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International Journal of Zoology and Animal Biology
ISSN: 2639-216X

A Latitudinal Gradient in Species Richness of Subgenus *Tetraconasoma* Verhoeff, 1924, not *Sphaerotherium* Brandt, 1833 (Diplopoda: Sphaerotheriida)?

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Short Communication

Volume 5 Issue 6

Received Date: November 02, 2022

Published Date: November 14, 2022

DOI: 10.23880/izab-16000413

Abstract

The Tropical Conservativism Hypothesis and Biogeographical Conservativism Hypothesis were tested in forest millipedes. Latitudinal diversity gradient (LDG) was measured in the genus *Sphaerotherium* and *Tetraconasoma* to distinguish between the two hypotheses. There was a marginally significant correlation between the number of species and latitudinal degrees away from the equator in *Tetraconasoma* (r=-0.78091517, Z score=-1.48168825, n=5, p=0.06921166), not *Sphaerotherium* (r=-0.73029674, Z score=-0.92936295, n=4, p=0.17635049). The relationship in *Tetraconasoma* was shown to be significant (Spearman's Rho rs=-0.89443, p (2-tailed) = 0.04052). An evolutionary preference for temperate environments appearing to have led to climatic constraints on dispersal based primarily on precipitation seasonality gradients was previously suggested. The antennal cone cells in the *Tetraconasoma* are suggested to be responsible for this sensory adaptive radiation and variation.

Keywords: Dimorphism; Sex Ratio; Size

Abbreviation: LDG: Latitudinal Diversity Gradient.

Introduction

Species richness is the number of species represented in an ecological community, landscape, or region [1,2]. Species richness and biodiversity increase from the poles to the tropics for a wide variety of terrestrial and marine organisms and is referred to as a latitudinal diversity gradient (LDG) [3,4]. Inverse LDG includes aphids, Chinese litter-dwelling thrips, diving beetle subfamily Colymbetinae, European bryophytes, freshwater zooplankton, Holarctic tree frogs, ichneumonids, marine benthic algae, marine bivalves Anomalodesmata, New World snake tribe Lampropeltini, North American breeding birds, penguins, peracarid crustaceans, pitcher plant mosquito, pond turtles, Shallow-water mollusks, shorebirds, southeastern United States trees, subarctic forests, and tropical leaf-litter ant communities [5-8,10-15].

The LDG is measured and tested in the Oniscomorph forest millipede subgenera *Sphaerotherium* Brandt, 1833 and *Tetraconasoma* Verhoeff, 1924.

These forest clades belonging to the Order Sphaerotheriida are distributed along the eastern coast of southern Africa consisting of species with concentrations around coastal bush and forests [3]. The null hypothesis is the Tropical Conservativism Hypothesis which suggests processes of speciation, extinction, and dispersal result in higher species richness in the tropics and decline away from the equator [9]. The alternative is the Biogeographical

Conservativism Hypothesis which suggests the processes invoked are not intrinsic to the tropics but are dependent on historical biogeography to determine the distribution of species richness [11].

Materials and Methods

49 valid species were identified as belonging to the genus *Sphaeotherium* Brandt [3]. These were split into two subgenera (based on the presence of four cone cells on the antenna in *Tetraconasoma*) and tabulated and known localities also listed (Appendix 1,2). Localities were obtained from a checklist of southern African millipedes [3]. GPS coordinates were obtained from internet sources for known localities using the locality followed by the keyword "GPS". Latitude and longitude coordinates were obtained. When coordinates were not in decimal degrees, they were converted to decimals by dividing the seconds by 60 and adding these to the minutes divided through 60 to get the decimal behind or following the degree. Species accepted were per MilliBase (http://www.millibase.org).

Results

Tetraconasoma

21 species were found between -35°S and -30°S, four between -30°S and -25°S, one between -25°S to -20°S, one between -20°S and -15°S, and one between -15°S and -10°S (Figure 1). Skewness was 2.52489 and kurtosis was 6.6084. There was a marginally significant correlation between the number of species and latitudinal degrees away from the equator in *Tetraconasoma* (r=-0.78091517, Z score=-1.48168825, n=5, p=0.06921166) (Figure 2).

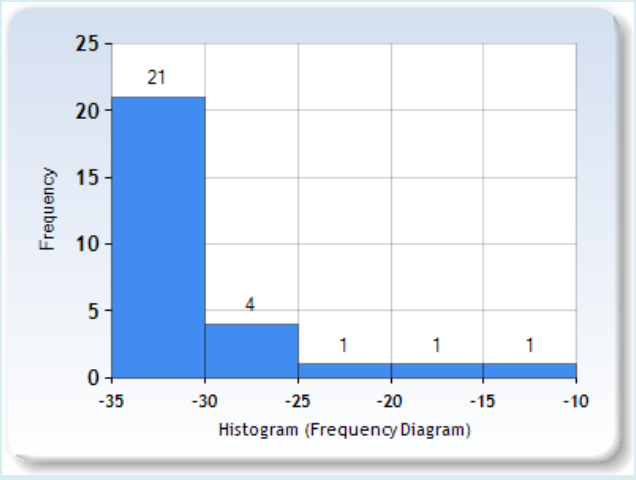

Figure 1: Histogram showing the number of species (Frequency) across latitudes in *Tetraconasoma*.

