Name_____

DATA Nugget

Are plants more toxic in the tropics?

Featured scientist: Carina Baskett from Michigan State University

Research Background:

Long before chemists learned how to make medicines in the laboratory, and even long before there were chemists, people found their medicines in plants. To this day, people still extract some medicinal drugs from plants, while others that we used to get from plants are now manufactured in factories.

Jaboncillo plants with herbivore damage in Costa Rica

Why do plants make these chemicals that are often so useful to people? One reason is that plants can't run away or hide from **herbivores**, the animals that eat them. So instead, many plants defend themselves using chemicals that are poisonous or toxic to herbivores. As pharmacists say, "the dose makes the poison," meaning it all comes down to quantity. A tiny amount of caffeine helps you stay awake, but you wouldn't feel so great if you ate a giant salad of coffee leaves. Similarly, an herbivore that tries to eat coffee leaves would get sick, so it will avoid eating coffee leaves. That's why plants have evolved to make chemicals – because the chemicals discourage animals from eating the plants. This benefit helps plants survive and reproduce, and any benefit to humans is an unintentional side effect of evolution.

Carina looking for *jaboncillo* plants in Costa Rica

Carina is fascinated by the amazing ways that plants have evolved to avoid being eaten. She also loves researching **tropical** forests near the Equator. Tropical forests have many more kinds of plants and insects than **temperate** places, which are farther from the Equator. One important difference between the climates is that the tropics don't have harsh winters that kill insects. Therefore, biologists think that tropical plants get eaten more by herbivores.

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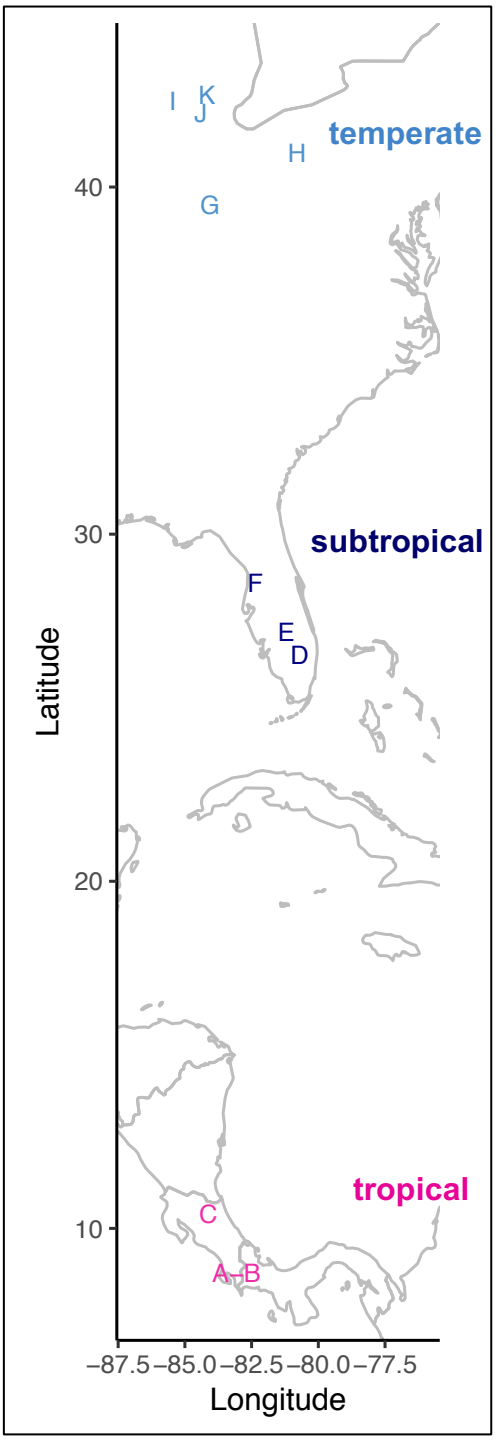


Map of Carina's sampling sites in temperate, subtropical, and tropical climates.

Some plants have high **chemical diversity**, and make many kinds of chemicals. Biologists have observed that some plants with high chemical diversity are especially difficult for herbivores to eat. Carina thought that maybe stronger insect attacks in the tropics would lead the tropical plants to evolve higher chemical diversity than temperate plants in order to better protect them from herbivory. She thought that over time, the individual plants that had more types of chemicals in their leaves would grow and reproduce more. This would allow them to pass on their traits to the next generation.

