Name_____

Changing Planet: Changing Mosquito Genes

Background

As the climate changes around the globe, organisms will need to adapt in order to survive. But what does it mean to adapt? When you put on a sweater because the air is cooler, are you adapting? When a bird seeks nourishment in a new location because a food source diminished is that adapting? Neither of these is considered "adaptation" if you are looking at the scientific definition of the term. In this lesson, you will take on the role of an evolutionary biologist in order explore the concept of microevolution, and by the end of the lesson, you will know how to correctly use the term adaptation.

Lab Question

What does it mean to adapt?

Materials per lab team

50 lima beans
Metric rulers (1 per person)

Procedure

Part I: Defining Key Terms

You will be using these terms throughout the lab, and therefore it is necessary to define them as they apply to evolution. Use your textbook or an Internet resource to locate the definitions.

Term	Definition
Evolutionary biologist	
Microevolution	
Natural selection	
Adaptation	

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Genotype	
Phenotype	
Fitness as applied to an evolving population	
Genotypic variability	
Phenotypic plasticity	

Part II: Exploring Important Terms

To explore the concept of genetic variability in a population, you will measure the lengths of lima beans and assess the amount of variation found within your sample. With your lab partners, measure the length of 50 lima beans in millimeters and place the lengths in the table below.

length	length	length	length	length

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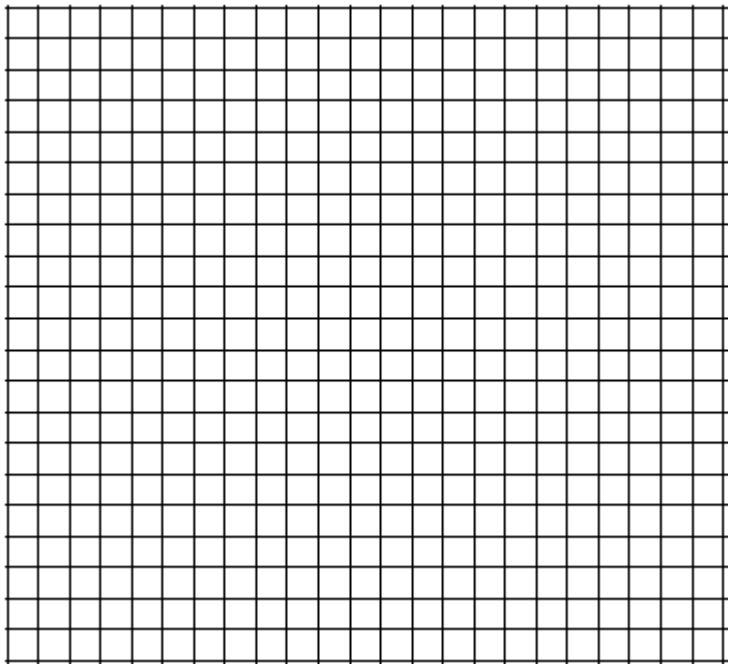
Assess your data and group the lengths into 5 or more categories. For instance if the range in sizes is between 1mm and 25mm, then your categories may include 1mm-5 mm, and the next could be 6mm-10mm, etc. Count of the number for each category and place the data in the table below.

Category	Number of lima beans in the category

Create a bar graph of your data in the grid below placing your categories on the horizontal axis and the number of lima beans on the vertical axis. Answer the questions that follow.



1. Describe the variability in your sample.

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You only assessed the variability among 50 members of the population. How do you think your sample compares to the world's entire population of lima beans? Explain your response.

2. What is the advantage of genetic variability within populations? First, consider the lima bean population in your response, and then consider another organism in your discussion of genetic variability.

3. How does this variability assist a population in surviving changes to its environment?

Part III: Phenotypic Plasticity

Visit a mature tree around campus and compare the size of the leaves on different sides of the tree.

1. What did you find? How does this fit into your definition of phenotypic plasticity? (Note: This is only a localized example of phenotypic plasticity. Plasticity occurs at a much greater scale across regions.)

2. This is a difficult concept that will become more obvious with a little practice. In each of the scenarios below, decide if it is referring to an adaptation related to genetic variability or to phenotypic plasticity. Explain your reasoning with your responses.

   Scenario #1 A hare living in the Arctic has white fur in the winter and brown fur in the summer. Do you think that this change likely resulted from evolutionary adaptation or phenotypic plasticity? Explain what features of change in the hare species make you think this.

   Scenario #2 Canadian climate has warmed and Canadian squirrels are now breeding earlier. Squirrels that breed earlier can take advantage of an earlier spring and hoard more pinecones for winter survival. Do you think that this change likely resulted from evolutionary adaptation or phenotypic plasticity? Explain what features of change in the squirrel species make you think this.

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Scenario #3 Because of their ability to live in a restricted temperature range, the geographic range of a number of plant species found in the Rocky Mountains has changed to higher altitudes. Do you think that this change likely resulted from evolutionary adaptation or phenotypic plasticity? Explain what features of change in these plant species make you think this.

Scenario #4 A mustard plant has adjusted to drought conditions in its location and flowers earlier so that it goes to seed faster. Do you think that this change likely resulted from evolutionary adaptation or phenotypic plasticity? Explain what features of change in these plant species make you think this.

3. How does a high level of phenotypic plasticity assist a population in surviving changes to its environment?

4. When faced with environmental changes, what happens to a species with minimal genetic variability and low phenotypic plasticity?

5. Organisms living in extreme latitudes (tropical and polar regions) are especially vulnerable to changes in their environments. Explain why this is so based on your understanding of evolutionary adaptation and phenotypic plasticity.

