2013 Evolution Team:

Ned Dochtermann
Erin Gillam
Tim Greives
Steve Travers
(North Dakota State Univ.)

Kris Holder
Jen Weghorst
(Univ. of Kansas)

Facilitators:
Catherine Kirkpatrick (Univ. of Minnesota)
Steven Ralph (Univ. of North Dakota)
Understanding the mechanisms of evolution: genetic drift

Context: sophomore-level evolution course for biological science majors

Previous unit: mutation and natural selection

Goal: understand the evolutionary mechanism of random genetic drift
Learning outcomes

Students will be able to:

1. recognize an example of random genetic drift
2. explain how drift differs from natural selection
3. use drift to explain why it is incorrect to state that evolution leads to perfection
4. explain how population size influences the relative ability of drift to affect allele frequencies
5. graph data and formulate hypotheses to explain their observations
6. understand that multiple biological scenarios can result in drift (e.g. bottleneck, founder effect)
7. use a simulation program to evaluate the mechanisms of natural selection, mutation, and drift
Learning outcomes for the tidbit

Students will be able to:

1. recognize an example of random genetic drift
2. explain how drift differs from natural selection
3. use drift to explain why it is incorrect to state that evolution leads to perfection
4. explain how population size influences the relative ability of drift to affect allele frequencies
5. graph data and formulate hypotheses to explain their observations
6. understand that multiple biological scenarios can result in drift (e.g. bottleneck, founder effect)
7. use a simulation program to evaluate the mechanisms of natural selection, mutation, and drift
Pre-tidbit assessment

• Pre-tidbit assessment: clicker questions on natural selection (from previous unit)
Sample clicker questions

• Which one of the following is an example of a situation where *natural selection* could be acting?

• Which of the following is a situation that is NOT likely to be affected by *genetic drift*?
Huntington’s Disease

Frequency of Huntington’s Disease

Frequency of Huntington’s Disease

• Huntington’s disease discussion
  – Form hypotheses
  – Discuss hypotheses
Experimental study system

• Simple model organisms

• Controlled environments
The elusive POISONOUS M&M

- Haploid
- Two color phenotypes of M&M’s
- Reproduces asexually by fission
M&M fission
M&M fission

http://www.mms.com/#character
• Please read through the activity instruction sheet silently.

http://www.mms.com/#character
• Questions?

http://www.mms.com/#character
Please proceed through steps 1-4
Please complete activity
Frequency of Huntington’s Disease

- **Worldwide**
- **Afrikaners**

---

**References**


Frequency of Huntington’s Disease

Learning outcomes

Students will be able to:

1. recognize an example of random genetic drift
2. explain how drift differs from natural selection
3. use drift to explain why it is incorrect to state that evolution leads to perfection
4. explain how population size influences the relative ability of drift to affect allele frequencies
5. graph data and formulate hypotheses to explain their observations
6. understand that multiple biological scenarios can result in drift (e.g. bottleneck, founder effect)
7. use a simulation program to evaluate the mechanisms of natural selection, mutation, and drift
Learning outcomes

Students will be able to:

1. recognize an example of random genetic drift
2. explain how drift differs from natural selection
3. use drift to explain why it is incorrect to state that evolution leads to perfection
4. explain how population size influences the relative ability of drift to affect allele frequencies
5. graph data and formulate hypotheses to explain their observations
6. understand that multiple biological scenarios can result in drift (e.g. bottleneck, founder effect)
7. use a simulation program to evaluate the mechanisms of natural selection, mutation, and drift
Post-tidbit
Learning outcomes

Students will be able to:

1. recognize an example of random genetic drift
2. explain how drift differs from natural selection
3. use drift to explain why it is incorrect to state that evolution leads to perfection
4. explain how population size influences the relative ability of drift to affect allele frequencies
5. graph data and formulate hypotheses to explain their observations
6. understand that multiple biological scenarios can result in drift (e.g. bottleneck, founder effect)
7. use a simulation program to evaluate the mechanisms of natural selection, mutation, and drift
Activities and assessments for these outcomes

1. Simulation homework
   – Introduced after tidbit
   – Discussed in next class
     • another formative assessment
   – *Summative assessment*

2. Conservation case study
   – Discussed in next class
   – Covers bottlenecks
   – *Formative assessment*
Simulation

• PopG (alternative programs available)
  – Allows alteration of numerous parameters
    • Population size (drift)
    • Fitness
    • Migration, mutation
Example homework questions

• How would you predict allele frequencies might fluctuate as population sizes are decreased? And when increased?

• Introduce selection into your simulations. What should happen if the AA genotype has a fitness of 0.9, and Aa and aa fitnesses of 1? Set these fitnesses and set population sizes to 25. Were your predictions supported?
Activities and assessments for these outcomes

1. Simulation homework
   – Introduced after tidbit
   – Discussed in next class
     • another formative assessment
   – Summative assessment

2. Conservation case study
   – Discussed in next class
   – Covers bottlenecks
   – Formative assessment
Assessments & Related Activities

1. Simulation homework
   – Introduced after tidbit
   – Discussed in next class
     • another formative assessment
   – Summative assessment

2. Conservation case study
   – Discussed in next class
   – Covers bottlenecks
   – Formative assessment
Conservation case study

http://www.hsd3.org/HighSchool/Teachers/MATTIXS/Mattix%20homepage/studentwork/Kyle%20Kohn%20web%20page/Cape%20buffalo.htm
http://www.sharewallpapers.org/d/3444-1/Stampede---African-Cape-Buffalo-Herd-1.jpeg
Conservation case study

• Cape buffalo (*Syncerus caffer caffer*)
  – Historically widespread and panmictic

  – Currently confined to protected areas
    • Isolation of populations

  – How might this affect genetic diversity?
Discuss in groups Propose hypotheses
Allelic richness ($A_R$) vs. Patch area (log km$^2$)

$R^2 = 0.59$
Instructor notes

Background information

• Reserves are of different sizes (area)

• Reserves support different size populations

• Researchers quantified allelic diversity (amongst other things)

• Go back to group discussions. Formulate hypotheses. Draw a figure with your expectations

Possible activities

• Group discussions formulating hypotheses

• Have groups draw hypothetical results

• Have class discuss drawings of multiple groups

• After data is presented, have students discuss what they would expect if selection were at play (e.g. bovine tuberculosis is a big problem for many wild ungulates)