Genetic Drift Simulation

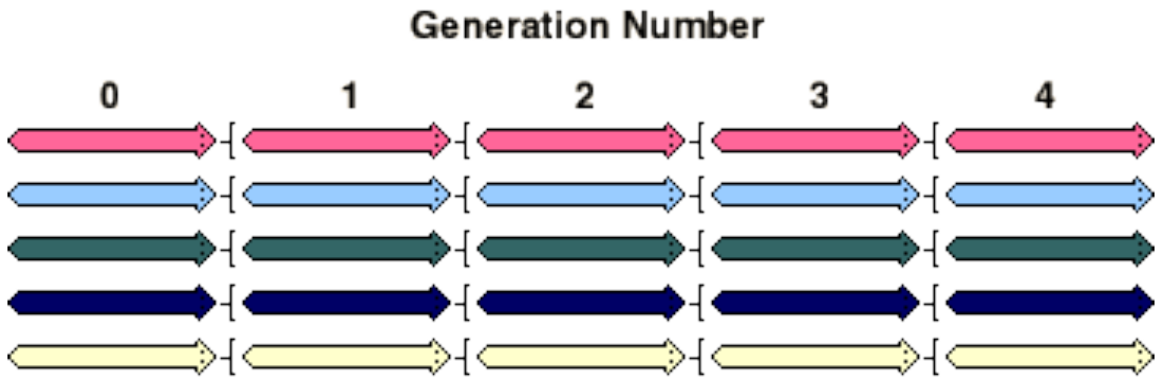
Experimental Question: How do random events cause evolution (a change in the gene pool)?

Hypothesis:

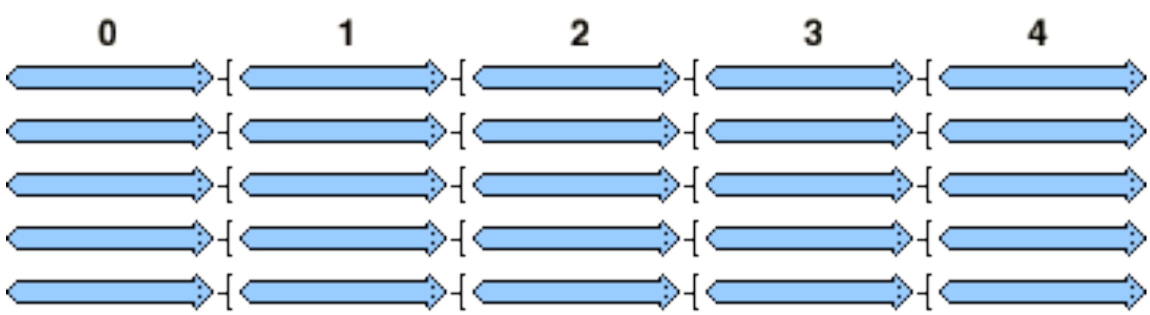
Introduction: What is Genetic Drift?

Let's examine a simple model of a population of fictional organisms called *driftworms*. In the following examples, the driftworms have only one gene, which controls skin color.

In the population of five worms below, each worm gives rise to exactly one worm in the next generation. There are five alleles (skin colors) at generation 0 and the same five alleles at generation 4. The **allele frequency** for a population is the proportion of each allele present for a given gene. For example, the allele frequency for skin color below is: Pink - 0.20, Light Blue 0.20, Dark Blue – 0.20, Green – 0.20, Yellow – 0.20. A **gene pool** is the frequency for all alleles within a population not for just a single gene such as skin color.



Note that the model above starts with a diverse population (5 worms, 5 alleles). What would the model look like if there were no diversity to begin with?



