Environmental Science Institute
THE UNIVERSITY OF TEXAS AT AUSTIN

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Natural Selection Vs. Sexual Selection: Small Steps in Evolution

Lesson plan for grades: 9-12
Length of lesson: Best for 1hr 30min classes, Can be split into two parts for two class periods
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Environmental Science Institute, 9/30/13

SOURCES AND RESOURCES:

- Dr. David Buss, Hot Science Cool Talks Lecture #86; Human Mating Strategies
  http://www.esi.utexas.edu/k-12-a-the-community/hot-science-cool-talks/human-mating-strategies
- Natural Selection Simulation – Created by Discovery Communications
  http://science.discovery.com/games-and-interactives/charles-darwin-game.htm
- Understanding Natural Selection
  http://evolution.berkeley.edu/evolibrary/article/evo_25

POTENTIAL CONCEPTS TEKS ADDRESSED THROUGH THIS LESSON:
§112.34. Biology, Grade 9-12: 7C, 7D, 7E,
§112.34. Biology, Grade 9-12: 12B

PERFORMANCE OBJECTIVES:
Students will be able to:

- Analyze and evaluate how natural selection produces change in populations, not individuals
- Utilize technology to explore how natural selection determines the survival of a species over time.
- Conceptualize and evaluate how sexual selection does not parallel natural selection in its outcome

MATERIALS (per group of four):

- Laptops - see preparation section for more details
- Activity worksheet (1 per student)

CONCEPTS: *(used Google and Sparknotes definitions)*

Speciation: the formation of new and distinct species in the course of evolution.
Natural Selection: the process whereby organisms better adapted to their environment tend to survive and produce more offspring. The theory of its action was first fully expounded by Charles Darwin and is now believed to be the main process that brings about evolution.
Sexual Selection: natural selection arising through preference by one sex for certain characteristics in individuals of the other sex.

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Morphs: The different physical forms a trait may have. Long necks and short necks are examples of morphs.
Polymorphism: A trait that exists in several different morphs is polymorphic.

BACKGROUND:

The Darwinian theory for evolution and speciation have been, and continue to be, a hot topic for scientific dispute. Despite all of the controversy on how sound and concrete the theory is, there is much evidence to support Darwin's ideas behind why species originate, why creatures diversify over time, and how some organisms adapt and evolve while the vast majority of others fail to last. With so much ground and material to cover, one could study Darwin's evolutionary theories all the way from a genetics to a biostatistical standpoint. However, this lesson focuses primarily on the comparison and contrast of Natural Selection and Sexual Selection.

When studying the survival and success of a species it comes down to a very simple fact. The most successful and prosperous species are those who can survive long enough to produce viable offspring that can also mature and produce their own offspring. Among the many variables that play into this survival concept are Natural Selection and Sexual Selection, both which are commonly misinterpreted and confused for one another.

Natural Selection describes the process by which individuals in a population can be selected for due to their outlying characteristics that provide some form of survival advantage. The organisms that lack this advantage may perish if the changing environment is too harsh or demanding. It is these "successful" organisms of the species that can continue to reproduce and carry on the necessary traits for survival.

Sexual Selection is much more of an individualistic concept. As it is known, sexes within a species have preferences and mating habits that can be very unique. Often, males compete for females that can produce healthy offspring. It is ultimately the more "competitive" and "attractive" males that are selected by the females to reproduce. Such selection leads to very specific traits and characteristics to dominate through the populations. These characteristics don't necessarily have to be preferred on a survival basis.

The goal of this lesson is to define these concepts through exploration and to compare and contrast the two.

PREPARATION:

Explore Preparation: This portion of the lesson requires computers or laptops that are have up to date software (Flash player). Though it is ideal that each student be supplied with their own computer, the lesson still works fairly well if the students are paired for each device. Each partner may be assigned a specific role for the exploration section and have different roles for the elaboration section. This can be determined by the teacher. To avoid tech problems, teachers may want to go through the computers at least a day prior to the lesson and make sure that all hardware and software is functioning properly. Another advantage would be to

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save or bookmark the web-page in every computer's web browser prior to the lesson date. That way, the students can quickly and easily navigate to the "Natural Selection Simulation".

Elaboration: The same rules apply for this section as the Explore preparation, in terms of technology (1 or 2 students per updated and functioning computer). This section asks the students to do 15 minutes of independent research to find 6 specific examples of sexual selection in nature. Supervision and teacher control over this section is vital. Teacher should be monitoring the class and walking around during this section to ensure student engagement and work efficiency.

