Modeling social network dynamics in the spotted hyena (*Crocuta crocuta*)

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Introduction

- Spotted hyenas (*Crocuta crocuta*) maintain a complex social structure.
- Sub-Saharan African hyenas live in large clans consisting of 10 – 100 individuals.
- Females are dominant to all males and the social structure is matrilineal.
- Each hyena has a specific rank determined by its matriline, which affects the individual's access to resources.

- We focused on the Talek clan in Maasai Mara National Reserve, Kenya.
- Over the 22 year study, 80,000 observations of hyena interactions were collected, along with profiles of each hyena.
- We are developing a model which will show how matrilineal rank, fitness, and connectivity of the network changes over time.

Methods

- All data were divided by year for females in the Talek clan.
- Dyadic connections were calculated using the Twice-Weight Association Index.

$$AI_{a,b} = \frac{obs_{a\_with\_b}}{obs_{a\_without\_b} + obs_{b\_without\_a} + obs_{a\_with\_b}}$$

Equation 1. Calculated from observations of two hyenas *a* and *b*

- Matrilines were determined by maternal data.
- Ranks were determined from dyadic aggressive interactions.

$$CB = \frac{1 + B + \sum_{i=1}^{B} b_i}{1 + L + \sum_{i=1}^{B} l_i}$$

Equation 2. The Clutton-Brock Index uses dyadic aggressive behavior to calculate social rank.

- Fitness was calculated for all individuals *h* and matrilines *m*.

$$fitness_h = \frac{births_h}{\sum_{i}^{N} births_i} \qquad fitness_m = \frac{births_m}{\sum_{i}^{N} births_i}$$

Equations 3 and 4. Ratio of individual and matriline births to total births.

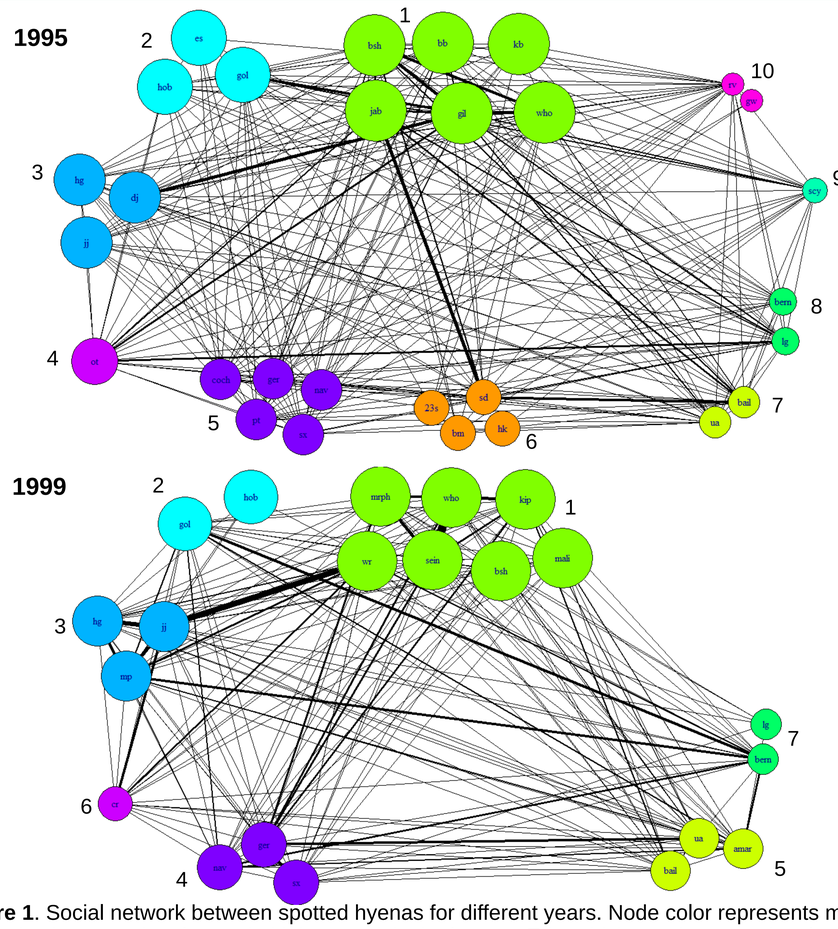

Figure 1. Social network between spotted hyenas for different years. Node color represents matrilines. Node size is proportional to rank; highest rank is the largest. Edge-thickness is proportional to strength of the association.

Preliminary Results

- Connectivity and matriline rank appear to affect trends in rank over time.
- Matrilines of higher ranks maintained their rank over time.
- Lower ranked matrilines were less stable and more likely to disappear or increase in rank.
- Increases in rank appear to be affected by connections with higher ranked individuals.

Future Work

- Create a mathematical model which will predict fitness over time based on rank and network connectivity.
- Compare the effects of internal connectivity within a matriline and external connectivity between matrilines.
- Generalize the model to apply to other complex social network structures.

References

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Acknowledgments: This work was conducted with funding from the National Institute for Mathematical and Biological Synthesis, an Institute sponsored by the National Science Foundation, the U.S. Department of Homeland Security, and the U.S. Department of Agriculture through NSF Award #EF-0832858, with additional support from The University of Tennessee, Knoxville. We thank Kay Holekamp for allowing us to use the data collected from her lab.

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