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SECOND POLAR MOMENTS OF INERTNESS WITH TEMPERATURE IN FOREST RED MILLIPEDES *CENTROBOLUS* COOK, 1897

Author's Name: M. Cooper

Affiliation: University of Johannesburg, South Africa.

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Abstract

The second polar moments of area were correlated with temperature in male and female red millipedes Centrobolus. Male second polar moments of area were correlated with temperature (r=0.37, Z score=1.71, n=22, p=0.04) (y = 0.00148584x + 17.1). Female second polar moments of area were correlated with temperature (r=0.39, Z score=1.78, n=22, p=0.04) (y = 0.00041332x + 17.6).

Keywords: *Polar, Area, Temperature, Red Millipedes*

INTRODUCTION

Red millipedes are found in the southern African subregion with northern limits on the east coast being about -17° latitude S and southern limits being -35° latitude S. They are well represented in the littoral forests of the eastern half of the subcontinent [1-301]. It consists of taxonomically important species with 12 species considered threatened and includes nine vulnerable and three endangered species [226]. It occurs in all the forests of the coastal belt from the Cape Peninsula to Beira in Mocambique [225]. These worm-like millipedes have female-biased sexual size dimorphism [57].

Here, second polar moments of inertia for males and females are correlated with temperature in *Centrobolus* Cook, 1897.

MATERIALS AND METHODS

Horizontal tergite width measurements for 22 species of southern African *Centrobolus* were obtained from published material [57]. These were halved to get radii (r). The second polar moments of area (mm^4) were calculated based on the equation $\pi/2.r^4$ for males and females (Appendix 1 and 2). A correlation between male and female second polar moments of area with temperature was generated at https://www.gigacalculator.com/calculators/correlation-coefficient-calculator.php. Tests for normality were conducted at https://www.statskingdom.com/kolmogorov-smirnov-test-calculator.html. Male and female second polar moments of area were compared using a Wilcoxon Signed-Rank test (https://www.statskingdom.com/175wilcoxon_signed_ranks.html).

RESULTS

Male second polar moments of area were correlated with temperature (Figure 1: r=0.37243318, Z score=1.70539813, n=22, p=0.04406007) (y = 0.00148584 · x + 17.12465892). Female second polar moments of area were correlated with temperature (Figure 2: r=0.38798010, Z score=1.78462041, n=22, p=0.03716140) (y = 0.00041332 · x + 17.58400637). Male second polar moments of area were not normal (D=0.1892, n=22, p=0.03926). Female second polar moments of area were not normal (D=0.2262, n=22, p=0.004715). Male and female second polar moments of area were significantly different (Z=-3.961070, W=4.00, n=22, 22, p=0.0000746146).