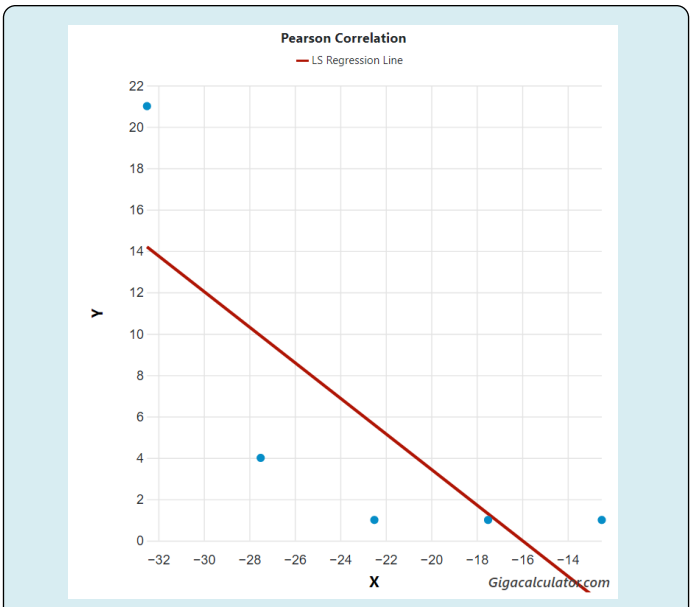

Figure 2: Relationship between species number (Y Values) and latitude S (X Values) in *Tetraconasoma.*

The relationship in *Tetraconasoma* was shown to be significant (Spearman's Rho r_s=-0.89443, *p* (2-tailed) = 0.04052).

Sphaerotherium

Five species were found between -34.1°S and -31.1°S, four between -31.1°S and -28.1°S, five between -28.1°S and -25.1°S, and two between -25.1°S and -22.1°S (Figure 3). Skewness was -0.00311 and kurtosis was -1.48539. There was no significant correlation between the number of species and latitudinal degrees away from the equator in *Sphaerotherium* (r=-0.73029674, Z score=-0.92936295, n=4, p=0.17635049).

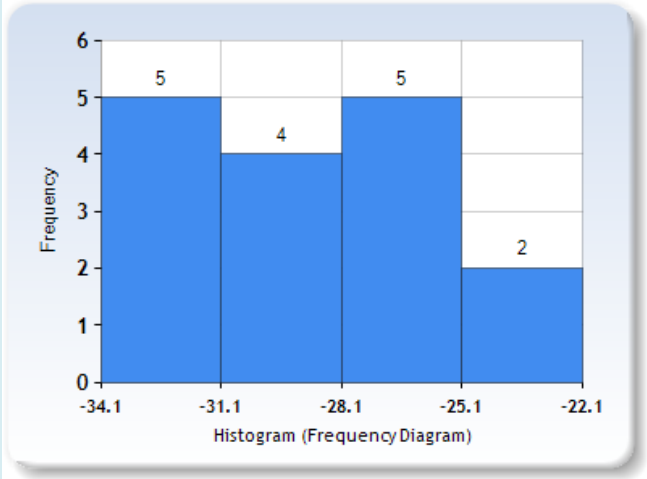

Figure 3: Histogram showing the number of species (Frequency) across latitudes in *Sphaerotherium*.

Discussion

For skewness (−1, 1) and (−2, 2) for kurtosis is an acceptable range for being normally distributed. So *Tetraconasoma* species richness is not normally distributed across latitudes while *Sphaerotherium* species richness is normally distributed across latitudes. This suggests the significant correlation between the number of species and latitudinal degrees away from the equator in *Tetraconasoma* is probably meaningful of a relationship between species richness and latitude. In contrast, the absence of a relationship between species richness and latitude in *Sphaerotherium* is meaningless. The Tropical Conservativism Hypothesis in *Sphaerotherium* and Biogeographical Conservativism Hypothesis in *Tetraconasoma* were accepted, respectively. If the number of antennal cone cells is a significant phylogenetic character it may explain different sensory cues in the *Tetraconasoma* manifest as a biogeographical difference with *Sphaerotherium. Tetraconasoma* biogeography may make the status of this group acceptable.

Conclusion

A latitudinal gradient in species richness of subgenus *Tetraconasoma* was found and not *Sphaerotherium.*

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