Bees, Butterflies, & Bottlenecks

Diversity of Living Things, Human Impacts on the Environment

Eastern Carpenter Bee

Ruby-Throated Hummingbird

Hoverfly

Checkered Beetle

Black Swallowtail Butterfly

BEES, BUTTERFLIES & BOTTLENECKS

Grades 11 - 12, Biology
Prepared for Monarch Mayhem 2020

OVERVIEW & PURPOSE

This lesson will explore the concept of biodiversity, explore the diversity of pollinators, and discuss the mechanisms for the decline in biodiversity and the consequences thereof.

UNIT: Diversity of living things, human impacts on the environment.

Estimated time to complete: 45 to 55 minutes.

OBJECTIVES

Accompanying this lesson will be an activity to illustrate the concept of a population bottleneck: namely, an extreme reduction in population results in low genetic diversity, making the population vulnerable to environmental threats.

MATERIALS NEEDED

1. Two bottles or cups for each group.
2. Beads (you will need five different colours). You will need enough so that each group of four students has 100 beads of each colour.
3. Optional: One six-sided dice for each group.

VERIFICATION

Questions to ask students to check understanding after completion of activity.

1) What does the collection of beads represent? What do the different coloured beads in a collection represent?
2) What do the results of step three and onward represent?
3) What do the dice rolls represent? What does adding the extra die (step 5) represent?
4) Predict what would happen if you poured more beads from the bottle during each iteration of the activity. Would the activity take more or less time?

PRESENTATION

Variation is a key feature of populations, species, communities, and ecosystems. The variation between organisms is referred to as *biodiversity*, and it exists at multiple scales. The type of biodiversity we will discuss today is:

- **Genetic biodiversity within a population**. Variation among individuals of the same population. Most species have multiple populations, each defined by their geographic range and genetic differences.

At any scale, biodiversity is a crucial aspect of environmental health. To explain why, we will have to review the basics of **evolution by natural selection:**

- All organisms are faced with environmental pressures, sometimes known as *biotic* and *abiotic* pressures present within an environment.
- If a genetic trait is beneficial (i.e. it allows an organism to overcome environmental pressures more effectively) then the organism will be more likely to survive and reproduce. The trait is then passed on to future generations and is further modified by the same process.
- In other words, the environment selects *for* individual organisms with beneficial traits. In the same way, the environment selects *against* individuals with detrimental traits.

Within a population, genetic diversity ensures that environmental pressures do not select against too many individuals, thus making the population more resilient to threats of *extinction*.

Similarly, overall biodiversity within an ecosystem ensures the same resilience. Greater species diversity means that if one species is removed, the environmental consequences are reduced.

The term pollinator refers to a diverse collection of animals that provide the vital service of pollinating plants (moving pollen from one flower to the next, fulfilling the plants reproductive needs). In Canada, pollination is fulfilled by many different species, such as:

- Bees and wasps (Class: Insecta, Order: Hymenoptera)
- Hover flies (Class: Insecta, Order: Diptera)
- Beetles (Class: Insecta, Order: Coleoptera)
- Moths and Butterflies (Class: Insecta, Order: Lepidoptera)
- Hummingbirds (Class: Aves, Order: Apodiformes)

Canada has over 1 000 species of pollinators. Some are **generalist** species that eat the nectar or pollen from a wide variety of flowering plants while others are **specialist** pollinators that have evolved to visit one plant species or a group of closely related plants.

The environment is never constant. It is always changing, and those changes are influenced by a variety of factors (such as the previously discussed biotic and abiotic

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factors). Recently, human activity has resulted in rapid and extreme environmental changes world-wide, creating many environmental pressures.

- o Can you think of some examples of human activities and how they would impose environmental pressures on pollinator populations? (Correct answers include loss of habitat, invasive species, pesticide use and climate change.)

Unfortunately, human activities have imposed environmental pressures that are putting the world's ecosystems at risk. Many Canadian pollinator populations are declining at alarming speed. Population numbers may recover from such threats, but there is the added risk of the loss of genetic diversity. This is called a *population bottleneck*. This process will be explored in the activity.

POPULATION BOTTLENECK ACTIVITY

1) Assign each colour of bead with a number on the die, ignoring six. If you do not have dice, place one bead of each colour into a container and then select one at random.
2) Fill a bottle or cup with 20 beads of each colour. Thoroughly mix the beads so they are randomized.
3) A) Pour ten beads from the bottle or randomly select ten beads from the cup and place them on the table.
   B) For each bead, add nine more beads of that colour so you have a total of 100 beads.
4) Place the beads that are on the table into an empty bottle or cup and repeat step 3. Roll a six-sided die. If you roll a six, reroll until you roll a different number. Otherwise, remove the beads with the corresponding colour. For all beads removed this way, add beads of the colour that is most numerous (or tied for the most numerous) in your current batch. If you roll a number that does not correspond to any colour in your batch, continue with the exercise.
5) Repeat step 4. Instead of one die, use two dice. Remove the beads that correspond with each die roll.
6) Continue the exercise until there is only one colour of beads left.