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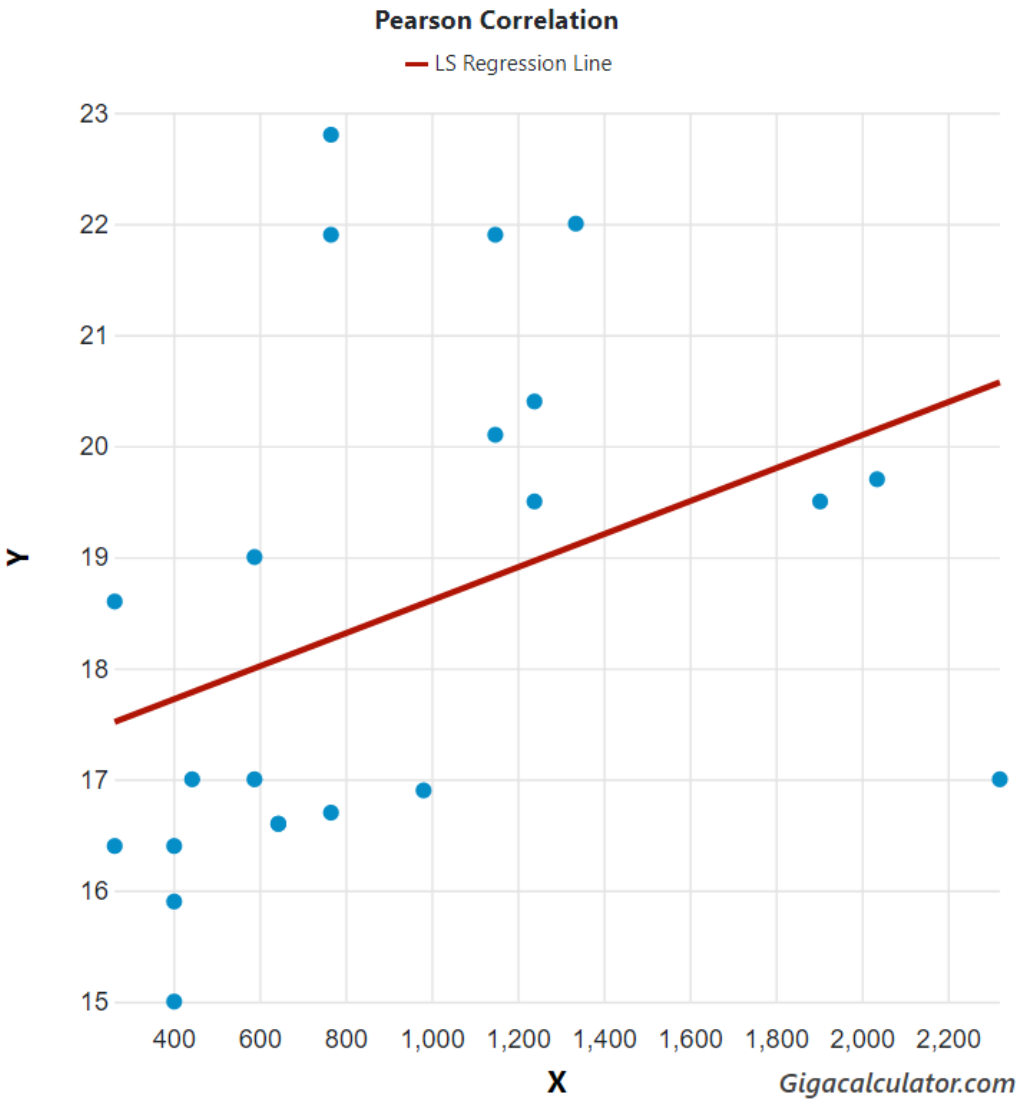

Figure 1. Correlation between the second polar moment of area and temperature in male *Centrobolus* Cook, 1897.