ENGAGE: *15 minutes*

Teacher: Nature seems to be readily available with a wide variety of animals, insects, plants, etc. One could take one stance and compare the blue jay to the Galapagos tortoise in terms of their physiological characteristics, mating habits, lifestyle, and so forth. However, these comparisons would occupy a very short list considering that these two animals are indeed quite different from one another. From a different stance, one could compare a blue jay and a particular species of finch. Using the same criteria from the blue jay tortoise comparison, a much more wholesome and lengthy list of similarities can be drawn. Why is this? Why is it that these two organisms (blue jay & finch) are so much more alike than the previous two (blue jay & tortoise)?

Starting from the left: Blue Jay, Tortoise, Finch (house finch)

The answer to these questions is rooted into the theory of evolution. Let's go ahead and address some principle concepts that associated with the Darwinian theory of evolution that you all might have come across before or heard about.

Possible student responses:

- I remember learning about "survival of the fittest."
- Darwin talked about how some traits had advantages over other.
- Didn't he come up with one of the theories to explain how **speciation** occurs?

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- Mating preferences seemed to be an important topic in his theories.

Teacher: Those are all great responses! Darwin indeed focused on such topics in his most famous work, Origin of Species. However, the focus of this lesson is not going to be entirely on the Origin of Species, but also on his other famous writing on sexual selection theory (minute reference 18:45).

More often than not, we come across a term called **Natural Selection** which seems to be self explanatory at first. Once can logically assume that it means that nature is through some process selecting what organisms in a species, or entire species in an ecosystem, survive. In a very fundamental way, this is indeed true, but there is more complexity to the concept. When organisms within a species vary and mutate in certain ways sometimes a new trait is created that can be advantageous to the organism of that species for its particular environment.

Can someone give the class a quick example of an advantageous trait?

Student could say: "One example that comes to mind is if there is deer that has the ability to run much faster than the other deer in its species. Because it runs so fast, it can avoid getting eaten while other deer in its species are consumed by predators."

Teacher: Exactly! There are hundreds of thousands of examples of traits that have proven to be advantageous for various species in their own environments. To help us better understand what natural selection does to a species over time and in a changing environment, we will play an online simulation.

EXPLORE: *20 minutes*
(see preparations for this activity in the "Preparation" section above)

Teacher: I would like everyone to go to the web-page for the Natural Selection Simulation. If you have trouble with your computer or trouble finding the website, just raise your hand and I will come around to assist you; however, remember that there are written instructions on how to get to the web-page at the top of your worksheets.

Now that everyone has made it to the correct page, continue to follow the written instructions on your worksheets and answer the questions on your worksheets as you go through the activity. Make sure to only do the "Natural Selection" and "Survival Game" tabs located at the top of the simulation.

Once you are done complete the follow-up questions on your worksheets that are related to the simulation.

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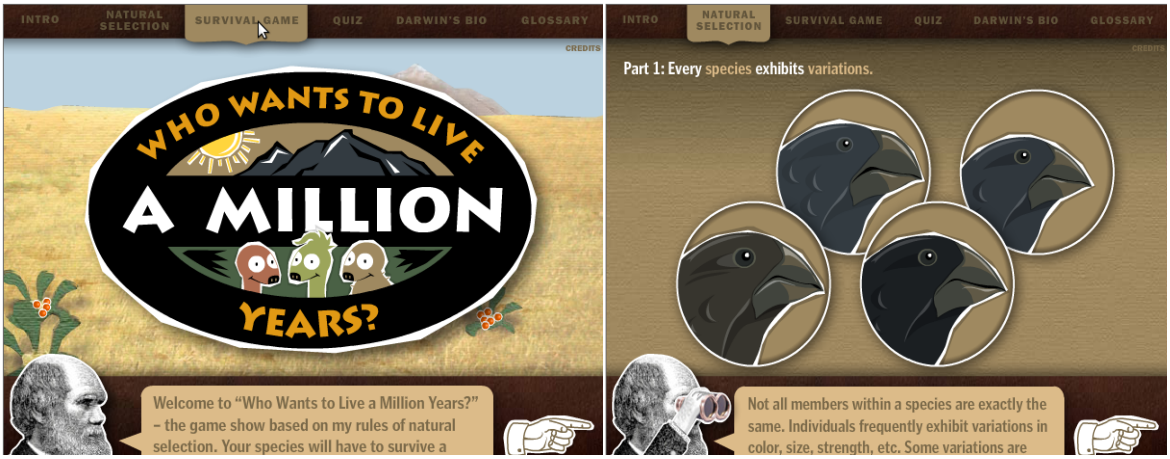
*Teacher will stop the students once the time for this section has expired or once all of the students have completed the simulation. This can be done by asking the students to either lower their laptop screens, return to their desks, or to turn off their desktop monitors.



