The Invasion of Alternative Mating Strategies

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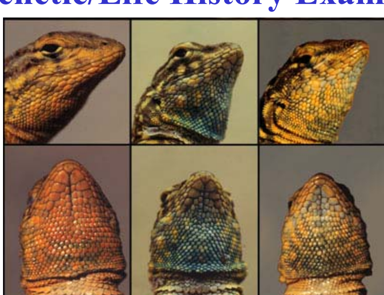
Mating Strategies (Alternative)

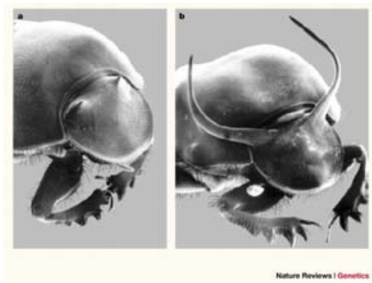
Polymorphisms in reproductive behavior, morphology or life history associated with competition for mates.

Genetic/Life History Example



Orange, blue and yellow males in the lizard, *Uta stansburiana*

Developmental Example



Developmental strategies in male *Onthophagus* beetles.

Behavioral Example

Extra-pair copulations (EPCs) in songbirds.

In Each of These Cases,

Novel phenotypes appear to have invaded, become modified and persist in natural populations.

Proximate Causes

Hormonal and neurological factors that regulate the ***timing and degree*** to which phenotypic differences appear.

Ultimate Causes

The ***genetic architectures*** underlying phenotypic expression.

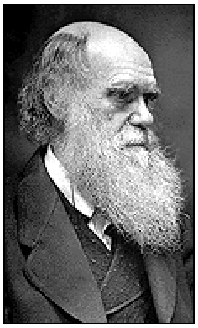
These depend on the circumstances in which mating opportunities arise.

That is,

On the ***intensity of selection*** favoring distinct reproductive morphologies.

On the ***predictability*** of mating opportunities ***relative*** to individual life span.

Intensity of Sexual Selection



"If each male secures two or more females, many males would not be able to pair."

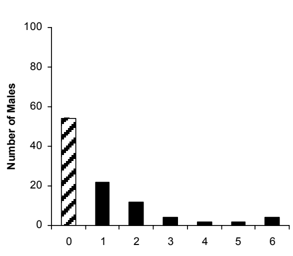
C. Darwin, 1871, p. 266.

Population Sex Ratio

The population sex ratio, ***R***, is the ratio of the total number of females to the total number of males, or,

$$R = N_{females} / N_{males}$$

Two Classes of Males



Mating males (p_m) = males with one or more mates.

Non-mating males (p_0) = males with no mates.

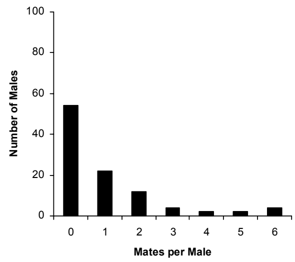
Since $(p_m + p_0) = 1$, $p_m = (1 - p_0)$.

The Average Number of Mates per Male, *m*

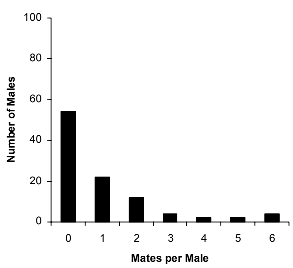
Equals the number of mates per male, ***i***, times the frequency of each male class, p_i, summed over all males.

Thus,

$$m = \Sigma\, i\, p_i$$



Sex Ratio Equals Average Mates per Male



The total number of females in the population are distributed as mates among the total number of males.

Thus, $R = m$.

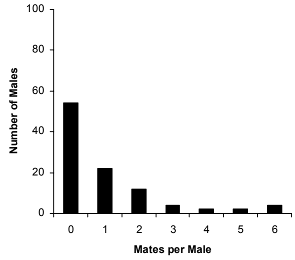
Other Relationships

If $m = \Sigma\, i\, p_i$

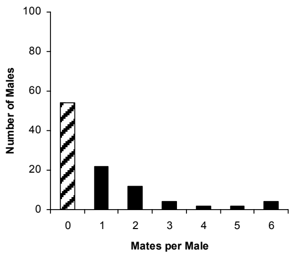
and if $R = m$,

then

$R = \Sigma\, i\, p_i$.



