EXPLORATION OF AVIAN SEXUAL SELECTION & DIMORPHISM

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data for analysis provided by …

T. Lislevand, J. Figuerola, and T. Székely. 2007. Avian body sizes in relation to fecundity, mating system, display behavior, and resource sharing. Ecology 88:1605.

What causes Sexual Dimorphism to be more pronounced in larger birds?

Julian Aileru.

Rensch's Rule

In the 1950s, German Zoologist, Bernhard Rensch, after thoroughly studying different avian and reptilian species proposed that in positive sexually dimorphic populations, (where the male is larger), size dimorphism increases with increasing body size.

Rensch's Rule

Phalacrocorax ranfurlyi SSD = 0

Otis Tarda SSD = 1.14

Rensch's Rule Test - Is this true across multiple populations?

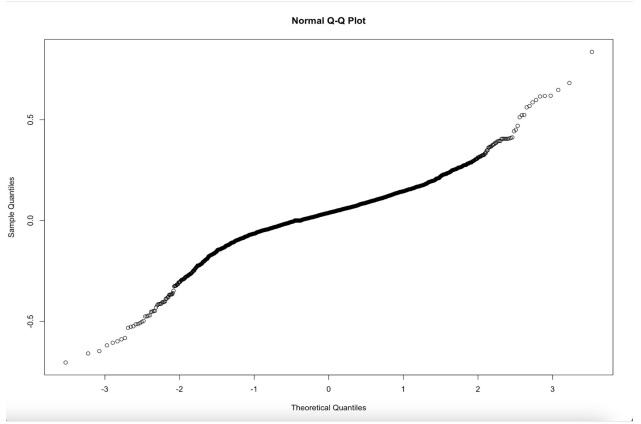
Research Question : Is the SSD of larger birds greater than the SSD of smaller birds?

```
#subset data top 10% and the rest
q90 <- quantile(as.numeric(filtered_birds$M_mass),0.90,na.rm = T)
q25 <- quantile(as.numeric(filtered_birds$M_mass),0.25,na.rm =T)
large_birds_male <- filtered_birds[filtered_birds$M_mass >= q90,]
small_birds_male <- filtered_birds[filtered_birds$M_mass < q90,]

#Calculate SSD and Attach to dataframes
male <- c(large_birds_male$M_mass)
female <- c(large_birds_male$F_mass)

SSD <- log(male) - log(female)
large_birds_male <- cbind(large_birds_male,SSD)

male_small <- c(small_birds_male$M_mass)
female_small <- c(small_birds_male$F_mass)

SSD_small <- log(male_small) - log(female_small)
small_birds_male <- cbind(small_birds_male,SSD_small)
```

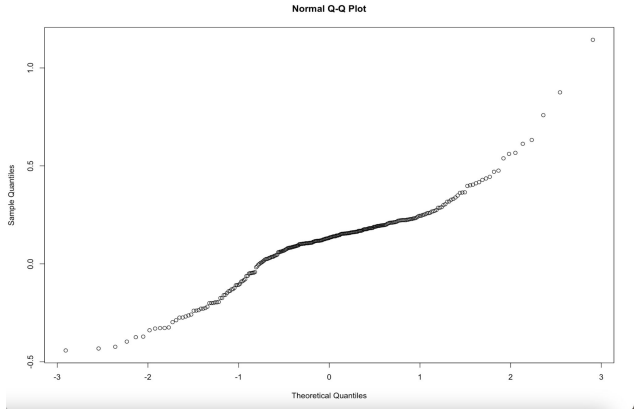
Normality Check and Mann-Whitney U Test

```
#Check Normality
qqnorm(large_birds_male$SSD)
qqnorm(small_birds_male$SSD_small)
shapiro.test(large_birds_male$SSD)
shapiro.test(small_birds_male$SSD_small)


#Non-parametric T-test (Independent Sample) - MannWhitneyU Test
#Ho largeSSD = smallSSD
#Ha largeSSD > smallSSD population 1 has shifted to the right of population 2

#Rensch's Rule Test
largeSSD <- large_birds_male$SSD
smallSSD <- small_birds_male$SSD_small

wilcox.test(largeSSD,smallSSD,alternative = "greater")
```

```
>shapiro.test(large_birds_male$SSD)

        Shapiro-Wilk normality test

data:  large_birds_male$SSD
W = 0.93481, p-value = 1.25e-09
```




```
>shapiro.test(small_birds_male$SSD)

        Shapiro-Wilk normality test

data:  small_birds_male$SSD_small
W = 0.93345, p-value < 2.2e-16
```




```
Wilcoxon rank sum test with continuity correction
data:  largeSSD and smallSSD
W = 432853, p-value < 2.2e-16
alternative hypothesis: true location shift is greater than 0
```

