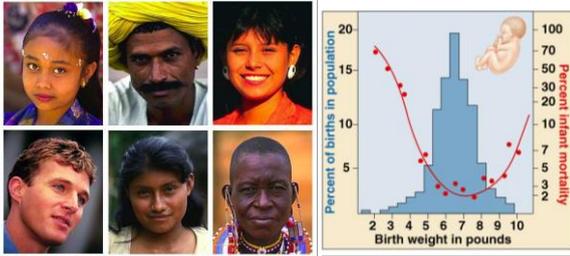


# Chapter 21.2

## Mechanisms of Evolutionary Change



## Populations Evolve!

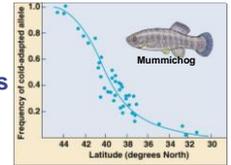
### Natural selection acts on individuals

- ◆ differential survival
  - “survival of the fittest”
- ◆ differential reproductive success
  - who bears more offspring



### Populations evolve

- ◆ genetic makeup of population changes over time
- ◆ favorable traits – alleles (greater fitness) become more common

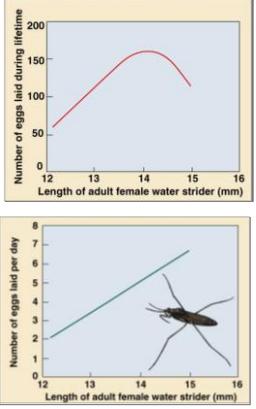
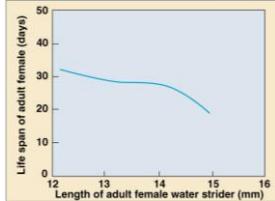


## Evolutionary Fitness

### Survival & Reproductive success

- ◆ individuals with one phenotype leave more surviving offspring

Body size & egg laying in water striders



## Variation & Natural Selection

### Variation is the raw material for natural selection

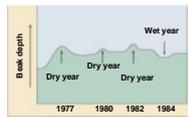
- ◆ there have to be differences within population
- ◆ some individuals must be more fit than others



## Where does variation come from?

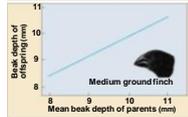
### Mutation

- ◆ random changes to DNA
  - errors in **mitosis & meiosis**
  - environmental damage

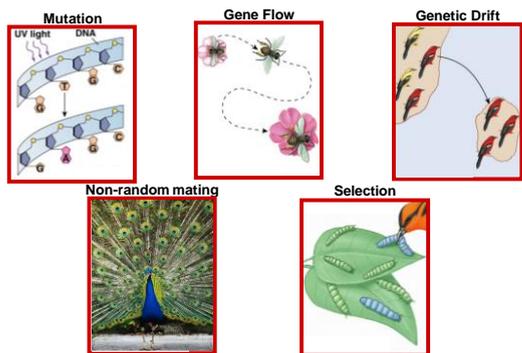


### Sex

- ◆ mixing of alleles
  - **recombination** of alleles
    - ◆ new arrangements in every offspring
  - new combinations = new phenotypes
- ◆ spreads variation
  - offspring inherit traits from parent

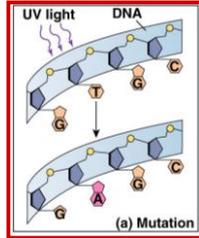


## 5 Agents of Evolutionary Change



### 1. Mutation & Variation

- Mutation creates **variation**
  - ◆ new mutations are constantly appearing
- Mutation **changes DNA sequence**
  - ◆ changes amino acid sequence?
  - ◆ changes protein?
    - changes structure?
    - changes function?
  - ◆ changes in protein can change phenotype & therefore change fitness



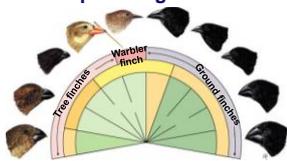
### 2. Gene Flow

- Movement of individuals & alleles in & out of populations
  - ◆ seed & pollen distribution by wind & insect
  - ◆ migration of animals
    - sub-populations may have different allele frequencies
    - causes **genetic mixing** across populations
    - can reduce differences between populations while increasing variation!



### 3. Genetic Drift

- Effect of **chance events**
  - ◆ **founder effect**
    - small group splinters off & starts a new colony
  - ◆ **bottleneck**
    - some factor (disaster) reduces population to small number & then population recovers & expands again



### Founder Effect

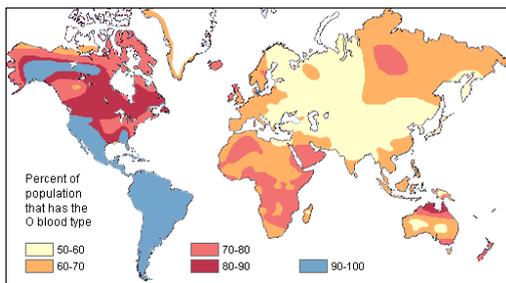
- When a new population is started by only a few individuals
  - ◆ some rare alleles may be at high frequency; others may be missing
  - ◆ skew the **gene pool** of new population
    - human populations that started from small group of colonists
    - **example:** colonization of New World

Journey of Man

Eyes of Nye—Race!

