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Lawrence's red millipede *Centrobolus lawrencei* shows length-based variability and size dimorphism

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Abstract
The present research aimed to study the sexual size dimorphism of *Centrobolus lawrencei* previously thought to be monomorphic. Diplopoda illustrated reversed sexual size dimorphism (SSD) where one sex was larger than the other. The SSD of *C. lawrencei* based on variability in length was shown from data taken in South Africa. Sexual dimorphism was identified through differences in length (t-value=-3.11362; p-value=0.006223; n=8, 3) but not width (t-value=0.64096; p-value=0.264412; n=8, 3). This finding together with the lower coefficients of variation in males indicate directional sexual selection on length.

Keywords: *Centrobolus*, dimorphism, lawrencei, size

1. Introduction
Sexual size dimorphism is prevalent in arthropods and one sex is usually larger than the other [1]. Behavioural patterns such as provisioning versus non-provisioning relate to sexual size dimorphism (SSD). Diplopoda illustrate reversed SSD and one sex is usually larger [1, 9]. Diplopoda are underrepresented in allometric analyses of SSD and SSD is known in body weight, length, width and legs of over half the taxa studied [6, 12, 13, 15]. SSD correlates with factors such as colour, copulation duration, sexes, species, urbanisation and water relations [8, 12]. Diplopoda tend to be similar to the majority of invertebrates where SSD is reversed. It has consequences for outcomes of sexual encounters in diplopod mating [20, 21]. The allometry of SSD involves the detection of a relationship between body size and SSD and is known by a rule [10, 16, 19, 22, 23]. This rule may be explained by sexual selection and fecundity selection [7, 14]. The evolutionary pattern is being resolved in Diplopoda.
A case of SSD has been calculated for *Centrobolus lawrencei* [2]. Here, SSD was re-examined in *C. lawrencei* where SSD had been understood as monomorphism in cylindrical sizes. The present study illustrated the variation in size and length SSD of *C. lawrencei* and shows how this variation could have resulted [17].

2. Materials and Methods
The average values of length and width were obtained from 8 male and 3 female individuals of *C. lawrencei*. These two factors were analysed from *Centrobolus lawrencei*: (1) body length and (2) width. *C. lawrencei* which were collected, described and identified in South Africa [18]. Body length and width data were inputted into an Excel spreadsheet and averages and standard deviations calculated from the most used formulae. The basic descriptive figures were then statistically compared using the online package Socscistatistics.com. Size was not re-calculated based on the formula for a cylinder ($h.\pi.r^2$) where h is body length and r half of the width.

2.1 Statistical analysis
Data were tested for normality with a Kolmogorov-Smirnov test at https://www.socscistatistics.com/tests/kolmogorov/Default.aspx. Comparisons between male and female length and width were made using a T-test for 2 independent means (https://www.socscistatistics.com/tests/studentttest/Default.aspx). Coefficients of variation were compared [11].

3. Results

SSD for *Centrobolus lawrencei* is shown in sexes which differed in length (t-value=-3.11362; p-value=0.006223; n=8, 3) but not width (t-value=0.64096; p-value=0.264412; n=8, 3). Mean male length was 43.125mm (S.D.=2.081666; CV=4.82705159) and mean female length was 32.66667mm (S.D.=9.291573; CV=28.4435879). When these coefficients of variation were compared they were found to be significantly different (F=0.03029, DF=7, 2; p=1.00000). The variation in male and female lengths are displayed in Figure 1.

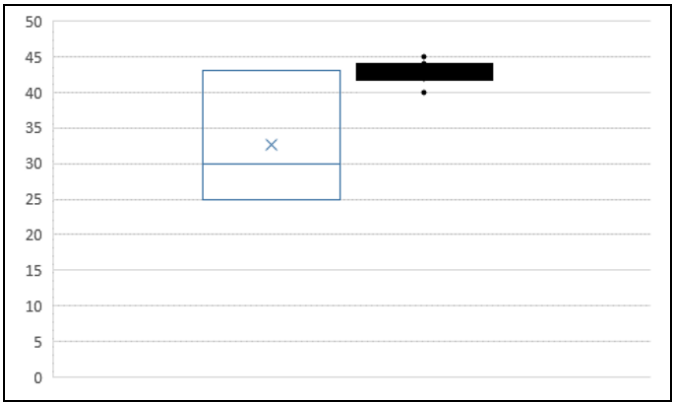

Fig 1: *Centrobolus lawrencei* sizes (mm) illustrated as length showing females (left) and males (right).

4. Discussion

The previous study on SSD in *C. lawrencei* gave monomorphism and break the biological rule [2, 17]. The finding here shows one sex gets larger than the other with an increase in body size. SSD was not significantly different from 1 in this species [2]. A suggested cause for SSD in diplopods is sexual bimaturism [3]. Another cause for SSD is ecological intersexual competition [4]. The evidence for sexual selection on the relative size dimorphism in *C. lawrencei* indicates size may affect copulation duration [19]. A conflict of interests in copulation duration is based on size as seen in *C. inscriptus* [5]. These outcomes resemble *Doratogonus uncinatus* where choice for partners is "size selective" [20, 21]. Cross-mating *Centrobolus* appears to have size assortative copulation [6].

