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PAIR-WISE COMPARISON OF SEXUAL SIZE DIMORPHISM AMONG NINE FACTORS IN FOREST MILLIPEDES CENTROBOLUS COOK, 1897

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Abstract

The objectives of this study were to determine what happened when Bergmann's Rule met Rensch's Rule if Sexual Size Dimorphism (SSD) varied with nine factors. Body size, latitude, longitude, male mass, precipitation, temperature, the highest total hours of sunshine in a month, the hours of sunshine throughout the year, and the month with the highest number of rainy days were correlated with SSD in the forest millipede genus Centrobolus. *Correlation coefficients were compared using MedCalc. 21 significant differences were found among the 36 pair-wise comparisons. Three highly significant differences in pair-wise comparisons of correlations in SSD were found among (1) body size and the highest total hours of sunshine in a month, (2) body size and latitude, and (3) body size and sunshine throughout the year.*

***Keywords**: Abiotic; biotic; dimorphic; gradient; size; species.*

INTRODUCTION

A forest genus of diplopods belonging to the Order Spirobolida found along the eastern coast of southern Africa was the subject of this study. The millipede genus *Centrobolus* is found in the temperate South African subregion, its northern limits on the east coast of southern Africa being about -17° latitude S. It occurs in all the forests of the coastal belt from the Cape Peninsula to Beira in Mocambique. While the coastal forests of the South-West and Eastern Cape are mist belt temperate forests, those of the Transkei, Natal, Zululand, and Mocambique are somewhat different, being better described as East Coast Bush, they are developed almost entirely in a narrow strip of the litoral on a dune sand substratum, and are more tropical in aspect and composition than those to the west of them. There is a summer rainfall of 76.2-101.6 cm, a uniform temperature, and an absence of frost; the component trees of the coastal bush with their abundant creepers and lianes, while not usually reaching a height of more than 11 meters, provide a dense covering with abundant shade and humidity at ground level. As essentially shade-loving Diplopoda, the members of the genus are especially well represented in these litoral forests of the eastern half of the subcontinent [3].

Sexual size dimorphism (SSD) is correlated with nine factors: body size, latitude, longitude, male mass, precipitation, temperature, the highest total hours of sunshine in a month, the hours of sunshine throughout the year, and the month with the highest number of rainy days the highest total hours of sunshine in a month in the pachybolid millipede genus *Centrobolus* Cook, 1897 [1-3]. The null hypothesis is that all nine factors are somewhat important in relative body size correlation comparisons.

MATERIALS AND METHODS

39 valid species were identified as belonging to the genus *Centrobolus* Cook, 1897. Millipede-type localities were obtained from a checklist of southern African millipedes [2]. These were tabulated and known type localities also listed in Microsoft Word online (https://office.live.com/start/Word.aspx). GPS coordinates were obtained from internet sources for known type localities using google (https://www.google.co.za/maps/place). The highest total hours of sunshine in a month, hours of sunshine throughout the year, mean annual precipitation, temperature and the month with the highest number of rainy days were obtained from https://en.climate-data.org/search/?q=. Body size was obtained by calculating the volumes (cylindrical) using the lengths and widths of species which were inputted into the formula for a cylinder's volume (https://byjus.com/volume-of-a-cylinder-calculator). SSD was calculated as the ratio of female volume to male volume. SSD, body size, latitude, longitude, male mass, precipitation, the highest total hours of sunshine in a month, hours of sunshine throughout the year, the month with the highest number of rainy days, and temperature were checked for correlations using the Pearson Correlation Coefficient calculator (https://www.gigacalculator.com/calculators/correlation-coefficient-calculator.php). Pairwise-comparisons between correlation coefficients of SSD and the nine factors were made at https://www.medcalc.org/calc/comparison_of_correlations.php.

