The Persistence of Alternative Mating Strategies

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2. Developmental Strategies

Discontinuous phenotypes produced by distinct developmental trajectories, which ***do not*** segregate in a Mendelian manner.

Developmental Strategies Arise When

√ Sexual selection favors specialized mating phenotypes.

The relative mating success of each phenotype is ***predictable*** within male lifetimes.

The time scale for change is ***long***.

Why?

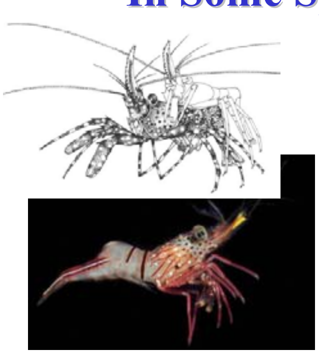
Phenotypic plasticity ***excludes*** genes of major effect when reliable cues predicting mating success ***are*** available.

When cues ***are*** available, the phenotypes produced by major genes are ***often incorrect***.

Which Cues?

In many species, the environmental cue to which males respond appears to be their own ***growth rate***.

In Some Species,



Slow growing males mature early as ***satellites***.

Males who cross a size threshold continue to grow and mature later as ***territorials***.

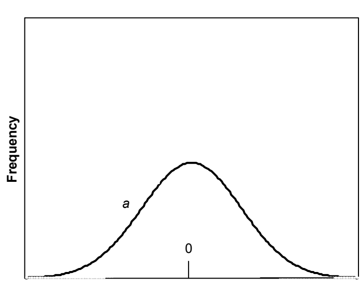
In Other Species,

Rapidly growing males become ***satellites***, and slower growers become ***territorials***.

This Pattern Is Consistent With

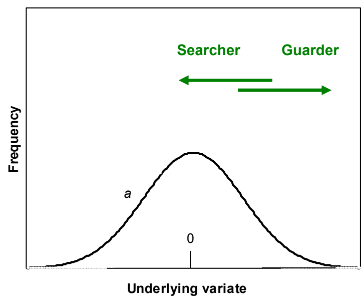
the observed expression of ***threshold characters***.

In Threshold Characters,



Genotypic AND phenotypic variation underlying characters (i.e., growth rate) are ***normally distributed***.

If Selection is Strong,



Distinct phenotypes are likely to evolve.

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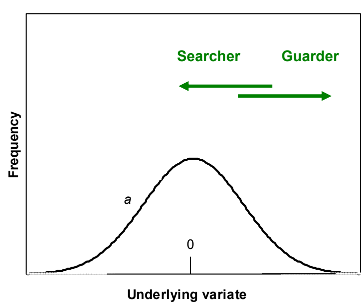
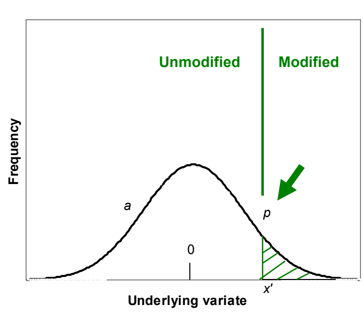


Distinct phenotypes are likely to evolve.

When environmental cues that predict success occur ***early in life***,

If Selection is Strong,

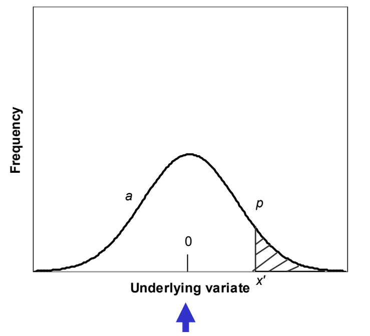


Distinct phenotypes are likely to evolve.