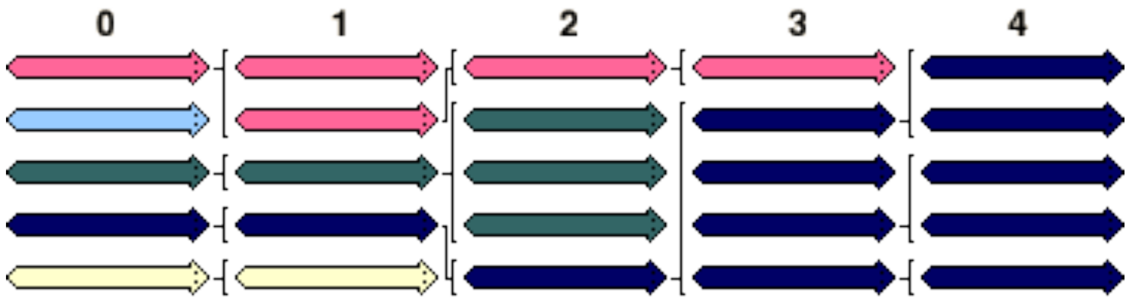
With no diversity in generation 0 and no forces of evolution acting on the population, the model above begins and ends with all worms in the population having the same allele.

The forces of evolution

In the above examples, the populations of worms are not evolving--neither the genotypes nor phenotypes are changing. For evolution to occur there must be mutation, selection (natural or artificial), immigration, emigration or random genetic drift. These are the major forces of evolution. The cause changes in genotypes and phenotypes over time. They also determine the amount and kind of variation seen in a population at a given time.

Random genetic drift

When genetic drift is introduced into the model, the results are different:



Note that in generation 2, the pink worm produces 1 offspring, the 3 green worms produced none, and the dark blue worm produced 4.

The role of chance

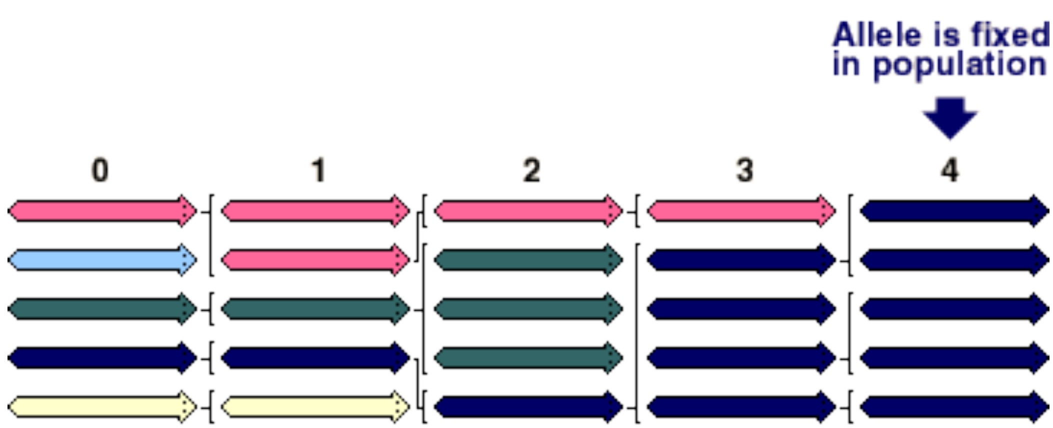
In real life, some individuals have more offspring than others--purely by chance. The survival and reproductions of organisms is subject to unpredictable accidents. It doesn't matter how good your drift worm genes are if you get squished by a shoe before producing offspring.

- An ant gets stepped on.
- A rabbit gets swept up by a tornado.
- A plane crashes killing a Nobel Laureate.

None of the above events has anything to do with the dead organism's genotype or phenotype--these events occurred purely by chance.

Fixation of an allele

In a population model with genetic drift, alleles will eventually become "fixed". When an allele is fixed, all members of the population have that allele. In the graphic below, note that the dark blue allele fixed after 4 generations.



Adapted From: http://www.biology.arizona.edu/evolution/act/drift/drift.html

Procedure: Population A

1. Color the worms of the original population (generation 1) six different colors. The simulation should start with the colors (alleles) equally represented (2 worms per color).
2. **Roll a twelve sided die to determine which worms reproduce. Draw a line connecting each parent to each offspring.**
3. **Roll a twelve random numbers to simulate the twelve offspring of the next generation. Each time a worms number is rolled they produce one offspring of the same color. Draw a line connecting the parent to each offspring for every generation. Note some worms will likely reproduce more than once and some may not reproduce at all.**
4. Repeat steps 2-3 until you have a population of driftworms with the allele frequency for color of 1 (all the driftworms are the same color).