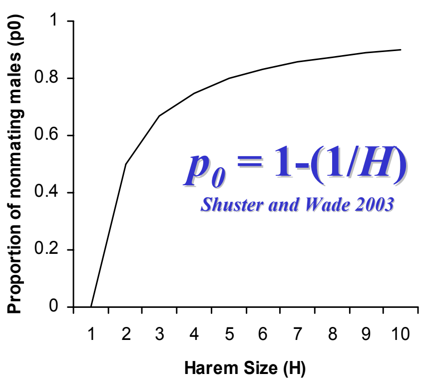
The Average Harem Size, *H*



Can be expressed as the total number of females, divided by the fraction of males who ***secure mates***, thus,

$$\boldsymbol{H} = \Sigma\, i\, p_i / (1 - p_0)$$
$$= \boldsymbol{R} / (1 - p_0)$$

$$\boldsymbol{H} = \boldsymbol{R} / (p_s)$$



Sexual Selection is a Powerful Evolutionary Force Because:

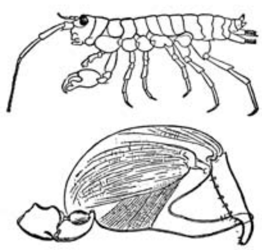
For every male who sires young with with several females, there must be several males who ***fail to reproduce at all***.

Strong Sexual Selection Creates a "Mating Niche"

Unconventional males need ***only*** achieve mating success greater than the reciprocal of harem size to invade.

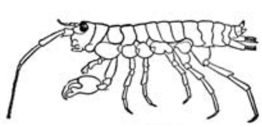
$s > 1/H$

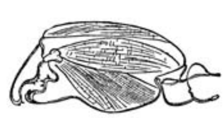
Orchestia darwinii: α- and β-males



α-males: robust with an enlarged chela; they displace other α-males from breeding territories.

Orchestia darwinii: α- and β-males



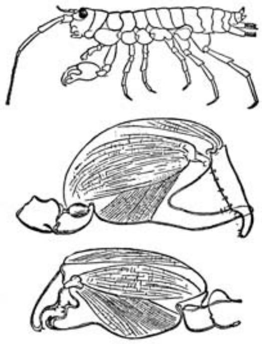


β-males: mature early, lack enlarged chelae, avoid fights, but are attracted to female aggregations.

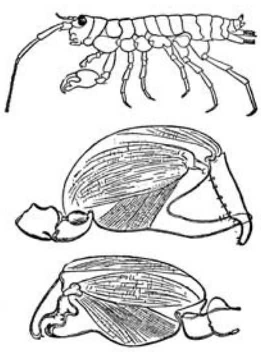
The Mating Success of β-males

β-males are successful in mating with some of the females in the harems of α-males.

Their success equals a ***fraction*** of that achieved by harem-holding α-males.



The Fitness of β-males



That fraction, ***s***, equals the success rate of β-males invading harems.

Thus, the fitness of β-males, W_β, equals,

$$W_\beta = s\,H_\alpha$$

In Most Mating Systems,

Only H_α can be calculated because the p_0 class of males is difficult to identify.

Thus,

The ***apparent*** relationship between the mating success of α- and β-males is,

$$H_\alpha > s\,H_\alpha$$

and therefore,

$$W_\alpha > W_\beta$$

Giving the appearance that β-males "make the best of a bad job."

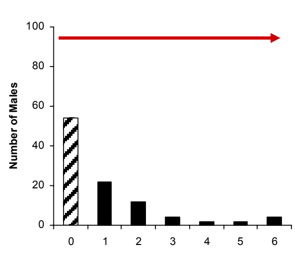
$W_\alpha > W_\beta$?

This approach considers *only* the average fitness of α-males that ***actually mate***.

In Fact,

The average fitness of ***all*** α-males, $W_{\alpha(all)}$, is equal to ***R.***

R includes the average mate numbers of mating ***and*** non-mating α-males.



To Invade a Population,

- The average fitness of a mutant strategy must ***exceed*** the average fitness of the conventional strategy.
- That is, the average fitness of β-males *must exceed* the average fitness of α-males.

