

evolution

*a journey into where we're from
and where we're going*

Evolutionary Forces

What changes populations?



Forces of evolutionary change

■ Natural selection

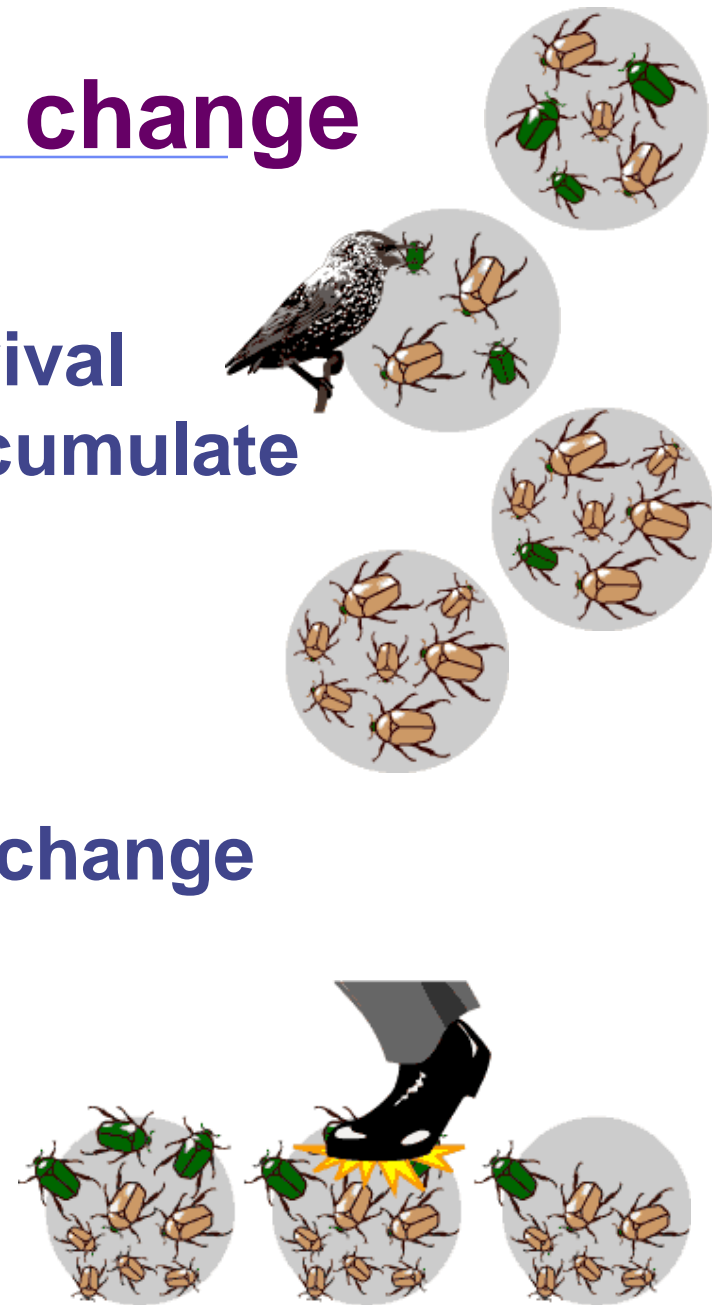
- ◆ traits that improve survival or reproduction will accumulate in the population

