Lab 23. Mechanisms of Evolution: Why Will the Characteristics of a Bug Population Change in Different Ways in Response to Different Types of Predation?

Introduction

The various components of an ecosystem are all connected. Plants depend on the abiotic resources of an ecosystem to produce the food they need to grow, herbivores eat these plants, and carnivores eat the herbivores. Thus, a change in the amount of abiotic resources available or a change in the size of any one of these populations of organisms can influence the size of the other populations found in that ecosystem. A drought, for example, could reduce the size of the plant population. A decrease in the size of the plant population results in less food for the herbivores. When herbivores do not have enough food to eat, the death rate of the population increases, which, in turn, results in fewer herbivores. The size of the carnivore population, as a result, begins to shrink because there is not enough food available.

In addition to influencing the size of a population, the interactions that take place between the organisms found within an ecosystem can actually change the characteristics of some populations. Some of the characteristics that can be influenced by these interactions include the ratio of males to females in a population or the ratio of juveniles to adults in the population. Other characteristics that can be influenced by population interactions include the proportion of individuals within a population that have a specific trait or the average height or weight of the members of that population. It is therefore important for biologists to understand how different types of interactions can result in a change in the characteristics of a population.

One type of interaction that can result in a change in the characteristics of a population is predation. Predation often has a strong influence on the characteristics of a prey population. For example, a population of herbivores that lives in an area with a lot of predators will often have different characteristics than a population of herbivores that lives in an area with few or no predators. The hunting strategy used by the predator will also have an influence on the characteristics of a prey population. For example, a herbivore population that is eaten by a predator that chases its prey and a herbivore population that is eaten by a predator that hunts by sitting and waiting for its prey will often have different characteristics. Biologists often study how the characteristics of a specific prey population change in response to a specific type of predation, to understand how different types of interactions can result in a change in the characteristics of a population.

Your Task

Use a computer simulation called Bug Hunt Speeds to explore how a population of a "bug" responds to the influence of two different types of predators. You will then develop an explanation for the changes you observe in the bug population. Your explanation must outline a mechanism that will cause the characteristics of a prey population to change in different ways in response to different types of predation.

The guiding question of this investigation is, **Why will the characteristics of a bug population change in different ways in response to different types of predation?**

Materials

You will use an online simulation called Bug Hunt Speed to conduct your investigation. You can access the simulation by going to the following website: *http://ccl.northwestern.edu/netlogo/models/BugHuntSpeeds*.

Safety Precautions

1. Use caution when working with electrical equipment. Keep away from water sources in that they can cause shorts, fires and shock hazards. Use only GFI protected circuits.
2. Wash hands with soap and water after completing this lab.
3. Follow all normal lab safety rules.

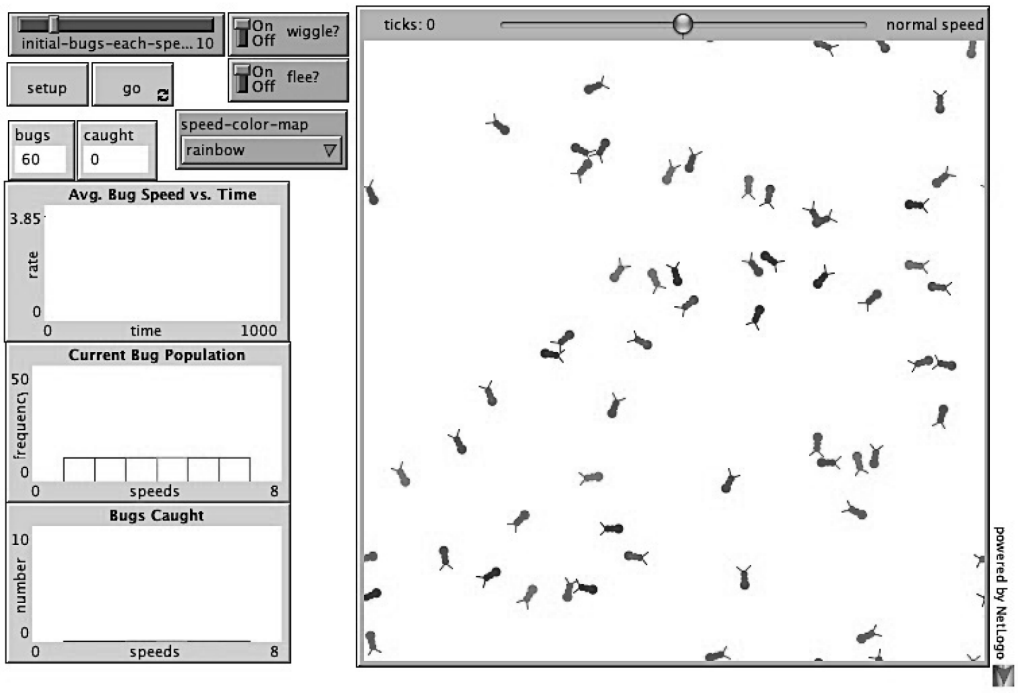
Getting Started

Bug Hunt Speed simulates a population of bugs that all belong to the same species. All the bugs in this population, however, are different, even though they belong to the same species. The bugs vary in terms of color, how fast they move, if they wiggle or not, and if they flee from predators when one is nearby.

