SIZE ACROSS WEATHER GRADIENTS IN PILL MILLIPEDES (DIPLOPODA): III. FEMALE VOLUME AND LOWEST NUMBER OF DAILY HOURS OF SUNSHINE (TOTAL), THE WARMEST MONTH IN THE YEAR, COOLEST MONTH IN THE YEAR, AVERAGE ANNUAL TEMPERATURE, AND MONTH WITH THE HIGHEST NUMBER OF RAINY DAYS

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***Abstract*-Sexual size dimorphism (SSD) was investigated across weather gradients in southern African members of the pill millipede genus *Sphaerotherium*. Body width was extracted from published material (1928) and used to compare interspecific variation in mean calculated volumes using a morphometric approach. Based on the formula for a sphere (4/3. π. r^3), volume was calculated in seven given species. Relationships between female volume and the lowest number of daily hours of sunshine (total) (r=-0.65, Z score=-1.53, n=7, p=0.06), warmest month in the year (r=0.69, Z score=1.68, n=7, p<0.05), coolest month in the year (r=0.76, Z score=1.99, n=7, p=0.02), average annual temperature (r=0.75, Z score=1.97, n=7, p=0.02), and month with the highest number of rainy days (r=0.62, Z score=1.44, n=7, p=0.07) were established.**

I. INTRODUCTION

Diplopoda is currently being studied concerning SSD, and intersexual differences are appearing in body mass, length, width, and leg dimensions in diverse taxa [8, 35, 36, 42, 44, 60, 64, 72]. Mensural differences may be detected in characters including sexual characteristics, urbanization, and hydraulic relations [4, 6]. Millipedes compare similarly with arthropods showing female-biased or reversed SSD [11-33]. Sexual dimorphism can determine reproductive events [1, 11-33, 65]. The relationship between body size and SSD can either be hypoallometrical or hyperallometrical if there are decreasing or increasing rates of SSD with increases in body size [11-33, 57, 58, 65]. This rule is often attributed to non-natural selection [2, 7, 9, 34]. The relationship is a corroboration of the hypoallometric rule which includes pill millipedes [33].

Sexual dimorphism and male and female volume in pill millipedes with 60 or more species are investigated [33]. Males and females can conglobate, or, roll into a ball [71]. Like other millipedes, these pill millipedes have female-biased SSD [11-33]. Specific relationships with weather gradients were investigated here. Specific relationships between male volume, female volume, and the weather were investigated here.

II. MATERIALS AND METHODS

Seven pill millipedes' (1) body width (mm) was extracted from published data [3] and males were compared to females with a matched-pairs test. Total body size estimated from horizontal dorsal tergite. SSD was taken to be female volume divided by male volume with an index and subtraction of one [46]. A model was given [51]. Absolute male and female volumes were calculated.

2.1 STATISTICAL ANALYSIS

SSD is compared across weather gradients at https://www.gigacalculator.com/calculators/correlation-coefficient-calculator.php. Weather gradients were obtained at https://en.climate-data.org/africa/south-africa.

III. RESULTS

In seven measurements of mean female volume, it was related to

The lowest number of daily hours of sunshine (total)

r=-0.64533523, Z score=-1.53452640, n=7, p=0.06245012 (Figure 1).

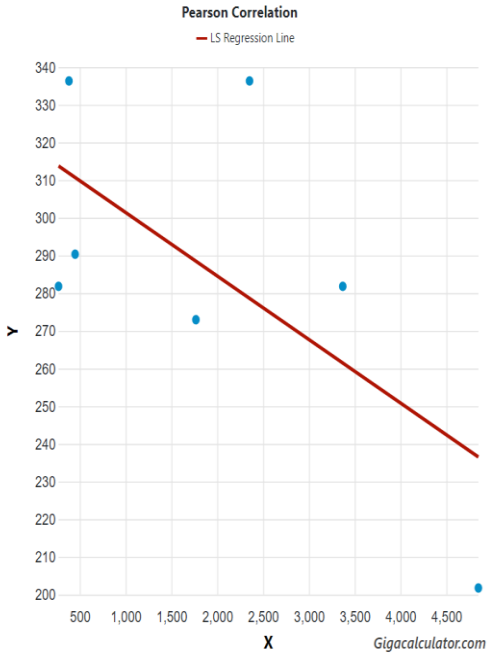

Figure 1. Relationship between female volume and lowest number of daily hours of sunshine (total).

Warmest month in the year

r=0.685571, Z score=1.67910136, n=7, p=0.04656612 (Figure 2).

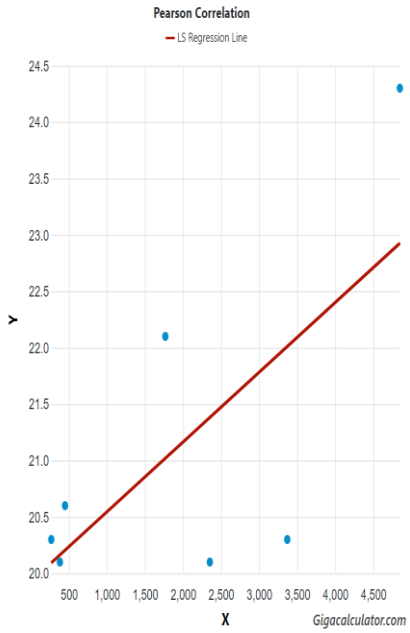

Figure 2. Relationship between female volume and warmest month in the year.

Coolest month in the year

r=0.76105171, Z score=1.99741929, n=7, p=0.02288976 (Figure 3).