RESULTS

The results of the 36 possible pair-wise comparisons between correlations with SSD were as follows: latitude and temperature (z=2.5341, p=0.0113), latitude and longitude (z=2.6548, p=0.0079), latitude and precipitation (z=-2.3560, p=0.0185), longitude and temperature (z=0.1206, p=0.9040), longitude and precipitation (z=0.2988, p=0.7651), precipitation and temperature (z=0.1782, p=0.8586), the month with the highest number of rainy days and latitude (z=2.6591, p=0.0078), the month with the highest number of rainy days and longitude (z=0.0044, p=0.9965), the month with the highest number of rainy days and precipitation (z=0.3032, p=0.7618), the month with the highest number of rainy days and temperature (z=0.1250, 0.9005), highest total hours of sunshine in a month and latitude (z=0.2150, p=0.8297), highest total hours of sunshine in a month and longitude (z=-2.4398, p=0.0147), highest total hours of sunshine in a month and precipitation (z=-2.1409, p=0.0323), highest total hours of sunshine in a month and temperature (z=-2.3191, p=0.0204), highest total hours of sunshine in a month and month with the highest number of rainy days (z=2.4441, p=0.0145), body size and latitude (z=3.8991, p=0.0001), body size and longitude (z=1.4054, p=0.1599), body size and precipitation (z=1.6861, p=0.0918), body size and temperature (z=1.5187, p=0.1288), body size and the month with the highest number of rainy days (z=1.4013, p=0.1611), body size and the highest total hours of sunshine in a month (z=3.6971, p=0.0002), male mass and latitude (z=1.6574, p=0.0974), male mass and longitude (z=2.4970, p=0.0125), male mass and precipitation (z=2.4025, p=0.0163), male mass and temperature (z=2.4588, p=0.0139), male mass and the highest total hours of sunshine in a month (z=1.7254, p=0.0844), male mass and the month with the highest number of rainy days (z=2.4983, p=0.0125), male mass and body size (z=2.9505, p=0.0032), male mass and sunshine throughout the year (z=1.6315, p=0.0128), sunshine throughout the year and latitude (z=-0.43808630, p=0.9347), sunshine throughout the year and longitude (z=-2.7367, p=0.0062), sunshine throughout the year and precipitation (z=0.28628078, p=0.0148), sunshine throughout the year and temperature (z=-2.6161, p=0.0089), sunshine throughout the year and highest total hours of

sunshine in a month (z=-0.2969, p=0.7665), sunshine throughout the year and highest number of rainy days (z=0.37383618, p=0.0061), sunshine throughout the year and body size (z=-3.9761, p=0.001). 21 significant differences were found among the 36 pair-wise comparisons. The data for all factors were normally distributed. The distribution of body size was normal (D=0.15999, n=22, p=0.57201). SSD was normally distributed (D=0.15168, n=22, p=0.20477).

DISCUSSION

21 significant differences were found among the 36 comparisons of nine factors. These occurred between correlation coefficients of SSD with latitude and temperature, latitude and longitude, latitude and precipitation, the month with the highest number of rainy days and latitude, highest total hours of sunshine in a month and longitude, highest total hours of sunshine in a month and precipitation, highest total hours of sunshine in a month and temperature, highest total hours of sunshine in a month and month with the highest number of rainy days, body size and latitude, body size and the highest total hours of sunshine in a month, male mass and longitude, male mass and precipitation, male mass and temperature, male mass and the month with the highest number of rainy days, male mass and body size, male mass and sunshine throughout the year, sunshine throughout the year and longitude, sunshine throughout the year and precipitation, sunshine throughout the year and temperature, sunshine throughout the year and highest number of rainy days, and sunshine throughout the year and body size.

Three highly significant differences in pair-wise comparisons of correlations with SSD were found between (1) body size and the highest total hours of sunshine in a month, (2) body size and latitude, and (3) body size and sunshine throughout the year. This indicates the importance of body size as a determining factor of SSD. Size-assortative mating based on width and male length determines the variance in millipede polygynandrous mating systems across the latitude, longitude, male mass, precipitation, temperature, the highest total hours of sunshine in a month, hours of sunshine throughout the year and the month with the highest number of rainy days gradients.

CONCLUSION

SSD varies systematically with body size, latitude, longitude, precipitation, temperature, the highest total hours of sunshine in a month and the month with the highest number of rainy days. The three highly significant differences in pair-wise comparisons of correlations in SSD were found among (1) body size and the highest total hours of sunshine in a month, (2) body size and latitude, and (3) and (3) body size and sunshine throughout the year.

COMPETING INTERESTS

The author has declared that no competing interests exist.

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