The lower coefficients of variation in the males indicates directional sexual selection for length [12]. This is similar to the findings in other millipedes where there is selection on male length such as male slenderness in *Ommatiulus sempervirilis* [1]. Juliform millipedes all tend to show this dimorphism with selection for longer males. Studies of diplopod sexual dimorphism now include SSD from nine taxa and show tergite widths or length determine size. This affects allometry in *Centrobolus*.

5. Conclusion

Precise data for *C. lawrencei* shows SSD based on variation in body length with directional selection on male length.

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7. References

1. Akkari N, Enghoff H. Copulatory-copulatory male succession and male slenderness in *Ommatiulus sempervirilis* n. sp., a new insular millipede from Tunisia (Diplopoda: Julida: Julidae). Journal of Zoological Systematics and Evolutionary Research. 2011; 49(4):285-291.
2. Cooper M. *Centrobolus lawrencei* (Schubart, 1966) monomorphism. Arthropods. 2018; 7(4):82-86.
3. Cooper MI. Sexual bimaturism in the millipede *Centrobolus inscriptus* (Attems). Journal of Entomology and Zoology Studies. 2016; 4(3):86-87.
4. Cooper MI. Sex ratios, mating frequencies and relative abundance of millipedes of the genus *Chersastus* (Diplopoda, Pachybolidae). Arthropods. 2014; 3(4):176-178.
5. Cooper MI. Sexual conflict over the duration of copulation in *Centrobolus inscriptus* (Attems). Journal of Entomology and Zoology Studies. 2016; 4(6):852-854.
6. Cooper MI. Fire millipedes obey the female sooner norm in cross mating *Centrobolus* Cook. Journal of Entomology and Zoology Studies. 2016; 4(1):173-174.
7. Dale J, Dunn PO, Figuerola J, Lislevand T, Székely T, Whittingham LA. Sexual selection explains Rensch's rule of allometry for sexual size dimorphism. Proceedings of the Royal Society B, 274:2971-2979.
8. David JF. Size criteria for the distinction between *Cylindroiulus londinensis* (Leach) and *Cylindroiulus caeruleocinctus* (Wood) (Diplopoda: Julidae). Journal of Natural History. 1995; 29:983-991.
9. Enghoff H. The size of a millipede. In: Meyer E, Thaler K, Schedl W (eds.) Advances in Myriapodology. Berichte des naturwissenschaftlich-medizinischen Vereins in Innsbruck, Supplement. 1992; 10:47-56.
10. Faiman R, Abergil D, Babocsay G, Razzetti E, Seligman H *et al*. A review of sexual dimorphism of eye size in Colubroidea snakes. Vertebrate Biology. 2018; 68:91-108.
11. Forkman J. Estimator and Tests for Common Coefficients of Variation in Normal Distributions. Communication in Statistics-Theory and Methods. 2009; 38(2):1-27.
12. Hopkin SP, Read HJ. The Biology of Millipedes. Oxford University Press, U. K., 1992, 246.
13. Mori E, Mazza G, Lovari S. Sexual Dimorphism. In: Encyclopedia of Animal Cognition and Behavior (J. Vonk, and T. Shakelford, Eds). Springer International Publishing, Switzerland, 2017, 1-7.
14. Pincheira-Donoso D, Hunt J. Fecundity selection theory: concepts and evidence. Biological Reviews. 2015; 92:341-356.
15. Rowe M. Copulation, mating system and sexual dimorphism in an Australian millipede, *Cladethosoma clarum.* Australian Journal of Zoology. 2010; 58(2):127-132.
16. Rensch B. Evolution above the Species Level. Columbia, New York, 1947, 419.
17. Ridley M. Evolution. Blackwell Scientific Publications, Oxford, 1993.
18. Schubart O. Diplopoda III. South African Animal Life. 1966; 12:62-63.
19. Seifan M, Gilad A, Klass K, Werner YL. Ontogenetically stable dimorphism in a lacertid lizard (*Acanthodactylus boskianus*) with tests of methodology and comments on life-history. Biological Journal of the Linnean Society. 2009; 97:275-288.
20. Telford SR, Dangerfield JM. Sex in millipedes: laboratory studies on sexual selection. Journal of

Biological Education. 1990; 24:233-238.
21. Telford SR, Dangerfield JM. Mating Tactics in the Tropical Millipede *Alloporus uncinatus* (Diplopoda: Spirostreptidae). Behaviour. 1993; 124:45-56.
22. Webb TJ, Freckleton RP. Only Half Right: Species with Female-Biased Sexual Size Dimorphism Consistently Break Rensch's Rule. PLoS ONE. 2007; 2(9):e897.
23. Werner YL, Korolker N, Sion G, Göçmen B. Bergmann's and Rensch's rules and the spur-thighed tortoise (*Testudo graeca*). Biological Journal of the Linnean Society. 2006; 117:796-811.