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Volumes of *Centrobolus albitarsus* (Lawrence, 1967)

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Abstract
Millipedes illustrate reversed sexual size dimorphism (SSD) where females are larger than males; and break Rensch's rule as this dimorphism increases with body size. SSD was calculated in 18 species of the genus *Centrobolus* and illustrated as a regression. The present research was aimed to study the relative volume of *Centrobolus albitarsus*. The approximate relative position of *C. albitarsus* was shown from measurements taken at Lochiel (*ca*. 26° 9' 0" S, 30° 47' 0" E). The size of *C. albitarsus* was between 490.0885-1413.717mm^3. The mean volume calculated for *C. albitarsus* log functions were 2.69-3.15. The difference between the SSD R-values for *C. albitarsus* and the trend for *Centrobolus* was not highly significant (Z=-2.46; P (one-tailed) = 0.0069; n=18).

Keywords: *albitarsus*, *Centrobolus*, millipede, size

1. Introduction
Size dimorphism is prevalent in arthropods and females are usually larger than males. Behavioural patterns such as provisioning *versus* non-provisioning relate to size. Millipedes illustrate reversed sexual size dimorphism (SSD) and females are larger than males [1-6]. SSD in forest millipedes has successfully been understood as volumetric measurements using *Centrobolus* to break Rensch's rule [1]. Based on the assumption of equal developmental rates in males and females, the proximate cause for Rensch's rule is sexual bimaturism [6]. The general trend of SSD has been calculated for *Centrobolus* and bimaturism shown [6]. The present study was aimed to illustrate the size for the species *Centrobolus albitarsus*.

2. Materials and Methods
Two factors were obtained from *Centrobolus albitarsus*: (1) body length (mm) from Lawrence (1967) collected in Lochiel (*ca*. 26° 9' 0" S, 30° 47' 0" E), South Africa; (2) width (mm) [5]. Millipede SSD was calculated in the genus *Centrobolus*. A regression of male volume on female volume was used to show the position of 18 species and the size of *C. albitarsus* was taken as a volumetric measurement and inserted into a Microsoft (MS) Excel spreadsheet and converted using the logarithmic (mathematical) equation $\pi r^2 h$. The chart for SSD in 18 species was captured, copied and exported using the snapshot function in the programme Soda Portable Document File (PDF) 8. It was pasted into a MS Word file and the position of *C. albitarsus* boxed.

2.1 Statistical Analysis
The basic descriptive figures were statistically compared using Statistica. Body length: width ratios were compared on arcsine transformed data. The mean values of length, width and number of segments was extracted from published data for 18 species intersexual comparisons performed using Wilcoxon matched pairs tests. Size was perceived as body volume and calculated based on the formula for a cylinder ($\pi r^2 h$) where h was body length and r half of the width. An R-value was calculated at http://www.socscistatistics.com/. Using the Fisher r-to-z transformation the SSD R-values for Centrobolus (n=18) was compared to C. albitarsus (n=1; 4) at http://vassar stats.net/rdiff.html.

3. Results
The quantitative resolution of Rensch's rule for 18 species of *Centrobolus* including the relative estimated position of *C. albitarsus* is shown in Fig. 1. The size of *C. albitarsus* was between 490.0885-1413.717mm^3. The log functions were 2.69-3.15. The R-value was 1 (as no SSD was measured). No mean volume ratio (female volume/male volume) for *C. albitarsus* could be calculated as the males and females were not measured separately. The difference between *C. albitarsus* and the trend for *Centrobolus* was not highly significant (Z=-2.46; P = 0.0069; n=18).

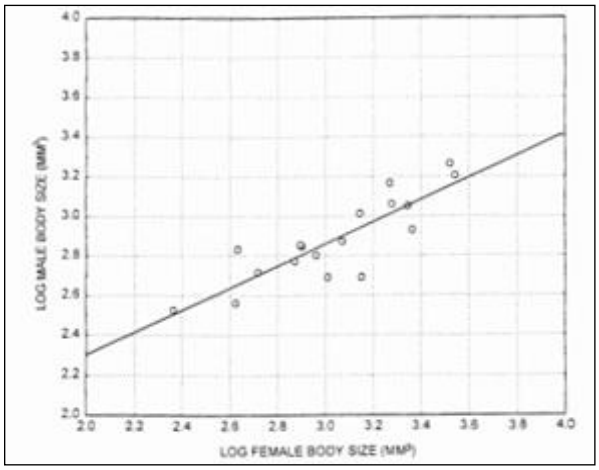

Fig 1: Quantitative resolution of Rensch's rule for 18 species of millipedes of the genus *Centrobolus*. Allometry for sexual size dimorphism (SSD) is based on the allometric model [7], male size = α (female size)$^{\beta}$; correlation coefficient, r = 0.85. The position of *C. albitarsus* was shown in the box; correlation coefficient, r = 1.

4. Discussion

Like previous studies on SSD in invertebrates these results consistently break Rensch's rule [8-11]. Figure 1 shows the finding for *Centrobolus* where the regression of log male volume on log female volume was highly significant with a positive slope and R of 0.85; showing females get larger than males with an increase in body size [1]. The mean volume ratio of 2.69-3.15 was boxed in the trend for the species. Importantly, because the position of *C. albitarsus* was on the line breaking Rensch's rule, and has an R of 1, it indicated individuals break the trend as do 18 other members of the 39-species [9-11]. *C. albitarsus* could potentially be the same size as 6 other species in the genus.

5. Conclusion

C. albitarsus indicate the trend for breaking Rensch's rule in *Centrobolus*.

6. References

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