- adaptive change

■ Genetic drift

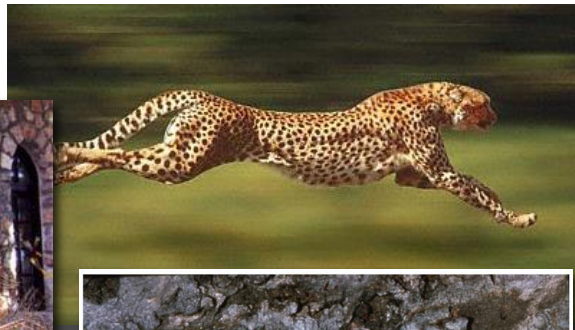
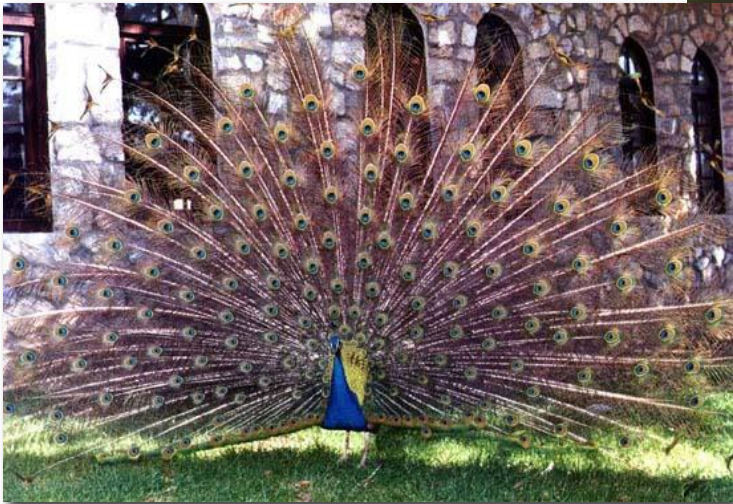
- ◆ frequency of traits can change in a population due to random chance events

- random change



Selection

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





■ Predation selection

◆ act on both predator & prey

- speed
- behaviors
- camouflage & mimicry
- defenses (physical & chemical)



Physiological Selection

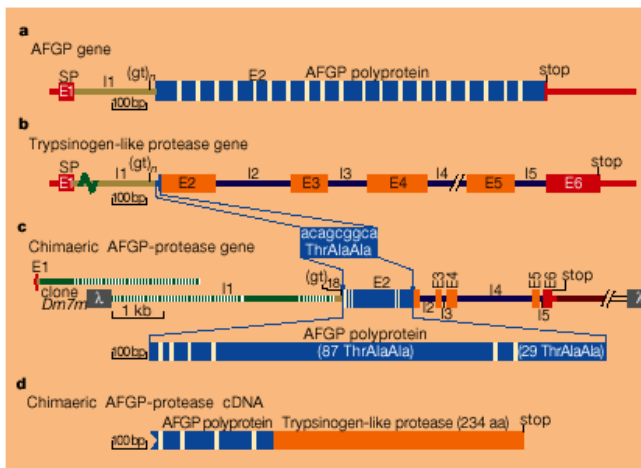
- Acting on body functions
 - ◆ disease resistance
 - ◆ physiology efficiency (using oxygen, food, water)
 - ◆ biochemical versatility
 - ◆ protection from injury

Evolution of an antifreeze glycoprotein

A blood protein that keeps Antarctic fish from freezing arose from a digestive enzyme.

The ice-binding antifreeze glycoprotein (AFGP) that circulates in the blood of Antarctic notothenioid fishes enables them to avoid freezing in their perpetually icy environment'. This crucial survival protein probably arose from a functionally unrelated pancreatic trypsinogen-like protease³. We have now discovered an important intermediate in this evolutionary process — transcriptionally active chimaeric genes that encode both an AFGP polyprotein and the protease, confirming the protease origin of AFGP and indicating how it was created.

AFGP binds to and arrests the growth of ice crystals that enter the fish, thereby preventing the fish from freezing. There are at least eight forms of the protein of different sizes (AFGP 1–8), all composed of repeats of a simple glycotripeptide monomer (Thr-Ala/Pro-Ala-) with a disaccharide attached to each threonine



5.5 mya

The Antarctic Ocean freezes over

HOT STUFF!
Some fish had the variation of producing anti-freeze protein



Physiological selection

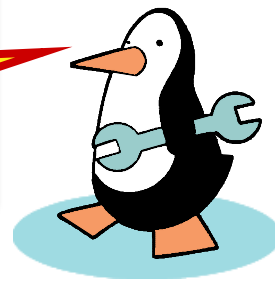
Dogs pee on trees...Why don't trees pee on dogs?



plant nutrient

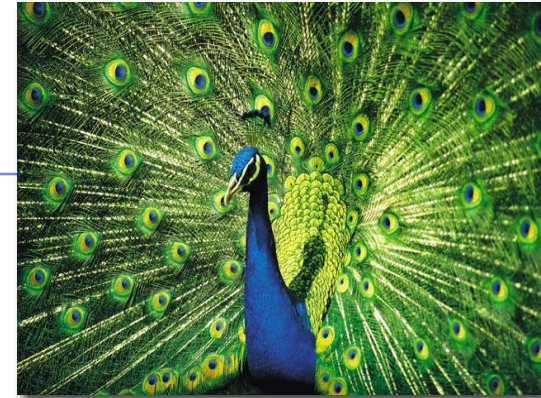
animal waste

One critter's trash
is another
critter's treasure!



