

DOES COPULATION DURATION VARY WITH SEX RATIO IN THE RED MILLIPEDE *CENTROBOLUS INSCRIPTUS* (ATTEMPS, 1928)?

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Abstract: Copulation duration and sex ratios were checked for correlations in the red millipede genus *Centrobolus*. Three scenarios were identified for (no) relationship between sex ratios recorded early (0.60, n=800) and late (0.33, n=135) in the trees (0.62, n=445) and on the ground (0.55, n=101) with copulation duration (145.5, n=8 & 173.5 minutes, n=46). (1) There was a positive relationship ($r=0.98$, Z score=2.19, n=46, 6, 46, 46, $p=0.01$); (2) there was a negative relationship ($r=-0.98$, Z score=-2.19, n=6, 46, 6, 6, $p=0.01$); or (3) there were no relationships ($r=-0.43$, Z score=-0.46, n=6, 46, 6, 46, $p=0.32$) ($r=0.74$, Z score=0.94, n=46, 6, 6, 46, $p=0.17$). *C. inscriptus* copulation durations were suspected to have increased or decreased with sex ratio bias; the most significant or likely options.

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^[8,9]. It consists of taxonomically important species with 12 species considered threatened and includes nine vulnerable and three endangered species^[9]. It occurs in all the forests of the coastal belt from the Cape Peninsula to Beira in Mocambique^[8]. Common with worm-like millipedes is the absolute abundance known to differ in several populations of the genus^[5]. Sex ratios are seasonal and may determine the copulation duration for pairs of individuals of each species at any one time^[6-8].

Copulation duration and sex ratios 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 sex ratio bias and copulation duration in one species.

II. MATERIALS AND METHODS

One species belonged to the genus *Centrobolus* Cook, 1897^[1]. The sex ratios during the breeding season were obtained for February and December^[2]. 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. The copulation duration was calculated as the time in copulation for male to female individual pairs^[2]. Copulation duration and sex ratios 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 sex ratios 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>). Copulation duration were recorded twice: (145.5 ± 29.6 minutes, n=6) and (173.5 ± 46.5 min., n=46).

III. RESULTS

Scenario 1: Positive relationship

There was a significant relationship between sex ratio with copulation duration (Figure 1: $r=0.97530483$, Z score=2.19093517, $p=0.01422819$) for *C. inscriptus*.

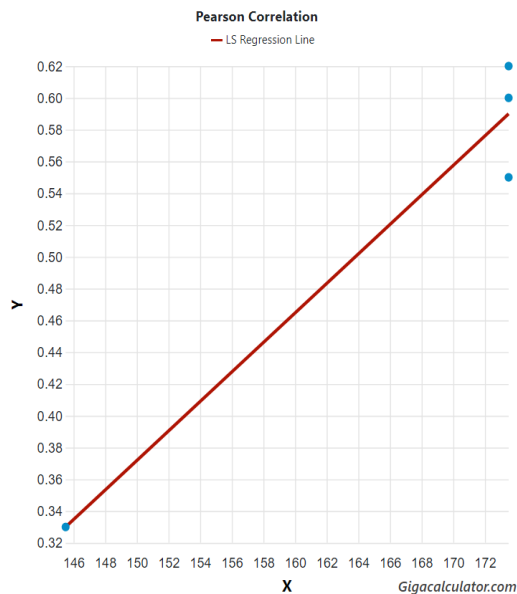


Figure 1. Relationship between copulation duration (y) and sex ratio (x) in *Centrobolus inscriptus* (Attems, 1928).

Scenario 2: Negative relationship

There was a significant relationship between sex ratio with copulation duration (Figure 2: $r=-0.97530483$, $Z \text{ score}=-2.19093517$, $p=0.01422819$) for *C. inscriptus*.

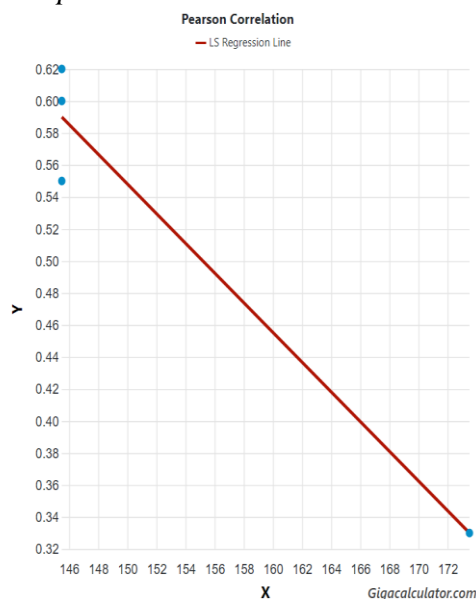


Figure 2. Relationship between copulation duration (y) and sex ratio (x) in *Centrobolus inscriptus* (Attems, 1928).

Scenario 3: No relationship

There are two equal results or alternatives with the same results of no correlation between sex ratio and

copulation duration ($r=-0.43314808$, $Z \text{ score}=-0.46376533$, $n=6$, 46 , 6 , 46 , $p=0.32140796$) ($r=0.73635174$, $Z \text{ score}=0.94246281$, $n=46$, 6 , 6 , 46 , $p=0.17297785$) only differing in order of events.

IV. DISCUSSION

A relationship was established between sex ratios and copulation duration in sympatric *Centrobolus*. Examples of copulation duration varying with sex ratios are known. Copulation duration variation with the sex ratio occurs during seasonal activity patterns in species such as millipedes [4,5]. 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* [6]. These differences are linked to the effects of SSD differences (65%) between the latter two species. Similarly, sex ratios are usefully investigated and compared in this study. Copulation duration was either negatively or positively related to sex ratio in *C. inscriptus*. Short copulations may be associated with low biases and long copulations associated with high male-biased sex ratios. This suggests the pattern of mate guarding is positively associated with sex ratios and the intensity of intra-male competition [10]. This implies the probability of a female remating is a function of (male and female) density and sex ratio [11].

V. CONCLUSION

Copulation duration and sex ratio varied in one of three ways in the *Centrobolus* species. An increase or decrease in the copulation duration occurs with higher sex ratios being equally likely.

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