When environmental cues that predict success occur ***early in life***,

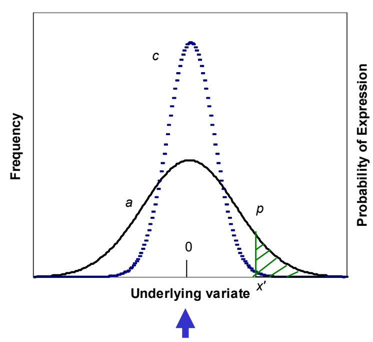
Expression is likely to be mediated by a ***developmental threshold*****.**

Genotype Influences the *Probability* of Trait Expression



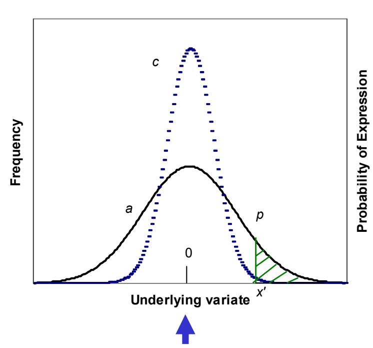
Each genotype (0) has its own ***probability distribution*** for trait expression.

Genotype Influences the *Probability* of Trait Expression



Each genotype (0) has its own ***probability distribution*** for trait expression.

But *Actual* Trait Expression,

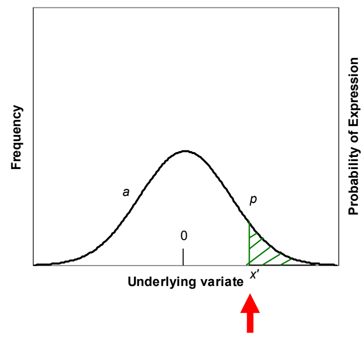


Depends on an ***interaction*** between genotype ***and*** environment;

GxE Interaction

In a *Given* Environment,

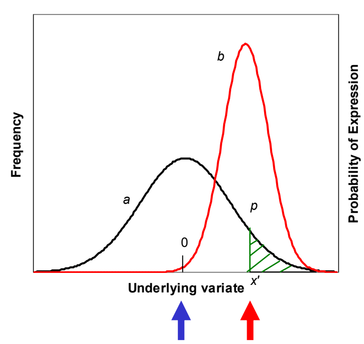
Genotypes at or above the threshold are ***likely*** to express the trait (b);



In a *Given* Environment,

Genotypes at or above the threshold are ***likely*** to express the trait (b);

Genotypes below the threshold ***seldom do*** (c).



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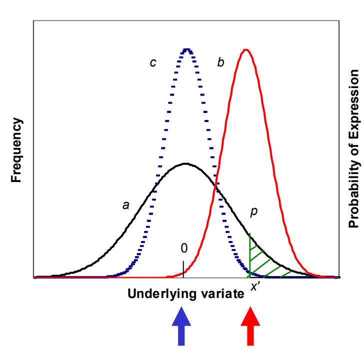
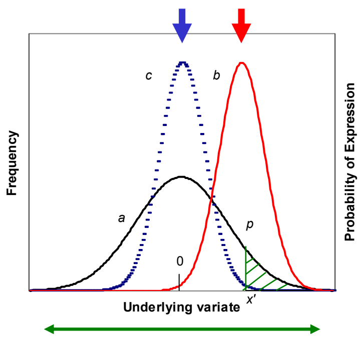


In a *Given* Environment,

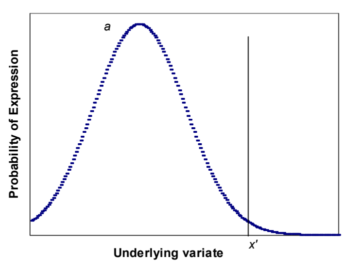
As a result of the ***distribution of genotypes*** (a) and their ***associated sensitivities***, i.e. their ***reaction norms*** (b, c)

The population appears ***dimorphic***.

Relative morph frequencies depend on the location of ***p***.



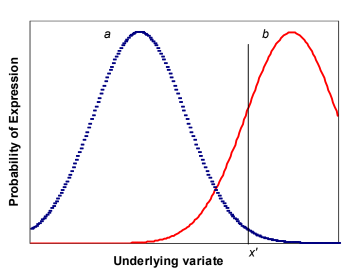
In a *Variable* Environment,



Genotype influences the ***probability of response*** to environmental cues.

Few genotypes express the trait at one environmental extreme (a);

In a *Variable* Environment,



Genotype influences the ***probability of response*** to environmental cues.

Few genotypes express the trait at one environmental extreme (a);

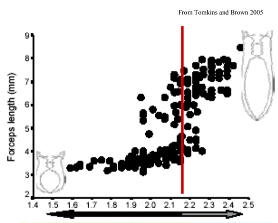
At the other extreme, ***nearly all*** genotypes become modified (b).

