Universe International Journal of Interdisciplinary Research
(Peer Reviewed Refereed Journal)

© UIJIR | ISSN (O) – 2582-6417
JULY 2022 | Vol. 3 Issue 2
www.uijir.com

THE MOMENTS OF INERTIA TIE-UP WITH FEMALE SIZE, HOURS OF SUNSHINE THROUGHOUT THE YEAR, LATITUDE, LONGITUDE AND MINIMUM TEMPERATURE IN RED MILLIPEDES *CENTROBOLUS* COOK, 1897

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DOI No. – **08.2020-25662434**

Abstract

Body size is a correlate of copulation duration in Centrobolus. I tested for the presence of relationships between latitude, longitude, female size, hours of sunshine throughout the year, and minimum temperature and moments of inertia in C. digrammus (n=6), C. fulgidus (n=11), C. inscriptus (n=88, 56+41), and C. ruber (n=18). Moments of inertia were related to hours of sunshine throughout the year (r=-0.67, Z score=-2.15, n=10, p=0.02). Male moments of inertia were not related to hours of sunshine throughout the year (r=-0.68, Z score=-1.19, n=5, p=0.12). Female moments of inertia were related to hours of sunshine throughout the year (r=-0.83, Z score=-1.67, n=5, p<0.05). Moments of inertia were related to female size (r=0.78, Z score=2.77, n=10, p<0.01). Male moments of inertia were related to female size (r=0.84, Z score=1.72, n=5, p=0.04). Female moments of inertia were related to female size (r=0.93, Z score=2.33, n=5, p<0.01). Moments of inertia were related to latitude (r=0.55, Z score=1.64, n=10, p=0.050). Male moments of inertia were not related to latitude (r=0.55, Z score=0.86, n=5, p=0.19). Female moments of inertia were not related to latitude (r=0.69, Z score=1.21, n=5, p=0.11). Moments of inertia were related to longitude (r=0.64, Z score=2.00, n=10, p=0.02). Male moments of inertia were not related to longitude (r=0.641, Z score=1.08, n=5, p=0.14). Female moments of inertia were marginally related to longitude (r=0.80, Z score=1.54, n=5, p=0.06). Moments of inertia were related to minimum temperature (r=0.58, Z score=1.74, n=10, p=0.04). Male moments of inertia were not related to minimum temeprature (r=0.56, Z score=0.89, n=5, p=0.19). Female moments of inertia were marginally related to minimum temperature (r=0.77, Z score=1.33, n=5, p=0.09).

***Keywords**: Interia, Sunshine, Latitude, Longitude, Millipedies*

INTRODUCTION

Male and female body sizes can influence the duration of copulation in arthropods [8]. Body size and morph are known drivers of copulation duration [10]. These factors may be interdependent [9]. The interdependence of male and female body size on each other is manifest in the relationship between reversed sexual size dimorphism (SSD) and copulation duration [2]. Like other worm-like millipedes, *Centrobolus* shows female-biased SSD [1, 3-7]. Here I test for the presence of interdependence between moments of inertia and latitude, longitude, female size, hours of sunshine throughout the year, and minimum temperature.

MATERIALS AND METHODS

Millipedes were collected in KwaZulu/Natal and Cape Town, South Africa. Live specimens of each sex were transported to the laboratory where conditions were kept under a constant regime of 25

°C temperature; 70 % relative humidity; 12: 12 hrs light-dark cycle. Food was provided in the form of fresh vegetable ad libitum. Individuals had unknown mating histories. Unisex groups were housed in plastic containers containing moist vermiculite (± 5 cm deep) for 10 days before commencing the first mating experiments. Three measurements were taken for all individuals once copula pairs had disengaged; body mass (accurate to 0.01 g), body length (mm), and dorsal tergite width (mm). Dorsal tergite width was measured horizontally using Vernier calipers. Moments of inertia were calculated as half the mass multiplied by the square of the dorsal tergite width. **Latitude**, longitude, hours of sunshine throughout the year, and minimum temperature were obtained from http://www.en.climate-date.org. Morphometric data were tested for normality previously. Female and male moments of inertia were previously compared at http://www.statskingdom.com/170median_mann_whitney.html.

