

DOES SEXUAL SIZE DIMORPHISM VARY WITH THE FEWEST DAILY HOURS OF SUNSHINE IN RED MILLIPEDES *CENTROBOLUS* COOK, 1897?

Author's Name: Mark I. Cooper

Affiliation: University of Johannesburg, SOUTH AFRICA

E-Mail ID: cm.i@aol.com

DOI No. – 08.2020-25662434

Abstract

The objectives of this study were to determine what happened when Bergmann's Rule meets Rensch's Rule if Sexual Size Dimorphism (SSD) and body size changed with an eco-geographical factor. The fewest hours of sunshine were correlated with body size and SSD in the forest millipede genus *Centrobolus*. There was a significant negative correlation between SSD and hours of sunshine a day ($r=-0.41$, Z score= -1.90 , $n=22$, $p=0.03$). Eco-geographical variance in the polygynandrous reproductive systems occurs with larger females and higher SSD occurring in lighter conditions.

Keywords: Dimorphic, eco-geography, gradient, precipitation, 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 (Lawrence, 1967; Cooper, 2015).

Sexual size dimorphism (SSD) is correlated with the fewest hours of sunshine in the pachybold millipede genus *Centrobolus* Cook, 1897 (Cook, 1897; Hamer, 1998; Lawrence, 1967). Like other millipedes, these worm-like millipedes have female-biased SSD (Cooper, 2014; 2015; 2016; 2017; 2018; 2019). The null hypothesis is that there is no body size correlation with hours of sunshine.

MATERIALS AND METHODS

41 valid species were identified as belonging to the genus *Centrobolus* Cook, 1897. Millipede type localities were obtained from a checklist of southern African millipedes (Hamer, 1998). These were tabulated and known type localities also listed in Microsoft Word online (<https://office.live.com/start/Word.aspx>) (Appendix). GPS coordinates were obtained from internet

sources for known type localities using google (<https://www.google.co.za/maps/place>). The mean hours of sunshine during the month with the fewest hours of sunshine were obtained from <https://en.climate-data.org/search/?q=> and internet sources for known type localities using google (<https://www.google.co.za>). 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 and latitude, longitude, precipitation, and temperature were checked for correlations using the Pearson Correlation Coefficient calculator (<https://www.gigacalculator.com/calculators/correlation-coefficient-calculator.php>).

RESULTS

There was a significant negative correlation between SSD and mean hours of sunshine (Fig. 1: $r=-0.40889615$, Z score= -1.89300461 , $n=22$, $p=0.02917856$).

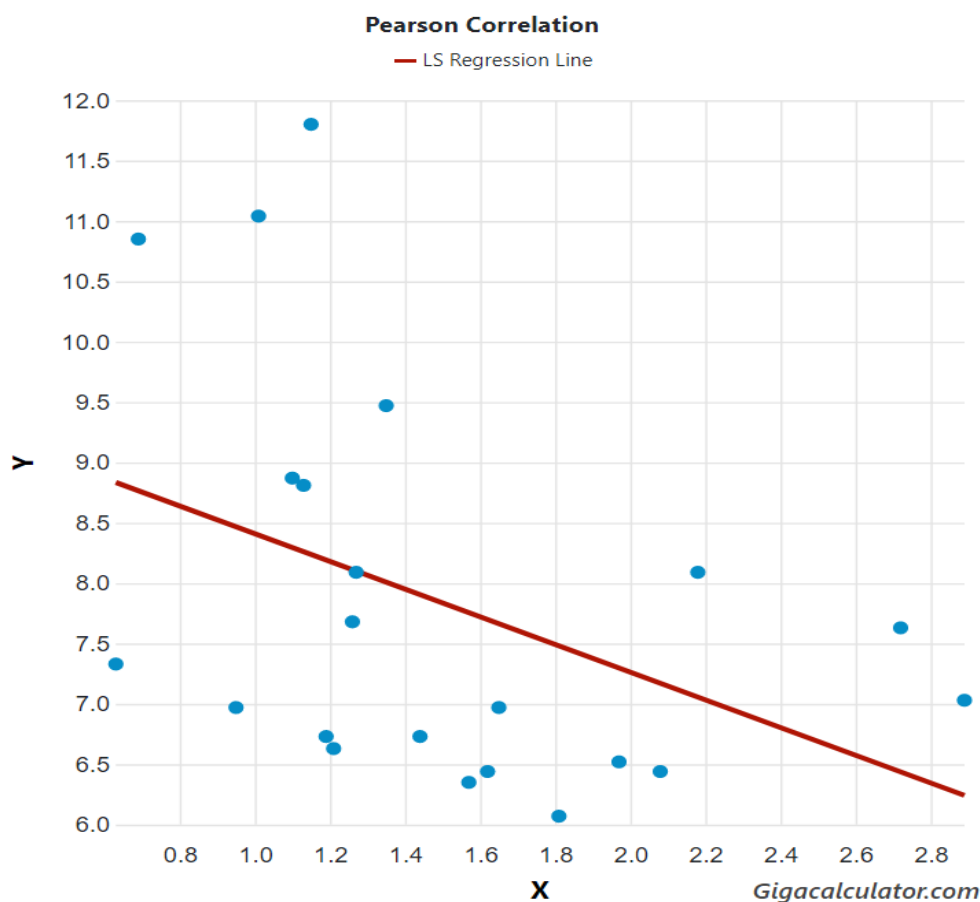


Figure 1. Negative correlation between SSD and mean hours of sunshine during the month with the lowest hours of sunshine in *Centrobolus*.