EXPLAIN: *20 minutes*

Teacher: What sorts of things did we notice from the "Survival Game" the first time you played it.? How successful were you?

Possible student responses:

- When we were choosing our 3 random traits for the first generation, we chose 3 that looked similar. Unfortunately, they didn't adapt to the changing environment fast enough, and we lost after the first round.
- The game encouraged that we choose a wide variety of traits.
- During the game, the creatures would change and adapt over time. Sometimes the variety of creatures would decrease at the end of a round (they were all similar in terms of their characteristics.

Teacher: That's interesting. It seemed from your responses that the species seemed to succeed the most when there was a wide variety of **Morphs** among them. Some of you failed to have a diverse population and were not able to last very long as the climate and environment changed. Others of you were more successful because of your population's ability to adapt to the changes that occurred over time. One of

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the important features of Natural Selection is that diversity and **Polymorphism** are vital to the adaptation of species. A great example in the game was when the climate was about to go through a major ice age period. If your population had at least a few members with warm fur coats, there was an opportunity for the species to survive because of those traits being selected for. However, when your population lacked any diversity that would be beneficial to adapting to the changing environment, the chance of survival was slim.

Another key point of this exercise is that not all forms of diversity were ideal. How many of you used the option to choose a genetic mutation only to notice that it wasn't selected for positively (that mutation began to thrive in the population)?.....(wait for responses)..... As a matter in fact, a vast majority of genetic mutations that are phenotypically present are either neutral in effect or are not positively selected for. It is only once in a while, within large population sizes that a mutation occurs which is naturally selected for.

Now that we have an idea of what Natural Selection is and how it impacts a given population, let's transition over to another important term for this lesson; **Sexual Selection**.

What are some ideas on what Sexual Selection is and how it's different than Natural Selection?

Possible student responses:

- I think they should be pretty much the same...but I'm not sure.
- Sexual selection might be more about mate preferences rather than environmental selectivity
- The results of Sexual Selection and Natural Selection might not be the same.

Teacher: Alright, so there seems to be some confusion behind the comparison of these two concepts. Let's go to the next activity so that we may better explore and understand what Sexual Selection is and what it can cause.

ELABORATE: *15 Minutes*
(See preparations for this activity in the "Preparation" section above)

Teacher: Please open up your computers and go to the Google homepage. Your objective for the next 15 minutes is to look up and describe 6 specific mating habits/ mating preferences that are found in nature. A prime example of this is how male peacocks show off their tail feathers to attract female mates. Follow the instructions on your worksheets to help guide you through your search. Once everyone is done, we will regroup and share some of the things that we find. Raise your hand if you are lost or in need of assistance; I will be walking around the classroom.

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*The worksheet has spaces designated for the 6 researched examples of sexual selection in nature. Once the 15 minutes is over, or once everyone has found their 6 examples, the teacher must recollect the class for the final section of the lesson.

EVALUATE: 20 *Minutes*

Teacher: I'm curious to see what examples each of you found. Considering how many different and unique species are out there, there is a good chance that there a wide variety of findings in this classroom.

*Teacher allows time for students to provide about 6 examples.

Teacher: Alright. We've talked about some of the examples we found and some of us seemed to have found similar examples and some of us may have found very bizarre examples. What is important about our findings is what the Sexual Selection habits of a particular species seem to dictate what the next generation of offspring will be like. If a female, for example, of a particular species only selects males with a certain characteristic, it is only those male's traits that can get passed on to the next generation. The male's who could not compete or were out-competed fail to reproduce and pass down their "undesirable" traits.

Let's now compare this concept with Natural Selection, which we discussed earlier. Notice that Natural Selection explains what happens to a population. The population is what goes through a selectivity process. Though members of the population will die out because of their failure to adapt, it is ultimately the species that is competing to survive. The outcome of Sexual Selection is more on the individual basis. It is the competing sex that is trying to pass on its traits to future generations of offspring. The context for Sexual Selection does not always parallel the traits that would be competitive in terms of Natural Selection.

Answer the "exit question" on your worksheets to wrap-up some of the connections that you all made throughout this lesson.