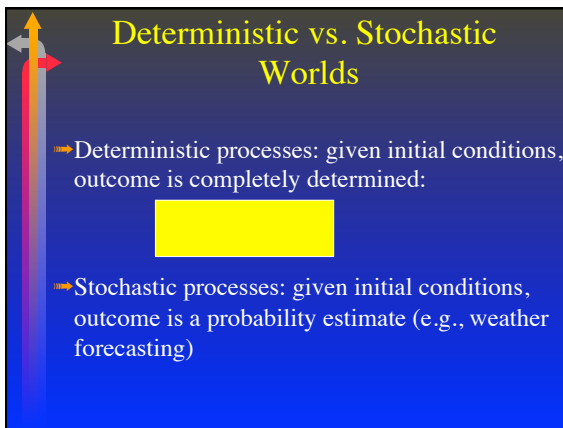



Lecture 14

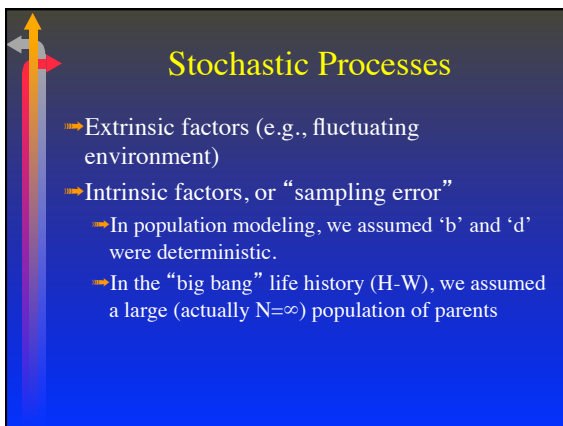
Genetic Drift
(Article 14)

Please pick up 2 pennies as you come in!



Deterministic vs. Stochastic Worlds

- Deterministic processes: given initial conditions, outcome is completely determined:

- Stochastic processes: given initial conditions, outcome is a probability estimate (e.g., weather forecasting)



Stochastic Processes

- Extrinsic factors (e.g., fluctuating environment)
- Intrinsic factors, or “sampling error”
 - In population modeling, we assumed ‘b’ and ‘d’ were deterministic.
 - In the “big bang” life history (H-W), we assumed a large (actually $N=\infty$) population of parents

Demographic stochasticity

- Imagine a simple annual plant.
- Probability of surviving to end of yr = 1 ($d=0$)
- $b=1$, but is stochastic. What does this mean?
- For example, it may mean:
 - $b=0$, with probability 0.25
 - $b=1$, with probability 0.50
 - $b=2$, with probability 0.25
- A population could go extinct, even though $r=1$! Rule of probability: If $N=1$, Chance of extinction = 0.25. If $N=2$, Chance of extinction = $0.25 \times 0.25 = .0625$.

Genetic Drift – Genetic Stochasticity

- Genetic Drift - allele frequency change due to small N (and resulting 'sampling error')
- How will allele frequency change?
- Model involves intensive probability theory: If you have $2N$ alleles combining at random, the probability that i of them will be A_1 is given by the binomial distribution:



Experimental Demonstration of Genetic Drift (Using Clickers!)

- Experiment 1: Infinite Population.
- Assume $p=0.5$, $q=0.5$
- What would p_{t+1} be after one generation of drift with $N=\text{infinity}$?

Expt' 1 Demo of Drift

→ 2. $N=X$ (Class size today). Flip your two coins; what is 'junior's genotype?

Genotype:	(A) HH	(B) HT	(C) TT	p	q
Observed					
Expected	.25	.50	.25	.5	.5

Expt' 1 Drift Demo

→ N =class size (trial 2). Repeat!

Genotype:	(A) HH	(B) HT	(C) TT	p	q
Observed					
Expected	.25	.50	.25	.5	.5

Expt' 1 Demo of Drift

→ $N=8$

Genotype:	(A) HH	(B) HT	(C) TT	p	q
Observed					
Expected	.25	.50	.25	.5	.5

Expt' 1 Demo of Drift

→ N=8 (trial 2)

Genotype:	(A) HH	(B) HT	(C) TT	p	q
Observed					
Expected	.25	.50	.25	.5	.5


Expt' 1 Demo of Drift

X populations with N=1

Time	# of Pop'ns		
	(A) HH (p=1)	(B) HT (p=.5)	(C) TT (p=0)
1			
2			
3			
4			


Genetic Drift - A Random Walk


→ Genetic drift is allele frequency change without a directional driving force:



Genetic Drift - A Random Walk


- By chance, in the absence of other forces, all small populations will drift to 'fixation': $p=0$ or $p=1$.






Genetic Drift and Small Populations

- Genetic drift results in most rapid allele frequency change in **small populations**
- Rare plants and animals will tend to lose genetic variability
- Is drift unimportant in large populations?
- *****Not necessarily!*****



Effective Population Size

- Individuals often mate within a small neighborhood, making N *effectively small* (and therefore drift becomes a potent force)



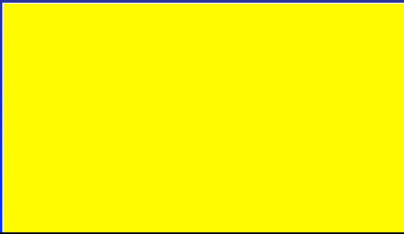
Effective Population Size

- Even if a population is panmictic (randomly mating with no distance limitation), $N_e < N$ because not all individuals in a population are reproductive
- Skewed sex ratio may lower N_e




Population Bottlenecks

- Due to effects of stochastic factors on **population size**, the stochastic process of drift can reduce genetic variation in low N periods



Genetics of Turtles

- Demonstration of population bottleneck
- GG=Dark Green Turtles
- Gg=Dark Green Turtles
- gg=Light Green Turtles



Summary-Genetic Drift

- Genetic drift is allele frequency change due to 'sampling error'
- Drift results in fixation of one allele or the other
- The rate of fixation is N-dependent, with fastest rates of change occurring in small populations
- A population bottleneck is a historical phenomenon that produces drift-like loss of genetic variation and differentiation
