Elysia Species Richness Fails to Follow a Linear Trend as Distance from Equatorial Plane Increases.

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Introduction

The Elysia genus comprises of more than 100 species of slugs with incredibly diverse morphological and physiological characteristics. For instance, some are able to survive months on just sunlight (*E. chlorotica, E. viridis, E. timida*) by rehoming plant chloroplasts into their stomach epithelial lining (Havurinne & Tyystjärvi, 2020). Other Elysia species are able to regenerate their entire body post-decapitation, including a new beating heart, stomach, and other internal organs (*E. atroviridis, E. marginata*; Mitoh & Yusa, 2021). Curiously, the factors that drive such biodiversity in Elysia have been poorly explored. In many species, it has been shown that species diversity gradients toward high diversity near the equatorial plane (Dowle et al., 2013). However, there have been studies that show a different distribution for marine animals, where diversity is highest at middling latitudes away from the equator (Boltovskoy & Correa, 2016). Barcode Index Number (BINs) is a commonly used estimate of species diversity (Sun et al., 2016). In this study, we examine changes in Elysia species richness (represented by the number of unique BINs per latitude category) as distance from the equator increases to determine whether Elysia species diversity follows the general species diversity gradient or lean towards a marine animal distribution. Our null hypothesis is that species richness will follow a linear trend of decrease as distance from the equator increases. We predict that Elysia, as a primarily marine gastropod, will follow the marine biodiversity distribution, with high species richness centered upon altitudes of 40-50° away from the equator and thus reject the null hypothesis.

Results and Discussion

In conclusion, Elysia species richness follows a non-linear trend as distance from the equatorial plane increases. First, we analyzed the distribution of Elysia records with increasing latitudinal

distance from the equatorial plane, and found that there was an abnormally large number of records in the 35-40° range (Fig. 4). Further investigation showed that nearly half of all records originated from Japan, representing 12 different species within that geographic location alone. Next, we examined for a linear correlation between species richness (number of unique BINS) and latitude, and we found that the relationship between the two variables was poorly correlated when fitted with both linear and polynomial (degree 3) models (Fig. 2). Most notably, there was a clear outlier in the overrepresented latitude discussed previously. Thus, taking into account the oversampling and representation from Japan, Japan was removed from the dataset as an outlier. The analysis was performed again. While a linear regression was poorly fitted (R^2=0.45), a polynomial trend (degree 3) was well fitted to the data(R^2=0.7). Thus, we conclude that Elysia species richness likely follows the marine distribution as predicted. We further examined whether the number of samples was related to the number of BINs identified, both with and without the outlier. Both graphs indicate that there is a good correlation between the number of samples and the number of species (R^2=0.88 and R^2=0.78 respectively). Therefore, it is reasonable to conclude that more sampling is needed to help determine species richness across latitudes.

Acknowledgements

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Works Cited

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FIGURES

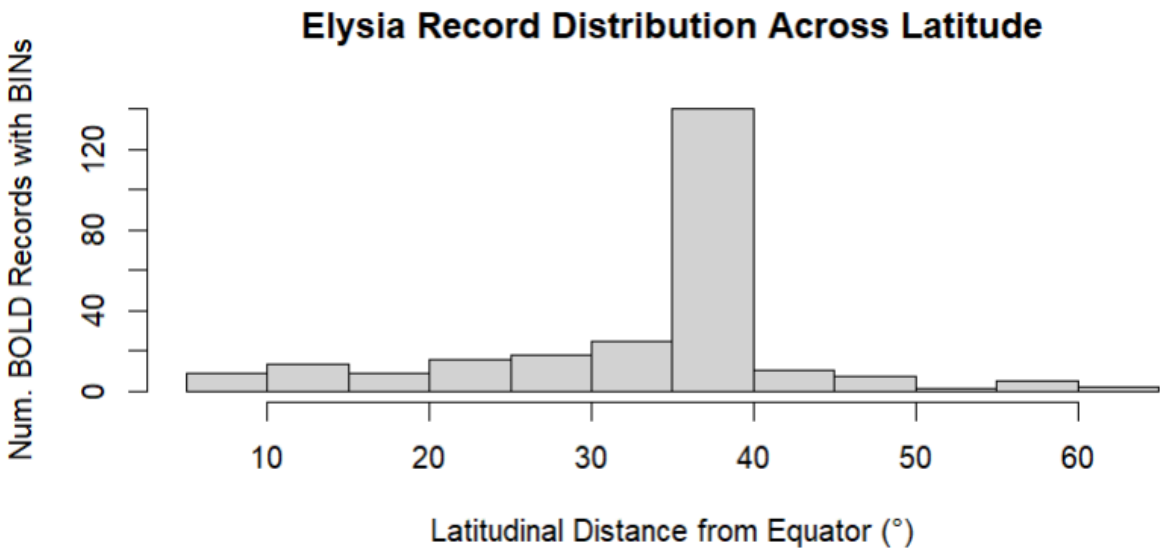

Figure 1. Distribution of BOLD records with BINs over latitude. Large number of records identified at 35-40° away from the equatorial plane.

