Lizy Brautigam Final Project Summary

**Multiple Expressions of Gender in Organism Sexes**

Over time, a sex of a species may develop two different mating strategies based on or resulting from different mating behaviors. A common example of this deviation is the large male fish and the small, 'sneaker' male fish. The large male has some success with the female, and the smaller male, being unable to provide resources for the female, must sneak in to spawn and fertilize the eggs of the female. These two mating strategies must both result in offspring, or one would give way (genetically, and over a long period of time) to the other.

Since the large male and the sneaker male have reproductive success, their genes are secure in the next generation. And, perhaps, the smallest, sneakiest male had more success than other males of its own size. In the next generation, its offspring that become sneaker males bring down the average size of the sneaker males by just the smallest fraction. If the environment selects for a certain phenotype that aids this mating strategy, then the physical and behavioral traits of each type of male becomes specialized for their reproductive strategy.

But, these may just be the mating strategies of younger, smaller fish, versus older, larger fish. What is the difference between fish size and difference genders within a sex?

A sex with more than one gender representation fulfills a few requirements. Both genders have reproductive strategies that are different, and phenotypes that represent and aid in those differences [7]. Both have the same chromosomal makeup, and must be sexually mature and capable of reproduction.

Organisms with haplodiploidy-chromosome systems, such as bees, wasps, and ants, have two kinds of females- the queen and the workers. In bees, the queen is much larger than the workers (all sisters), but they all have the same amount of chromosomes (while the males only have one set) [6]. The queen is sexually mature, and the workers, while able to lay unfertilized eggs infrequently, fulfill different functions in the hive social structure. They are not capable of reproduction at the rate of the queens, and thus cannot be considered a separate gender.

There are examples of multiple genders all over. In orangutans and common side-blotched lizards, there are multiple genders within a sex, with different, but successful, reproductive strategies.

Orangutans (genus *Pongo* with two similar species) originate from Indonesian islands. Male orangutans are known for their loud, long calls, strong odors, their size, and their large territory [3]. Within a flanged male's territory (so-called because of the large pads on their cheeks) reside the individual territories of his small female harem.

When a male orangutan reaches puberty (between 5-8 years) he becomes sexually mature, and grows to the size of the female orangutan [5]. There his development pauses. This male, who has no flanges, makes no loud calls, and is sexually mature, is called a subadult male. They travel on the edge of the large males' territories.

Until recently, the transformation of a young male orangutan into large, flanged male orangutans was considered a natural progression, a second puberty that always occurs between 8 - 13 years of age. Scientists assumed that subadults were just pausing on the developmental path to full, flanged adulthood. However, a new study shows that the stressful relationship between unflanged and flanged males hinders that second puberty [2].

The unflanged male may also remain so if there is food scarcity: the rapid transformation into a flanged male is metabolically exhausting [2]. The unflanged male may not undergo the transformation until he is 15-17 [5]. In captivity, the absence of a flanged male from a group results in the quick transformation of a younger male [3]. A study done about the testosterone levels of male orangutans at different points in development actually showed that the males who are in the process of that second puberty to become flanged males have the highest rate of testosterone and stress-related hormones- it

is at this stage in development that there may be more than one male developing, so an altercation is more likely [4].

Flanged and unflanged males also have different mating strategies. While the flanged male attracts females with his strong odor and loud calls, the unflanged male must sneak into the flanged male's territory and often ends up force copulating with a female [2]. While forced copulation is not uncommon for both orangutan males, the unflanged males have a much higher percentage of these couplings, overall.

Both flanged and unflanged males successfully reproduce, but their phenotypes and mating strategies are different.

Side-blotched Lizards are common in the southwest, with many morphs and subspecies. Among the males of the common side-blotched lizard (*Uta stansburiana*), there are three genders that have different mating strategies. Each different gender morph is formed by the "organizing" effects of hormones- as the lizards developed, different levels of hormone resulted different morphs of male lizard [7].