RESULTS

Female size

Moments of inertia were related to female size (Figure 1: r=0.78028429, Z score=2.76771230, n=10, p=0.00282262). Male moments of inertia were related to female size (Figure 2: r=0.83776694, Z score=1.71634087, n=5, p=0.04304980). Female moments of inertia were related to female size (Figure 3: r=0.92897818, Z score=2.33469587, n=5, p=0.00977964).

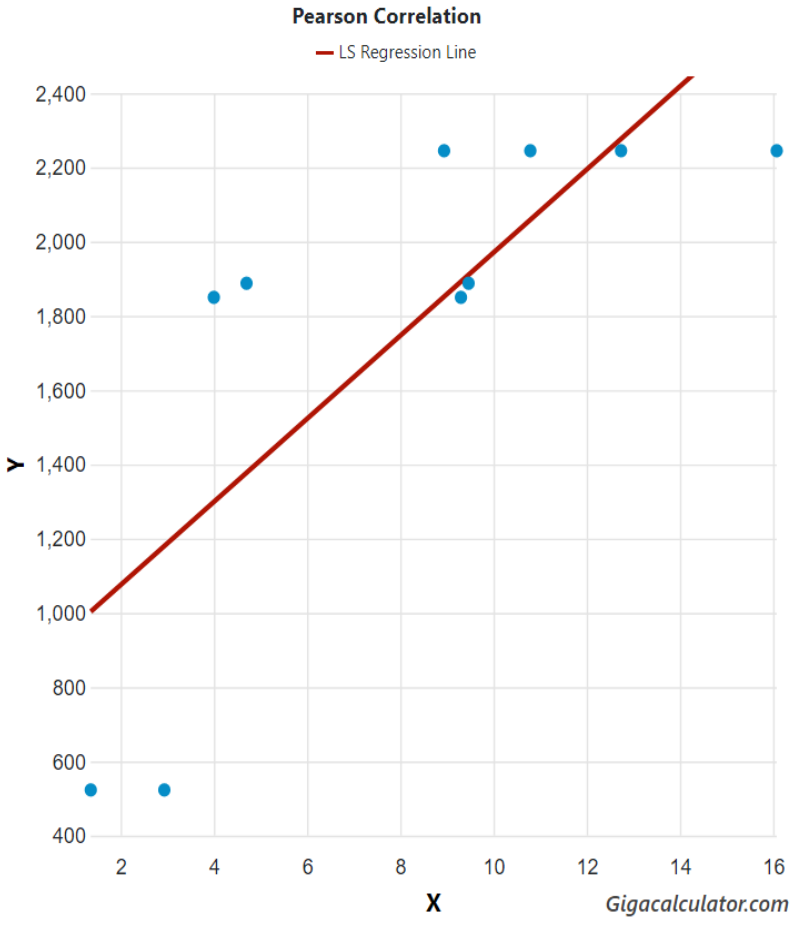

Figure 1. Correlation between moments of inertia (x) and female size (y) in four species of *Centrobolus* Cook, 1897.

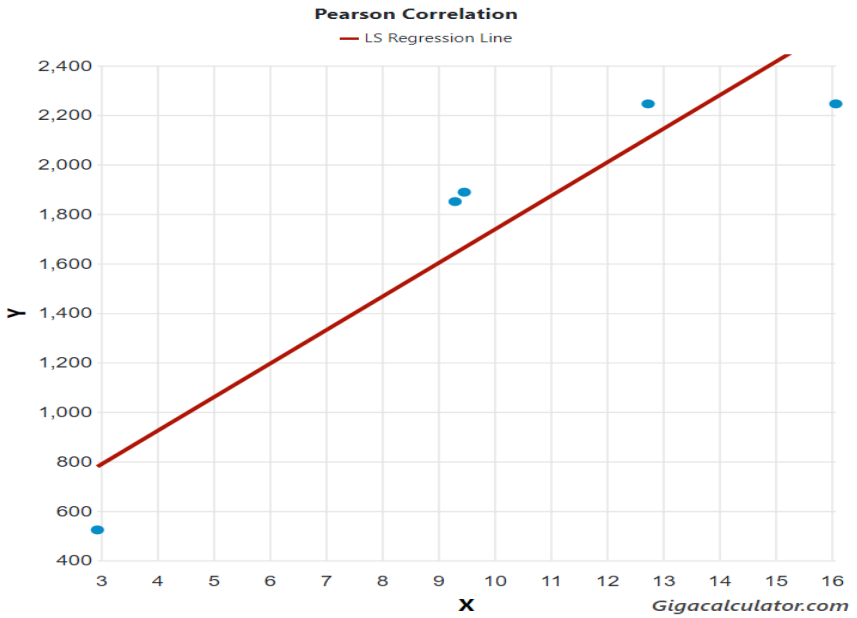

Figure 2. Correlation between female moments of inertia (x) and female size (y) in four species of *Centrobolus* Cook, 1897.

