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Millipede mass: Intersexual differences

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Abstract
Mass (g) was re-analyzed in 15 species of diplopods. Values were compared intersexually. Male and female mass was not normally distributed (D=0.28, n=44, $p< 0.01$) and differed significantly (z=-3.60, n=22, 22, $p< 0.01$). The mean female mass was 2.47 g and the mean male mass was 1.98 g. Mean male mass was significantly correlated with mean female mass (r=0.97, Z score=8.81, n=22, p=0).

Keywords: Diplopoda, heavier, lighter, sex

1. Introduction
Millipedes display female-biased Sexual Size Dimorphism (SSD) based on body mass, length, width, and leg dimensions [7-17, 19-23]. SSD is mostly reversed in many species [6]. Female-biased SSD is most probably under Darwinian fecundity selection [4]. Size-assortative mating is known in some species [22]. Live body mass records have been demonstrated in some 15 populations [1, 2, 5, 15, 17, 19, 22]. No trend in sex-specific differences across the 15 species has been documented [3]. Mass was investigated in 15 examples, and SSD was re-analyzed [3]. A re-analysis of the same data to establish if there is lighter sex is undertaken here. A test for normality was a requirement.

2. Materials and Methods
Previous analyses and reviews using the available literature were used [3]. The first test (Kolmogorov-Smirnov) is to see if the data are normally distributed and the second test (Wilcoxon Signed-Rank) is a comparison between the same male and female mass data. Mean male mass was correlated with mean female mass using a Pearson Correlation Coefficient.

3. Results: Male mass did not fit a normal distribution (D=0.32748, n=22, p=0.01331). Female mass did not fit a normal distribution (D=0.32163, n=22, p=0.01591). Male and female mass was not normally distributed and differed significantly (D=0.27825, n=44, p=0.00165). The mean female mass was 2.474 g and the mean male mass was 1.97541 g. An intersexual difference in mass was detected (z=-3.5974, n=22, 22, p=0.0032). Mean male mass was significantly correlated with mean female mass (Figure 1: r=0.96546690, Z score=8.80839043, n=22, p=0).

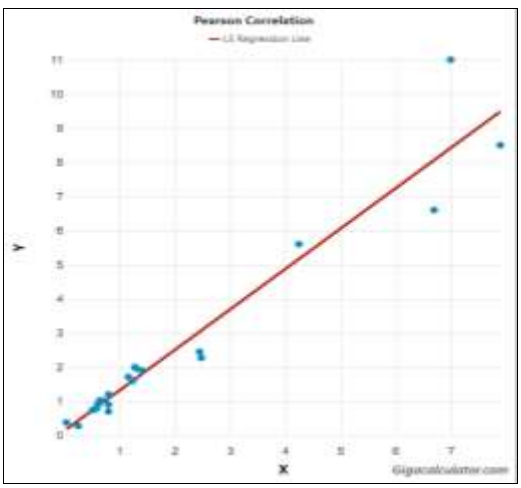

Fig 1: Correlation between mean male mass (x) and mean female mass (y)

4. Discussion

15 species illustrate significant intersexual differences in mass [3]. Mean male mass was correlated with mean female mass. The mass statistics of 15 species were presented and re-analyzed to show a non-normal distribution of data showing males are lighter than females. In a single study on millipede mass, no difference between male and female mass could be found [3]. This was because no test for normality was carried out. The distribution of mean female and mean male body mass was not normally distributed. One of the requirements for a T-test is for the data to be normally distributed [18]. Because this was not carried out in the previous study the data were re-analyzed here using an appropriate non-parametric test and a difference across taxa was found. Wilcoxon signed-rank test, also known as Wilcoxon matched pair test - a non-parametric hypothesis test that compares the median of two paired groups and tells if they are identically distributed or not - was used [25]. This is appropriate because differences between the pairs of data are non-normally distributed [25]. The interaction between divergence, selection, time, and variation may further explain differences in mass evolution across the sexes.

5. Conclusion

SSD of diplopods based upon body mass being lighter in male millipedes was shown in a re-analysis of previous data. The interaction between divergence, selection, time, and variation explains condition-dependent evolution.

