**Speciation Simulation**

Names \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

In this simulation you will investigate the way populations of birds living on an island change, due to mutations and natural selection, over 1,000,000 years. Any bird populations that diverge from other populations in at least two traits will no longer be able to interbreed with one another, and will therefore be considered separate species.

**Part A:** You will track a bird population that exists in the southwestern portion of an island, where the birds will encounter a certain set of environmental conditions: seeds, edible insects, no nectar, light green foliage, and no predators.

The online simulation can be found here: <http://sepuplhs.org/high/sgi/teachers/evolution_act11_sim.html>

Over the course of 500,000 years, mutations may alter the ability of some birds and their descendants to thrive in the environment. Birds with traits that enhance their fitness are more likely to survive and reproduce.

To begin the simulation, you will select phenotypes for three birds. **For this first simulation, all bird will start with exactly the same phenotype:**

* **Brown plumage**
* **Medium body size**
* **Medium, curved beak (the one in the very center)**

Ignore the message on the first map page, and click through to watch the animation. As you watch, record in the chart the changes – mutations, mutation effects, and population numbers – that occur across the three populations.

|  |  |  |  |
| --- | --- | --- | --- |
|  | ***Bird Population 1*** | ***Bird Population 2*** | ***Bird Population 3*** |
| ***# Years Passed*** | ***Mutations*** | ***Mutation Effects*** | ***Population Size*** | ***Mutations*** | ***Mutation Effects*** | ***Population Size*** | ***Mutations*** | ***Mutation Effects*** | ***Population Size*** |
| **50,000** |  |  |  |  |  |  |  |  |  |
| **100,000** |  |  |  |  |  |  |  |  |  |
| **150,000** |  |  |  |  |  |  |  |  |  |
| **200,000** |  |  |  |  |  |  |  |  |  |
| **250,000** |  |  |  |  |  |  |  |  |  |
| **300,000** |  |  |  |  |  |  |  |  |  |
| **350,000** |  |  |  |  |  |  |  |  |  |
| **400,000** |  |  |  |  |  |  |  |  |  |
| **450,000** |  |  |  |  |  |  |  |  |  |
| **500,000** |  |  |  |  |  |  |  |  |  |

* Describe the three bird populations after 500,000 years of evolution. If any population(s) went extinct, just cross out that square with an X.

|  |  |  |
| --- | --- | --- |
| ***Bird Population 1*** | ***Bird Population 2*** | ***Bird Population 3*** |
| Plumage: Body Size: Beak size and shape:  | Plumage: Body Size: Beak size and shape:  | Plumage: Body Size: Beak size and shape:  |

* Summarize how the bird populations changed over time. For example, what types of mutations occurred? Under what circumstances, in general, were the offspring more fit as a result of the mutation?
* Compare the changes in your bird populations with those of another group. What differences and similarities do you notice?

**Part B:** A hurricane has hit the island, and some of the birds have been blown to three new areas! Each area has a unique environment.

* You will be prompted to select the environmental conditions for the Northeast section of the island. Choose any combination of food sources, predators, and foliage color that you like.
* Record in the chart below the environment that exists in each of the three new areas, when each bird population arrives.
* Generate a hypothesis as to which of the bird populations you think will be most fit in each of the habitats, and which will be less fit, based on their plumage, size, and beak shape traits. Briefly, explain your reasoning.

|  |  |  |
| --- | --- | --- |
| ***Area:***  | ***Description of environment*** | ***Hypothesis:***  |
| **Northeast:** |  |  |
| **Northwest:**  |  |  |
| **Southeast:** |  |  |

* Watch the animation for the next 500,000 years, and record your observations in the table below. Unlike the table above, each population does not have its own set of columns; instead, can combine your list of mutations and phenotypic changes for all three populations in each area.

