

DOES COPULATION DURATION VARY WITH ABSOLUTE ABUNDANCE IN RED MILLIPEDES *CENTROBOLUS* COOK, 1897?

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Abstract- Copulation duration and absolute abundances were checked for correlations in the red millipede genus *Centrobolus*. There was a significant relationship between abundances (pooled) with copulation duration ($r=0.74563599$, Z score= 1.66805834 , $n=6$, $p=0.04765205$). *C. annulatus* copulation durations (39.4 ± 18.6 minutes, $n=8$) occur at lower abundances (59.67 ± 14.57 , $n=3$) and *C. inscriptus* copulation durations (145.5 ± 29.6 minutes, $n=6$) occur at higher densities (493.67 ± 335.57 , $n=3$).

I. INTRODUCTION

The millipede genus *Centrobolus* Cook, 1897 is found in the temperate South African subregion, its northern limits on the east coast of southern Africa being about -17° latitude South (S) and its southern limits being about -35° latitude S^[9, 10]. It consists of taxonomically important species with 12 species considered threatened and includes nine vulnerable and three endangered species^[10]. It occurs in all the forests of the coastal belt from the Cape Peninsula to Beira in Mocambique^[9]. Common with worm-like millipedes is the absolute abundance known to differ in several populations of the genus^[6]. Absolute abundance is seasonal and may determine the copulation duration for pairs of individuals of each species at any one time^[7-9]. Copulation duration and absolute abundance are tested for a correlation with each other during the breeding season in the pachybolid millipede genus *Centrobolus*. The aim is to determine if there is a correlation between absolute abundance and copulation duration across several species.

II. MATERIALS AND METHODS

Two species belonged to the genus *Centrobolus* Cook, 1897^[1]. The absolute abundance during the breeding season was obtained for *C. annulatus* and *C. inscriptus*^[3]. The number of individual millipedes was hand collected, counted, and sexed

in situ from the Mick's Park Conservation area in Twin Streams farm (Mtunzini) over a period of up to 3 days early and late in a season. 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>)^[2]. The copulation duration was calculated as the time in copulation for a male to female individual pairs^[3]. Copulation duration and absolute abundance during early and late in the breeding season were checked for correlations using the Pearson Correlation Coefficient calculator (<https://www.gigacalculator.com/calculators/correlationcoefficient-calculator.php>). Tests for normality were conducted. Differences between absolute abundances were compared across time (early and late) and space (ground or trees) using the P-value calculator (<https://www.gigacalculator.com/calculators/p-valuesignificance-calculator.php>).

III. RESULTS

There was a significant relationship between abundances (pooled) with copulation duration (Figure 1: $r=0.74563599$, Z score= 1.66805834 , $n=6$, $p=0.04765205$). *C. annulatus* copulation durations (39.4 ± 18.6 minutes, $n=8$) occur at lower abundances (59.67 ± 14.57 , $n=3$) and *C. inscriptus* copulation durations (145.5 ± 29.6 minutes, $n=6$) occur at higher densities (493.67 ± 335.57 , $n=3$). Copulation duration variation was also related to absolute abundance (Figure 2: $r=0.74563599$, Z score= 1.66805834 , $n=6$, $p=0.04765205$)

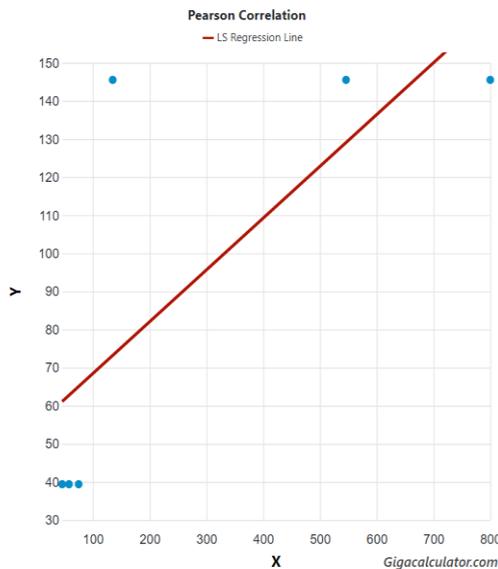


Figure 1. Relationship between absolute abundance and copulation duration in sympatric *Centrobolus annulatus* and *C. inscriptus*.

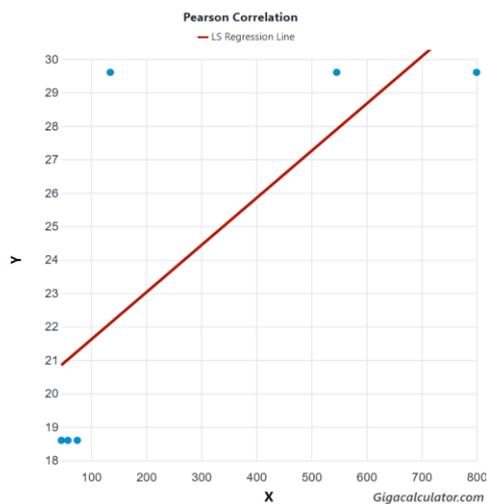


Figure 2. Relationship between absolute abundance and copulation duration variation in sympatric *Centrobolus annulatus* and *C. inscriptus*.

• IV. DISCUSSION

A relationship was established between absolute abundance and copulation duration (variation) in sympatric *Centrobolus*. Examples of copulation duration varying with absolute abundance are not given. Copulation duration variation with the absolute abundance occurs during seasonal activity patterns in species such as millipedes [5,6]. Absolute abundance can bias the sex ratio and covary with many other factors depending on the time and place

in the season. Spatial changes in habitat preference are known in *C. fulgidus* and *C. richardii* [7]. These differences are linked to the effects of SSD differences (65%) between the latter two species. Similarly, sex ratios may be usefully investigated and compared with this study. Copulation duration and copulation duration variation were positively related to absolute abundances across *Centrobolus*. Short copulations (*C. annulatus*) were associated with low absolute abundances and long copulations (*C. inscriptus*) were associated with high absolute abundances. This suggests the pattern of mate guarding is positively associated with absolute abundance and the intensity of intra-male competition [11]. The probability of a female remating is a function of male density [12].

• V. CONCLUSION

Copulation duration and copulation duration variation varied sympatrically with the absolute abundance in two *Centrobolus* species. A longer copulation duration occurs with higher absolute abundance.

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