PREDICTED ABUNDANCES FOR CALCULATED AND CONTROLLED SEXUAL SIZE DIMORPHISM AT DISTANT LATITUDES AND LONGITUDES IN RED MILLIPEDES *CENTROBOLUS* COOK, 1897

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Abstract- Solutions in the form of simultaneous equations are given for precited abundances (z) from calculated sexual size dimorphism (SSD) (x) across latitude and longitude in red millipedes *Centrobolus*. The solution to the simultaneous equation (LATITUDE-SSD-ABUNDANCE SIMULTANEOUS EQUATION) was x=12.6+0.35y-0.35z. The solution to the simultaneous equation (LONGITUDE-SSD-ABUNDANCE SIMULTANEOUS EQUATION) was x=-0.31z-7.31+0.33w. This generated a further simultaneous equation -0.43z+14.9+0.43y=-0.16w-2.87+0.16x which was solved as y=0.08z-56.2+0.92w where the x was the SSD and w, y, and z were longitude, latitude, and the abundance, respectively. When the northern-most, southern-most, eastern-most and western-most species GPS co-ordinates were substituted into these equations the expected abundances were 72.9 (*C. immaculatus*), 47.3 (*C. dubius*), and 65.8 (*C. promontorius*); when SSD was explained. The expected abundances were a similar order of magnitude for different species in this genus. Predicted abundances were marginally related to female moments of inertia across four species (r=-0.82, Z score=-1.63, n=5, p=0.05).

I. INTRODUCTION

A forest genus of diplopods belonging to the Order Spirobolida found along the eastern coast of southern Africa was the subject of this study. The millipede genus *Centrobolus* is found in the temperate South African subregion, its northern limits on the east coast of southern Africa being about -17° latitude S [1-88]. It occurs in all the forests of the coastal belt from the Cape Peninsula to Beira in Mocambique. While the coastal forests of the South-West and Eastern Cape are mist belt temperate forests, those of the Transkei, Natal, Zululand and Mocambique are somewhat different, being better described as East Coast Bush, they are developed almost entirely in a narrow strip of the litoral on a dune sand substratum, and are more tropical in aspect and composition than those to the west of them. There is a summer rainfall of 762-1016 mm, a uniform temperature, and an absence of frost; the component trees of the coastal bush with their abundant creepers and lianes, while not usually reaching a height of more than 11 meters, provide a dense covering with abundant shade and humidity at ground level. As essentially shade-loving Diplopoda, the members of the genus are especially well represented in these litoral forests of the eastern half of the subcontinent.

In this paper, the aim is to predict estimated abundances at distant latitudes and longitudes for members of the red millipede genus *Centrobolus* as this correlates with post-insemination associations [88].

II. MATERIALS AND METHODS

Three linear equations were calculated for combinations of SSD, latitude, longitude, and sex ratios in *Centrobolus* Cook, 1897.

$y = 2.82127413 \cdot x + -34.36594357$
(SSD(x)-latitude(y) equation),
$w = 3.06830771 \cdot x + 23.62207844$
(SSD(x)-longitude(w) equation), and
$z = 0.00003491 \cdot x + 1.19791097$
(SSD(x)-abundance(z) equation).

These were solved at https://www.equationcalc.com/simultaneous-equations-solver.

III. RESULTS

Three simultaneous equations and the solutions are given for the four factors:

LATITUDE-SSD-ABUNDANCE SIMULTANEOUS

EQUATION

y-2.82127413x+34.36594357=z-0.00003491x-1.19791097 (LATITUDE-SSD-ABUNDANCE SIMULTANEOUS EQUATION).

x=12.605758+0.354454y-0.354454z (LATITUDE-SSD-ABUNDANCE SIMULTANEOUS EQUATION SOLUTION).

LONGITUDE-SSD-ABUNDANCE SIMULTANEOUS EQUATION

w-3.06830771x-23.62207844=z-0.00003491x-1.19791097 (LONGITUDE-SSD-ABUNDANCE SIMULTANEOUS EQUATION).

x=-0.325916z-7.3084+0.325916w (LONGITUDE-SSD-ABUNDANCE SIMULTANEOUS EQUATION SOLUTION).

For the final equation SSD was removed:

LATITUDE-SSD-ABUNDANCE LONGITUDE-SSD-ABUNDANCE

-0.433862z+14.867171+0.433862y=-0.160158w-2.874591+0.160158x (LATITUDE-SSD-ABUNDANCE=LONGITUDE-SSD-ABUNDANCE SIMILTANEOUS EQUATION).

y=0.080513z-56.18263+0.919487w (LATITUDE-ABUNDANCE=LONGITUDE-ABUNDANCE SIMULTANEOUS EQUATION SOLUTION).

Predicted abundances were marginally related to female moments of inertia across four species (Figure 1: r=-0.81758792, Z score=-1.62563656, n=5, p=0.05201349).

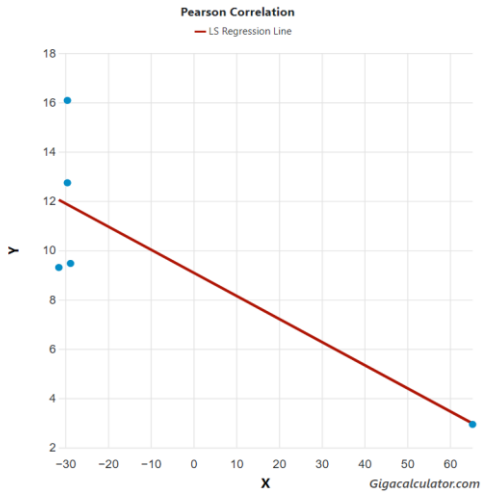

Figure 1. Marginal relationship between predicted abundance and female moments of inertia in *Centrobolus*.

IV. DISCUSSION

The abundances are predictable across latitude and longitude when SSD is controlled. The abundances are given in the equation y=0.080513z-56.18263+0.919487w. When the northern-most, southern-most, eastern-most and western-most co-ordinates were substituted into this equation the predicted abundances were 72.922348 (*C. immaculatus*), 47.267671 (*C. dubius*), and 65.772149 (*C. promontorius*); when SSD was explained. The expected abundances were a similar order-of-magnitude for species in this genus. From the calculated equation it is now possible to obtain estimates for the relative abundances of the different species in this genus. As no linear equation could be generated between sex ratios and SSD it was not possible to predict sex ratios across latitude and longitude when SSD was controlled in the same manner. The direction of the sex ratios and copulation duration both increase with abundance, so these are both predictable from abundances. Abundances are suggested to be a better alternative to the sex ratio in some cases. The predicted abundances for *C. anulatus* (-26.640344), *C. digrammus* (65.280414), *C. fulgidus* (-28.778417), *C. inscriptus* (-29.507446), and *C. ruber* (-31.510514), showed no correlation with moments of inertia.

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