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### Term Project Summary

Thriving social and philosophical movements and the growing number of LGBTQIA groups nowadays embrace different sexualities and appeal for the rights of sexual minorities, and people who do not contain their own personalities in boxes called biological sexes or label them with 'man' or 'woman'. Whether these sexualities that are considered abnormal in many societies should exist become a question for some people and constant debates are held because some people believe that sexual attractions except between men and women are either unnatural or immoral or somehow pathological. Some people wonder why evolution has not wiped out these 'freaks' yet because they think individuals who do not produce any offspring will never be favored by the natural selection. To me, how do people experience and express them sexually in various ways are neither diseases nor failures of evolution; rather, they are just choices that people make. Mother nature herself does not approve that homosexuality is an error, which is actually common among animals. Homosexual behavior has been seen in many species, not only limited to mammals, but also a common practice in birds, reptiles, and even insects and arachnids as well. A famous example for this is the same-sex male couple of chinstrap penguins in Central Park Zoo located in New York City. Some species not only espouse homosexual intercourses but also have developed a unique social structure that espouses different genders of individuals. Based on my research into the mating system of *Calidrius pugnax* and a short song, my term project is meant to encourage people who are currently having a difficult time because they are struggling with their sexual identities and to explain to people who may not necessarily understand that the variety genders of humans also have its biological basis in nature.

*Calidris pugnax*, also known as *Philomachus pugnax*, is a kind of piper whose habitats are mostly near marshes, swamps, or shorelines. The population breeds in palearctic areas during summers and migrates south to warmer regions, stretching as far as southern Australia. The neck plumage of male birds during their breeding seasons looks like a ruffed accessory which was worn from the mid sixteenth century to the mid-seventeenth century in western Europe. Like mandarin ducks and peacocks, the ruff is one of a dimorphic species, which means the body colors of males and females can be distinguished from each other. What makes the ruff distinct from the other two dimorphic birds is that they have more than two genders; instead, they have four. There are three plumage patterns in the males as well, and based on their plumage color, males in each category have developed completely different mating tactics of their own [1][2]. These four genders can be broken down into the "Independent", the "Satellite", the "Faeder", and the female. Except the latter one, the others are all biologically male.

The independents are the aggressive males that will protect their own territories and fight against those who show interest in sacking this territories or mating with the females in this territory. The independents have more variety of patterns for their plumage, but their neck ruffs and head tufts tend to be darker than the other two genders [2][3]. In terms of their body size, the independents are bigger than individuals of other three genders. [2] The independents spend up to 90 percent of the day on their lekking territory [4].

The satellites, on the other hand, do not defend or manage territories. Instead, satellites are busy flying between different territories, following, and eagerly accommodating females. The body colors of the 'Satellite' males are the opposite of the 'Independent' ones, which are white or light colors and they have adopted a smaller body size, as compared to the independents, for

better performance on searching and foraging [4]. There is also a clear divergence of mating time between the independents and the satellites. The satellites mate much earlier than the independents [5]. While it seems that being a ‘Satellite’ may be more beneficial, their population only consists of 5-15% male ruffs [6] [7] [8]. Both the independents and the satellites will attend leks, which are competitive displays for pleasing the females. Although, attending leks also contributes to the mating success, both independent and satellite males do not invest all their time in leks, and the overall population of males who attend leks are low, approximately 12 percent [8]. There are basically three strategies the independents and the satellites employ when they are off-lek, which consist of, “*Following*,” which is directly pursuing, “*Intercepting*,” which is waiting for females in a fertile site for potential rearing, and “*True Lekking*,” which is waiting for females without any other outside resources [8].

The ‘Faeder’ is a new kind of male which was only discovered in 2006. The word ‘faeder’ in Old-English means father [1]. These males have plumage that look like similar to the females’, but their blood samples indicate that they are 100 percent male, and what is more intriguing is that their feminine plumage will remain for their entire life, making *Calidrius pugnax* the sole example in all avian species to have “permanent, non-conditional, alternative mating strategies’ to mimic females [1]. Their average body size ranges between the size of a female and an independent [1]. The sexual intercourses relating to the faeders show a high ratio of homosexual copulatory practice among the ruffs, as the faeders are found mating more often with males of other genders than with females [1]. How do the ruffs evolve such an unusual social structure? Preference of the females contributes heavily to this situation.