To answer her question, Carina collected seeds from wild pokeweed plants in Michigan and Florida. She also collected seeds in Costa Rica from *jaboncillo*, a species closely related to pokeweed that lives in tropical countries in Latin America. She chose these locations because they vary in how close they are to the equator, and how severe their winters can be. Michigan has long and very cold winters (a temperate climate), Florida has mild winters with occasional freezing (a **subtropical** climate), and in Costa Rica temperatures never go below freezing (a tropical climate).

She started by growing 15-20 plants from each location in a greenhouse. Then, she extracted chemicals from their leaves and analyzed the chemical diversity of each plant. Chemical diversity is measured by an index that includes how many and how abundant different kinds of chemicals are. Carina predicted that the tropical plants would have the highest chemical diversity. She also predicted that the subtropical plants would have higher chemical diversity than the temperate plants.

Name_____

Scientific Question: Do plants from different climates show differences in chemical diversity as a result of herbivory defense?

What is the hypothesis? Find the hypothesis in the Research Background and underline it. A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.

Scientific Data:

Use the data below to answer the scientific question:

Seed collection location	**Climate**	**Sample size (n)**	**Chemical diversity index**	**SD***	**SE***
Michigan	temperate	15	3.30	0.24	0.06
Florida	subtropical	16	3.52	0.22	0.05
Costa Rica	tropical	17	3.63	0.17	0.04

**Standard deviation (SD) tells us about the amount of variation in the data. A large SD means there is a lot of variation around the mean, while a small SD means the data points all fall very close to the mean. Standard error (SE) tells us how confident we are in our estimate of the mean, and depends on the number of replicates in an experiment and the SD. A large SE means we are not very confident, while a small SE means we are more confident.*

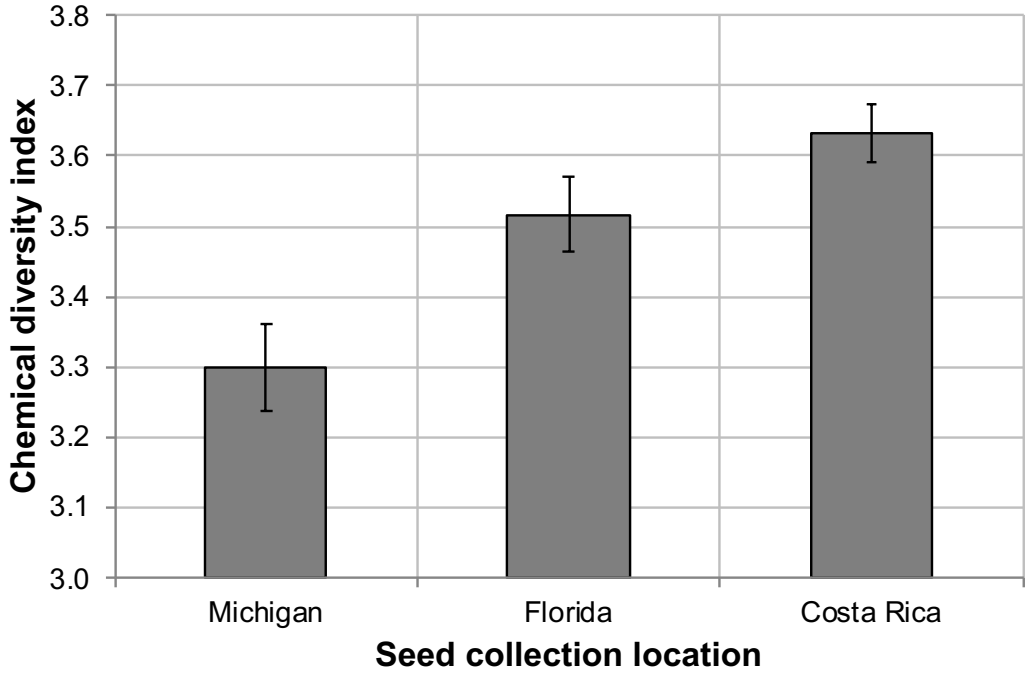
What data will you graph to answer the question?

Independent variable:_____

Dependent variable: _____

Name_____

Below is a graph of the data: Identify any changes, trends, or differences you see in your graph. Draw arrows pointing out what you see, and write one sentence describing what you see next to each arrow.



Interpret the data:

Make a claim that answers the scientific question.

What evidence was used to write your claim? Reference specific parts of the table or graph.

Name_____

Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about why a plant would have high chemical diversity.

Did the data support Carina's hypothesis? Use evidence to explain why or why not. If you feel the data are inconclusive, explain why.

Your next steps as a scientist: Science is an ongoing process. What new question do you think should be investigated? What future data should be collected to answer your question?