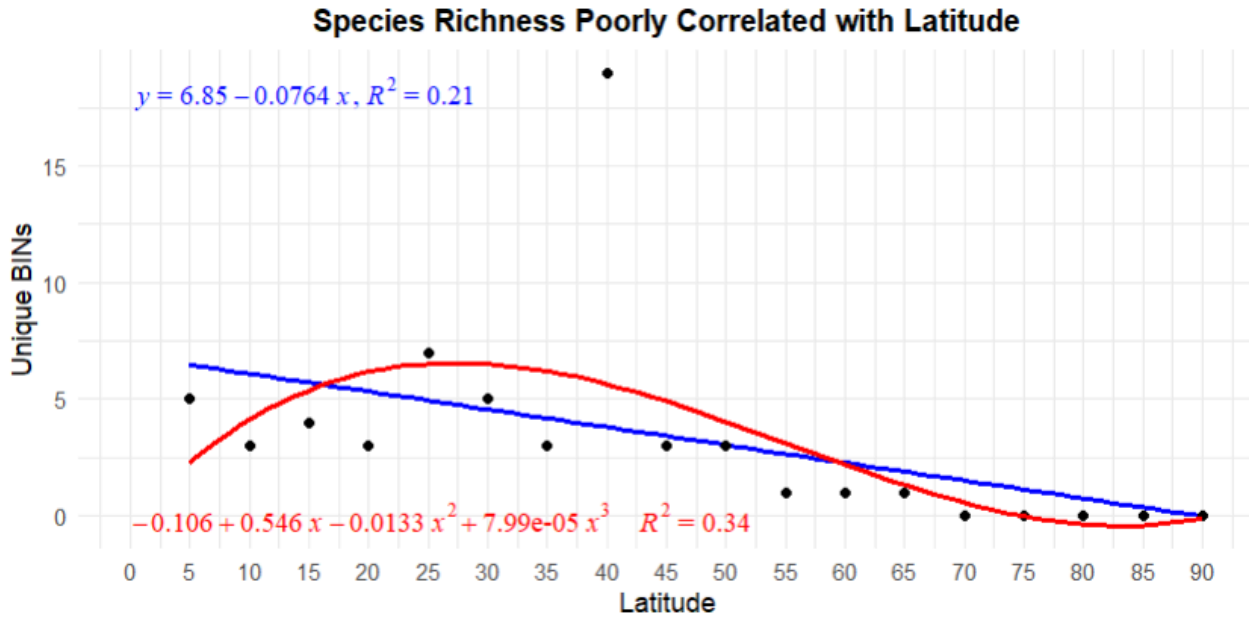

Figure 2. Species Richness Poorly Correlated with Latitude.

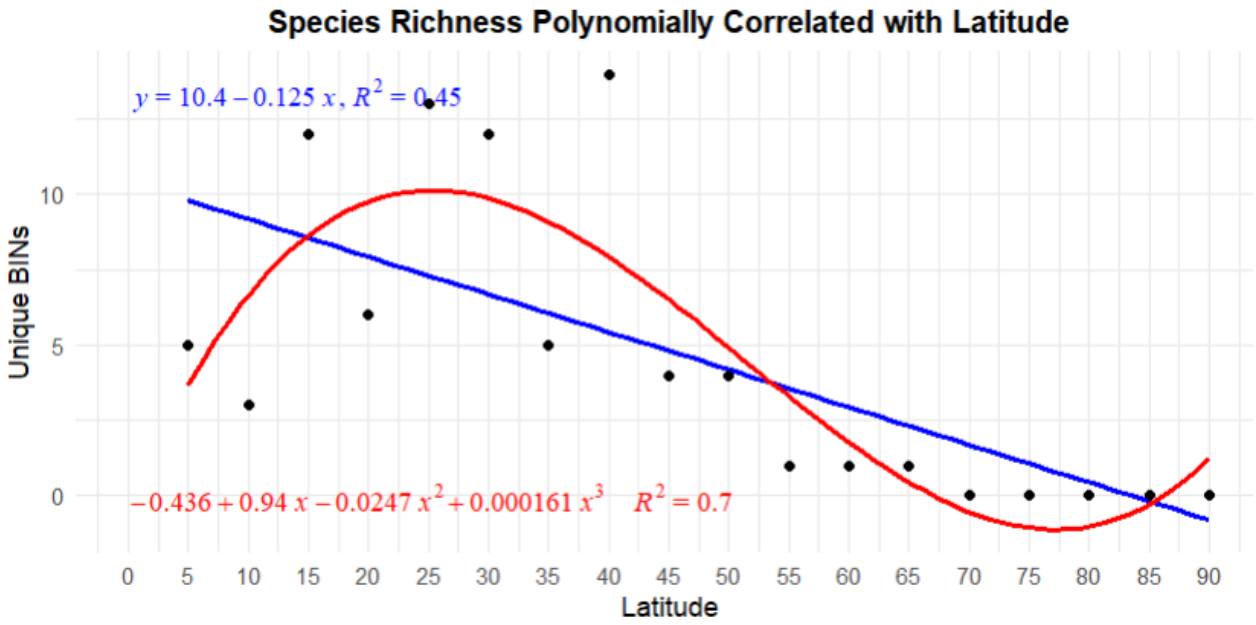

Figure 3. Species Richness Polynomially Correlated with Latitude.