Hierarchy Establishment from Nonlinear Social Interactions and Metabolic Costs: an Application to the Harpegnathos saltator.

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Theory suggests that increased group size reduces overall metabolic costs, thereby increasing the efficiency of the group. To test this theory, we investigate the hierarchical and population dynamics of the ant species *H. saltator* through both mathematical modeling and the numerical simulations. We obtained data of the demographics of *H. saltator* colonies from the Liebig Laboratory at Arizona State University. The relationship between the ratio of reproductive workers and colony size is contained in the data. Thus, our interest is focused in how the relationship forms and affects hierarchy structure, and how the colony size of an ant species plays a role in the population dynamics of the ant colonies.We develop a theoretical model incorporating metabolic costs for the case of H. saltator in order to describe the non-linear hierarchical establishment. Furthermore we combined metabolic theory with hierarchical theory to see how costs and benefits of being a reproductive member can influence colony population dynamics. We found that the colony size regulate the proportion of gamergates in the colony by making it converge to an optimum value. The vital life parameters are critical in the bounds for gamergates' proportion. Moreover, the metabolic-related parameters have an impact in the colony size growth and gamergates proportion growth, as well. In addition, metabolic parameters keep a correlation with vital parameters. Although, the only values that presented no changes for the colony size and for proportion of gamergates were the scaling exponents δ_g and δ_n.