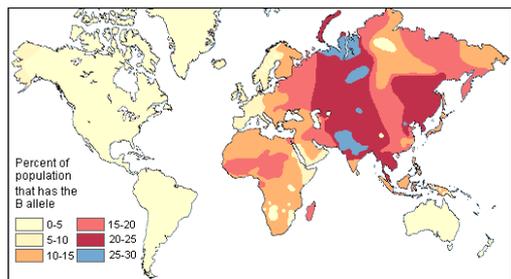
### Distribution of Human Blood Types

- Distribution of the **O type** blood allele in **native** populations of the world reflects original settlement



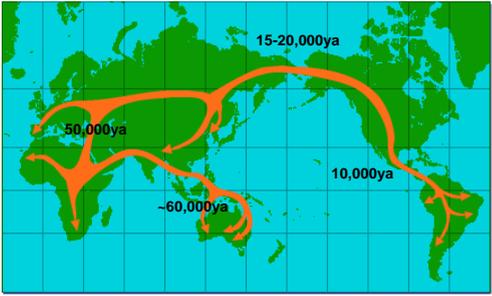
### Distribution of Human Blood Types

- Distribution of the **B type** blood allele in **native** populations of the world reflects original migration



**Out of Africa** Journey of Man

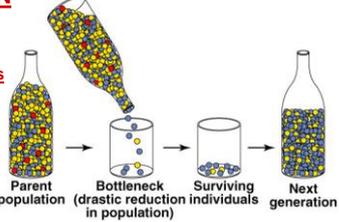
Likely migration paths of humans out of Africa



Many patterns of human traits reflect this migration!

**Bottleneck Effect**

- When large population is drastically **reduced by a disaster**
  - famine, natural disaster, loss of habitat...
  - loss of variation by **chance event**;
- NOT SELECTION**
  - alleles lost from gene pool
    - not due to **fitness**
  - narrows the gene pool**



**Cheetahs**

- All cheetahs share a small number of alleles
  - less than 1% diversity
  - as if **all** cheetahs are identical twins
- 2 bottlenecks**
  - 10,000 years ago
    - Ice Age
  - last 100 years
    - poaching & loss of habitat



**Conservation Issues**

- Bottlenecking is an important concept in **conservation biology** of endangered species
  - loss of alleles from gene pool
  - reduces variation**
  - reduces adaptability**

Breeding programs must consciously outcross



**4. Non-Random Mating**

- "Sexual selection"

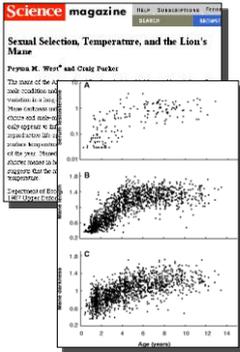


**Sexual Selection**

- Acting on reproductive success
  - attractiveness to potential mate
  - fertility of gametes
  - successful rearing of offspring



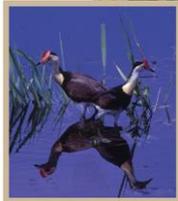
### The lion's mane...

- Females are attracted to males with larger, dark manes
- **Correlation with higher testosterone levels**
  - ♦ better nutrition & health
  - ♦ more muscle & aggression
  - ♦ longer life
- **But imposes a cost to male**
  - ♦ **HOT!** Worth it??

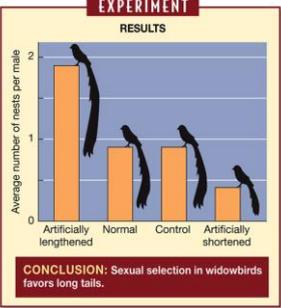
### Sexual Selection

- Sexual selection acts in all sexually reproducing species
  - ♦ “the traits that get you mates”
  - ♦ it influences morphology & behavior
  - ♦ it acts on both males and females

### Can sexual selection change populations?

- male African long-tailed widowbirds had different amounts of nests based on tail length
- either artificially or naturally lengthened or shortened



**CONCLUSION:** Sexual selection in widowbirds favors long tails.

### Natural Selection

- Selection acts on any trait that affects survival or reproduction
  - ♦ predation selection
  - ♦ physiological selection





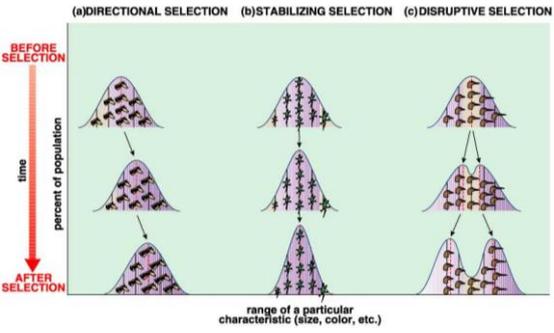
### 5. Natural Selection

- Differential survival & reproduction due to changing environmental conditions
  - climate change
  - food source availability
  - predators, parasites, diseases
  - toxins
- ♦ combinations of **alleles** that provide “**fitness**” **increase** in the population
  - adaptive evolutionary change



### Effects of Selection

- Driving changes in a population



(a) DIRECTIONAL SELECTION (b) STABILIZING SELECTION (c) DISRUPTIVE SELECTION

BEFORE SELECTION

time

percent of population

AFTER SELECTION

range of a particular characteristic (size, color, etc.)