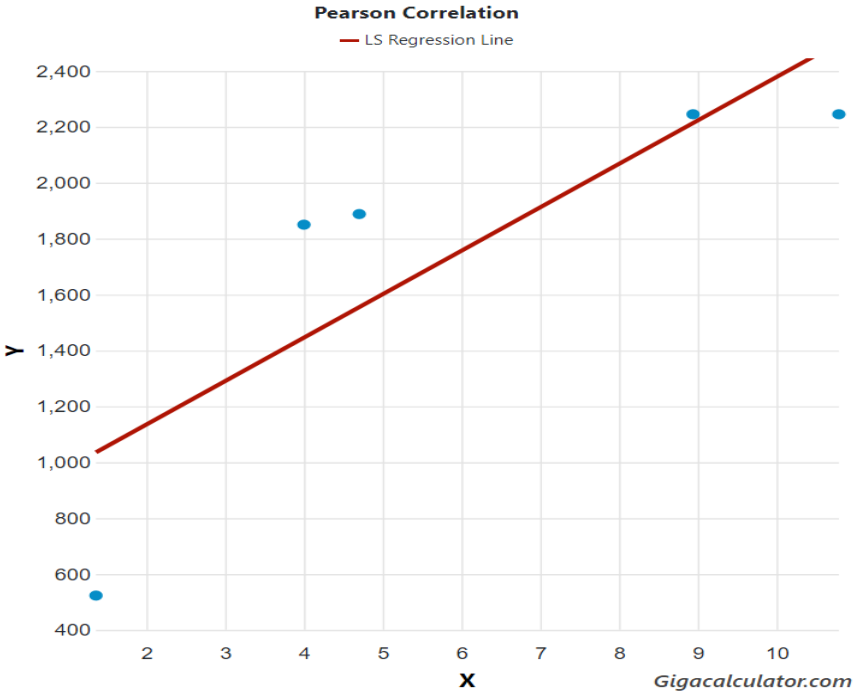

Figure 3. Correlation between male moments of inertia (x) and female size (y) in four species of *Centrobolus* Cook, 1897.

Hours of sunshine throughout the year

Moments of inertia were related to hours of sunshine throughout the year (Figure 4: r=-0.67095293, Z score=-2.14960487, n=10, p=0.01579318). Male moments of inertia were not related to hours of sunshine throughout the year (r=-0.68494744, Z score=-1.18564142, n=5, p=0.11788203). Female moments of inertia were related to hours of sunshine throughout the year (Figure 5: r=-0.82668614, Z score=-1.66534578, n=5, p=0.04792187).