Sexual Selection

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

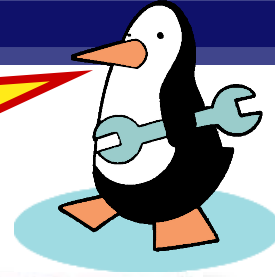


Survival doesn't matter
if you don't reproduce!



Sexual selection

ornamented males...
the traits
that get you mates

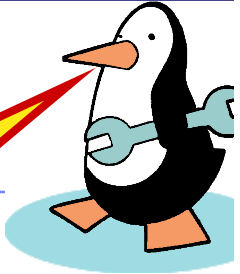


It's FEMALE CHOICE, baby!



sexual dimorphism

The lion's mane



Science magazine

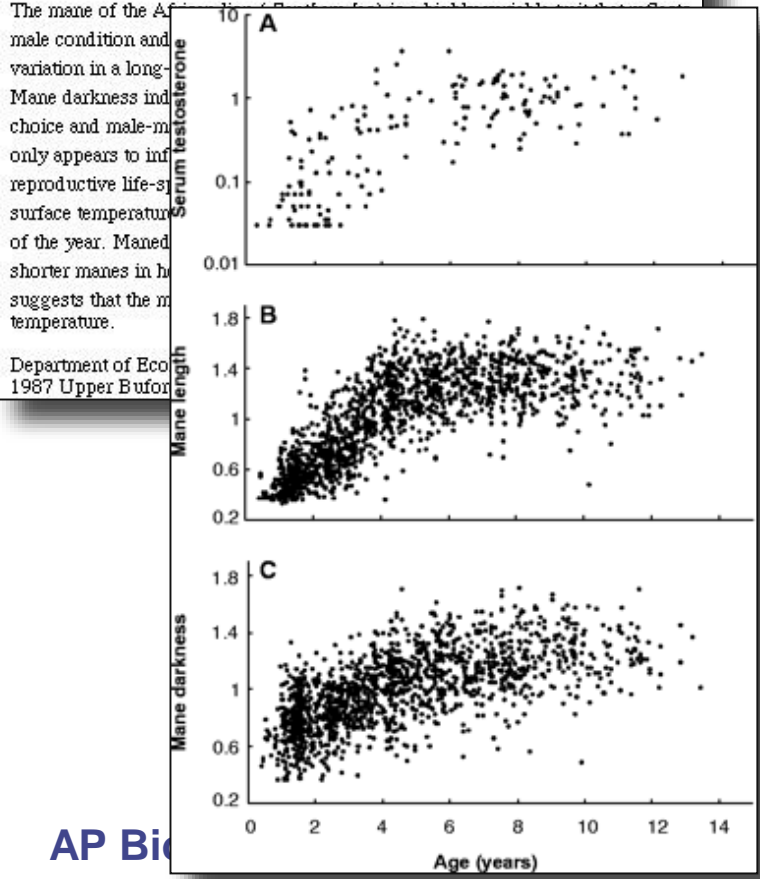
Sexual Selection Mane

Peyton M. West* and Craig Packer

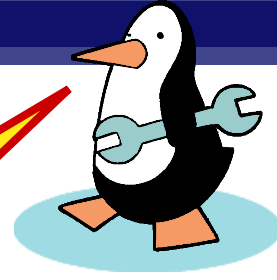
The mane of the African male condition and variation in a long-
Mane darkness indicates choice and male-m
only appears to influence reproductive life-span
surface temperature of the year. Males with
shorter manes in hot suggests that the mane
temperature.

Department of Ecology
1987 Upper Buffalo

Sexual selection may act in opposition to natural selection!



- Females are attracted to males with larger, dark manes
- Correlation with higher testosterone levels
 - ◆ better nutrition & health
 - ◆ more muscle & aggression
 - ◆ better sperm count / fertility
 - ◆ more successful young
- **But imposes a cost to male**
 - ◆ **HOT!** Is it worth it??