Procedure: Population B

1. Repeat the same steps for population A with the initial population of six worms for population B. Color the original population six different colors (1 worm per color). Then generate a random number between 1 and 6 to simulate the random inheritance of color. Connect the parents of the previous generation to their offspring with a line. Repeat these steps until the allele for color is fixed, in other words all the worms are the same color making the frequency for this allele 1.

Conclusions

1. What was the allele frequency at the beginning and end of your simulations (Population A and B)?
2. How many generations passed before your driftworm had an allele frequency of 1 for populations A and B? Do you think your population reached an allele frequency of 1 at the same time as other students' simulation? Why or why not?
3. Do you think an allele frequency of 1 (no genetic diversity) is beneficial or harmful to the species? Justify your answer.
4. Predict how the results of your simulation may have differed if you began with 20 worms of each color for a total of 120 worms.
5. Do you think genetic drift has the potential to drive evolution more in small or large populations? Explain your answer.

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Generation: Population A

	1	2	3	4	5	6	7	8	9	10
1										
2										
3										
4										
5										
6										
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11										
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	11	12	13	14	15	16	17	18	19	20
1										
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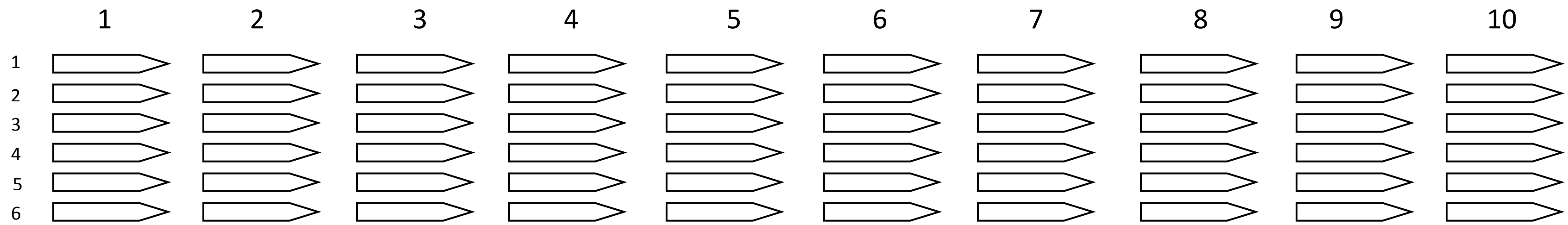
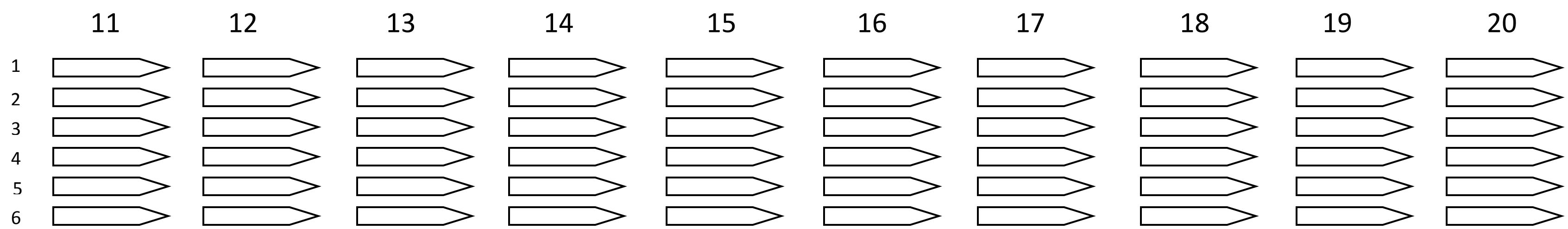
Generation: Population B





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