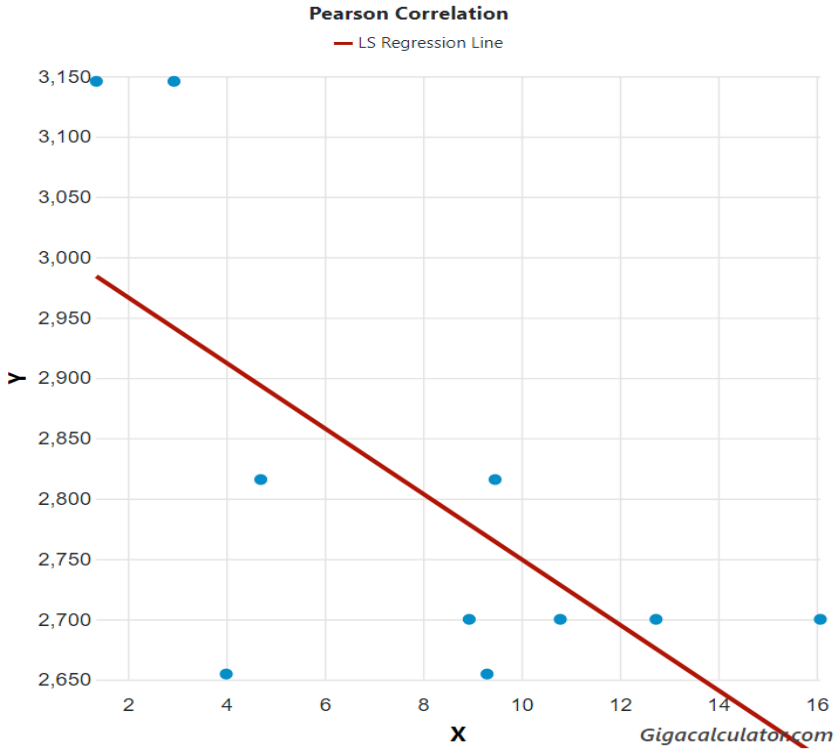

Figure 4. Correlation between moments of inertia (x) and hours of sunshine throughout the year (y) in four species of *Centrobolus* Cook, 1897.

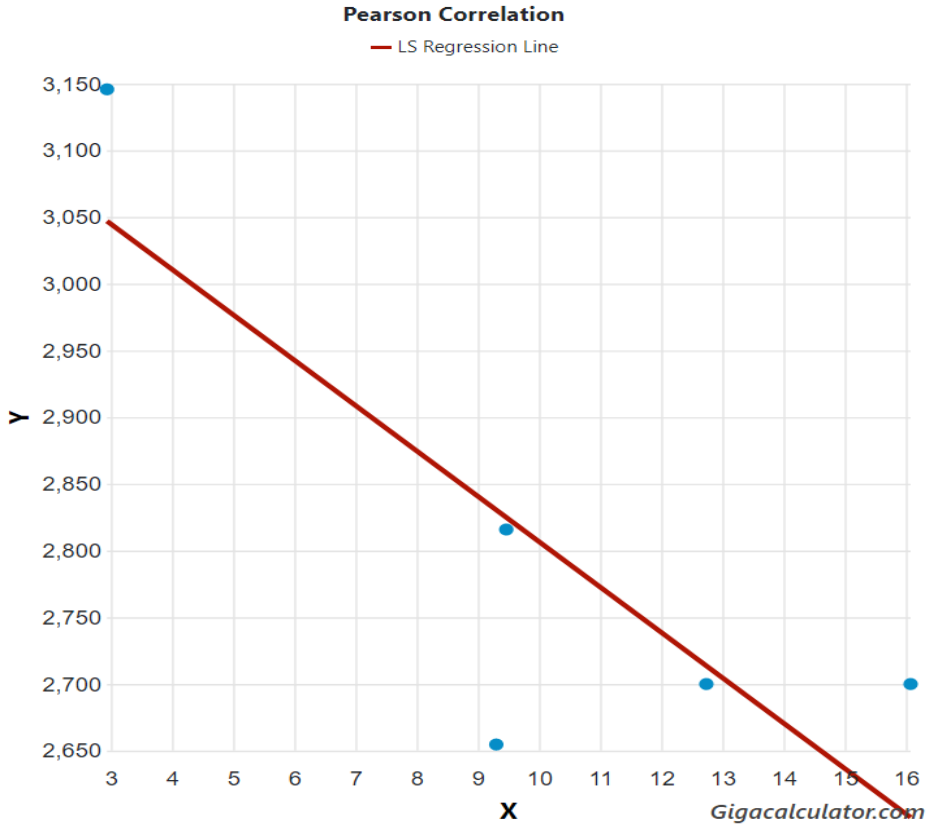

Figure 5. Correlation between female moments of inertia (x) and hours of sunshine throughout the year (y) in four species of *Centrobolus* Cook, 1897.

Latitude

Moments of inertia were related to latitude (Figure 6: r=0.55214545, Z score=1.64423508, n=10, p=0.05006381). Male moments of inertia were not related to latitude (r=0.54522104, Z score=0.86486991, n=5, p=0.19355505). Female moments of inertia were not related to latitude (r=0.69480901, Z score=1.21225506, n=5, p=0.11270744).

