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The dynamics of social queues

A wide variety of animals are known to form simple hierarchical groups called social queues, where individuals inherit resources or social status in a predictable order. Queues are often age-based, so that a new individual joins the end of the queue on reaching adulthood, and must wait for older individuals to die in order to reach the front of the queue. While waiting, an individual may work for her group, in the process often risking her own survival and hence her chance of inheritance. Eventually, she may survive to reach the head of the queue and becomes the dominant of the group. Queueing has been particularly well-studied in hover wasps (Hymenoptera: Stenogastrinae). In hover wasp social groups, only one female lays eggs, and there is a strict, age-based queue to inherit the reproductive position. While the dominant individual (queen) concentrates on breeding, subordinate helpers risk death by foraging outside the nest, but have a slim chance of eventually inheriting dominance. Some explanations for this altruistic behavior and for the stability of social queues have been proposed and analyzed [1, 2]. Since both the productivity of the nest and the chance to inherit the dominant position depend critically on group size, queueing dynamics are crucial for understanding social queues, but detailed analysis is lacking. Here, using hover wasps as an example, we demonstrate that some basic queueing theory[3] and non-homogeneous birth and death processes are useful for analyzing queueing dynamics and the population demographics of social queues. Our work leads to better understanding of how environmental conditions and strategic decision-making by individuals interact to produce the observed group dynamics; and in turn, how group dynamics affects individual decision-making.

REFERENCES

[1] J. Field, A. Cronin, and C. Bridge. Future fitness and helping in social queues. *Nature*, 441:214–217, 2006.

[2] H. Kokko and R. A. Johnstone. Social queuing in animal societies: a dynamic model of reproductive skew. *Proc. R. Soc. Lond. B*, 266:571–578, 1999.

[3] H. Toyoizumi. Sample path analysis of contribution and reward in cooperative groups. *Journal of Theoretical Biology*, 2008.