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Research Article

# Centrobolus silvanus dimorphism based on tergite width

## Abstract

The forest genus *Centrobolus* of diplopoda belonging to the Order Spirobolida is distributed along the eastern coast of southern Africa. Sexual size dimorphism (SSD) can be explained as sexual selection and fecundity selection. Width and length were analysed in *Centrobolus* to derive SSD in 22 species. Width size of *C. silvanus* collected in South Africa was calculated as 47.5 mm (n=8). Male width was 43 mm (μ ± σ; n=1) and female width 54 mm (μ ± σ; n=1). An analysis from data presently available showed average SSD for *C. silvanus* was 1.25581395 differing from 1 (t=1.52753, p=0.085235; n=6). *C. silvanus* dimorphism was based on a 11 mm difference in horizontal tergite width. Sexual dimorphism appeared as in *C. inscriptus* female width which was positively related to copulation duration. Keywords. C. silvanus, horizontal tergite width.

## Introduction

Size differences of diplopods correlate with factors such as color, sexes, species, urbanisation and water relations [1,2]. SSD has consequences for outcomes of sexual encounters in diplopod mating [3-5]. The allometry of SSD involves the detection of a relationship between body size and SSD and is known as Rensch's rule which may be explained as sexual selection and fecundity selection [6,7]. This allometric rule predicts SSD is negatively correlated with body size [8-10]. The forest genus of diplopods belonging to the Order Spirobolida found along the eastern coast of southern Africa was the subject of this study [11,17]. Length, width and ring data are known in 22 species (*Centrobolus albitarsus, C. anulatus, C. decoratus, C. digrammus, C. dubius, C. fulgidus, C. immaculatus, C. inscriptus, C. inyanganus, C. lawrencei, C. lugubris, C. promontorius, C. pusillus, C. richardi, C. ruber, C. rugulosus, C. sagatinus, C. silvanus, C. titanophilus, C. transvaalicus, C. tricolor,* and *C. vastus*). The revision of the genus *Centrobolus* (Cook, 1897) was part of this data [12-15]. SSD in these forest diplopods have been understood as size using *Centrobolus* to test body size relationships and the trend of SSD has been calculated for *Centrobolus* [2]. The present study re-illustrates the trend of SSD for the genus *Centrobolus* and shows the sizes of *C. silvanus* relative to 21 of congenerics in order to express how species do not follow the trend of Rensch's rule [16].

## Materials and Methods

One factor was analysed from *Centrobolus silvanus*: (1) horizontal tergite width (mm) [15,17]. *C. silvanus* (Attems) were collected from Kentani District and Knysna, South Africa. SSD was calculated based on the volumes for 22 species in the genus *Centrobolus* [16,18] and included data for *C. richardi*.

### Statistical analysis

The basic descriptive figures of horizontal tergite width were analysed. The average width was obtained for 2 individuals of *C. silvanus*. Size was based on dorsal tergite width. SSD was the average female size divided by average male size and converted into a SSD ratio. Allometry for SSD was based on a model where male size = $\alpha$ (female)$^{\beta}$. A linear regression was tested the relationship between sexual sizes at http://www.socscistatistics.com. SSD was compared to 1 using a t-test for 2 dependent means at http://www.socscistatistics.com/tests/studentttest/Default2.aspx.

## Results

Sizes were estimated in the following 22 taxa: *Centrobolus albitarsus, C. anulatus, C. decoratus, C. digrammus, C. dubius, C. fulgidus, C. immaculatus, C. inscriptus, C. inyanganus, C. lawrencei, C. lugubris, C. promontorius, C. pusillus, C. richardi, C. ruber, C. rugulosus, C. sagatinus, C. silvanus, C. titanophilus, C. transvaalicus, C. tricolor,* and *C. vastus*. SSD is shown in figure 1. For the data, the regression equation for *Y* was: $\hat{y}$ = 0.44407*X* + 316.81644. The quantitative resolution of the rule for *Centrobolus* species together with the relative estimated position of *C. silvanus* is shown in figure 1. The size of *C. silvanus* collected in South Africa was calculated as 47.5 mm (n=8). Males size was 43 mm (μ ± σ; n=1) and female size 54 mm (μ ± σ; n=1). An analysis from data presently available showed average SSD for *C. silvanus* was 1.25581395 differing from 1 (t=1.52753, p=0.085235; n=6) (Table 1).

