Clipbirds: A simulation of specific subtypes of Natural Selection

Modified from a lab designed by Al Janulaw and Judy Scotchmoor.

In 1859, Charles Darwin published his most famous and influential work, *The Origin of Species*. In this book, Darwin presents two main arguments. First, he argues persuasively that biological species are not constant, as had been previously supposed by most scientists, but instead had evolved (or, "transmuted", in Darwin's words) through long periods of geological time. Second, Darwin argued that this evolutionary transformation had been brought about by a mechanism he called **Natural Selection**. Darwin's evidence for evolution was regarded as compelling by most biologists within a few years after publication, but Darwin's suggested mechanism, Natural Selection, was hotly debated by biologists for many decades. Natural Selection was not widely accepted by biologists until the 1930s, many years after Darwin's famous book was first published. Today, although biologists still debate the importance of alternate mechanisms of evolutionary change, most agree that Natural Selection is the most significant mechanism.

One of the reasons that Natural Selection is not well understood today by non-biologists is that the concept is statistical in nature, and cannot be observed or understood by examining individual organisms. In Darwin's conception, individual animals and plants do not evolve; rather, populations or species evolve. To illustrate this subtle concept, we will do a simulation of Natural Selection. Although the simulation is fun, since it is, after all, basically a game, the concepts it illustrates are essential for a serious understanding of how evolution works.

The Simulation

Consider a single population of a species known as "Clipbirds" from the island group of Far Far Away. The Clipbird populations have a gene, with two alleles, that regulate beak size. The alleles are B and b. This trait is expressed with incomplete dominance, so that the genotypes and phenotypes are:

BB = Large Beaks, Bb = Medium Beaks, bb = Small Beaks

The selection factor for this simulation is the competition for food (considered to be distinct seed types). Specific seed types favor specific beak sizes.

Rules of the simulation:

Seeds can only be grabbed by an open beak and then closed. No shoveling or scraping of the seeds.

Seeds must be placed into the "stomachs" (cups) to be considered as part of the food value weight for that season.

Procedure for the simulations:

1. Initial populations are even in number of large, medium, and small beaked clipbirds. One population is on the West Far Far Away Island and the other population is on East Far Far Away Island. Each Island has its own specific diversity of seed plants – based on evolutionary history and climate. The West Far Far Away Island is mountainous and subject to heavy and predictable rainfall. The East Far Far Away Island is low elevation and in the rainshadow of the West Far Far Away Island mountain, and therefore semiarid with unpredictable rainfall.
2. Limited time (30 seconds) for collection of the seeds – severe competition results during this time.

Three categories of food calories ensue per each season, with three separate consequences:

1) Insufficient calories to survive to the next season. That student must turn in their beak and wait out the next season.
2) Sufficient calories obtained to survive to the next season. That student continues as the same beak sized clipbird.
3) Sufficient calories obtained to reproduce offspring for the next season. That student continues as the same beak sized clipbird and selects another student to join as that beak size for the following season.

Total calories per "seed" item are as follows:

Seed Type	Calories
Marblefruit	10
Big Toot Seed	5
Small Toot Seed	2

Calories required for Survival and Reproduction for each beak type/season are:

Beak Size	Survive	Reproduce
Small Beaks	25	50
Medium Beaks	50	100
Large Beaks	80	160

Regardless of whether you are simulating a clipbird or not, you are responsible for collection of all data for both populations during the simulations and for answering all the questions regarding the simulation and results.

The hypothesis to be tested (write this in your notebook) is:

1) Natural Selection occurred (was simulated) based upon differential survival and/or reproduction in each of the populations.

Record the initial numbers, results, graphs and answers of clipbirds (in your lab notebooks, with a title and brief introduction) and prepare the first season simulations.

Repeat the steps, adding and subtracting clipbirds dependent upon the outcomes for three more trials. Record the results in each case.

Graph the results (one per west and east islands) for each population over the four generations. A bar graph would be most appropriate to indicate relative numbers of phenotypes for each generation.

Amount of seeds x energy/season collected by participating clipbird (YOU)

Season	Survived	Offspring (limit per reproductive energy amount)
1 _____	_____	_____
2_____	_____	_____
3_____	_____	_____
4_____	_____	_____

If a student doesn't eat enough to survive, they must turn in their beak and wait out the next season.

Island	Season 1	Season 2	Season 3	Season 4
West Far Far Away	2 C popcorn 1/2 C lima beans 50 marbles	½ C popcorn 1/4 lima beans 75 marbles	¼ C popcorn 1/8 C lima beans 75 Marbles	1/8 C popcorn No lima beans 100 marbles
East Far Far Away	2 C popcorn 1/2 C lima beans 50 marbles	3 C popcorn No lima beans 25 marbles	1/2 C popcorn 1/8 C lima beans 75 marbles	3 C popcorn No lima beans 25 marbles

West Island Generation Number

Beak Size 0 1 2 3 4

Small 2

Medium 2

Large 2

East Island Generation Number

Beak Size 0 1 2 3 4

Small 2

Medium 2

Large 2

Graph out your data in a similar fashion to the example supplied at the end of this.

Discussion questions

1) Was natural selection supported or rejected in each of the two populations
2) Was a distinct subset of natural selection occurring in each population? If so, which types would you label this as?
3) How did environmental differences result in distinct outcomes in the populations? Do you think that this would occur in nature? Provide one actual example of this.
4) What type of selection appears to be supported in the graph below? Why?