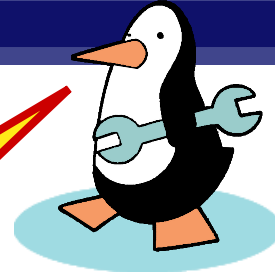


Sexual selection

- Acts in all sexually reproducing species
 - ◆ influences both morphology & behavior

Is there a testable hypothesis here?





Sexual selection

- Acts in all sexually reproducing species
 - ◆ influences both morphology & behavior

Is there a testable hypothesis here?

Jacanas



Effects of Selection

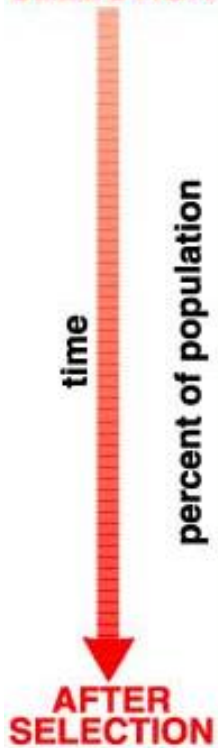
- Changes in the average trait of a population

DIRECTIONAL SELECTION

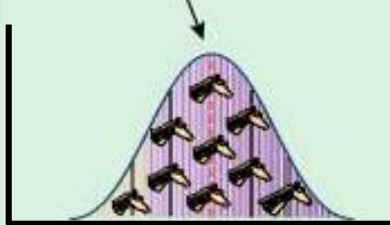
STABILIZING SELECTION

DISRUPTIVE SELECTION

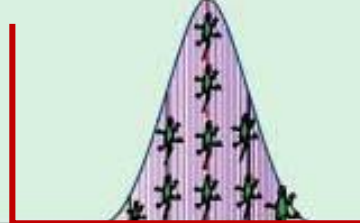
BEFORE SELECTION



percent of population



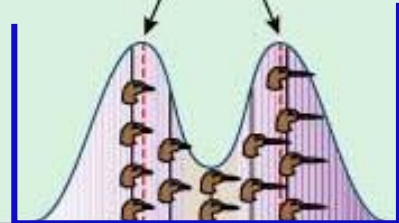
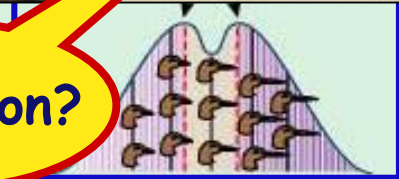
giraffe neck
horse size



human birth weight



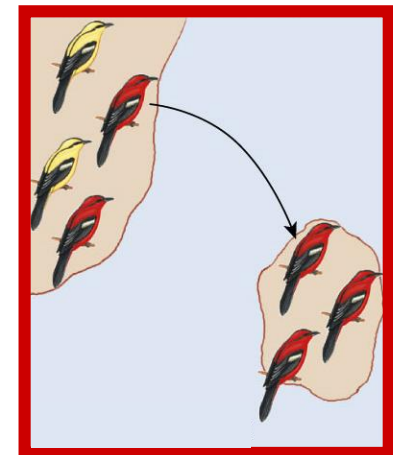
speciation?



rock pocket mice

Genetic Drift

- **Chance events changing frequency of traits in a population**
 - ◆ **not** adaptation to environmental conditions
 - **not** selection
 - ◆ **founder effect**
 - small group splinters off & starts a new colony
 - *it's random who joins the group*
 - ◆ **bottleneck**
 - a disaster reduces population to small number & then population recovers & expands again but from a limited gene pool
 - *who survives disaster may be random*



