Are Evolutionary Processes *Sexist*??

Seth Watt
Sex Differences in Evolutionary Processes
Consider…
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Goals for Today

1. Explore sex differences in the evolutionary mechanisms we have discussed in this course
2. Assess their importance for population genetic theory and empirical research
3. Understand how social behaviour is often a key determinant of these sex differences
Mutation: “Male-Driven Evolution”

\[ \alpha = \frac{\mu_m}{\mu_f} \]

**Table 2**

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<tr>
<th>Taxa</th>
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References

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Why is Mutation Rate Male-Biased?

**Female**

- 23 cell divisions, all before birth

---

*Crow, 2000*
Why is Mutation Rate Male-Biased?

**Female**
- Primordial female germ cell
- Sexual maturity
- Fertilization
- Birth
- 23 cell divisions, all before birth

**Male**
- Primordial male germ cell
- Puberty
- One stem-cell division every 16 days
- 30 mitotic divisions
- 4 mitotic divisions
- 2 meiotic divisions

30 cell divisions before puberty, followed by one every ~23 days

---

Crow, 2000
Why is Mutation Rate Male-Biased?
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Methylation rate also higher in male germ line in mammals.

Li et al., 2002
Recall …

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The relative substitution rates are sensitive to the dominance of mutations. This is seen in Figure 2, which shows counters.

Fig. 1. Effects of sex-biased mutation on substitution rates of Z- and X-linked loci relative to autosomal loci. Additive fitness effects ($h = 1/2$), dosage compensation, and equal selection on both sexes are assumed.

Kirkpatrick & Hall, 2004
Incorporating into Theory

For autosomal genes

\[ \mu = \frac{\mu_m + \mu_f}{2} \]

For X-linked genes

\[ \mu = \frac{\mu_m + 2\mu_f}{3} \]
Sexual Dimorphism

Intra-species sexual section: competition & mate choice
Sexual Dimorphism

Intra-species sexual section: competition & mate choice

Sex-specific survival selection
Sexual Dimorphism
Sexually Antagonistic Genes

Definition: traits that are adaptive when expressed in one sex, but maladaptive when expressed in the other sex.
Male sex-determining region

- Female (50%)
- Male (50%)

[Diagram showing the male sex-determining region]
This will allow even a highly detrimental allele (for females) to accumulate when rare.

Rice, 1992
Opposing selection can lead to stable polymorphisms

- **Dominance**
  \[ S_f > S_m > \frac{S_f}{1 + 2S_f} \]

- **Additive**
  \[ \frac{S_m}{1 - S_m} > S_f > \frac{S_m}{1 + S_m} \]
MIGRATION
Sex-Biased Dispersal

Increase if:
1. Competition for mates
2. Avoiding inbreeding

Decrease if:
1. Need to provide parental care
2. Kin cooperation: need for collective effort to acquire and defend resources
Mating System Matters

Whichever sex pays higher “cost of inbreeding” is predicted to disperse more.
Mating System Matters

Polygynous wild horses: one stallion with at least two adult females

Females are expected to invest more in reproduction than males.

In a polygynous species with a single male in the social group, female offspring expected to disperse.

Monard & Duncan, 1996
Monard & Duncan, 1996

Figure 2. Changes over time in the frequency (over 15 h of observation) of eight focal females being herded by the adult stallion of their new groups. Q10 was the first female of a new harem.

Motivated by:

1. Competition for mates
2. Inbreeding avoidance
Monard & Duncan, 1996

Motivated by:

1. Competition for mates
2. Inbreeding avoidance

Figure 4. Frequency distribution of the inbreeding coefficients of the females’ progeny (N=86 foals, born to 25 different females of the 1974–1985 cohorts). ■: Foals conceived before natal dispersal, □: foals conceived after natal dispersal. Inbreeding coefficients resulting from matings between cousins (A), half siblings (B) and full siblings or father–daughter (C).
Dispersal ≠ Gene Flow

Radio tracking and mark-recapture to allow researchers to determine which individuals are contributing to gene pool.
GENETIC DRIFT
\[ N_e = \frac{4N - 2}{V + 2} \]
Larger male reproductive variance

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Smaller male effective population size

Stronger effect of drift on genes passed through male line

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- Larger female reproductive variance
- Smaller female effective population size
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Thanks for listening!
References