|  |  |  |  |
| --- | --- | --- | --- |
|  | ***Northeast Bird Populations*** | ***Northwest Bird Populations*** | ***Southeast Bird Populations*** |
| ***# Years Passed*** | ***Mutations*** | ***Mutation Effects*** | ***Population Size*** | ***Mutations*** | ***Mutation Effects*** | ***Population Size*** | ***Mutations*** | ***Mutation Effects*** | ***Population Size*** |
| **50,000** |  |  |  |  |  |  |  |  |  |
| **100,000** |  |  |  |  |  |  |  |  |  |
| **150,000** |  |  |  |  |  |  |  |  |  |
| **200,000** |  |  |  |  |  |  |  |  |  |
| **250,000** |  |  |  |  |  |  |  |  |  |
| **300,000** |  |  |  |  |  |  |  |  |  |
| **350,000** |  |  |  |  |  |  |  |  |  |
| **400,000** |  |  |  |  |  |  |  |  |  |
| **450,000** |  |  |  |  |  |  |  |  |  |
| **500,000** |  |  |  |  |  |  |  |  |  |

* Describe the bird populations after 1,000,000 years of evolution. Please also take a screenshot of your birds. If any populations went extinct, just cross off that square with an X.

|  |  |  |  |
| --- | --- | --- | --- |
| ***Area*** | ***Bird Population 1*** | ***Bird Population 2*** | ***Bird Population 3*** |
| **Northwest** | Plumage: Body Size: Beak size and shape:  | Plumage: Body Size: Beak size and shape:  | Plumage: Body Size: Beak size and shape:  |
| **Northeast** | Plumage: Body Size: Beak size and shape:  | Plumage: Body Size: Beak size and shape:  | Plumage: Body Size: Beak size and shape:  |
| **Southeast** | Plumage: Body Size: Beak size and shape:  | Plumage: Body Size: Beak size and shape:  | Plumage: Body Size: Beak size and shape:  |

At the start, all the birds were members of a single species. After several generations of natural selection, any population of birds that has **at least two traits that are different** from those of another population will no longer be interbreed, and will therefore have become two different species.

* How many different species are present across the island after 1,000,000 years of evolution? Describe the phenotypes of each species:
* Did any species go extinct? Go back to the tables above and see if you can determine the cause of this extinction. Was it due to an unfavorable mutation? If so, which one(s)?

|  |
| --- |
| ***Simulation #2*** |
| Plumage: Body Size: Beak size and shape:  |

**Part C:** Now, you will do another round of evolution simulations. This time, you can select the traits for your starting populations. Again, please give all three populations the same phenotypes (so we start with a single species on the island). You can choose traits that you think will be well adapted in this habitat, or ones that you think are unfavorable. (Hint: you can view which adaptations are most favorable by hovering over the Food Sources, Predators, and Foliage listings in the right sidebar).

* List the traits that you chose in the table at right:
* Now, run the simulation as before, and record the mutations and effects:

|  |  |  |  |
| --- | --- | --- | --- |
|  | ***Bird Population 1*** | ***Bird Population 2*** | ***Bird Population 3*** |
| ***# Years Passed*** | ***Mutations*** | ***Mutation Effects*** | ***Population Size*** | ***Mutations*** | ***Mutation Effects*** | ***Population Size*** | ***Mutations*** | ***Mutation Effects*** | ***Population Size*** |
| **50,000** |  |  |  |  |  |  |  |  |  |
| **100,000** |  |  |  |  |  |  |  |  |  |
| **150,000** |  |  |  |  |  |  |  |  |  |
| **200,000** |  |  |  |  |  |  |  |  |  |
| **250,000** |  |  |  |  |  |  |  |  |  |
| **300,000** |  |  |  |  |  |  |  |  |  |
| **350,000** |  |  |  |  |  |  |  |  |  |
| **400,000** |  |  |  |  |  |  |  |  |  |
| **450,000** |  |  |  |  |  |  |  |  |  |
| **500,000** |  |  |  |  |  |  |  |  |  |

* Describe the three bird populations after 500,000 years of evolution. If any population(s) went extinct, just cross out that square with an X.

|  |  |  |
| --- | --- | --- |
| ***Bird Population 1*** | ***Bird Population 2*** | ***Bird Population 3*** |
| Plumage: Body Size: Beak size and shape:  | Plumage: Body Size: Beak size and shape:  | Plumage: Body Size: Beak size and shape:  |

* Did the populations change in the way you expected? In other words, if you chose favorable mutations, did the birds seem to do well? If you chose unfavorable mutations, did the populations need to evolve new traits in order to thrive? Explain your answer.