Part IV: Options in Natural Selection

Over time, environmental pressures on a species may cause changes through natural selection. Depending on the variability within it, the species may adapt, migrate, or go extinct. In order for a species to persist in a changing environment, it must adapt. During adaptation the

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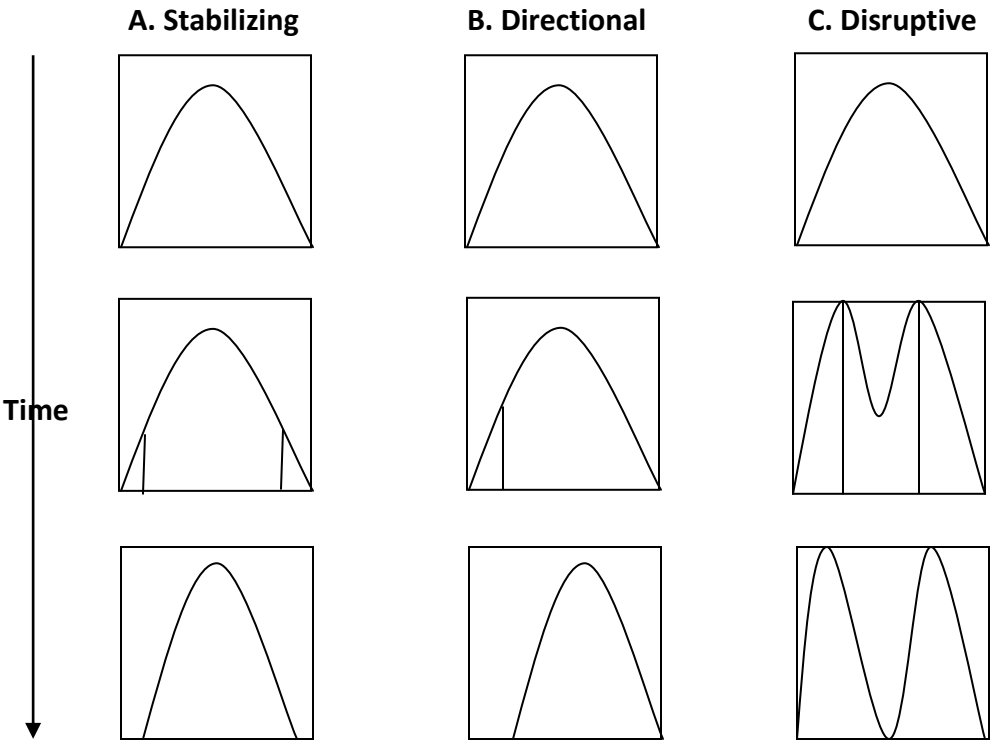
conditions within the environment may favor some genetic variations over others and select for particular variants. This form of natural selection can be directional, stabilizing, or disruptive. The graphs below are models of what will happen to the populations over a period of time under each form of selection.



1. In each of the scenarios, predict which type of selection will occur within the population.

a) The majority of sparrows in a population have average weight, length, and wingspan. The larger members of the population were killed off by a severe weather event, and the smaller members of the population could not survive the harsh winters.

Type of natural selection: _____

b) If seeds of a particular plant species are variable in size and birds recognize and eat the larger seeds, eventually the entire population of seeds will be small or average sized.

Type of natural selection: _____

c) A pathogen of a frog species infects only those frogs with common traits for that species, whereas it does not infect those frogs with extreme traits.

Type of natural selection: _____

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The survival of the species described above only included an organism's tolerance of a set of conditions. However, evolutionary fitness is also based on an organism's reproductive ability—finding a mate and producing offspring in order to pass its genes on to the next generation. The fittest genotypes will vary as environmental pressures impact the populations.

Listed below are factors affecting the survival of a species if it is faced with rapid changes in its environment. In front of each trait, place an "H" if this describes a highly adaptive species (one that would be able to adapt to a wide range of changes) and a "V" if this trait is more true of a vulnerable species (one that will probably have a difficult time adapting to rapid changes in its environment).

____ high degree of genetic variation

____ narrow distribution

____ limited genetic variation

____ large size

____ small number of offspring

____ wide distribution

____ large population

____ long generation time

____ small population

____ large number of offspring

____ short generation time

____ ability to migrate

____ small size

____ limited ability to migrate

Summarize the characteristics of a species that will go extinct if faced with rapid environmental changes.

Part V: Changing Genes in our Mosquito

As you learned from watching *Changing Planet: Changing Mosquito Genes,* mosquitoes are a highly adaptive species that can adapt quickly when faced with rapid environmental changes. However, not all of the factors listed in Part IV for highly adaptive species lead to better fitness for a species. If you were a species attempting to survive in the following conditions, which traits would benefit you and your species the most? Why? Which type of natural selection will follow as a result of your traits? Explain.

a) Warming temperatures:

b) Increased precipitation:

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c) Drought:

What is the overall impact of evolutionary adaptation and phenotypic plasticity on global biodiversity? How will global biodiversity change in the future?

Application

You are an evolutionary biologist and the World Ecological Assessment Organization (WEAO) has asked you to present a model of how climate change (warmer, wetter, drier, stormier, etc.) will affect the organism you are studying. In your report to the organization, use your knowledge of evolutionary adaptation and phenotypic plasticity to predict the future of your species. Be sure to cite examples and use all the terms defined in this lesson in your 5-slide presentation. Your presentation should discuss the habitat and traits of your species. After you and your fellow evolutionary biologists have presented your slides to the organization, discuss what the future holds in terms of biodiversity as numerous species adapt and acclimate or go extinct.

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