIONS & DISCUSSION

- We found that spiders were very diverse in Cusco, Peru. Species estimation curves did not reach a plateau suggesting that more sampling is needed for more accurate estimates.
- Spider diversity in the Tropical zone was similar in both studies (57 species in 1911 and 68 species in 2017-18). However, diversity in the Highlands doubled from 38 species in 1911 to 78 species in 2017-18.
- This suggests that spiders have benefited from environmental changes and have successfully established at higher elevations. However, our results could be confounded by sampling effort or seasonality⁶.
- Our work is the first project attempting to establish a list of spiders in Cusco and will serve as a foundation study to future biodiversity assessments in the region.

FUTURE DIRECTIONS

- Specimens are being sequenced and DNA barcodes will be utilized to determine diversity with phylogenetic trees.
- Community composition will be analyzed across regions to estimate species gains and losses spatially and temporally.
- Maps with species distributions will be created and compared to determine habitat/altitudinal ranges.



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