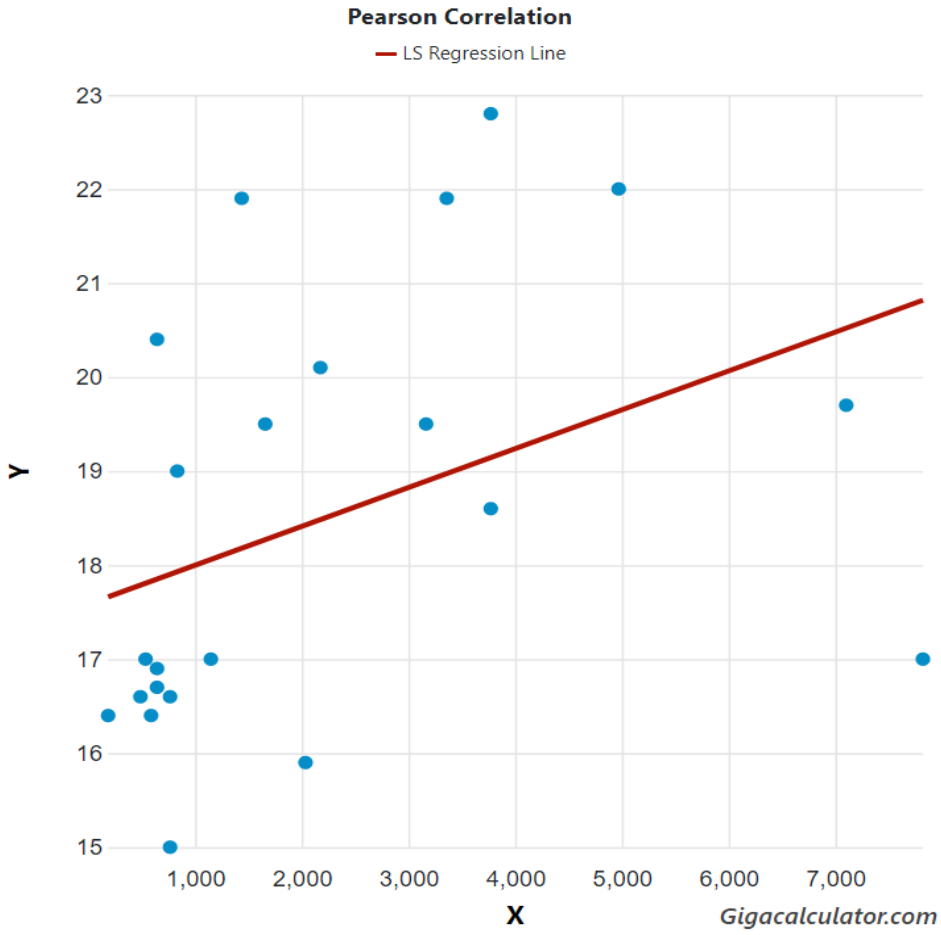

Figure 2. Correlation between the second polar moment of area and temperature in female *Centrobolus* Cook, 1897.

DISCUSSION

The significant differences between males and females in second polar moments of area are known in this genus. There is a correlation between second polar moments of area and temperature in both males and females. This is an addition to one of the many correlated with body size in millipedes. An alternative calculation including body length is another option in calculating the second polar moments of area in these millipedes with cylindrical body shapes.

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259. □□□□□COOPER, M. I. Warmest months vary with the highest relative humidity in determining the size of female pill millipedes *Sphaerotherium* Brandt, 1833. (IN PREP.).
260. □□□□□COOPER, MARK IAN. Mean annual temperature varies with the highest average temperature in determining the size of female pill millipedes *Sphaerotherium* Brandt, 1833. (IN PREP.).
261. □□□□□Cooper, Mark I Mean annual temperature varies with the lowest average temperature in determining the size of female pill millipedes *Sphaerotherium* Brandt, 1833. (IN PREP.).
262. □□□□□COOPER, MARK IAN. One independent variable and two dependent variables: Lowest relative humidity is dependent on temperature variation throughout the year while the mean annual temperature is independent in determining the size of pill millipedes *Sphaerotherium* Brandt, 1833. (IN PREP.).
263. □□□□□COOPER, MARK IAN. Male surface area-to-volume ratio tracks average temperature

variation in *Sphaerotherium* Brandt, 1833. (IN PREP.).
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266. Cooper, Mark. The highest relative humidity varies with the distance to the closest airport across the distribution of pill millipedes Sphaerotherium Brandt, 1833. (IN PREP.).
267. Cooper, Mark. The driest month varies with the distance to the closest airport across the distribution of pill millipedes Sphaerotherium Brandt, 1833. (IN PREP.).
268. Cooper, Mark. The month with the lowest number of rainy days varies with the distance to the closest airport across the distribution of pill millipedes Sphaerotherium Brandt, 1833. (IN PREP.).
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279. Cooper, Mark. DOES MASS VARY WITH SEX RATIO IN CENTROBOLUS COOK, 1897? (IN PREP.).
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APPENDIX 1. Second polar moments of area (mm^4) and surface area (mm^2) for male *Centrobolus* Cook, 1897.

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402.12386, 15.9
1239.43386, 20.4
644.12467, 16.6
402.12386, 16.4
981.747706, 16.9
1148.50596, 21.9
766.498501, 22.8
1903.39062, 19.5
644.12467, 16.6
766.498501, 16.7
2321.06144, 17.0
263.833465, 16.4
1239.43386, 19.5
766.498501, 21.9
1148.50596, 20.1
1335.65692, 22.0
263.833465, 18.6
588.749544, 19.0
443.869501, 17.0
588.749544, 17.0
402.12386, 15.0
2035.75204, 19.7

APPENDIX 2. Second polar moments of area (mm^4) and surface area (mm^2) for female *Centrobolus* Cook, 1897.
2035.75204, 15.9
644.12467, 20.4
488.784066, 16.6
588.749544, 16.4
644.12467, 16.9
3358.5787, 21.9
3771.48199, 22.8
3165.33069, 19.5
766.498501, 16.6
644.12467, 16.7
7820.54505, 17.0
186.284035, 16.4
1658.13276, 19.5
1437.37682, 21.9
2174.89962, 20.1
4970.09776, 22.0
3771.48199, 18.6
833.844037, 19.0
537.024006, 17.0
1148.50596, 17.0
766.498501, 15.0
7101.91201, 19.7