

Finding Mr. Right

Featured scientist: Carrie Branch from University of Nevada Reno
(This activity has been developed by Michigan State University fellows in the NSF BEACON and GK-12 programs)

Research Background:

Depending on where they live, animals can face a variety of challenges from the environment. For example, animal species that live in cold environments may have adaptive traits that help them survive and reproduce under those conditions, such as thick fur or a layer of blubber. Animals may also have **adaptive behaviors** that help them deal with the environment, such as storing food for periods when it is scarce or hibernating during times of the year when living conditions are most unfavorable. These adaptations are usually consistently seen in all individuals within a species. However, sometimes populations of the same species may be exposed to different conditions depending on where they live. The idea that populations of the same species have evolved as a result of certain aspects of their environment is called **local adaptation**.



Mountain chickadee, photo by Vladimir Pravosudov

Mountain chickadees are small birds that live in the mountains of western North America. These birds do not migrate to warmer locations like many other bird species; they remain in the same location all year long. To deal with living in a harsh environment during the winter, mountain chickadees store large amounts of food throughout the forest during the summer and fall. They eat this food in the winter when very little fresh food is available. There are some populations of the species that live near the tops of mountains, and some that live at lower elevations. Birds at higher elevations experience harsher winter conditions (lower temperature, more snow) compared to birds living at lower elevations. This means that birds higher in the mountains depend more on their stored food to survive winter.

Carrie studies mountain chickadees in California. Based on previous research that was done in the lab she works in, she learned these birds have excellent **spatial memory**, or the ability to recall locations or navigate back to a particular place. This type of memory makes it easier for the mountain chickadees to find the food they stored.



Carrie conducting field research in winter, photo by Vladimir Pravosudov

Carrie's lab colleagues previously found that populations of birds from high elevations have much better spatial memory compared to low-elevation birds. Mountain chickadees also display aggressive behaviors and fight to defend resources including territories, food, or mates. Previous work that Carrie and her lab mate conducted found that male birds from low elevations are **socially dominant** over male birds from high elevations, meaning they are more likely to win in a fight over

resources. Taken together, these studies suggest that birds from high elevations would likely do poorly at low elevations due to their lower dominance status, but low-elevation birds would likely do poorly at high elevations with harsher winter conditions due to their inferior memory for finding stored food items. These populations of birds are likely locally adapted – individuals from either population would likely be more successful in their own environments compared to the other.

In this species, females choose which males they will mate with. Males from the same elevation as the females may be best adapted to the location where the female lives. This means that when the female lays her eggs, her offspring will likely inherit traits that are well suited for that environment. If she mates with males that match her environment, she is setting up her offspring to be more successful and have higher survival where they will live. Carrie wondered if female mountain chickadees prefer to mate with males that are from the same elevation and therefore contribute to local adaptation by passing the adaptive behaviors on to the offspring. This process could contribute to the populations becoming more and more distinct. Offspring born in the high mountains will continue to inherit genes for good spatial memory, and those born at low elevations will inherit genes that allow them to be socially dominant.

To test whether female mountain chickadees contribute to local adaptation by choosing and mating with males from their own elevation, Carrie brought high- and low-elevation males and females into the lab. Carrie made sure that the conditions in the lab were similar to the light conditions in the spring when the birds mate (14 hours of light, 10 hours of dark). Once a female was ready, she was given time to spend with both males in a cage that is called a two-choice testing chamber. On one side of the testing chamber was a male from a low-elevation population, and on the other side was a male

from a high-elevation population. Each female could fly between the two sides of the testing chamber, allowing her to "choose" which male she preferred to spend time close to (measured in seconds [s]). There was a cardboard divider in the middle of the cage with a small hole cut into it. This allowed the female to sit on the middle of the cardboard, which was not counted as preference for either male. Females from both high- and low-elevation populations were tested in the same way. The female bird's preference was determined by comparing the amount of time the female spent on either side of the cage. The more time a female spent on the side of the cage near one male, the stronger her preference for that male.

Scientific Question: How does mate choice by high- and low- elevation female mountain chickadees contribute to local adaptation?

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.



Photo showing a female mountain chickadee in the right side of the two choice testing chamber. To the right is another cage housing a low-elevation male, and to the left is a cage housing a high-elevation male. By sitting on the right side of the cage she is showing a preference for low-elevation male.

Scientific Data:

Use the data on the following page to answer the scientific question:

Female mountain chickadee preference, measured as time spent next to males in seconds (s)

Female #	Elevation	Pair 1		Pair 2		Pair 3		Pair 4		Pair 5		Pair 6	
		Same Elevation Male	Different Elevation Male	Same Elevation Male	Different Elevation Male	Same Elevation Male	Different Elevation Male	Same Elevation Male	Different Elevation Male	Same Elevation Male	Different Elevation Male	Same Elevation Male	Different Elevation Male
1	high	2376	842	1822	934	2203	674	704	2429	1490	1589	2168	995
2	high	1648	1661	2054	1416	2452	895	1109	1512	1286	2279	1306	1241
3	low	2791	801	1204	2311	1416	2122	282	3312	2572	1022	2732	855
4	low	2244	1306	1444	2004	426	3129	393	3201	1873	1656	1487	2002
5	high	802	1835	1478	1300	1247	2149	1891	1013	2310	796	1262	936
6	high	1516	1137	2754	635	2269	1098	1174	2012	1637	1809	1423	2116
7	low	1937	375	2680	1085	344	2339	1004	2490	2015	889	919	2062
8	low	0	3600	3600	0	0	3600	0	3600	3600	0	3600	0
9	high	1206	2388	1039	2560	1023	2516	2404	1111	3173	422	2544	1025
10	high	541	1627	2937	480	2180	790	1885	1003	1719	525	862	2270
11	low	825	2683	442	3137	2433	1149	2525	1050	849	2723	2902	662
12	low	3560	40	215	3378	267	3330	3423	163	714	2883	3219	378

Name

Female #	Elevation	Mean Time Spent with Same Elevation Male (s)	Mean Time Spent with Different Elevation Male (s)
1	high		
2	high		
3	low		
4	low		
5	high		
6	high		
7	low		
8	low		
9	high		
10	high		
11	low		
12	low		

Elevation	Mean Time Spent with Same Elevation Male (s)	SE	Mean Time Spent with Different Elevation Male (s)	SE
high elevation females		57		81
low elevation females		93		94

** 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 how much variation is in the data. A large SE means we are not very confident, while a small SE means we are more confident.*

Name _____

What data will you graph to answer the question?

Independent variable: _____

Dependent variable: _____

Draw your graph below: 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.



Name _____

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.

Explain your reasoning and why the evidence supports your claims. Connect female preference data from this experiment back to female mate choice in the wild, and the effects this may have on the traits of their offspring.

Name _____

Did the data support Carrie's hypothesis that females are reinforcing local adaptation by choosing mates from their own elevations? Use evidence to explain why or why not. If you feel the data was inconclusive, explain why.

Your next steps as a scientist: Science is an ongoing process. What new question(s) should be investigated to build on Carrie's research? What future data should be collected to answer your question(s)?