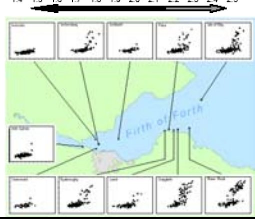
Relative Mating Success

For satellites and territorials, determines where the ***average male growth rate*** lies with respect to the ***body size threshold***.

Average fitnesses are ***equal***.

Inter-population variation is expected.





Genetic Architectures

Sensitive to environmental cues ***can*** allow males to express ***appropriate phenotypes*** in response to changing environments.

Provided That,

The cost of making the wrong choice is ***high***.

Circumstances favoring plasticity occur ***frequently***.

Are experienced by a ***large fraction*** of the population.

Phenotypic Plasticity is *Unlikely* When,

Selection is ***weak***.

Circumstances favoring plasticity are ***rare and highly contingent***.

Are experienced by ***few*** individuals in the population.

3. Behavioral Strategies

Discontinuous behavioral phenotypes expressed in response to changes in mating opportunities.

Are also known as "*tactics*."

Behavioral Example

Mate guarding tactics in stomatopods, *Gonodactylus bredini.*

Behavioral Strategies Arise When

√ Sexual selection favors specialized mating phenotypes.

The relative mating success of each phenotype is ***predictable*** within male lifetimes.

The time scale for change is ***short***.

Why?

Behavioral plasticity ***excludes*** major genes and developmental plasticity,

when reliable ***cues*** predicting mating success ***are available***,

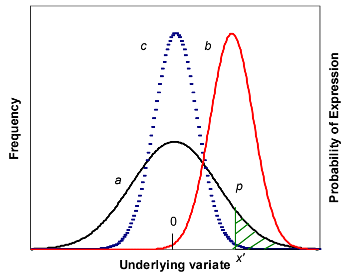
and mating opportunities ***change quickly***.

Genetic Architectures

Underlying behavioral plasticity appear to be ***similar*** to those of developmental strategies.

Genetic variation underlying quantitative traits influences the likelihood that individuals express a particular mating behavior.

The Behavioral Threshold Hypothesis Predicts:



Differential responsiveness to the ***same*** environmental cues among individuals within populations,

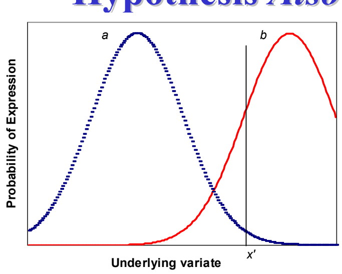
Due to ***genetic differences*** among males.

This May Explain Why,

Certain individuals in a population express one set of mating behaviors,

And under the same conditions, other individuals express another behavioral set.

The Behavioral Threshold Hypothesis *Also* Predicts:



Variable responses to ***different*** cue intensities among individuals within populations,

Due to ***genetic differences*** among males.

This May Explain Why,

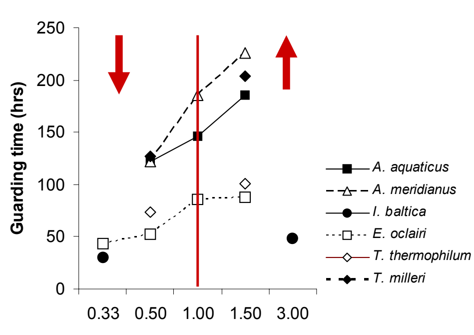
Weak stimuli will induce ***few individuals*** to perform mate acquiring behaviors.

Strong stimuli, however will cause ***most individuals*** to attempt to mate.

Mate Guarding in Isopods

Mate guarding in the Socorro Isopod, *Thermosphaeroma thermophilum.*

Male Responses to Sex Ratio



Mate Guarding Behavior

Is under strong sexual selection; ineffective guarders lose fertilizations.

Changes in OSR :

Influence mating opportunities.

Occur often.

Are experienced by most males.

Thus,

Factors influencing the expression of mate guarding behavior ***are consistent*** with expectations for threshold inheritance.

