

## TARSAL PAD LENGTHS ARE RELATED TO SURFACE-AREA-TO-VOLUME RATIOS IN *CENTROBOLUS* COOK, 1897

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### **Abstract**

*Red millipedes (Centrobolus) have elongated tarsal pads. I tested for a relationship between tarsal pad length and surface-area-to-volume ratio and surface area in red millipedes Centrobolus. Specimens were fixed, first in 2.5% glutaraldehyde (pH 7.4 phosphate-buffered saline) at 4 °C for 24 hours, then in osmium tetroxide (2%). Dehydration through a graded alcohol series (50%, 60%, 70%, 80%, 90% to 100% ethanol) and critical point drying followed. Specimens were mounted on stubs and sputter coated with gold palladium. Tarsal pads and gonopods were viewed under a Cambridge S200 SEM. SEM micrographs were examined and the individual components of the gonopods were identified according to the species descriptions. One set of measurements was made from the micrographs (1) tarsal pad length and these were tested for a correlation with data for surface areas and surface-area-to-volume ratios. Tarsal pad length was negatively related to surface-area-to-volume ratios across two species ( $r=-0.99$ ,  $Z$  score= $-4.53$ ,  $n=6$ ,  $p<0.01$ ). Tarsal pad length was not related to surface area ( $r=0.20$ ,  $Z$  score= $0.36$ ,  $n=6$ ,  $p=0.36$ ).*

**Key words:** red millipedes, tarsal pad, gonopods, species.

### **INTRODUCTION**

The 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  $-17^{\circ}$  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 littoral 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 littoral forests of the eastern half of the subcontinent (Lawrence, 1967). Members of the genus all have polygynandrous mating systems with sperm competition and cryptic female choice (Cooper, 2016; Cooper, 2017; Cooper, 2019; Cooper, 2022).

### **MATERIALS AND METHODS**

Millipedes were hand collected in coastal forest habitat at Mtunzini ( $28^{\circ} 55' S$ ;  $31^{\circ} 45' E$ ) during the summer season (1995-1996). Individual millipedes were identified as species and sexed based on the presence of gonopods in males and their absence in females. The tarsi and gonopods were dissected from males of these two species and prepared for SEM. Specimens were fixed, first in 2.5% glutaraldehyde (pH 7.4 phosphate-buffered saline) at 4 °C for 24 hours, then in osmium tetroxide (2%). Dehydration through a graded alcohol series (50%, 60%, 70%, 80%, 90% to 100%

ethanol) and critical point drying followed. Specimens were mounted on stubs and sputter coated with gold palladium. Tarsal pads and gonopods were viewed under a Cambridge S200 SEM. SEM micrographs were examined and the individual components of the gonopods were identified according to the species descriptions. One set of measurements was made from the micrographs (1) tarsal pad length and these were tested for a correlation with data for surface areas and surface-area-to-volume ratios (Cooper, 2019).

## RESULTS

Tarsal pad length was negatively related to surface-area-to-volume ratios across species ( $r=-0.98941872$ ,  $Z \text{ score}=-4.53495176$ ,  $n=6$ ,  $p=0.00000288$ ). Tarsal pad length was not related to surface area ( $r=0.20272483$ ,  $Z \text{ score}=0.35606208$ ,  $n=6$ ,  $p=0.36089710$ ).

## DISCUSSION

A negative relationship between surface-area-to-volume ratios and tarsal pad length was discovered across the two species of *Centrobolus* (*C. anulatus*, *C. inscriptus*). This is suggestive of positive interspecific allometry for the tarsal pad and perhaps allometry for the tarsal pad. The tarsal pad functions as a grasping device and plays a key role in the acquisition and holding and securing of mates in species. Further research could acquire tarsal pad measurements from members across the genus through scanning electron microscopy (SEM).

## APPENDIX.

Tarsal pad length (micrometers) and surface-area-to-volume ratios ( $\text{mm}^{-1}$ ) in two species of *Centrobolus* Cook, 1897.

1018, 0.000136

1018, 0.000136

1018, 0.000113

1018, 0.000113

540, 0.000486

540, 0.000578

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