We Can Express This Condition As,

$$W_\beta > W_{\alpha(\mathrm{all})}$$

Or by substitution,

$$sH_\alpha > R$$

By Rearrangement This Becomes,

$$s > R/H_\alpha$$

And if $R = 1$,

$$s > 1/H_\alpha$$

Remember that,

$$p_0 = 1 - (1/H)$$

Or by rearrangement,

$$(1 - p_0) = 1/H$$

So if,

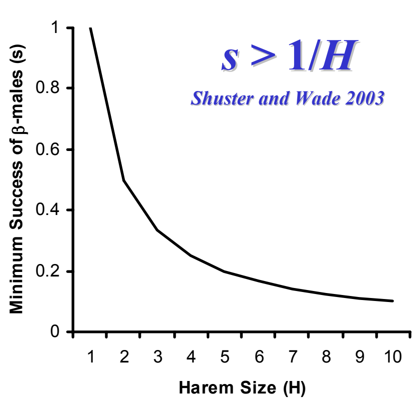
$$s > 1/H_\alpha$$

Then by substitution,

$$s > (1 - p_0)$$

Differently Put,

The more females are clumped within the harems of a few α-males (i.e., more α-males are *excluded* from mating), the ***easier*** invasion by β-males becomes.



A Worked Example

Let $H = 4$.

If $s > 1/H$

then s need only be **>0.25**!

That is, satellite males need only mate 25% as successfully as the average polygynous male!

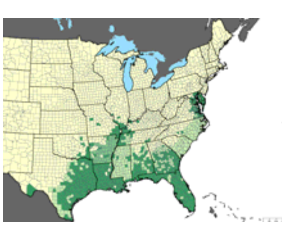
Strong Sexual Selection Favors Alternative Mating Strategies

Unconventional males need ***only*** achieve mating success greater than the reciprocal of harem size to invade, and to PERSIST.

Therefore…

A Classic Study

Hyla cinerea by Gerhardt et al. (1987) who recorded the mating success of calling, satellite, and non-calling males over 3 years.



Of the 57 males who mated, 50 were callers and 7 males were satellites, suggesting that the average success of callers was greater than for satellites.

However,

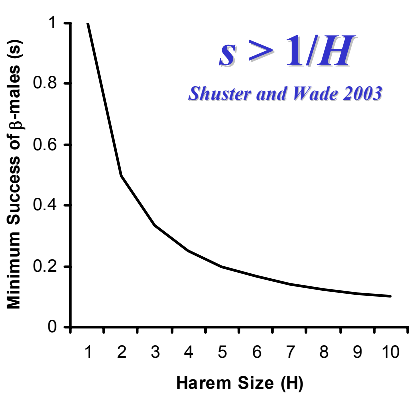
Gerhardt et al. (1987) identified mating as well as non-mating males in their analysis.

They showed that 416 of the 466 calling males (89%) were unsuccessful at mating.

Also, 50 of the 57 satellite males (88%) were unsuccessful.

Equal Fitnesses

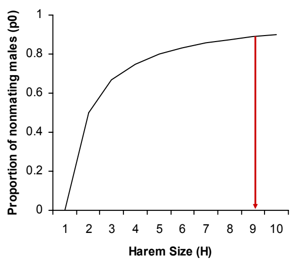
Gerhard et al. (1987) concluded that the fitnesses of the two male phenotypes were equal because nearly equal proportions of each population were successful in mating (11–12%).



Stated Differently,

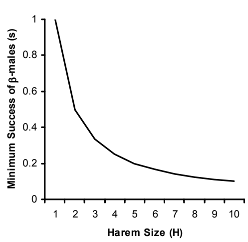
If $p_{0\text{calling}}$ equals 0.89, then the average harem size of calling males, H_{calling} equals 9.32 (not reported by Gerhardt et al.).

$$p_0 = 1-(1/H)$$



And If,

$$s > 1/H$$



Where ***s*** represents the success satellites must obtain by stealing mates from calling males, then $s > 1 - p_{0\text{calling}}$ or 0.11, which is approximately equal to the fraction of the total matings satellite males obtain (7/57 = 0.12).

"Making the Best of a Bad Job"

Is a fallacy.

Individuals with fitness less than average, ***by definition***, are ***selected against***.

Persistence within a population is ***impossible*** without ***equality*** of fitnesses over time.

Equal Fitness Over Time

The condition that is ***necessary*** and ***sufficient*** for the persistence of distinct genotypes.