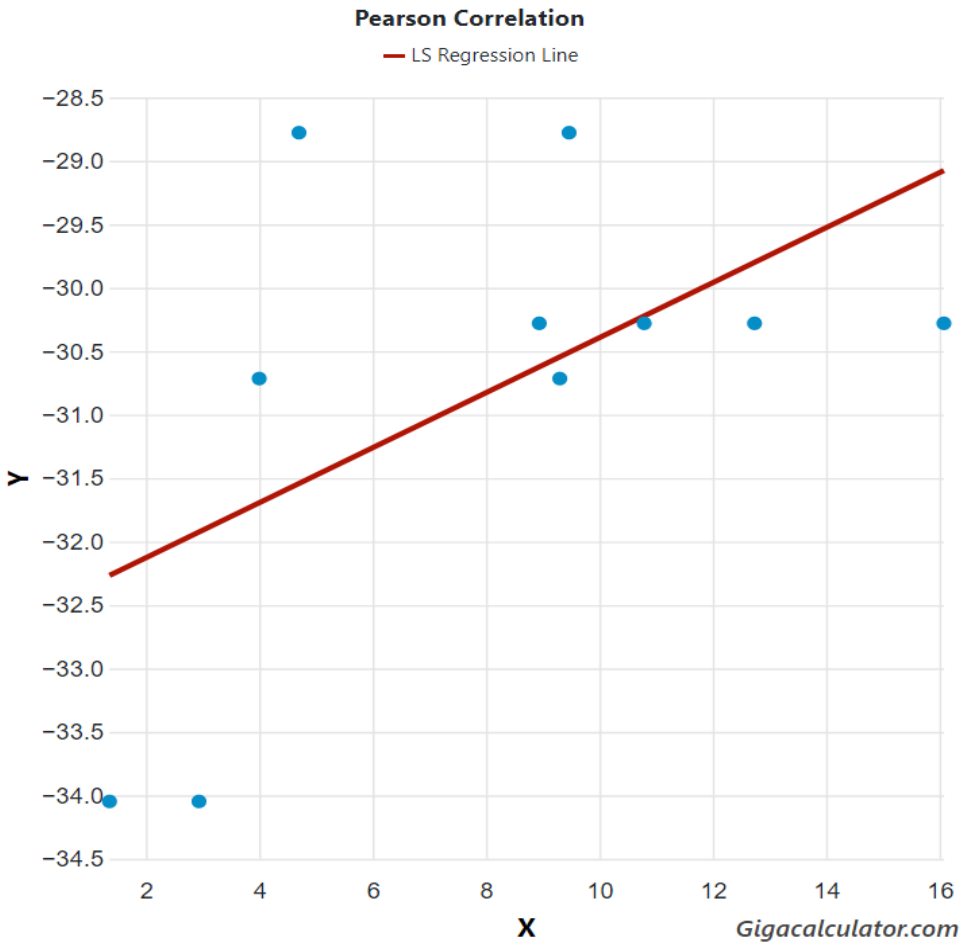

Figure 6. Correlation between moments of inertia (x) and latitude (y) in four species of *Centrobolus* Cook, 1897.

Longitude

Moments of inertia were related to longitude (Figure 7: r=0.63891466, Z score=2.00108117, n=10, p=0.02269175). Male moments of inertia were not related to longitude (r=0.64143216, Z score=1.07565546, n=5, p=0.14104072). Female moments of inertia were marginally related to longitude (r=0.79571424, Z score=1.53699439, n=5, p=0.06214736).