Founder effect

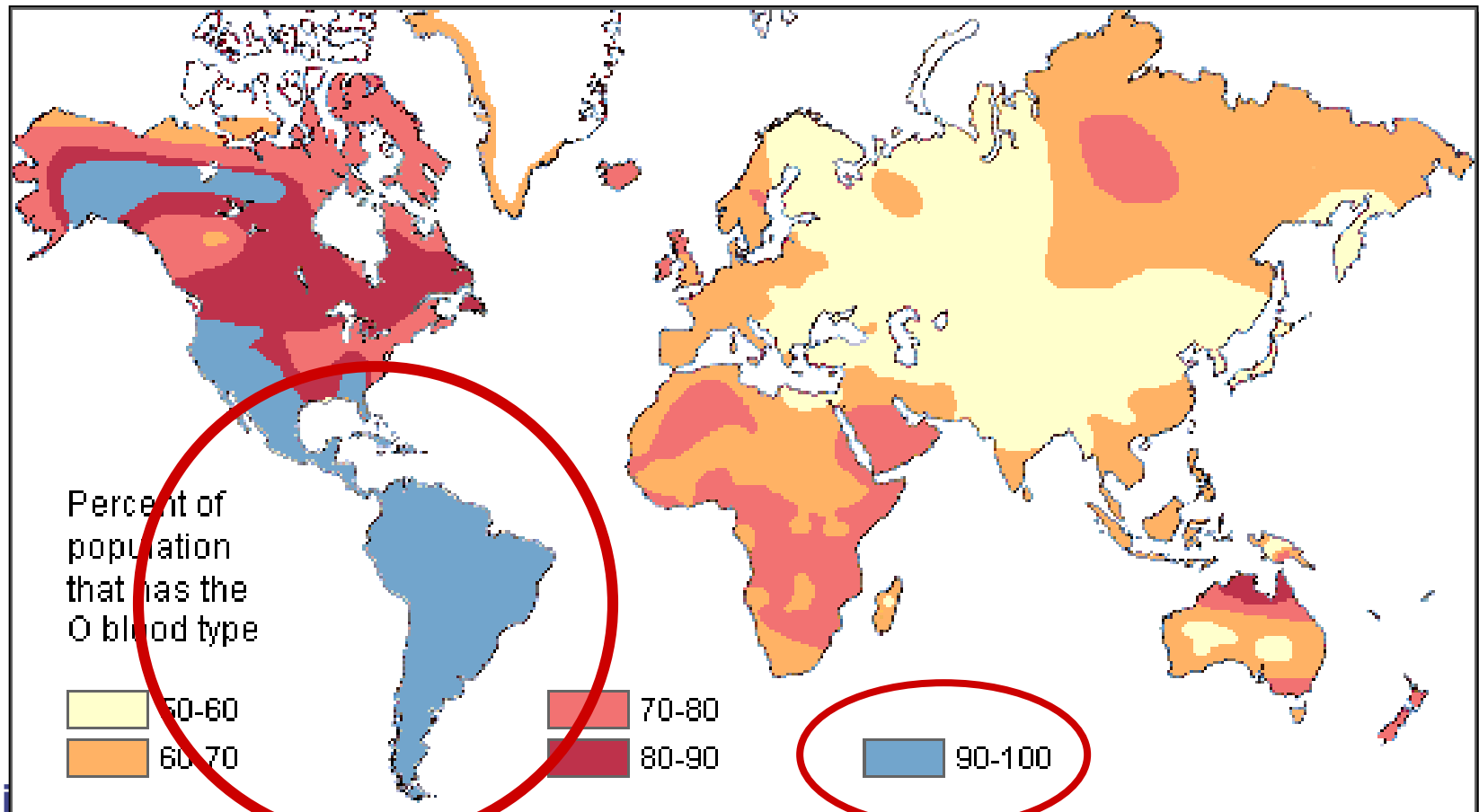
- When a new population is started by only a small group of individuals
 - ◆ just by chance some rare **alleles** may be at high frequency; others may be missing
 - ◆ skew the **gene pool** of new population
 - human populations that started from small group of colonists
 - **example:** colonization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