## Discussion

*Centrobolus* species based on tergite width are clearly recognisable [16,18]. Because SSD was significantly different



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**Table 1:** Body length: width ratios and mean body volumes calculations for male and female *Centrobolus*.

| Species | Male | | Female | | Ratio (Female/Male) | | Species size |
|---|---|---|---|---|---|---|---|
| | Length: width | Volume (mm³) | Length: width | Volume (mm³) | Length: width | Volume (mm³) | Volume (mm³) |
| *albitarsus* | 9 | 490 | 8 | 1414 | 0.89 | 2.89 | 952 |
| *anulatus* | 13.1458967 | 1729 | 13.0056744 | 2059 | 0.989333379 | 1.19086177 | 1894 |
| *decoratus* | 9 | 684 | 7 | 429 | 0.78 | 0.63 | 557 |
| *digrammus* | 10 | 520 | 7 | 523 | 0.7 | 1.01 | 522 |
| *dubius* | 10 | 1030 | 8 | 1389 | 0.8 | 1.35 | 1210 |
| *fulgidus* | 10 | 1147 | 7 | 1888 | 0.7 | 1.65 | 1518 |
| *immaculatus* | 10 | 850 | 8 | 2309 | 0.8 | 2.72 | 1580 |
| *inscriptus* | 11.50 | 1841 | 9.06 | 2245 | 0.78782608 | 1.2194459 | 2043 |
| *inyanganus* | 8 | 636 | 8 | 913 | 1.0 | 1.44 | 775 |
| *lawrencei* | 9 | 748 | 7 | 1176 | 0.78 | 1.57 | 962 |
| *lugubris* | 8 | 1600 | 7 | 3491 | 0.88 | 2.18 | 2046 |
| *promontories* | 9 | 336 | 8 | 231 | 0.89 | 0.69 | 284 |
| *pusillus* | 9 | 490 | 7 | 1021 | 0.78 | 2.08 | 756 |
| *richardi* | 11.3461538 | 1252.993 | 9.09090909 | 1187.915 | 0.801232669 | 0.94806196 | 1220.454 |
| *ruber* | 11.46 | 1141 | 10.18 | 1850 | 0.888307155 | 1.62138475 | 1450.5 |
| *rugulosus* | 9 | 1122 | 6 | 2209 | 0.67 | 1.97 | 1666 |
| *sagatinus* | 7 | 1464 | 6 | 1855 | 0.86 | 1.27 | 1659 |
| *silvanus* | 10 | 704 | 9 | 793 | 0.9 | 1.13 | 749 |
| *titanophilus* | 6 | 365 | 6 | 421 | 1.0 | 1.15 | 393 |
| *transvaalicus* | 8 | 593 | 7 | 746 | 0.88 | 1.26 | 669 |
| *tricolor* | 10 | 716 | 7 | 786 | 0.7 | 1.10 | 781 |
| *vastus* | 10 | 1838 | 7 | 3327 | 0.7 | 1.81 | 2683 |

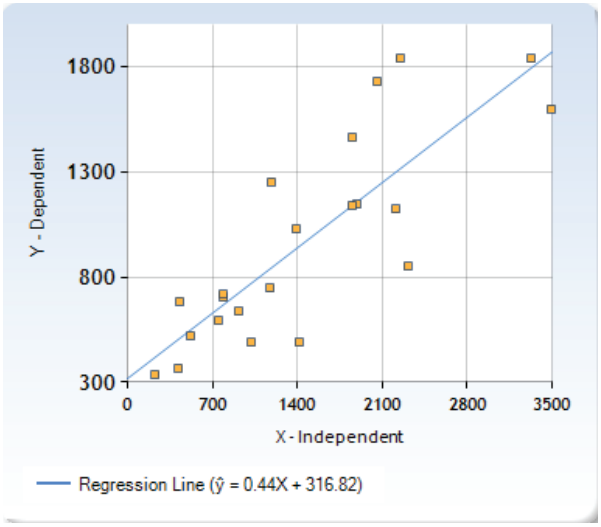


**Figure 1:** (Sexual size dimorphism for 22 species of diplopods of the genus *Centrobolus* where allometry for sexual size dimorphism (SSD) was based on the model male size = α (female size)$^{\beta}$; ŷ = 0.44407*X* + 316.81644. X – Independent male; Y – Dependent female.

from 1 in the species, the average size ratio of 1.25581395 for *C. silvanus* indicates dimorphism. The positive relationship between female and male body sizes in this genus of diplopods is an exception to Rensch's rule [8-10]. Studies on SSD in other invertebrates have a positive correlation [19]. Figure 1 shows the finding for *Centrobolus* where the regression of log male size on log female size was significant with a positive slope showing females get larger than males with an increase in body size. The analysis presented here shows SSD based on the horizontal tergite width and size may be a primary factor in mating because the radius of a cylinder can be more powerful in attempts to increase size which is similar to *Doratogonus uncinatus* where female choice for mating partners is "size selective" [20].

Sexual dimorphism resembles *C. inscriptus* female width which is positively related to copulation duration and larger females are probably more fecund [21]. Sexual dimorphism in *Apfelbeckia insculpta* shows female-biased SSD with longer and wider females [11]. On the basis of the findings in *C. sagatinus* I suggest width is the primary factor and length secondary factor in achieving size differences in Myriapoda [22]. Although no dimorphism was detected in two species of *Centrobolus* (*dubius* and *lawrencei*) differences in dorsal tergite width may occur when larger numbers are studied [23,24].

## Conclusion

*C. silvanus* shows sexual size dimorphism with small males and larger females based on the finding of differences in horizontal tergite width. Sexual dimorphism resembles *C. inscriptus* and *C. sagatinus* female width which is positively related to copulation duration and larger females are fecundity selected [18,21].

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