

ARE SURFACE AREA AND SURFACE-AREA-TO-VOLUME RATIO RELATED TO LATITUDE AND LONGITUDE IN *CENTROBOLUS* COOK, 1897?

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Abstract-In this paper, I check for relationships between male and female surface area and male and female surface area to volume ratio with latitude and longitude in red millipedes *Centrobolus* Cook, 1897. Male surface area was related to latitude ($r=-0.39$, Z score= -1.80 , $n=22$, $p=0.04$). Male surface area was marginally related to longitude ($r=-0.35$, Z score= -1.58 , $n=22$, $p=0.06$). Female surface area was not related to latitude ($r=0.15$, Z score= 0.68 , $n=22$, $p=0.25$). Female surface area was related to longitude ($r=0.41$, Z score= 1.92 , $n=22$, $p=0.03$). Male surface-area-to-volume ratio was not related to latitude ($r=-0.28$, Z score = -1.24 , $n=22$, $p=0.11$). Male surface-area-to-volume ratio was not related to longitude ($r=-0.28$, Z score= -1.26 , $n=22$, $p=0.10$). Female surface-area-to-volume ratio was not related to latitude ($r=-0.18$, Z score= -0.79 , $n=22$, $p=0.21$). Female surface-area-to-volume ratio was marginally related to longitude ($r=-0.34$, Z score= -1.56 , $n=22$, $p=0.06$).

I. 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 762-1016mm, 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 ^[1-78].

In this paper, from the results, I check for relationships between male and female surface area and male and female surface area to volume ratio with latitude and longitude in red millipedes *Centrobolus* Cook, 1897.

II. MATERIALS AND METHODS

Body volumes, surface areas, and surface area to volume ratios were calculated in 22 forest species of red millipedes *Centrobolus*. Two morphometric parameters were used to obtain measurements, length and width, both of which were obtained from the published literature ^[79]. Body volumes were calculated based on the formula for a cylinder $V = \pi r^2 h$ and surface areas were calculated based on the formula for the same cylinder $SA = 2\pi r(r+h)$ in all species. Surface-area-to-volume ratios were calculated as proper fractions of surface area to volume.

III. RESULTS

Male surface area was related to latitude (Figure 1: $r=-0.39028527$, Z score= -1.79646143 , $n=22$, $p=0.03621053$). Male surface area was marginally related to longitude ($r=-0.34640331$, Z score= -1.57509165 , $n=22$, $p=0.05761765$). Female surface area was not related to latitude ($r=0.15475547$, Z score= 0.68002729 , $n=22$, $p=0.24824352$). Female surface area was related to longitude (Figure 2: $r=0.41467922$, Z score= 1.92335988 , $n=22$, $p=0.02721737$). Male surface-area-to-volume ratio was not related to latitude ($r=-0.277691$, Z score = -1.24306383 , $n=22$, $p=0.10692222$). Male surface-area-to-volume ratio was not related to longitude ($r=-0.28167376$, Z score= -1.26189753 , $n=22$, $p=0.10349290$). Female surface-area-to-volume ratio was not related to latitude ($r=-0.17939213$, Z score= -0.79050611 , $n=22$, $p=0.21461606$). Female surface-area-to-volume ratio was marginally related to longitude ($r=-0.34364344$, Z score= -1.56143609 , $n=22$, $p=0.05921046$).

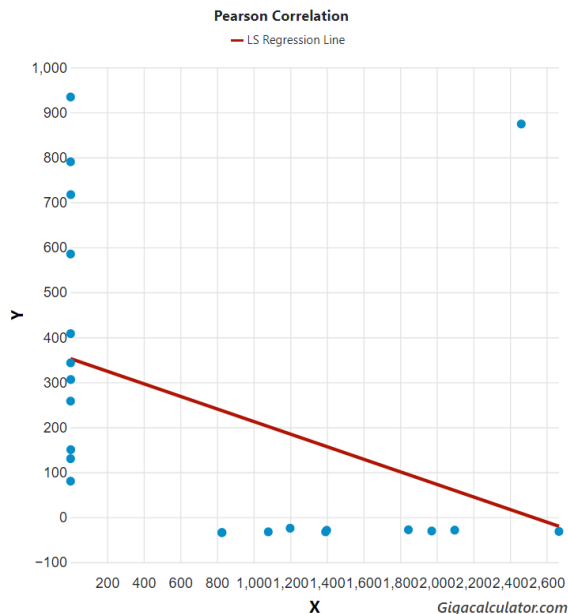


Figure 1. Relationship between male surface area and latitude in *Centrobolus* Cook, 1897.

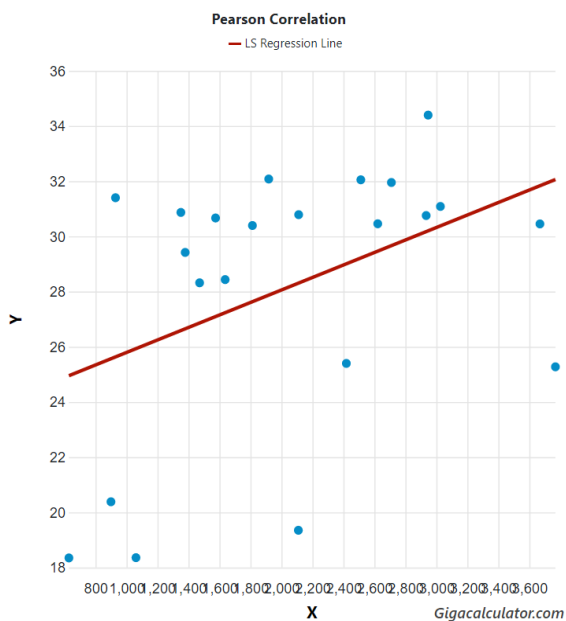


Figure 2. Relationship between female surface area and longitude in *Centrobolus* Cook, 1897.

IV. DISCUSSION

Two new relationships are documented between male surface area which was related to latitude and female surface area which was related to longitude. The male surface area was marginally related to longitude and the female surface-area-to-volume ratio was marginally related to longitude. The other four possibilities were not significant. It suggests

there are precipitation-size patterns in worm-like millipedes which may affect the adaptability to and validity of biological rules^[80, 81]. The significantly higher surface area to volume ratios of female forest millipedes is known^[79]. The relationship between female surface area and longitude provides new evidence for higher surface areas in the eastern species. The female surface-area-to-volume ratio was marginally related to longitude.

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