albino deer Seneca Army Depot

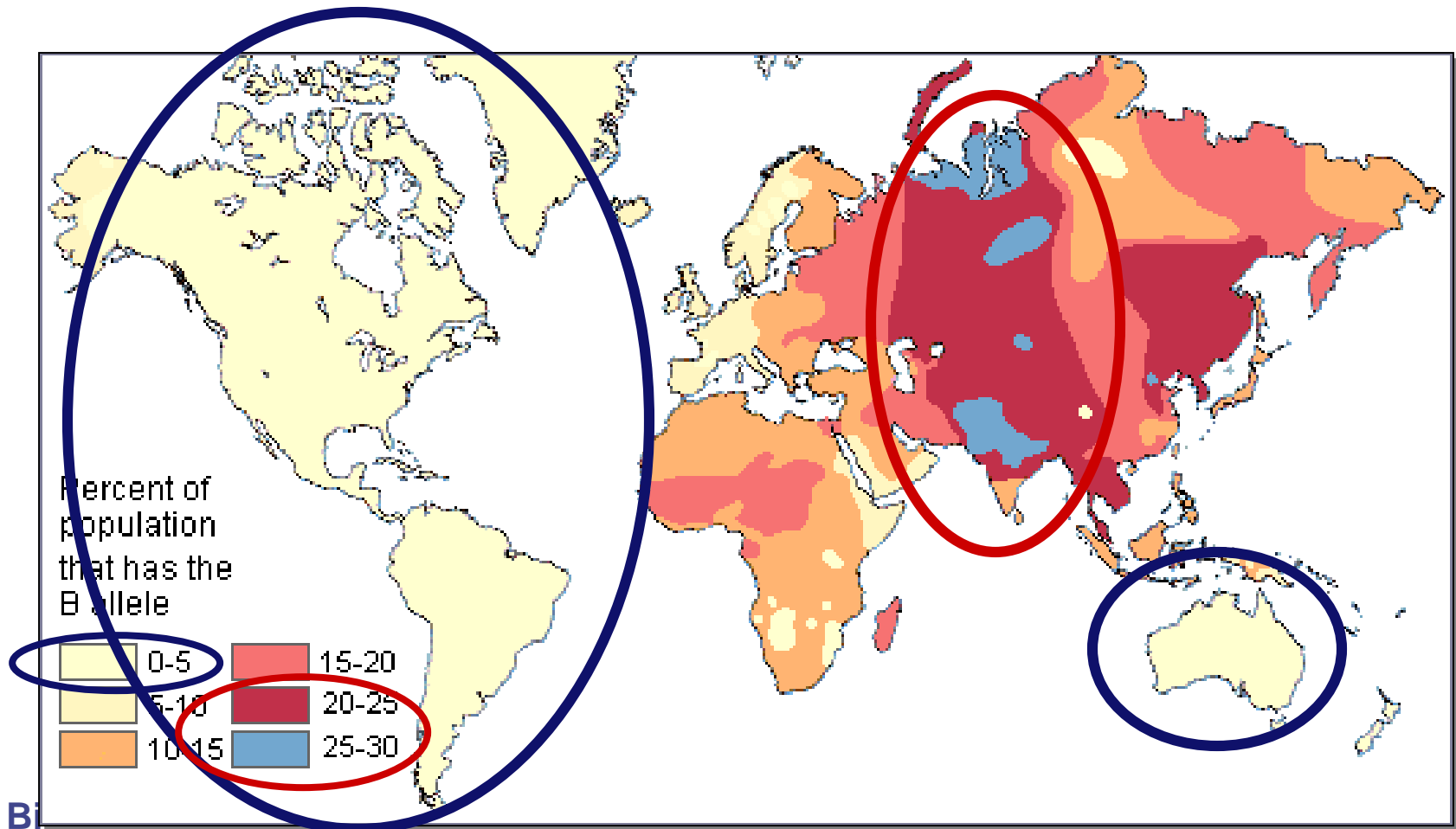
Distribution of blood types

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



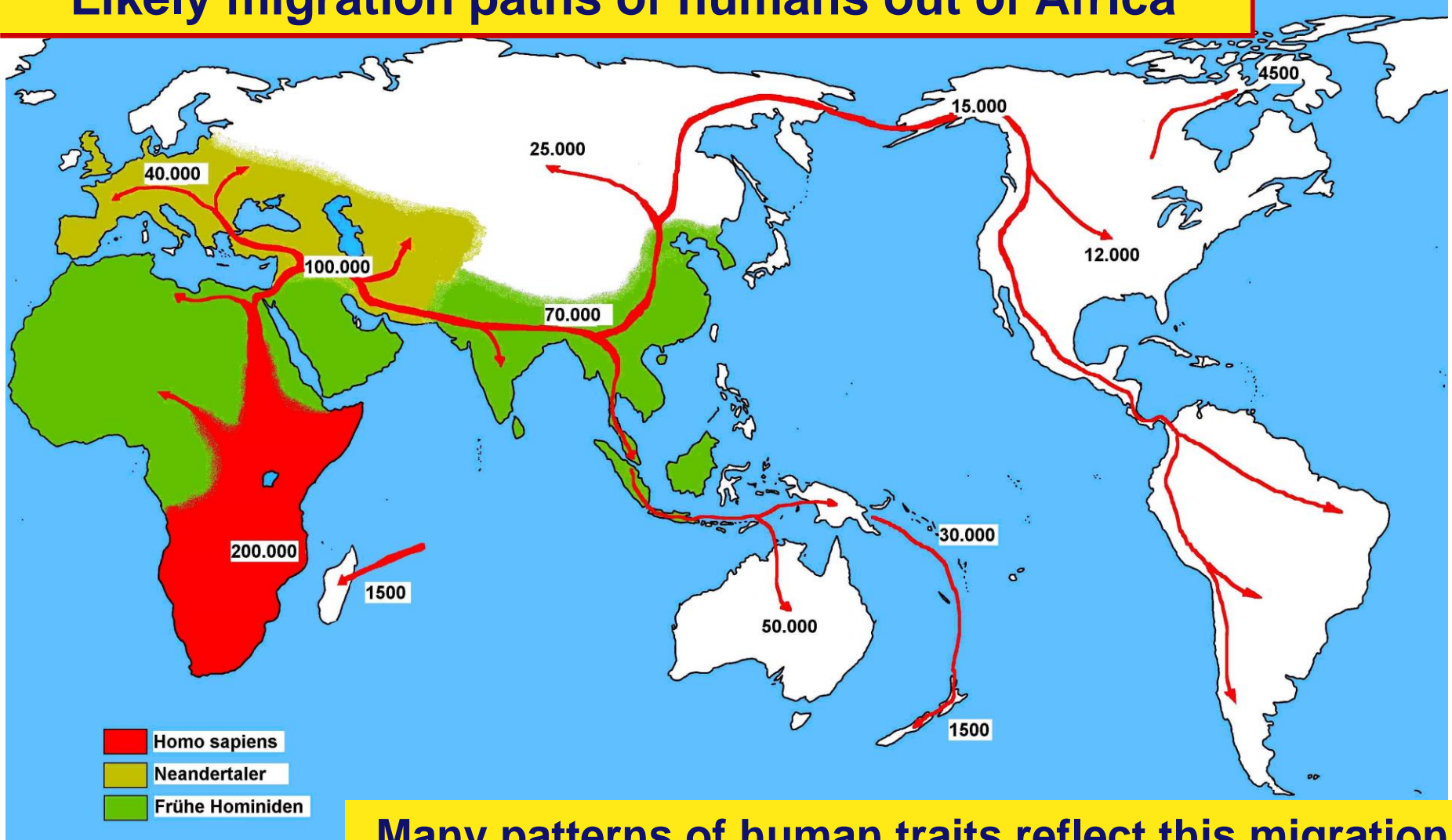
