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HOW WILL CLIMATE CHANGE AFFECT PIKAS' FAVORITE SNACKS?

Emily Monk[1,2], *Karli Weatherill*[3], *Chris Ray*[1,4], *Ashley Whipple*[1,4] *and Johanna Varner*[3*]

[1]*Department of Ecology and Evolutionary Biology, University of Colorado Boulder, Boulder, CO, United States*
[2]*Department of Biology, Memorial University of Newfoundland, St. John's, NL, Canada*
[3]*Department of Biology, Colorado Mesa University, Grand Junction, CO, United States*
[4]*Institute of Arctic and Alpine Research, University of Colorado Boulder, Boulder, CO, United States*

YOUNG REVIEWERS:

IZZY
AGE: 13

LUCINDA
AGE: 15

SAM
AGE: 10

Many animals are herbivores, which means they get all their nutrients from eating plants. American pikas are cute rabbit relatives that eat plants in the mountains. But alpine winters are harsh, so pikas spend their entire summer gathering and storing plants to eat under the winter snow. Just like people, pikas in Colorado have a favorite food: a plant called alpine avens. This plant species is a special pika snack because it contains natural preservatives called phenolics, which keep the food fresh all winter. We studied how climate change is affecting this important feature of the pika's favorite meal. Alpine avens contains more phenolics now than it did 30 years ago, so they preserve better in storage. But there is a catch: these preservatives can be hard to digest. Studies like this help us start to understand the many complicated ways that climate change affects herbivores like pikas.

A PIKA'S LIFE AT THE ALPINE SALAD BAR

Imagine if your house were high up in the mountains and you spent your summers gathering your favorite foods. That is similar to the life of one animal species, called the American pika (Figure 1). Pikas are small mammals related to rabbits. They usually live high in the mountains, in rocky areas called **talus**. The talus provides a pika with shelter from the weather and a place to feel safe. But living in the mountains is not easy for pikas. Their homes can be covered in snow for 9 months of the year. Pikas live under the snow in their talus homes all winter long: they do not hibernate or sleep all winter like other animals. Instead, during the short **alpine** summer when mountain meadows are full of plants to eat, they work hard to stock up enough food to last the entire winter. Imagine if you had to grocery shop for the entire school year all at once!

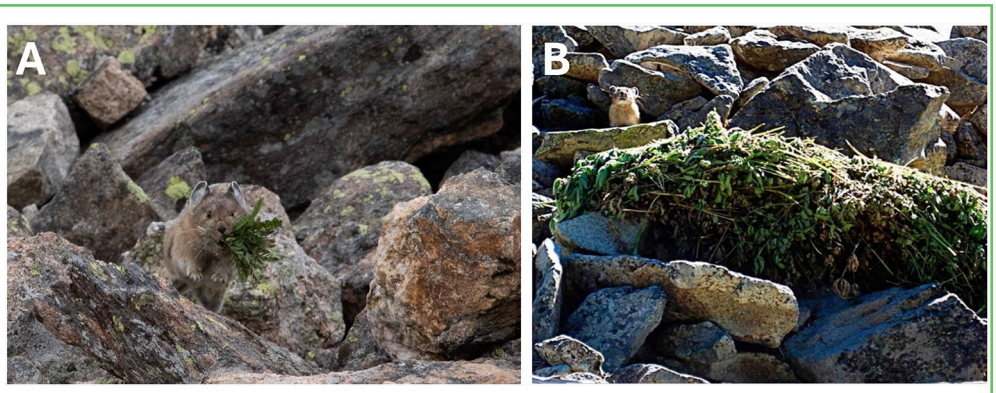

Figure 1

TALUS

Rock piles that collect at the base of a cliff or along the edge of a glacier. Pikas in North America like to live in rock piles instead of burrows.

ALPINE

Relating to high mountains. Alpine plants and animals are well-adapted to living at high elevations, in habitats with short, cool summers, and long winters.

Figure 1

American pikas and their haypiles. **(A)** American pika carrying a mouthful of alpine avens to its haypile (Photo: Holly Nelson). **(B)** A pika with its haypile (Photo: Juliana Pearson).

STOCKING UP FOR WINTER

Pikas are herbivores, which means they eat only plants. Pikas eat grasses and flowers from meadows near their rocky homes. During the summer, pikas must collect food for the winter. Pikas spend their summers collecting huge amounts of plants to store in a **haypile** [1]. This haypile is all that they have to eat during the winter when their whole neighborhood is deep under snow, so it is important for them to collect enough plants. Just like people, pikas in Colorado (USA) have a favorite snack to put in their haypiles: a plant called alpine avens. Alpine avens makes up most of the pika's winter diet. They are the most common plant in a haypile, making up over half of everything stored in the pika's pantry.

HAYPILE

A collection of plants (mostly wildflowers) stored by a pika. A pika will eat this "food cache" throughout the winter when it is hard to find other food.