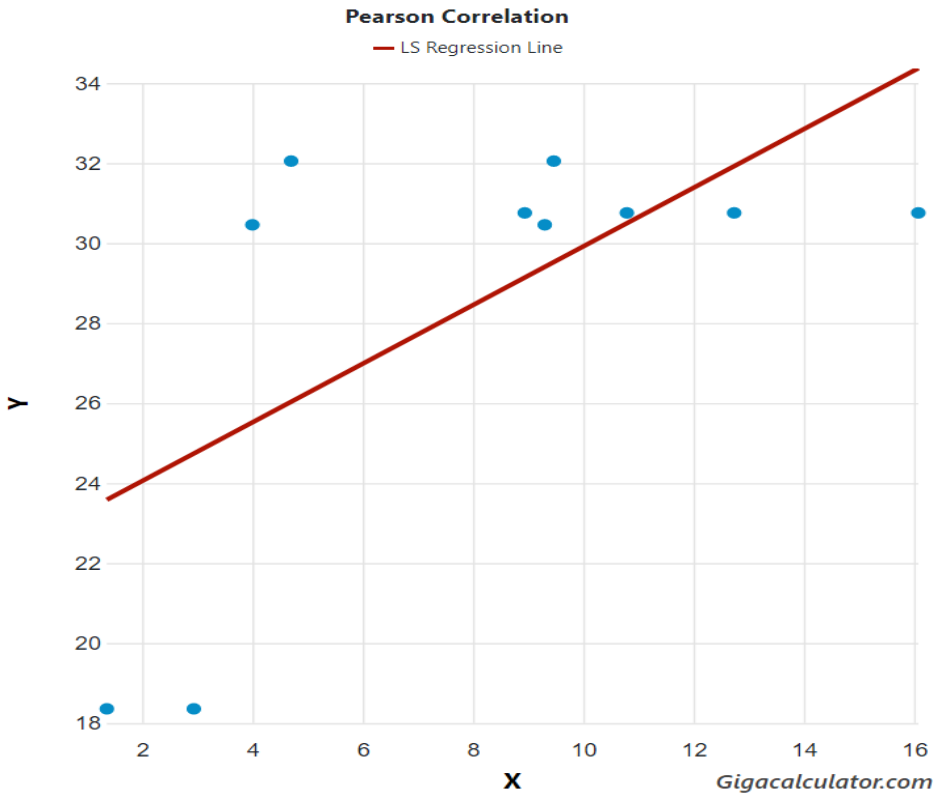

Figure 7. Correlation between moments of inertia (x) and longitude (y) in four species of *Centrobolus* Cook, 1897.

Minimum temperature

Moments of inertia were related to minimum temperature (Figure 8: r=0.57716511, Z score=1.74143685, n=10, p=0.04080348). Male moments of inertia were not related to minimum temeprature (r=0.55697730, Z score=0.88874879, n=5, p=0.18706901). Female moments of inertia were marginally related to minimum temperature (r=0.73648006, Z score=1.33324018, n=5, p=0.09122656).

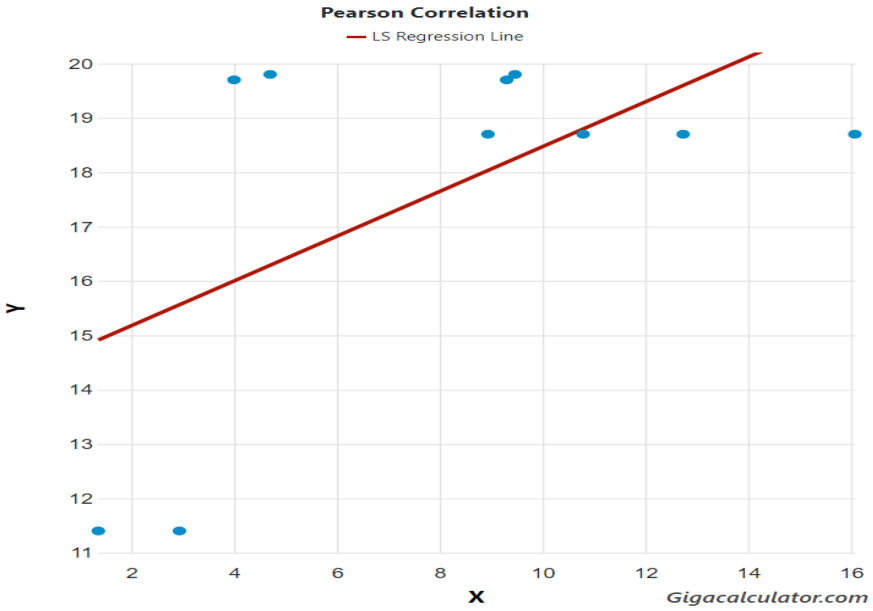

Figure 8. Correlation between moments of inertia (x) and minimum temperature (y) in four species of *Centrobolus* Cook, 1897.

DISCUSSION

The null hypothesis is confirmed in eight relationships with moments of inertia and latitude, longitude, female size, hours of sunshine throughout the year, and minimum temperature found through this research. All relationships were positive except the two with hours of sunshine throughout the year. Female moments of inertia independently correlate with hours of sunshine and size while male moments of inertia independently correlate with female size only. This emphasizes the uniquity of the size assortment of *Centrobolus* millipedes. Moments of inertia correlate with all five factors when male and female components are combined. This study successfully examined the interdependence of male and female moments of inertia on one mensural factor (female size) and four eco-geographical factors.

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