Distribution of blood types

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



Out of Africa

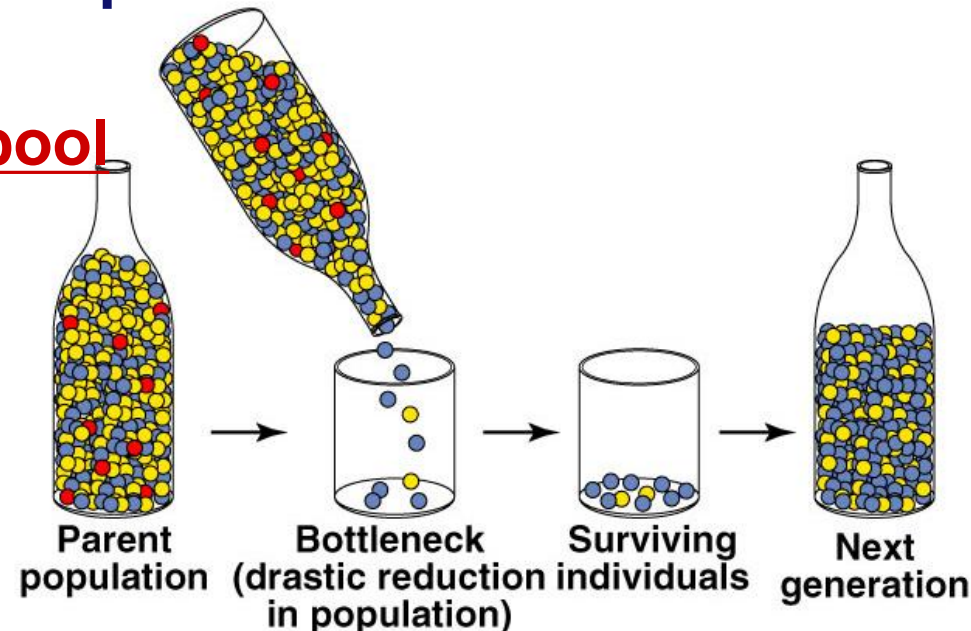
Likely migration paths of humans out of Africa