In this simulation, you will act as the predator. You are able to eat the bugs (your prey) by clicking on them. You can act as a "hunting" predator by moving the mouse around to catch the bugs, or you can act as a "sit and wait" predator by keeping the mouse in one place and then catching the bugs that come to you. When a bug is eaten, it is replaced through reproduction by a bug in the simulated ecosystem. The new bug, therefore, will have the same characteristics as a bug that has not been eaten yet. Remember, all of the bugs in the ecosystem are from the same species.

The simulation also allows you to adjust the characteristics of the bugs. You can use the menus on the left of the screen to determine the color scheme for the bugs, the initial number of bugs in the habitat, if the bugs wiggle or not, and if they "flee" from a predator or not (see figure below).

A screen shot from the Bug Hunt Speed simulation



To answer the guiding question, you must determine what type of data you will need to collect, how you will collect it, and how you will analyze it. To determine *what type of data you will need to collect,* think about the following questions:

- How will you determine if the characteristics of the bug population change over time?
- How will you test your explanation for the changes you observe in the population of bugs?
- What will serve as your dependent variable (e.g., color, speed, number of bugs caught)?
- What type of measurements or observations will you need to record during your investigation?

To determine *how you will collect your data,* think about the following questions:

- What will serve as a control condition (e.g., no predation)?
- What types of treatment conditions will you need to set up and how will you do it?
- How many trials will you need to conduct?
- How long will you need to run the simulation during each trial (e.g., for three minutes or until 60 bugs are caught)?
- How often will you collect data and when will you do it?
- How will you keep track of the data you collect and how will you organize the data?

To determine *how you will analyze your data,* think about the following questions:

- How will you determine if there is a difference between the different treatment conditions and the control condition?

- What type of calculations will you need to make?
- What type of graph could you create to help make sense of your data?

Investigation Proposal Required? ☐ Yes ☐ No

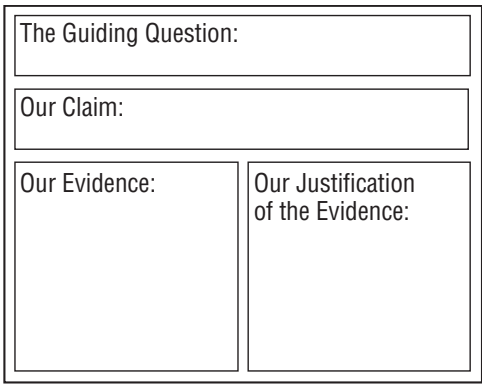
Connections to Crosscutting Concepts and to the Nature of Science and the Nature of Scientific Inquiry

As you work through your investigation, be sure to think about

- the importance of looking for patterns in nature,
- the importance of developing causal explanations for natural phenomena,
- the different types of methods that scientists use to answer questions, and
- the difference between observations and inferences.

Argumentation Session

Argument presentation on a whiteboard



Once your group has finished collecting and analyzing your data, prepare a whiteboard that you can use to share your initial argument. Your whiteboard should include all the information shown in the figure to the right.

To share your argument with others, we will be using a round-robin format. This means that one member of your group will stay at your lab station to share your group's argument while the other members of your group go to the other lab stations one at a time to listen to and critique the arguments developed by your classmates.

The goal of the argumentation session is not to convince others that your argument is the best one; rather, the goal is to identify errors or instances of faulty reasoning in the arguments so these mistakes can be fixed. You will therefore need to evaluate the content of the claim, the quality of the evidence used to support the claim, and the strength of the justification of the evidence included in each argument that you see. In order to critique an argument, you will need more information than what is included on the whiteboard. You might, therefore, need to ask the presenter one or more follow-up questions, such as:

- How did you use the simulation to collect your data?
- What did you do to analyze your data? Why did you decide to do it that way? Did you check your calculations?
- Is that the only way to interpret the results of your analysis? How do you know that your interpretation of your analysis is appropriate?
- Why did your group decide to present your evidence in that manner?
- What other claims did your group discuss before you decided on that one? Why did your group abandon those alternative ideas?
- How confident are you that your claim is valid? What could you do to increase your confidence?

Once the argumentation session is complete, you will have a chance to meet with your group and revise your original argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the most valid or acceptable answer to the research question!

Report

Once you have completed your research, you will need to prepare an investigation report that consists of three sections that provide answers to the following questions:

1. What question were you trying to answer and why?
2. What did you do during your investigation and why did you conduct your investigation in this way?

3. What is your argument?

Your report should answer these questions in two pages or less. This report must be typed, and any diagrams, figures, or tables should be embedded into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid!