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

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Abstract: Many organisms form groups to obtain benefits that they wouldn't have been able to accomplish otherwise e.g. improved foraging, predator evasion, and brood care. Theory suggests that increased group size reduces overall metabolic costs, thereby increasing the efficiency of the group. Furthermore, the notion of group size leads to competition within the group for power. These competitions lead to a formation of a hierarchy. To test the metabolic theory, we investigate the hierarchal dynamics and population dynamics of the ant species *H. saltator*. We obtained data from a lab showing the relationship between the ratio of reproductive workers and colony size, and we are interested in how it forms. We are interested on how the colony size of an ant species plays a role in the population dynamics of the ant colonies. While there are many previous works that have investigated the hierarchy of *H. saltator*, we are the first to develop a dynamical system based on intrinsic costs and demands to model *H. saltator* hierarchal establishment. We found the equilibria of the system and performed sensitivity analysis on it. We also performed bifurcation analysis, and we found that the most sensitive parameter is the cost of being a gamergate.