DISCUSSION

An interesting relationship between body size/SSD and hours of sunshine was found. *C. vastus* demonstrates high female-biased SSD (1.81) and occurred at the lowest mean hours of sunshine in a month. *C. promontorius* has male-biased SSD and occurs in higher hours of sunshine.

This study supports the fewest hours of sunshine as a predictor of SSD in *Centrobolus*. Size assortative

mating based on width and male length determines the variance in millipede polygynandrous mating systems across an hour of the sunshine gradient with higher SSD due to several factors (Cooper, in press). SSD decrease with hours of sunshine may explain greater mate competition. Hours of sunshine may be an explanation for skewed sex ratios in species showing sexual size dimorphism, such as millipedes.

REFERENCES

1. Cook O. F. 1897. New relatives of *Spirobolus giganteus*. *Brandtia* (A series of occasional papers on Diplopoda and other Arthropoda), 18: 73-75.
2. Cooper, M. I. 2014. Sexual size dimorphism and corroboration of Rensch's rule in *Chersastus* millipedes. *Journal of Entomology and Zoology Studies*, 2(6): 264-266.
3. Cooper, M. I. 2015. Competition affected by re-mating interval in a myriapod. *Journal of Entomology and Zoology Studies*, 3(4): 77-78.
4. Cooper, M. I. 2015. Elaborate gonopods in the myriapod genus *Chersastus* (Diplopoda: Trigonulidae). *Journal of Entomology and Zoology Studies* 2015; 3(4): 235-238.
5. Cooper, M. I. 2016. Fire millipedes obey the female sooner norm in cross mating *Centrobolus* (Myriapoda). *Journal of Entomology and Zoology Studies* 2016; 4(1): 173-174.
6. Cooper, M. I. 2016. Confirmation of four species of *Centrobolus* Cook (Spirobolida: Trigonulidae) based on gonopod ultrastructure. *Journal of Entomology and Zoology Studies*, 4(4): 389-391.
7. Cooper, M. I. 2016. Sexual bimaturism in the millipede *Centrobolus inscriptus* Attems (Spirobolida: Trigonulidae). *Journal of Entomology and Zoology Studies*, 4 (3): 86-87.
8. Cooper, M. I. 2016. The relative sexual size dimorphism of *Centrobolus inscriptus* compared to 18 congeners. *Journal of Entomology and Zoology Studies*, 4(6): 504-505.
9. Cooper, M. I. 2017. The affect of female body width on copulation duration in *Centrobolus inscriptus* (Attems). *Journal of Entomology and Zoology Studies*, 5(1): 732-733.
10. Cooper, M. I. 2017. Size matters in myriapod copulation. *Journal of Entomology and Zoology Studies*, 5(2): 207-208.
11. Cooper, M. I. 2017. Relative sexual size dimorphism in *Centrobolus digrammus* (Pocock) compared to 18 congeners. *Journal of Entomology and Zoology Studies* 2017; 5(2): 1558-1560.
12. Cooper, M. I. 2017. Relative sexual size dimorphism in *Centrobolus fulgidus* (Lawrence) compared to 18 congeners. *Journal of Entomology and Zoology Studies*, 5(3): 77-79.
13. Cooper, M. I. 2017. Copulation and sexual size dimorphism in worm like millipedes. *Journal of Entomology and Zoology Studies*, 5(3): 1264-1266.
14. Cooper, M. I. 2017. Allometry of copulation in worm-like millipedes. *Journal of Entomology and Zoology Studies*, 5(3): 1720-1722.
15. Cooper, M. I. 2017. Relative sexual size dimorphism *Centrobolus ruber* (Attems) compared to 18 congeners. *Journal of Entomology and Zoology Studies*, 5(3): 180-182.
16. Cooper, M. 2018. *Centrobolus anulatus* (Attems, 1934) reversed sexual size dimorphism. *Journal of Entomology and Zoology Studies*, 6(4): 1569-1572.
17. Cooper, M. I. 2018. Sexual size dimorphism and the rejection of Rensch's rule in Diplopoda. *Journal of Entomology and Zoology Studies*, 6(1): 1582-1587.
18. Cooper, M. I. 2018. Sexual dimorphism in pill millipedes (Diplopoda). *Journal of Entomology and Zoology Studies* 2018; 6(1): 613-616.

19. Cooper, M. 2018. A review of studies on the fire millipede genus *centrobolus* (diplopoda: trioniulidae). Journal of Entomology and Zoology Studies, 6(4): 126-129.
20. Cooper, M. 2018. *Centrobolus sagatinus* sexual size dimorphism based on differences in horizontal tergite widths. Journal of Entomology and Zoology Studies, 6(6): 275-277.
21. Cooper, M. 2018. *Centrobolus silvanus* dimorphism based on tergite width. Global Journal of Zoology, 3(1): 003-005.
22. Cooper, M. 2019. Xylophagous millipede surface area to volume ratios are size dependent in forest. Arthropods, 8(4): 127-136.
23. Hamer, M. L. 1998. Checklist of Southern African millipedes (Myriapoda: Diplopoda). Annals of the Natal Museum, 39 (1): 11-82.
24. Lawrence, R. F. 1967. The Spiroboloidea (Diplopoda) of the eastern half of Southern Africa*. Annals of the Natal Museum, 18 (3): 607-646.