So,

If ***genetic variation*** underlies the tendency for males to guard a potential mate or to continue searching,

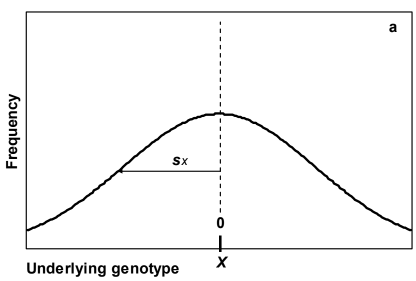
If males tend to ***guard*** females closest to their reproductive molt,

And If,

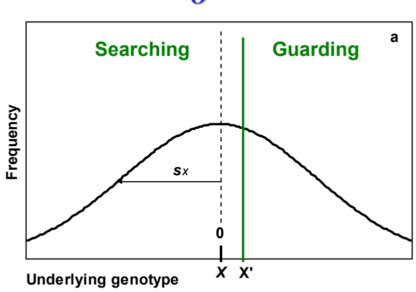
Sex ratio provides an ***environmental cue*** such that male-biased sex ratios intensify male mate guarding behavior,

We *can* visualize behavioral polymorphism from a norm of reaction perspective.

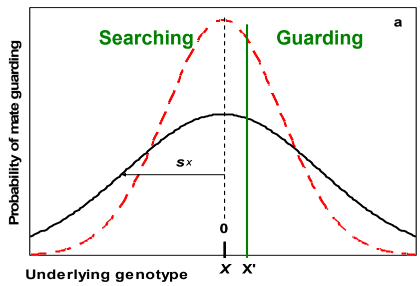
The Expected Distribution of Mate Guarding Reaction Norms with R_O=1



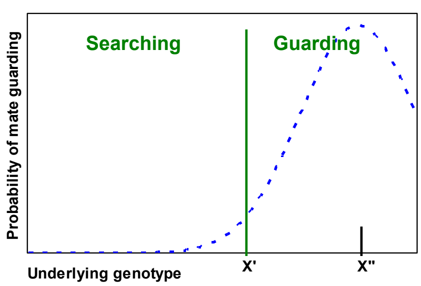
The Position of the Average Mate Guarding Reaction Norm with R_O=1



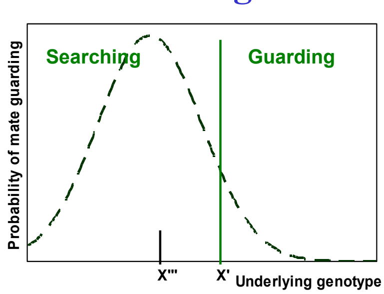
The Expected Distribution of Mate Guarding Phenotypes for Genotype x_0



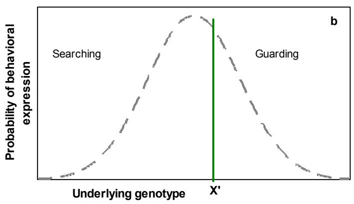
Male Genotypes Above the Threshold Will Guard Most Females



Male Genotypes Below the Threshold Will Tend to Keep Searching



As a Consequence of,



The normal distribution of genotypes above and below the behavioral threshold, when R_O=1,
The population will appear ***dimorphic***

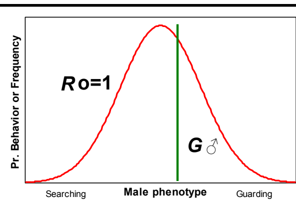
Mate-Guarding Males

Let $G_{♂} = N_{guarding♂}/N_{♂}$
and $G_{♀} = N_{guarded♀}/N_{♀}$

Because each pair consists of one male and one female,

$G_{♂} = R_O G_{♀}$

Where $R_O = N_{♂}/N_{♀}$.