The ruff is one of the Polygynous species but the rate of Polyandry practice among the females is also high among all avian lekking species [10] [11]. Because male ruffs do not provide any food resources or parental care and male ruffs are not able to restrict the activities or force cooperation of the reeves, female ruffs can choose mates by their own preference. It appears that the females prefer to mate with different genders of males [5]. Therefore, sometimes an independent will try to approach the satellites and invite them to its territory if there is no female present. It would be the best for all independent males to refuse satellites entering into their territories, but if a satellite is allowed in, then females will only visit that territory and not independent-only territories. Therefore, independents have to accept this rule, and, as a result, the satellites will fly between invited territories and sneak mating opportunities, but the independents will try their best to manage the satellites to prevent them from mating with females or sabotaging copulatory processes. If their attempts are proved to fail, the independents will evict the satellites [7]. Based on this hypothesis, the faeder’s existence may also be the result of the females’ preference. Thus, it is reasonable to conclude that the female’s choice is the key factor that drives the development of distinctive gender role and mating tactics.

I was fascinated by this special species and made a music track that incorporated different characteristics from the four genders of *Calidrius Pugnax* each with different musical instruments, much like the character voices in the video game *Don’t Starve*. I worked on my computer with software such as GarageBand, Adobe After Effects CC, Adobe Audition CC, and Audacity. I have used GarageBand often to create original sounds, but it was easy to edit audio files which I had downloaded online, as well, because it showed the notes while I was composing. Also, because I was not very good at composing, I found some free sounds on websites like Freesound.com. In AE or Audition, I cut the record, pasted it, and rearranged the lyrics. After I figured out each gender’s voice, I put them into four composition panels in AE and did some adjustments of timelines. Sometimes, even if I turned the volume down to the lowest volume, the sound could still be too loud and causes disharmony. Audacity was very helpful because it allowed me to make change to the original audio file, in case if the adjustment of

volume and tone made in AE was not satisfying. AE and GarageBand also made it possible for me to alter the tone and volume of the same audio record easily. I also added background sounds and fit them in the composition to give an emotional touch. My final creative work was a 60-second-long music file.

I figured out the independent-owned territory was a perfect setting for my song because it was the only place which involved every gender. Therefore, the independent sound was heard throughout the whole song and this sound played the role of the 'landlord', who was dominant and aggressive, and I chose the French Horn for the Independent. The satellite played the role of the 'knight' because it was invited by its landlord, but it had its own strategies to keep balance between the landlord's order and its own interests. Because of the satellite's personality, I decided to choose more lively instruments, the Grand Piano, for this gender because these satellites were constantly flying, following, and 'flirting' with the females. The faeders had a more complicated situation because they had more sex with other males than with females as I had mentioned in my proposal (only one case in 25 cases) and also their plumage was more like females' than males'. Faeders were presented by me as their characters were more like 'concubines' or 'lovers.' As a result, I rendered a more female-like sound to the faeders using a clarinet. Females, whose preferences construct the ruff's social structure, took a dominant position in my song because all males (except maybe the faeders) were trying hard to display, to show-off, to attract attention. Females were 'princesses' in the common fairytale stories because they had a lot of admirers and females were picky in choosing their partners. The female voices, compared to others, tended to be more dynamic and had more small variations in terms of their responses toward the males. I chose Dizi for that reason because a little bit change made to the tone and volume of the Dizi changed the feeling and emotion of the songs heavily. If a female was interested in mating, she put her voice in synchrony and in harmony with the accepting male for a period of time. Otherwise, the female produced either no response or a brief, careless answer. A female can afford to do so because it does not receive any resource from her partners, and a male cannot restrict her from mating with other males as well. Therefore, it is easy to understand that the formation of the social structure of the ruffs is actually shaped by females' preference. For the independent and the satellite both displayed to the female, but because the female favors the independent, the independent got the chance to sing with the female at last. In my composition, besides the major storyline, which involved the Independent and the female, I insert a small interaction between the faeder and the satellite into my composition as well.

