Independent Project – Final Script [redacted] and [redacted]
BIO 295 April 21, 2014

Project Title: The Evolution of Social Monogamy: Not What You Would Expect!

Citation: Lukas, D. Clutton-Brock, T.H. 2013. The Evolution of Social Monogamy in Mammals. Science. 341(6145): 526-30. [Available from: www.sciencemag.org]

Introduction:

This article evaluates the evolutionary reasons behind social monogamous systems in mammals, which is also strongly associated with genetic monogamy. Lukas and Clutton-Brock indicate that the primary theories for social monogamy are derived from mate guarding in species where female territories were too far apart for males to mate guard more than one female at a time and parental care. Researchers used data from more than 2500 mammals and the social systems observed were classified as solitary, socially monogamous, or group living; paternal care was classified as males regularly participating in feeding and carrying offspring. The study classified 68% of species as solitary, 9% as socially monogamous, and 23% as group living. The researchers also found that social monogamy occurs more frequently in primates and carnivores than in other orders. Phylogenetic reconstruction showed that the ancestors of mammalian species were made up of solitary females. The study used parsimonious reconstructions to suggest that the current distribution of social monogamy requires it to have transitioned from solitary living to social monogamy 61 times independently; it also suggested that social monogamy transitioning from group living only occurred once (in primates) and that group living generally transitioned from social monogamy. Field studies found no paternal care in 41% of socially monogamous species used. Analysis of transitions suggested that paternal care is a consequence rather than a cause of social monogamy. Phylogenetic analysis also suggests that male infanticide and social monogamy are independent traits.

The researchers found that socially monogamous species evolved from solitary ancestors where males could only mate guard one female at a time. Socially monogamous species were actually found to have much lower population density than solitary species (median of 15 individuals/square kilometer versus median of 156 individuals/square kilometer). Analyses of patterns of sexual dimorphism also suggest that competition between females may be more intense in socially monogamous species than in solitary. The high incidence of social monogamy in Primates and Carnivora compared with more herbivorous orders suggests that the evolution of low range-overlap in females and social monogamy may be a consequence of a reliance on resources of high nutritional quality but low abundance.

Ultimately, Lukas and Clutton-Brock found that the most recent common ancestors of socially monogamous mammals were made up of solitary females and roaming males. They determined that the socially monogamous system developed because males were more likely to be reproductively successful if they stayed with one female because the ancestral females were competitive, intolerant, and sparse.

Three theory concepts from class:

Phylogenetics (Ackerly, D.D) - Phylogenetic trees are graphical interpretations of the evolutionary history of a group taxa (which can consist of populations, species, genera, phylum, kingdom, etc). The trees are made up of nodes, which connect branches, where the taxa are labeled on the tips. Nodes of these trees indicate a possible common ancestor between two connecting branches. Generally, nodes connect multiple branches, this compilation of branches is called a clade. Ultimately, phylogenetic trees give us an idea of how an organism evolved, by illustrating which groups it was initially derived from, or the steps it took to speciate from their ancestral state.

Furthermore, there are several different methods for deriving a phylogenetic tree including the Bayesian method, Parsimony methods, Distance methods, and Likelihood methods. The Bayesian method uses prior beliefs about a taxon and compares it to what is currently known about it to create the most likely tree. The Parsimony method involves creating the tree with the least amount of nodes, or the fewest changes to get to one particular trait or taxon. The Distance method's goal is to make a tree that mirrors the evolutionary distance between two taxon and their distance on the tree. Lastly, the likelihood method that is most likely. In other words, it is the tree that best explains the observed data. In order to assure that the resulting tree is correct, researchers generally integrate more than one method. In other words, compare trees compared through differing methods, and compile them. Once the trees are compiled into one they are adorned with bootstrap values that indicate how often the particular nodes, connections, lineages, and branches were created the same way. There are several ways in which the traits on a phylogenetic tree grouped including, but not limited to, morphologically, genetically, etc. Additionally, phylogenetic trees can be rooted, unrooted, include an outgroup, or not. Ultimately, a phylogenetic tree illustrates the evolutionary history of a taxon.

Mating Systems - Mating systems are a result of individual reproductive strategies. In other words, the best mating strategies and behaviors for the individual will proliferate through the species, genera, etc (Clutton-Brock, 1989). This indicates that there is going to be wide variety in the types of mating systems between species, possibly between different populations of the same species, as well. Mating systems also depend on female/male availability, natural selection, sexual selection, and, of course, fitness (Clutton-Brock, 1989). There are several different mating systems including, but not limited to, (social) monogamy, polygyny, harems, leks, polyandry, polygynandry, and promiscuity. Monogamy is defined as one male and one female mating with only one another. Social monogamy involves a similar thing, but it also includes "sneak" copulations with other members of the population (Lukas and Clutton-Brock, 2013). There are two forms of polygamy in the animal kingdom: polygyny and polygynandry. Polygyny involves one male and several females, and polyandry involves one female with several males. Polygynandry is when two males have an exclusive relationship with two females. This is generally illustrated in family-like units. For example, two brothers find two females, and the more dominant brother gets to mate, etc. Promiscuity is when there is no discrimination in who mates with whom. Then there are also "strange" mating systems, like harems (one male defending a territory containing several females) and Lek mating systems (a group of males

displays in the same area and mates with females that pass by). Overall, mating systems have evolved to increase the individuals' fitness. For instance, some mating systems have evolved as a way to combat or increase sperm competition.

