Contributors

Terry Lester, Jr.
Graduate Student
Georgia Southern University, GA

Yvonne Arnsdorff
Partner Teacher
Effingham County High, GA

Intended Audience

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>K-4</td>
<td></td>
</tr>
<tr>
<td>5-8</td>
<td></td>
</tr>
<tr>
<td>9-12</td>
<td>X</td>
</tr>
</tbody>
</table>

Activity Characteristics

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom Setting</td>
<td>X</td>
</tr>
<tr>
<td>Requires special equipment</td>
<td></td>
</tr>
<tr>
<td>Uses hands-on manipulatives</td>
<td>X</td>
</tr>
<tr>
<td>Requires mathematical skills</td>
<td>X</td>
</tr>
<tr>
<td>Can be performed individually</td>
<td>X</td>
</tr>
<tr>
<td>Requires group work</td>
<td>X</td>
</tr>
<tr>
<td>Requires more than one (45 min class) period</td>
<td></td>
</tr>
<tr>
<td>Appropriate for special needs student</td>
<td></td>
</tr>
</tbody>
</table>
Introduction

Description

This bottleneck effect activity develops the students’ understanding of the genetic contribution to the change of species over time.

Abstract

Evolution is described as a change in the genetic composition of a population from generation to generation. During this activity, students will examine how a population bottleneck can influence the occurrence of a trait in a population. Students will also learn how traits can reach fixation and what this means in evolutionary terms.

Core Themes Addressed

<table>
<thead>
<tr>
<th>Microbial Cell Biology</th>
<th>Microbial Genetics</th>
<th>Microorganisms and Humans</th>
<th>Microorganisms and the Environment</th>
<th>Microbial Evolution and Diversity</th>
<th>Other – Evolution</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

Keywords

Fixation, bottleneck effect, evolution, genetic drift

Learning Objectives

At completion of this activity, learner will

1. Demonstrate a population bottleneck effect.
2. Describe how genetic drift could lead to evolution of species.
3. Recognize the disadvantages of a small population size.
National Science Education Standards Addressed

Standard A: Science as Inquiry
- Abilities necessary to do scientific inquiry

Standard C: Life Science
- Biological evolution
Teacher Handout

Bottleneck Effect

Student Prior Knowledge

Students should have prior exposure to terminology associated with genetics (traits, gene, gene pool). In addition, students should know how to convert proportions to percentages and be able to determine percentages of a whole number.

Teacher Background Information

Class Time

This activity will require a minimum of one-50min class period

1. Introduction Powerpoint (8min)
2. Explain Activity (5min)
3. Complete Activity (30min)
4. Clean-up (2min)
5. Write conclusion paragraph (5min)

Teacher Preparation Time

This lesson will require approximately 45minutes of preparation time.

1. Print student worksheets
2. In a Ziploc bag, place 100 bingo chips of two different colors (50 each color).

Safety Precautions

None

Materials and Equipment

1. 100 bingo chips (e.g. 50-blue, 50-green) per group (4students/group)
2. 1 Ziploc bag per group
3. Student worksheet
**Methods** (4 students/group)

1. Give each student a worksheet.
2. Place Ziploc bag with bingo chips near each group.
3. Review the activity procedures with students.
4. Allow students 30 minutes to complete activity (until fixation).
5. Clean-up.
6. Allow students to complete questions.
7. Lead discussion of questions.

**Tips/Suggestions**

1. Have an example of the mathematical procedures posted in classroom
2. Have another starting population frequency for students who reach fixation in fewer generations

**References.**

This activity was modified from:


**Answers to Student Handouts**

3. Only chance events—that is, the effects of small population size, are responsible for the change in gene frequencies. Would you say that evolution has occurred? Explain.

Answer: Yes, evolution can occur when we have genetic drift as in the case of a chance event that reduces population size.
Introduction

Bottleneck effect occurs when a population undergoes a drastic reduction in size. This usually occurs with natural disasters or even with intense human selection. The north elephant seal, for example, was reduced to 20 individuals in the 1890s due to over-hunting for oil from the seal’s bladder. The population was restored to 30,000 individuals after the Marine Mammal Protection Act of 1972, but there was less genetic diversity in the recovered seals.

Student Background Knowledge

Evolution is the change in the genetic composition of a population from generation to generation. One key principle for equilibrium (no evolution) is random mating within a large population. Genetic drift is the genetic change in a small population by chance alone (no selection). Small populations can occur due to natural disasters such as hurricanes and volcanic eruption.

Vocabulary

Evolution: change in the genetic composition of a population across generations.
Genetic drift: change in genetic composition in small population as a result of chance.
Bottleneck Effect: population undergoes a drastic reduction in size as a result of chance event.
Fixation: the loss of all but one possible trait in a population

Safety Considerations

None

Materials Checklist (4 students/group)

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>100 bingo chips of two different colors (50 each color).</td>
</tr>
<tr>
<td>1</td>
<td>Ziploc bag</td>
</tr>
<tr>
<td>1</td>
<td>Student Worksheet</td>
</tr>
</tbody>
</table>
Procedure

1. To investigate the bottleneck effect, establish a starting population containing 100 individuals (100 bingo chips)
2. Without looking, remove 10 bingo chips from the starting population of 100.
3. Record the percentage of each bingo chip color (i.e. 60% green, 40% blue)
4. Using your new frequency (percentage) of bingo chip color, establish a new population of 50 individuals (50 bingo chips).
5. Repeat steps 2, 3, and 4. Keep going until all individuals are alike (all green or blue)
6. Summarize your results in the discussion session.
# Student Worksheet

## Bottleneck Effect

### Record Data

<table>
<thead>
<tr>
<th>Generation</th>
<th>Frequency Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Blue Trait</td>
</tr>
<tr>
<td></td>
<td># of chips</td>
</tr>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>
1. How many generations did you simulate?

2. Did one trait go to fixation in that time period? Which trait?

   (Remember, fixation occurs when the population is composed of only one trait. The others have been eliminated. Did the other trait ever appear to be going to fixation?)

3. Only chance events—that is, the effects of small population size, are responsible for the change in gene frequencies. Would you say that evolution has occurred? Explain.