I was really struggling to balance scientific ideas and the statement I want to make. I felt like I had to let the female and the independent together, but I did not want the satellite and the faeder to look like miserable also. For my song, I hope all people who have different identities can live and love freely because everyone deserves it. Love is not a sin. Not only the prince and the princess get married and live a happy life, but the concubine and the knight also manage to escape from the castle and live happily ever after as well. I hope more people can actually understand this variety in nature and do not feel shame about it.

## Bibliography

- [1] Jukema, Joop and Piersma, Theunis. 2006. "Permanent female mimics in a lekking shorebird"(PDF). *Biology Letters* 2 (2): 161–164.
- [2] Höglund, Jacob and Lundberg, Arne. 1989. "Plumage Color Correlates with Body Size in the Ruff (*Philomachus Pugnax*).” *The Auk* 106(2): 336–338.
- [3] Hill, Wendy L. 1991. "Correlates of Male Mating Success in the Ruff *Philomachus Pugnax*, a Lekking Shorebird.” *Behavioral Ecology and Sociobiology* 29(5): 367–372.
- [4] Bachman, G., and Widemo, F. 1999. "Relationships between Body Composition, Body Size and Alternative Reproductive Tactics in a Lekking Sandpiper, the Ruff (*Philomachus Pugnax*).” *Functional Ecology* 13(3): 411–416.
- [5] van Rhijn, Johan. G. 1985. A scenario for the evolution of social organization in ruffs *Philomachus Pugnax* and Other charadriiform species. *Ardea* 73: 25-37.
- [6] van Rhijn, Johan. G. 1983. On the maintenance and origin of alternative strategies in the ruff *Philomachus pugnax*. *Ibis* 125, 482–498.
- [7] Hugie, D. M. and Lank, David. B. 1997. The resident’s dilemma: a female choice model for the evolution of alternative mating strategies in lekking male ruffs (*Philomachus pugnax*). *Behavior Ecology* 8: 218–225.
- [8] Widemo, F. 1998. Alternative reproductive strategies in the ruff *Philomachus pugnax*: a mixed ESS? *Animal Behavior* 56: 329–336.
- [9] Lank, David B., and Constance, Smith M. 1987. "Conditional Lekking in Ruff (*Philomachus Pugnax*).” *Behavioral Ecology and Sociobiology* 20(2): 137–145.
- [10] Colwell, Mark A. 2010. Mating Systems. Page 45-66 in *Shorebird Ecology, Conservation, and Management*. First edition. Los Angeles: University of California Press.
- [11] Lank, David B. Smith, Constance M. Hanotte, Oliver. Ohtonen, Arvo. Bailey, Simon. Burke, Terry. 2002. "High frequency of polyandry in a lek mating system”. *Behavioral Ecology* 13(2): 209-215.

## Annotated Bibliography

- [1] Jukema, Joop and Piersma, Theunis. 2006. "Permanent female mimics in a lekking shorebird"(PDF). *Biology Letters* 2 (2): 161–164.

Females mimics are common among many species but there are few examples of animals who adapt female mimicry as a lifelong, non-conditional, alternative strategy. This article is about the discovery of the new 'Faeder' gender in *Calidrius pugnax* by scientists Joop Jukema and Theunis Piersma in 2006, which turns out to be the sole example who practice permanent female mimicry among all avian species. The existence of the 'Faeder' suggests that there is a third mating strategy of the ruff that needs to be explored.

- [2] Höglund, Jacob and Lundberg, Arne. 1989. "Plumage Color Correlates with Body Size in the Ruff (*Philomachus Pugnax*).” *The Auk* 106(2): 336–338.

In this article, Höglund and Lundberg measured ruff samples from the collections of the British Museum in Tring, England, and the Natural History Museum in Stockholm, Sweden. The results of their research suggested that the colors of plumage were strongly related to different sizes of ruffs. Black individuals always had bigger bills, tarsus, wings, and tail length than the individuals who were in brown or white.

- [3] Hill, Wendy L. 1991. "Correlates of Male Mating Success in the Ruff *Philomachus Pugnax*, a Lekking Shorebird.” *Behavioral Ecology and Sociobiology* 29(5): 367–372.