**Part D:** Again, a hurricane has hit the island, and some of the birds have been blown to three new areas! Each area has a unique environment.

* Record in the chart below the environmental conditions that you select for the Northeast area, along with the starting conditions for the two other areas.
* Generate a hypothesis as to which of the bird populations you think will be most fit in each of the habitats, and which will be less fit, based on their plumage, size, and beak shape traits. Briefly, explain your reasoning.

|  |  |  |
| --- | --- | --- |
| ***Area:***  | ***Description of environment*** | ***Hypothesis:***  |
| **Northeast:** |  |  |
| **Northwest:**  |  |  |
| **Southeast:** |  |  |

* Watch the animation for the next 500,000 years, and record your observations in the table below. Again, each population does not have its own set of columns; instead, can combine your list of mutations and phenotypic changes for all three populations in each area.

|  |  |  |  |
| --- | --- | --- | --- |
|  | ***Northeast Bird Populations*** | ***Northwest Bird Populations*** | ***Southeast Bird Populations*** |
| ***# Years Passed*** | ***Mutations*** | ***Mutation Effects*** | ***Population Size*** | ***Mutations*** | ***Mutation Effects*** | ***Population Size*** | ***Mutations*** | ***Mutation Effects*** | ***Population Size*** |
| **50,000** |  |  |  |  |  |  |  |  |  |
| **100,000** |  |  |  |  |  |  |  |  |  |
| **150,000** |  |  |  |  |  |  |  |  |  |
| **200,000** |  |  |  |  |  |  |  |  |  |
| **250,000** |  |  |  |  |  |  |  |  |  |
| **300,000** |  |  |  |  |  |  |  |  |  |
| **350,000** |  |  |  |  |  |  |  |  |  |
| **400,000** |  |  |  |  |  |  |  |  |  |
| **450,000** |  |  |  |  |  |  |  |  |  |
| **500,000** |  |  |  |  |  |  |  |  |  |

* Describe the bird populations after 1,000,000 years of evolution. Please also take a screenshot of your birds. If any populations went extinct, just cross off that square with an X.

|  |  |  |  |
| --- | --- | --- | --- |
| ***Area*** | ***Bird Population 1*** | ***Bird Population 2*** | ***Bird Population 3*** |
| **Northwest** | Plumage: Body Size: Beak size and shape:  | Plumage: Body Size: Beak size and shape:  | Plumage: Body Size: Beak size and shape:  |
| **Northeast** | Plumage: Body Size: Beak size and shape:  | Plumage: Body Size: Beak size and shape:  | Plumage: Body Size: Beak size and shape:  |
| **Southeast** | Plumage: Body Size: Beak size and shape:  | Plumage: Body Size: Beak size and shape:  | Plumage: Body Size: Beak size and shape:  |

As before, at the start, all the birds were members of a single species. After several generations of natural selection, any population of birds that has **at least two traits that are different** from those of another population will no longer be interbreed, and will therefore have become two different species.

* How many different species are present across the island after 1,000,000 years of evolution? Describe the phenotypes of each species:
* Did any species go extinct? Go back to the tables above and see if you can determine the cause of this extinction. Was it due to an unfavorable mutation? If so, which one(s)?
* How does evolution explain the changes you witnessed in bird populations over 1,000,000 years? Your answer should include terms such as natural selection, random mutation, selection of favorable traits, reproduction, genetic variation, and extinction.
* In this activity, you worked with a model to simulate natural selection. In what ways did this simulation model natural selection well? What aspects of natural selection did the simulation not include?

Adapted from <http://sepuplhs.org/sgi/evolution/sgi_evolution_ss_11_1.pdf>