The orange-banded male has vast territories, often containing many females. He is large and territorial, and is able to provide females with multiple resources [source 1]. Blue-banded males have enough territory to provide for one female, and guard the female. He is slightly larger than the female, but smaller than the orange-banded male. The blue-banded male can fight off the yellow-banded male, but not the orange-banded male. Yellow-banded males do not have their own territories- they stay at the fringes of the orange male's territory and will mate with a female upon opportunity. Each male gender undercuts one and is undercut by the other, forming an equal system of checks and balances. While each reproductive season results in a different balance of colored bands, all are represented each season. This shows that each reproductive strategy works, each phenotype is optimized for its reproductive strategy.

For some types of fish, it's possible that the large and small morphs may be working together. In *Evolution's Rainbow*, Joan Roughgarden speculates that "The idea of helping at the nest in return for reproductive access… works for how multiple genders are integrated into a social system." [7] Roughgarden has also considered the possibility that the smaller morph may help make the larger (and usually more aggressive) morph less threatening to females.

If the behavioral differences in mating systems didn't work for the males, the separate genders would not exist. Every year, the balance between the three banded lizard morphs changes depending on which was the most successful reproductively, but all three are consistently present.

My project illustrates these separate genders by representing their behaviors and phenotypic differences in character designs. While differing in size, color, pose, expression, and body language, the characters exhibit the differing traits of their species. The characters in each picture attempt to show their best traits, assumedly to an interested female.

The orangutans are designed to be industrialist businessmen, one very prosperous (the flanged male on the left), and the other, not so much (the unflanged male on the right). Both have had some amount of success, but the flanged male has the advantage of resources. The unflanged male, whom I believe to be a clerk of mild importance and large aspirations, is definitely doing well enough for himself, but certainly does not has as many resources as the flanged male. The lizards are reminiscent of the romanticized cowboys of the early 20$^{th}$ century novels, while keeping their bow-legged lizard legs.

1. Judson, Olivia. *Dr. Tatiana's Sex Advice to All Creation*. New York: Owl Books. 2002. Print
*Dr. Tatiana's* discussed side-blotched lizards' 'rock-paper-scissors' method of checks and balances clearly (pg. 80-81).

2. Maggioncalda, Anne Nacey, and Sapolsky, Robert M. "Disturbing Behaviors of the Orangutan." Scientific American, Inc. 2009.
This article covers the new findings related to the causes of orangutan unflanged-males' developmental delays, as well as their copulation behaviors.

3. *Pongo Foundation (Orangutan Conservation and Research)*. Orangutan Development. Web. 21 Nov. 2013. <http://www.orangutan.nl/orangutan_development.htm>.
Statistics and specific ages of orangutan development, including up-to-date information on unflanged males' developmental delays in captivity and acknowledging that specific reasons for this development is only speculated.

4. Emery Thompson, Melissa, Zhou, Amy, Knott, Cheryl D. "Low Testosterone Correlates with Delayed Development in Male Orangutans". *PLoS ONE* (2012) 7.10. Web. 21 Nov. 2013. <http://www.researchgate.net/publication/232281829_Low_testosterone_correlates_with_delayed_development_in_male_orangutans>.
A study about the testosterone levels of orangutan males at different ages and levels of maturation.

5. Schwartz, Jeffrey H. *Orang-utan Biology*. New York: Oxford University Press, Inc., 1988. Ebook. <http://books.google.com/books?hl=en&lr=&id=K6XZOOinwPAC&oi=fnd&pg=PA123&dq=orangutan+development+subadult+male&ots=vBPnK2u2Xr&sig=-Rm1eGLCrPpan74xTKMRxPS1kJw#v=onepage&q=orangutan%20development%20subadult%20male&f=false>.
This biology ebook clarified orangutan male development; includes a detailed list of changes an unflanged male goes through to become a flanged male.

6. Gempe, Tanya, Beye, Martin. "Sex Determination in Honeybees." Scitable by Nature Education. 2009. Web. 22 Nov. 2013. <http://www.nature.com/scitable/topicpage/sex-determination-in-honeybees-2591764>.
The site has a basic overview of honeybee genetics, including queen and worker bee differences and male vs. female chromosomal differences.

7. Roughgarden, Joan. *Evolution's Rainbow*. Los Angeles: University of California Press, 2009. Print.
This project wouldn't be started if not for Roughgarden. I'm using both the theory of social selection, as well as her concept of organism genders outside humans, and even the side-blotch lizard descriptions. Roughgarden also explains the evolutionary standpoint of multiple genders.