6. References

1. Adolph SC, Geber MA. Mate-Guarding, Mating Success and Body Size in the Tropical Millipede 'Nyssodesmus Pythos' (Peters) Polydesmida: Platyrhacidae). The Southwestern Naturalist. 1995;40(1):56-61.
2. Brygadyrenko V, Ivanyshyn V. Changes in the body mass of *Megaphyllum kievense* (Diplopoda, Julidae) and the granulometric composition of leaf litter subject to different concentrations of copper. Journal of Forest Science. 2015;61(9):369-376.
3. Cooper M. Non-significant intersexual differences in millipede mass. Journal of Entomology and Zoology Studies. 2019;7(3);763-765.
4. Cooper MI. Heavier-shorter-wider females in the millipede *Centrobolus inscriptus* (Attems). Journal of Entomology and Zoology Studies. 2016; 4(2):509-510.
5. Cooper MI. Allometry of copulation in worm-like millipedes. Journal of Entomology and Zoology Studies. 2017;5(3):1720-1722.
6. Cooper M. *Centrobolus anulatus* reversed sexual size dimorphism. Journal of Entomology and Zoology Studies. 2018;6(4):1569-1572.
7. Cooper MI. Lawrence's red millipede *Centrobolus lawrencei* shows length-based variability and size dimorphism. Journal of Entomology and Zoology Studies. 7(2), 1037-1039.
8. Cooper M. *Centrobolus titanophilus* size dimorphism shows width-based variability. Arthropods. 2019;8(2):80-86.
9. David JF. Size criteria for the distinction between *Cylindroiulus londinensis* (Leach) and *Cylindroiulus caeruleocinctus* (Wood) (Diplopoda: Julidae), Journal of Natural History. 1995;29(4):983-991.
10. David JF, Gillon D. Annual feeding rate of the millipede *Glomeris marginata* on holm oak (Quercus ilex) leaf litter under Mediterranean conditions. Pedobiologica. 2002;46(1):45-52.
11. Dwarakanath SK. The influence of body size and temperature upon the oxygen consumption in the millipede, *Spirostreptus asthenes* (Pocock). Comparative Biochemistry and Physiology Part A: Physiology. 1971;38(2):351-358.
12. Echeverría KS, Ignacio C, Bueno-Villegas J. Relationship between millipede body size (Polydesmida: Xystodemidae: Rhysodesmus) and altitude, latitude, precipitation, and temperature. 16th International Conference of Myriapodology, 2014.
13. Enghoff H. The Size of a Millipede. Berichte der naturhistorisch-medizinischen Vereins Innsbruck, Supplement. 1992, 10.
14. Hopkin SP, Read HJ. The Biology of Millipedes. Oxford University Press, Oxford, 1992.
15. Ilić BS, Mitić BM, Makarov SE. Sexual dimorphism in *Apfelbeckia insculpta* (L. Koch, 1867) (Myriapoda: Diplopoda: Callipodida). Archives of Biological Sciences. 2017;69:23-33.
16. Ilić BS, Vujić VD, Javonovic Z, Pavković-Lučić SB, Dudić BD, Lucić LR, *et al*. Sexual dimorphism in some morphological traits of three European millipedes (Diplopoda, Julida, Julidae). Animal Biology. DOI: 10.1163/15707563-20191113
17. Javonovic Z, Pavković-Lučić S, Ilić B, Vujić V, Dudić B, Makarov S, *et al*. Mating behaviour and its relationship with morphological features in the millipede *Pachyiulus hungaricus* (Karsch, 1881) (Myriapoda, Diplopoda, Julida). Turkish Journal of Zoology. 2017;41:1010-1023.
18. Kim TK, Park JH. More about the basic assumptions of t-test: normality and sample size. Korean Journal of Anethesiology. 2019;72(4):331-335.
19. Penteado CHS, Hebling-Beraldo MJA, Mendes EG. Oxygen consumption related to size and sex in the tropical millipede *Pseudonannolene tricolor* (Diplopoda, Spirostreptida), Comparative Biochemistry and Physiology Part A: Physiology. 1991;98(2):265-269.
20. Rowe M. Copulation, mating system and sexual dimorphism in an Australian millipede, *Cladethosoma clarum*. Australian Journal of Zoology. 2010;58(2):127-132.
21. Smit AM, van Aarde RJ. The influence of millipedes on selected soil elements: a microcosm study on three species occurring on coastal sand dunes. Functional Ecology. 2001;15(1):51-59.
22. Telford SR, Dangerfield JM. Mating behaviour and mate choice experiments in some tropical millipedes (Diplopoda: Spirostreptidae). South African Journal of Zoology. 1993;28(3):155-160.
23. Telford SR, Webb PI. The energetic cost of copulation in a polygynandrous millipede. Journal of Experimental Biology. 1998;201(11):1847-1849.
24. Vujić V, Ilić B, Jovanović Z, Pavković-Lučić S, Selaković S, Tomić V, *et al*. Sexual behaviour and morphological variation in the millipede *Megaphyllum bosniense* (Verhoeff, 1897). Contributions to Zoology. 2018;87(3):133-148.
25. Woolson RF. Wilcoxon Signed-Rank Test. Wiley Encyclopaedia of Clinical Trials, 2007, 1-3.