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IS A PROMINENT STERNITE RELATED TO MOMENTS OF INERTIA IN *CENTROBOLUS* COOK, 1897?

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Abstract- **Three species of *Centrobolus* were identified (*C. fulgidus*, *C. inscriptus*, *C. ruber*) based on morphology and confirmed using Scanning Electron Microscopy (SEM) of gonopod structure. One set of linear measurements was made from the SEM micrographs: (1) prominence of the stemite. Moments of inertia in three species were calculated. Sternite prominence and moments of inertia were positively related (r=0.69, Z score=1.88, n=8, p=0.03). This supports the function of the sternite in sperm competition.**

I. INTRODUCTION

The red millipede genus *Centrobolus* is well known for studies on sexual size dimorphism (SSD) and displays prolonged copulation durations for pairs of individuals of the species [4-9]. *Centrobolus* is distributed in temperate southern Africa with northern limits on the east coast of southern Africa at -17° latitude South (S) and southern limits at -35° latitude S. It consists of taxonomically important species with 12 species considered threatened and includes nine vulnerable and three endangered species [24]. It occurs in all the forests of the coastal belt from the Cape Peninsula to Beira in Mocambique [23]. Spirobolida has two pairs of legs modified into gonopods on the eighth and ninth diplosegments [25]. In *Centrobolus* the coleopods are the anterior gonopods of leg-pair eight and can be classed as paragonopods or peltogonopods because they are fused into a single plate-like structure and play a subsidiary role as inseminating devices while leg-pair nine are sperm-transferring [1]. The sternites (or stigma-carrying plates [26]) prevent lateral shifting (stabilizer) and stretch the vulva sac in a medial plane [3].

The genital morphology and mechanics of copulation were figured in three *Centrobolus* species [1, 2]. These are worm-like millipedes that have female-biased SSD [4-9, 12-18, 21]. From the results, correlations between coleopod sternite prominence and moments of inertia were checked for correlations.

II. MATERIALS AND METHODS

Three species of *Centrobolus* were identified based on morphology and confirmed using Scanning Electron Microscopy (SEM) of gonopod structure (*C. fulgidus*, *C. inscriptus*, *C. ruber*). The gonopods were dissected from males of these three 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. Gonopods were viewed under a Cambridge S200 SEM. SEM micrographs were examined and the individual components of the gonopods were identified according to the available species descriptions. One set of linear measurements was made from the SEM micrographs: (1) prominence of the stemite (%). This has been estimated before as a ratio of how far it extends from the basal region up to the top of the coleopod. The collection of SEM micrographs for each species is particularly informative when comparisons are made between congruent views. These results have been published [1]. 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. Sternite prominence and moments of inertia were correlated here using a Pearson Correlation Coefficient (https://www.gigacalculator.com/calculators/correlation-coefficient-calculator.php). Sternite prominence was correlated with moments of inertia in three species (*C. fulgidus*, *C. inscriptus*, *C. ruber*) using a Pearson's Correlation Coefficient.

III. RESULTS

Sternite prominence and moments of inertia were positively related (r=0.68659667, Z score=1.88162551, n=8, p=0.02994337). Least-Squares Regression Line y = 1.97256980 · x + 21.25645237.

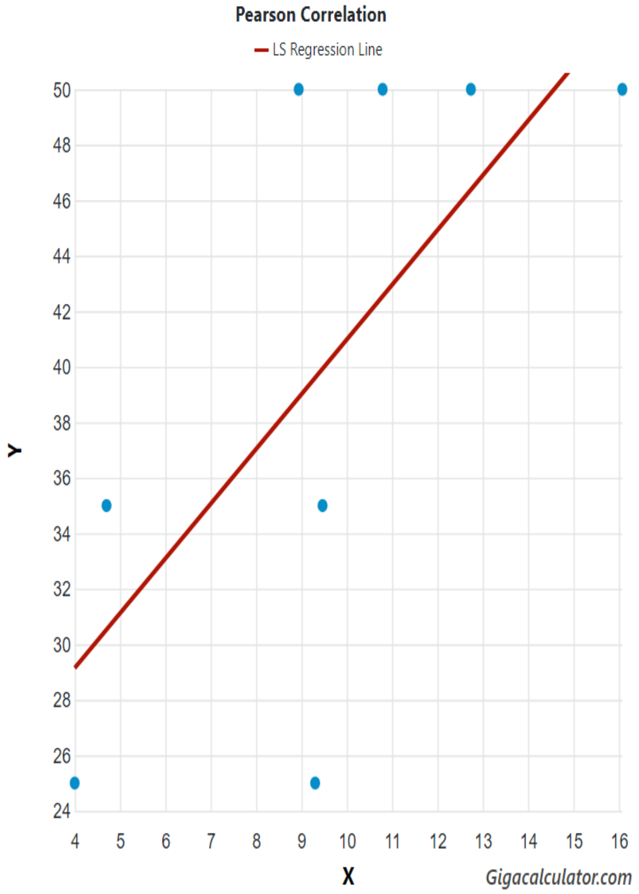

Figure 1. Relationship between the prominence of the sternite and moments of inertia across three species of *Centrobolus* (*C. fulgidus*, *C. inscriptus*, *C. ruber*).

IV. DISCUSSION

The genital morphology and mechanics of copulation were figured in three *Centrobolus* species [1, 2]. A direct relationship between an ultrastructural feature (sternite prominence) and moments of inertia of the millipedes is compared which may support the function of the sternite as a device adapted toward sperm competition [10, 27]. A relationship between this structural feature is present across three species suggesting adaptation to insemination. It can be difficult to understand the functionality and where there is no functional significance this could have been overlooked [22]. However, the sternites in *Centrobolus* millipedes predict a functional significance in assuring paternity.

V. CONCLUSION

New relationships between ultrastructural features of the morphology (sternite prominence) and moments of inertia of the *Centrobolus* millipedes support the function of the sternite as a device adapted toward reducing sperm competition and assuring paternity. A prominent sternite is related to higher moments of inertia.

APPENDIX

Female followed by male moments of inertia (kg.m^2) and sternite prominence (%) in three species of *Centrobolus* with the first species (*C. inscriptus*) having two measurement sets.

C. inscriptus 12.7375375, 50
C. inscriptus 10.791, 50
C. inscriptus 8.9401, 50
C. inscriptus 16.0777305, 50
C. fulgidus 9.46585, 35
C. fulgidus 4.70205, 35
C. ruber 9.3025, 25
C. ruber 4, 25

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