Parental Investment - Parental investment differs between males and females in different mating systems. Ideally, the male provides sperm and moves onto the next female, which will allow for the highest level of fitness. In fact, males can theoretically find and fertilize female's eggs at a faster rate than they can produce them! However, the female must put more energy into producing the egg, and ensuring they survive after fertilization. In other words, her investment is converting her resources (food, water, etc) into nutrition for the eggs/offspring. Females tend to invest more parental care and energy because there is no doubt that the resulting offspring are her own; however, the male can never be certain that the offspring are his. Additionally, females invest more time and energy into their offspring because it cost so much energy to create the egg. It is more beneficial to ensure her offspring survive than it is to produce another egg and hope this one survives on its own. Ultimately, a male's fitness is limited by the number of eggs females produce, and a female's fitness is limited by the amount of resources she has access to. In situations where the female cannot obtain enough resources for herself or her offspring, it is necessary that the male provide parental care. Theoretically, in these situations the male cannot find and mate with other females. Therefore, he must put all his resources into the few eggs he has fertilized to ensure his successful fitness. Overall, if males are providing parental care, they are not mating with other females (because they don't have time or energy to provide for another family unit). As they are only mating with one female, the chance that several of their offspring will survive are limited unless he ensures that the female has enough resources to care for the offspring. In other words, fewer offspring mean more parental care, as this ensures offspring survival and increases the male's fitness.

Link between theory (from class) and paper:

1. Lukas and Clutton-Brock used concepts of phylogenetics to determine whether or not their theory of the evolution of social monogamy was correct. The researchers used parsimonious and Bayesian methods to construct a representative phylogenetic tree. Ultimately, the researchers found that there social monogamy evolved independently 61 times. This shows that there is not one common ancestor to which we can attribute this mating system. They found that social monogamy evolved from a system that involved female competition, female intolerance, and low female densities. In other words the ancestral state, as far as social structure, was solitary females and roaming males.
2. This article discusses the evolution of a mating system - monogamy. More specifically, Lukas and Clutton-Brock evaluate the development of social monogamy. As aforementioned, social monogamy is a system that involves one male and one female mating with only one another (theoretically). They were also able to identify qualities about socially monogamous species, and what about their evolutionary history led them to this specific mating system.

3. In most socially monogamous systems, the males and females both contribute some form of parental care. This may increase both parents' fitness; however Lukas and Clutton-Brock made a point to highlight that social monogamy came before shared parental care. In other words, parental care is a result of social monogamy. It is a result of the male's confinement to one female. As a result, he produces only so many offspring, and provides parental care to increase his own fitness.

Movie Description:

Initially, we were going to create a PowerPoint that "presented itself." However, we changed our minds, and decided to produce a newscast. We realized that this would allow us to explain our rather complex article without using any writing, but also presenting some videos and images, as well. We begin the newscast by introducing the article we read. The first concept we define is mating systems. More specifically, we found a YouTube video that perfectly defined each mating system, and goes into social monogamy v. (sexual) monogamy. After this, we discuss the authors' results - highlighting that social monogamy did not evolve after parent care (our second theory concept). We wanted to make sure the class understood that social monogamy (and as a result, increased parental investment) evolved because females were widely dispersed at low densities. Therefore, males had to expend more energy to find mates. Once they found mates, they were unlikely to mate with more than one female. In order to drive this point home we created a short film about a male meerkat seeking a female meerkat. We made the video comical. However, the point we are trying to get across is that females are so few and far between that once a male finds a female he is unlikely to go out looking for another. Following this segment, we discussed the authors' methods. In this segment, we really try to highlight the way the authors used phylogenetic trees (our third theory concept) to understand why this mating system may have evolved. We even found a YouTube video that defines phylogenetic trees and goes into their structure. Lastly, we concluded our video by re-summarizing the authors' results in what would be considered the "discussion" section of a scientific article. We mention that the authors compared modern socially monogamous mammals to group living and solitary species, we give examples of mammals in the different living systems, we reiterate that parental care is a result of social monogamy, and we repeat why social monogamy evolved. Overall, we summarized the paper we read by discussing the authors' methods and results, providing video examples that define key terms, and providing examples of different systems.

References

Ackerly. D.D. Phylogenetics and Comparative Methods. Princeton University Press. 117-125

Clutton-Brock, T.H. 1989. Mammalian Mating Systems. *Proceedings of the Royal Society of Biological Sciences*. 236(1285): 339-372.

FEEDBACK FROM INSTRUCTOR:

Hi [redacted] & [redacted],

You did an excellent job on the **movie**. You included all elements I asked for and satisfied the criteria indicated in the rubric. You earned full credit for your movie.

You made a really nice movie, very professional. Good job!

You provided nice background information and explained methods and theory concepts. A minor comment is that although the video clip of Hank Green was good, it was a little long and took up 1/3 of your entire movie.

But as I said, overall very well done!

Here's what your peers said about your movie:

- *well explained video and presented the study very well, good examples*
- *Presented the study very well! Loved the music and everything about it.*
- *Good format and info*
- *Good job with the green screen – looks great*
- *Liked the anchor set up*
- *Good use of another video(s) to explain concept, great music*
- *Good dialogue, lots of diversity in film types*
- *Creative*
- *Good use of other resources*
- *Really liked the background changes*
- *Really awesome video!*
- *It was good to see Iris talk with a strong voice!*

I would like to echo the last comment; it was great to see you talk so confidently, Iris! Good job!

Overall, you did an excellent job on the **final script**. You included all elements I asked for and satisfied all of the criteria indicated in the rubric. You earned full credit on this assignment.

You did a particularly nice job on defining your theory concepts and explaining your movie. You put a lot of thought into this and it shows. Great job!

Best,
D. Magdalena Sorger