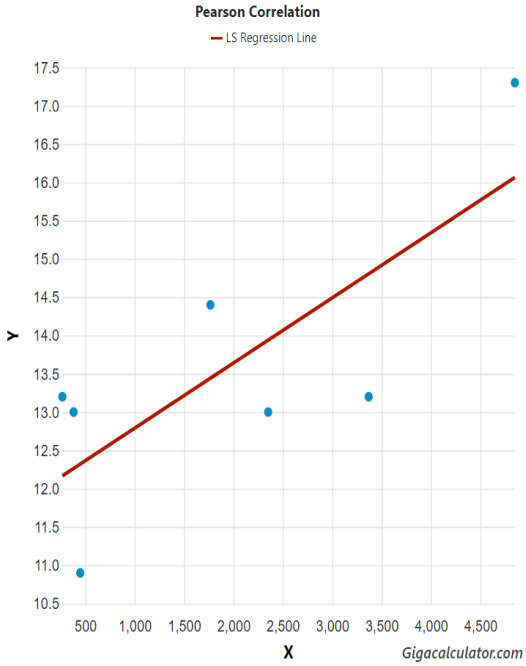

Figure 3. Relationship between female volume and coolest month of the year.

Average annual temperature

r=0.75448380, Z score=1.96656702, n=7, p=0.02461650 (Figure 4).

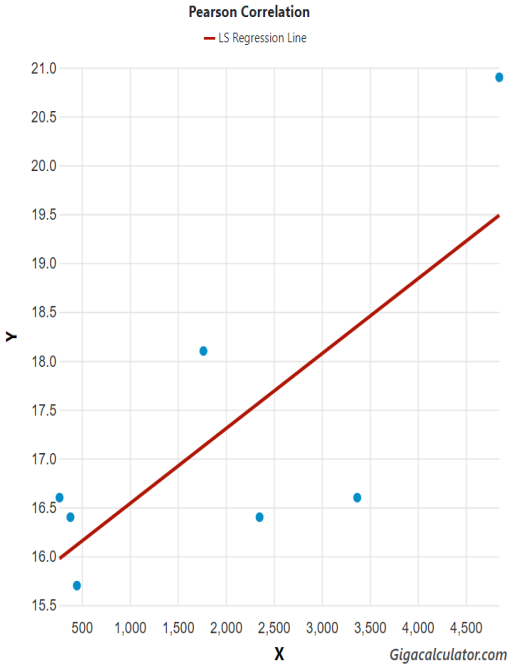

Figure 4. Relationship between female volume and average annual temperature.

The month with the highest number of rainy days

r=0.61802127, Z score=1.44359433, n=7, p=0.07442660 (Figure 5).

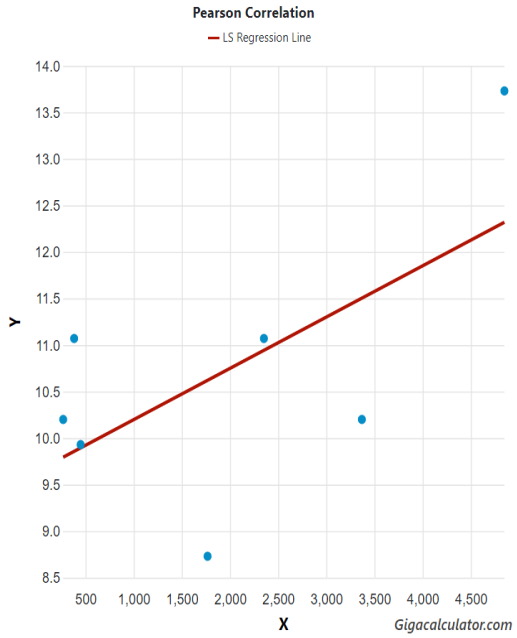

Figure 5. Relationship between female volume and month with the highest number of rainy days.

IV. DISCUSSION

SSD showed a linear relationship or correlation here typical and new of taxa with reversed SSD [5, 10, 41, 43, 45, 46-50, 52-56, 59, 61-63, 65-66]. Female volume showed linear relationships with the lowest number of daily hours of sunshine (total), the warmest month in the year, the coolest month in the year, the average annual temperature, and the month with the highest number of rainy days. *S. punctulatum* has the highest female volume and occurs in the lowest number of daily hours of sunshine (total), the warmest month in the year, the coolest month in the year, the highest average annual temperature, and the highest number of rainy days. *S. tenuitarse* has the lowest female volume and occurs in the highest low number of daily hours of sunshine (total), the least warm month of the year, the least cool month in the year, the lowest average annual temperature, and the lowest number of rainy days. Identification of SSD across weather gradients is generated without a phylogenetic approach [67, 69, 70]. As many pill millipedes are arboreal one may also imply interspecific competition as a driver of SSD [33]. The new relationship proposed between SSD/size and the lowest number of daily hours of sunshine (total), the warmest month in the year, the coolest month in the year, the highest average annual temperature, and highest number of rainy days is an opportunity to increase the sample sizes given. Principal filling of the gap between the most and least dimorphic species across latitude is required to increase the significance of these relationships through precision and accuracy means it may not have any genetic grounding it does seem interesting as it questions the causality of SSD. It is most likely that the relationship that has evolved has done so through natural or sexual selection.

V. CONCLUSION

Several new relationships between the lowest number of daily hours of sunshine (total), the warmest month of the year, the coolest month in the year, average annual temperature, the highest number of rainy days, and female volume in *Sphaerotherium* pill millipedes are given.

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