What is driving Rensch's Rule

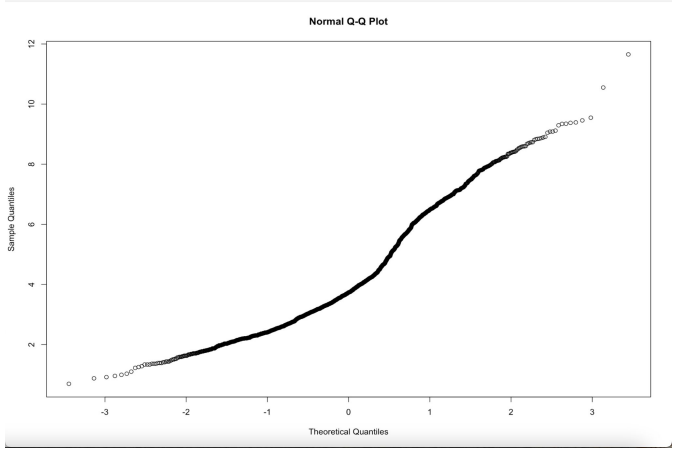
- Natural Selection?
  - Intersexual Resource Competion
  - Fecundity Selection
- Evolutionary Constraints?
  - Differing amounts of genetic variation in males vs females due to differing responses to selective pressures
- **Sexual Selection?**
  - **Intrasexual competition**

"Most researchers generally attribute the probable cause of positive sexual size allometry to sexual selection processes; however, we still do not have a conclusive empirical demonstration that this is the case across a broad range of taxa"

Sexual Selection Test : Normality Test

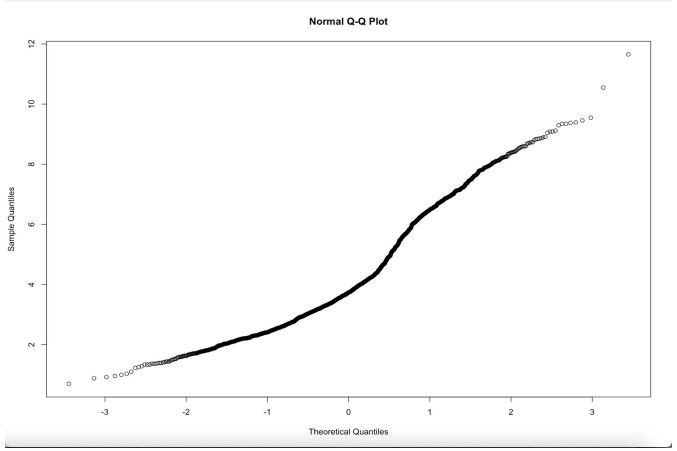
Research Question : In sexually dimorphic populations (SSD > 0), is male mass > female mass?

```
#Non-parametric T-test (Independent Sample) - MannWhitneyU Test
#Ho : M_mass = F_mass
#Ha : M_mass > F_mass
#male_mass > female_mass in sexually dimorphic populations

qqnorm(log(male_mass))
qqnorm(log(female_mass))
shapiro.test(log(male_mass))
shapiro.test(log(female_mass))

#Subset groups to check for normality
m <- median(male_mass,na.rm = T)
f <- median(female_mass,na.rm = T)

large_top_male_mass <- posSSD[posSSD$M_mass >= m, ]
small_bottom_male_mass <- posSSD[posSSD$M_mass <= m, ]

large_top_female_mass <- posSSD[posSSD$F_mass >= f, ]
small_bottom_female_mass <-  posSSD[posSSD$F_mass <= f, ]

shapiro.test(log(large_top_male_mass$M_mass))
shapiro.test(log(small_bottom_male_mass$M_mass))

shapiro.test(log(large_top_female_mass$F_mass))
shapiro.test(log(small_bottom_female_mass$F_mass))
```




```
> shapiro.test(log(male_mass))
Shapiro-Wilk normality test
data:  log(male_mass)
W = 0.93878, p-value < 2.2e-16
```

```
>shapiro.test(log(large_top_male_mass$
M_mass))
Shapiro-Wilk normality test
data:
log(large_top_male_mass$M_mass)
W = 0.94341, p-value < 2.2e-16
```




```
> shapiro.test(log(female_mass))
Shapiro-Wilk normality test
data:  log(male_mass)
W = 0.94271, p-value < 2.2e-16
```

```
>shapiro.test(log(small_bottom_male_mass$
M_mass))
Shapiro-Wilk normality test
data:  log(small_bottom_male_mass$M_mass)
W = 0.96991, p-value = 1.914e-12
```

Sexual Selection : MannWhitneyU Test

Non-parametric T-test (Independent Sample) - MannWhitneyU Test
Ho : M_mass = F_mass
Ha : M_mass > F_mass
male_mass > female_mass in sexually dimorphic populations

```
wilcox.test(posSSD$M_mass,posSSD$F_mass,alternative = "greater")
```

```
Wilcoxon rank sum test with continuity correction
data:  posSSD$M_mass and posSSD$F_mass
W = 1581002, p-value = 0.0284
alternative hypothesis: true location shift is greater than 0
```

Reject Ho, that male mass is equal to female mass

Conclusions

- Results from this test show that since male mass is statistically larger than female mass in dimorphic populations, intrasexual competition is driving the increased differences between male and female sizes with larger birds.
- In mate choice, female preference for specific traits can result in an exaggeration of those traits in males over a longer period of time
- Larger body size might be required to hold,maintain,and survive with these large,distinct appendages