

## Evolution Lecture 18 - Chapter 12

### Topics for today

1. What is the difference between natural selection and evolution?
2. Modes of natural selection
3. Genetical theory of natural selection

### *Scenario 1 – traits are genetically based*

#### **Natural selection occurs**

- Interaction between phenotypes and the environment resulting in fitness differences

#### **Evolutionary response to natural selection occurs**

- Genetic change in genotypic frequency of offspring

### *Scenario 2 – traits variation is environmentally induced*

#### **Natural selection occurs**

- Interaction between phenotypes and the environment resulting in fitness differences

#### **No evolutionary response to natural selection**

- No genetic change in genotypic frequency of offspring because the phenotype is related to environmental variation rather than genetic variation

### Key points

- Natural selection is the favorable survival or reproduction of organisms with particular phenotypes
- Evolution only occurs when phenotypic variation is genetically based
  - Some phenotypic variation can be strictly environmental
  - Genetic variability in quantitative traits as measured by heritability
  - Polymorphism of alleles at a single locus
- Evolution is the change in gene frequencies over generations
  - Sometimes mediated by natural selection
  - Sometimes mediated by genetic drift

### Three modes of selection

- Quantitative trait
- Single locus with two alleles

#### *Fig. 12.1*

#### **Directional selection**

- Moves the mean
- Reduces variance

#### **Stabilizing selection (balancing)**

- Doesn't move mean (if symmetrical)
- Reduces variance

#### **Diversifying selection (disruptive)**

- Doesn't move the mean (if symmetrical)
- Increases variance
- Eventually results in a bimodal distribution

## Episodes of selection in life

### Fig. 12.3

“Components of fitness are combined (usually by multiplying them)...” page 273.  
Bogus method. New method forthcoming – keep tuned.

## Unifying life history analyses for inference of fitness and population growth

R. G. Shaw, S. Wagenius, H. Hangelbroek, J.R. Etterson, C.J. Geyer

## Genetical theory of natural selection

### Box 12.A

|              |                               |   |          |  |                       |
|--------------|-------------------------------|---|----------|--|-----------------------|
| <b>Gen 1</b> | Genotypes                     | $A_1A_1$  | $A_1A_2$ | $A_2A_2$   |                       |
|              | Allele frequencies            | $p$   |          | $q$  |                       |
|              | Expected Genotype Frequencies | $p^2$   | $2pq$    | $q^2$  | <i>No selection</i>   |
|              | Relative fitness              | $w_{11}$  | $w_{12}$ | $w_{22}$   | <i>With selection</i> |
| <b>Gen 2</b> | Count up alleles              | $p^2w_{11} + 1/2(2pqw_{12})$  |          | $q^2w_{22} + 1/2(2pqw_{12})$   |                       |
|              | Divide divide by total number | $p' = \frac{p(pw_{11} + qw_{12})}{p^2w_{11} + 2pqw_{12} + q^2w_{22}}$ |          | $q' = \frac{q(qw_{22} + pw_{12})}{2p^2w_{11} + 2pqw_{12} + q^2w_{22}}$ |                       |
|              | Genotype frequencies          | $p'^2$  | $2p'q'$  | $q'^2$   |                       |

**Evolutionary change in  $p$ ?**  $\Delta p = p' - p$

$$\Delta p = \frac{p(pw_{11} + qw_{12})}{2p^2w_{11} + 2pqw_{12} + q^2w_{22}} - p$$

- If you know  $p$  and  $q$
- And relative fitness of genotypes
- Can predict evolutionary change

## Key points from simulations

### Selection on beneficial alleles

- An allele with even a miniscule advantage will eventually be fixed by selection
- An advantageous allele moves to fixation more slowly if it is recessive, especially if it starts at low frequency

### Selection on deleterious alleles

- An allele with even miniscule disadvantage will eventually be eliminated by selection (purging selection)
- A deleterious allele is purged more slowly if it is recessive, especially if it starts at low frequency

### Selection on heterozygotes

- Heterozygote advantage leads to maintenance of alleles
- Heterozygote disadvantage leads to multiple fixation points depending upon initial allele frequencies