Many patterns of human traits reflect this migration

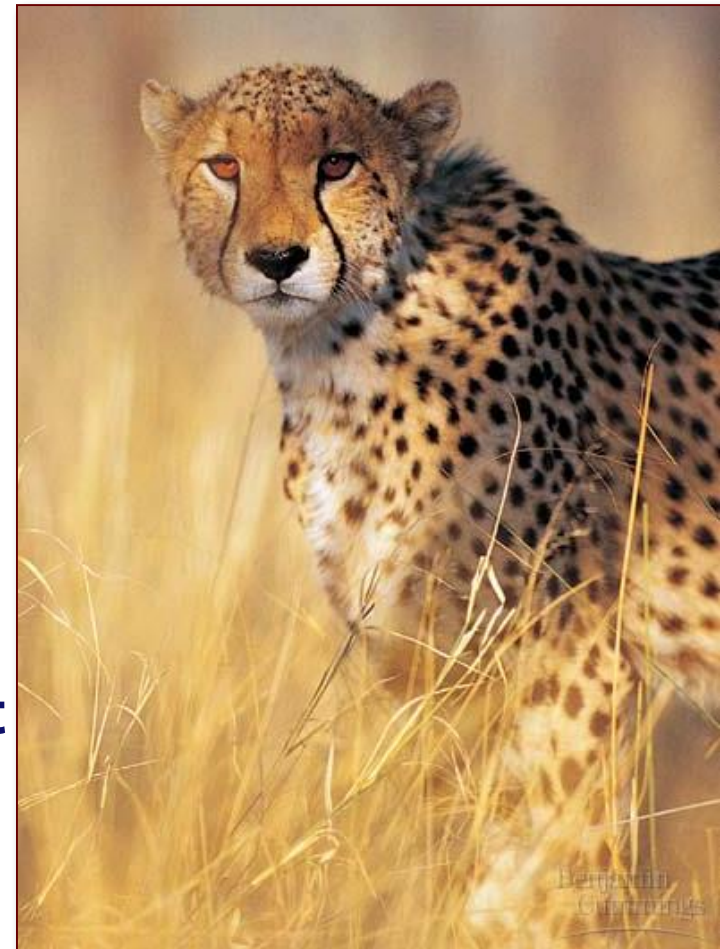
Bottleneck effect

- When large population is drastically reduced by a disaster
 - ◆ famine, natural disaster, loss of habitat...
 - ◆ loss of variation by chance event
 - 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

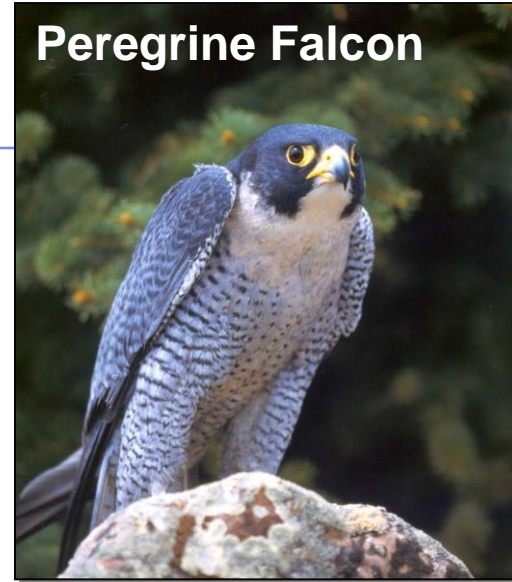


Conservation issues

- 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

Peregrine Falcon



Golden Lion
Tamarin

Any Questions??



Coevolution

- Two or more species affect each other's evolution
 - ◆ predator-prey
 - disease & host
 - ◆ competitive species
 - ◆ mutualism
 - pollinators & flowers