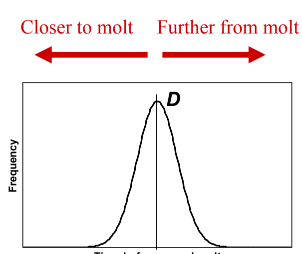
When $R_O = 1$

$G_{♂} = G_{♀}$

The Duration of Female Receptivity

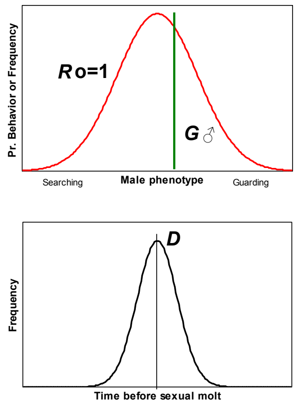
Let $D = \Sigma\, d_i/N_{♀}$,
where d_i=the time remaining before molting for female *i*.

$V_D = \Sigma\, d_i^2/N_{♀} - D^2$



When $R_O = 1$

$G_♂$ will guard the $G_♀$ closest to their sexual molt (i.e., < D).

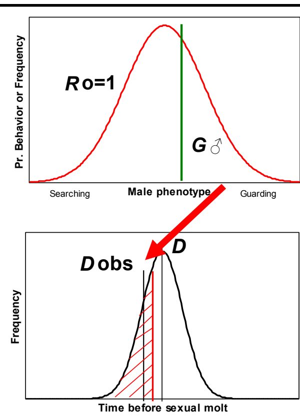


When $R_O = 1$

$G_♂$ will guard the $G_♀$ closest to their sexual molt (i.e., < D).

The observed average guarding duration, D_{obs}, is,

$$D_{obs} = G_♂ D$$

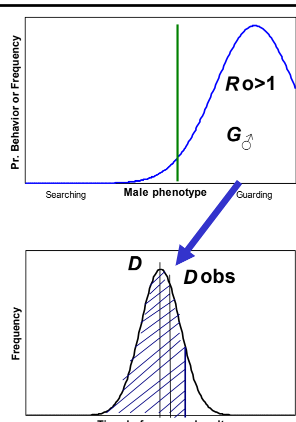


If Competition Increases ($R_O > 1$),

This environment may serve as a ***cue***, causing males to guard females ***more readily***.

$G_♂$ will increase.

And because more females will be guarded, $G_♂ D = D_{obs}$ will ***increase***.

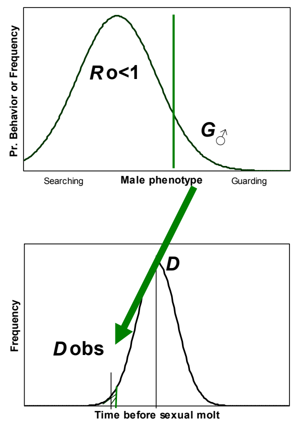


If Competition Decreases ($R_O < 1$),

Weaker cue intensity may cause males to guard females ***less readily***.

$G_♂$ will decrease.

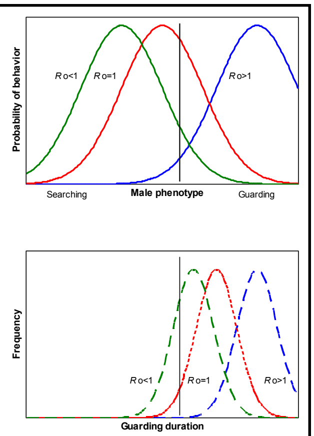
And because more males will tend to search, $G_♂D = D_{obs}$ will ***decrease***.



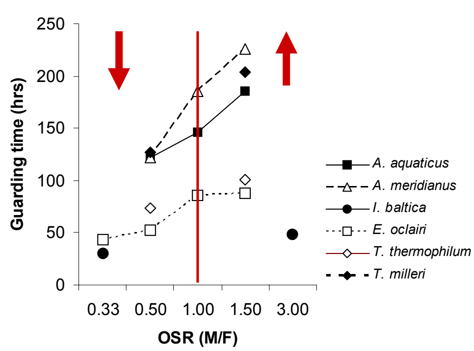
Male Reponses to Changing Sex Ratio

Are consistent with threshold inheritance of a behavioral phenotype

Suggest that males use OSR as a cue; NOT that OSR indicates selection intensity



Male Responses to Sex Ratio



Conclusions

The expression of mating strategy depends on ***genetic architecture***.

Architectures underlying developmental and behavioral plasticity are likely to be ***similar***
(Levins 1968; Roff 1996; Roff et al. 1998; Shuster and Wade 2003).

Strategies = Tactics