The independents are mostly dark, and the satellites always have lighter body colors, like white. Hill conducted several research projects during May and June of 1985 and 1987 in Sweden to determine whether the body colors of the males contributed to their mating success. According to his data, Hill found that three characteristics were related to mating success, which did not include the degree of darkness of their body color. The three beneficial traits for mating success consisted of "high frequency of visits by satellites to an independent male's residence, consistency of lek attendance, and low rates of aggressive behavior".

- [4] Bachman, G., and Widemo, F. 1999. "Relationships between Body Composition, Body Size and Alternative Reproductive Tactics in a Lekking Sandpiper, the Ruff (*Philomachus Pugnax*).” *Functional Ecology* 13(3): 411–416.

Bach and Widemo explain that the independents and the satellites had different tactics for mating. While the independents spent most of the day within their territory, the satellites were hovering over territories. Because the independents need aggressive behavior to defend their territories, Bach and Widemo argued that the independents were larger than the satellites. The satellites invested most of their day to foraging food or following reeves and expended their energy on flying, so they could gain more benefits if they evolved into a smaller body size, which was better for flying.

- [5] van Rhijn, Johan. G. 1985. A scenario for the evolution of social organization in ruffs *Philomachus Pugnax* and Other charadriiform species. *Ardea* 73: 25-37.

This article gave a general introduction on the migration patterns of the ruffs and also van Rhijn's personal hypotheses of how prototypes of the independents and the satellites diverged into two genders that had completely differed mating tactics and body features. Van Rhijn explained why female preference stimulated the development of the gender structure.

- [6] van Rhijn, Johan. G. 1983. On the maintenance and origin of alternative strategies in the ruff

*Philomachus pugnax*. *Ibis* 125, 482–498.

Van Rhijn has tried to explain the origination of different mating strategies of the independents and the satellites and how their strategies survived through evolution. According to the data he collected, he found that the level of copulatory success was almost equivalent between the independents and the satellites. He suggested that the female preference contributed to the formation of the social structure of the ruffs.

[7] Hugie, D. M. and Lank, David. B. 1997. The resident's dilemma: a female choice model for the evolution of alternative mating strategies in lekking male ruffs (*Philomachus pugnax*). *Behavior Ecology* 8: 218–225.

This paper also discusses how the alternative mating strategies of ruffs have evolved and maintained because they are favored by the females. In order to attract the females more efficiently, the independents will try to recruit and accept the satellites into established territories, which is fundamentally a cooperative association favored by female choice. In addition, females' choice also creates the form of leks.

[8] Widemo, F. 1998. Alternative reproductive strategies in the ruff *Philomachus pugnax*: a mixed ESS? *Animal Behavior* 56: 329–336.

According to the research project conducted by Widemo, there are two genders in the ruff. One is called the "Independent"; the other is called the "Satellite". Females are attracted by dominant Independent males while they will also enjoy the company with the Satellite males. The independents appear to gain more copulation than the satellites on lek but they have less chance to mate with the females.

[9] Lank, David B., and Constance, Smith M. 1987. "Conditional Lekking in Ruff (*Philomachus Pugnax*)." *Behavioral Ecology and Sociobiology* 20(2): 137–145.

The ratio of lek attendance was low according to the data from the research did by Lank and Constance, which was only 12 percent. Lank and Constance found out the main three tactics that the male ruffs employed while they were off-lek, which included "Following", "Intercepting", and "True Lekking".

[10] Colwell, Mark A. 2010. Mating Systems. Page 45-66 in *Shorebird Ecology, Conservation, and Management*. First edition. Los Angeles: University of California Press.

This chapter of Colwell's book is dedicated to explaining the principal mating systems observed in shorebirds. The ruff is a Polygyny species according to this book, which means the ruff males display on lek and compete via dominance hierarchies for females.

[11] Lank, David B. Smith, Constance M. Hanotte, Oliver. Ohtonen, Arvo. Bailey, Simon. Burke, Terry. 2002. "High frequency of polyandry in a lek mating system". *Behavioral Ecology* 13(2): 209-215.

Evidence shows that the ruff is also a polyandry species. In fact, more than 50 percent of the ruffs mate with more than one male. However, it is still unknown why the ruffs prefer to mate with different genders of males. Lank and his colleagues argue that male cooperation and the potential benefits of diversification can be used to explain how females choose their mates.