Pikas have different diets in the summer and winter because of what is in the plants they eat. The foods they eat in the summer are high in nutrients and easy to digest. But winter food is a bit more complicated. Foods that pikas store for the winter must last many months before they are eaten. Most normal plants would go bad long before winter is over. Can you imagine leaving a salad in your room all winter? It

would not be very tasty by springtime! This is why alpine avens are special: they contain natural chemicals called **phenolics**, which act like preservatives [2]. Phenolics keep the alpine avens in a haypile fresh, so that a pika can eat them all winter long. But eating preservatives comes with a cost—phenolics are also **toxic**, which means that a pika cannot eat too many alpine avens without getting very sick or spending a lot of energy on digestion. Luckily, pikas know that, over time, the toxic phenolics break down and the plants become edible. Since the phenolics also preserve the alpine avens, the plants stay fresh until they are not toxic anymore. This means pikas can eat lots of stored alpine avens later in the winter, without getting sick.

PHENOLICS

Chemicals that some wildflowers make naturally, which protect the plant's tissue from the harsh environment and from herbivores; they also help preserve plants stored in pika haypiles.

TOXIC

Harmful when eaten. Toxic plants can cause a range of problems for herbivores, from being difficult to digest (by requiring too much energy), to causing illness or even death.

LEARNING MORE ABOUT PIKA SNACKS

Climate change has already affected many species of plants and animals, as you can learn about in this Frontiers for Young Minds article. But the ways that changes in temperature and precipitation affect the daily lives of mountain species are not always obvious. We wanted to know more about how climate change might be affecting the pika's main winter food source in Colorado. We expected that alpine avens may have become more toxic because plants could use the extra carbon dioxide in the atmosphere to make more phenolics.

We compared the phenolics in alpine avens now to alpine avens in the 1990s, to see if there were any differences over time. We started by returning to a site on Niwot Ridge, the same place where another scientist named Denise Dearing studied pikas in 1992 [1, 2]. Niwot Ridge is located high in the mountains of Colorado at an elevation of about 11,000 ft. We collected alpine avens each year from 2010 to 2018, just like Dr. Dearing did about 25 years earlier.

We took some of those plants back to the lab to measure the amount of phenolics they contained (Figure 2). We ground up the plant samples in a liquid that dissolved the phenolics. Then, we measured the phenolic levels using a chemical reaction in which the liquid changes color depending on the amount of phenolics present. So, the samples from plants with a lot of phenolics turned dark green, and the samples from plants with only a little bit of phenolics stayed yellow. Finally, a machine measured how yellow or green each sample was and translated the color into an amount of phenolics.

We also wanted to know how changes in phenolics might change plant preservation in pika haypiles. So, in September 2017, we put some plants in wire cages and placed them in the talus like a pika haypile (Figure 3). The cages kept the plants safe from curious pikas or other animals but let the plants break down, just like they would in a real haypile. These experimental haypiles spent the winter under the snow at Niwot Ridge, until we collected them in July 2018. Then,

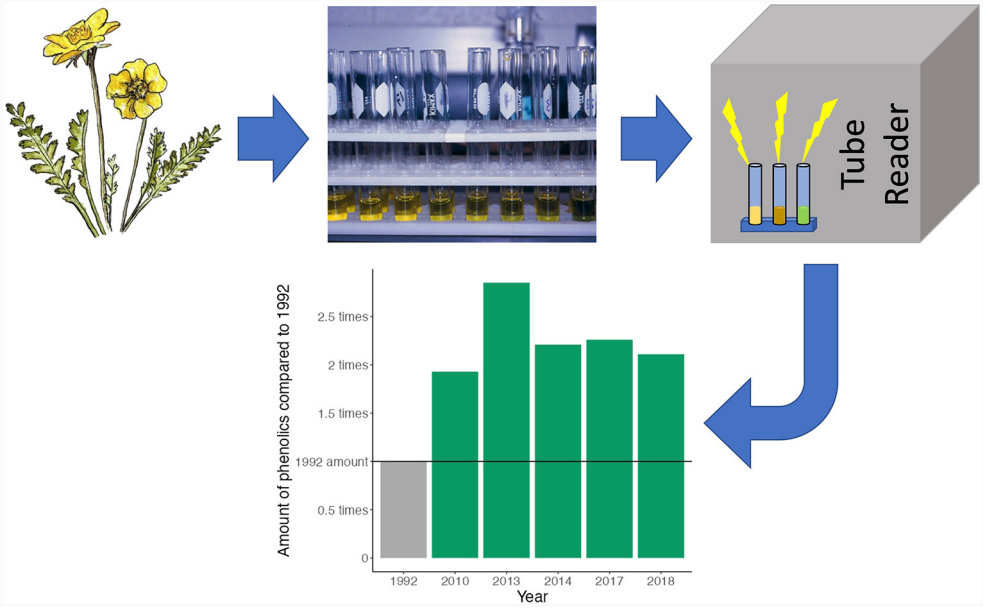

Figure 2

Measuring the phenolic content of pika snacks. Alpine avens samples were first ground up in the lab. Then, a chemical reaction in test tubes turned the samples from yellow to green, in proportion to the amount of phenolics in the sample. The more phenolics, the darker green the samples turned. Finally, a machine measured the colors of each sample and translated these colors into an amount of phenolics for each sample (Avens drawing by Alexandra Weatherill).

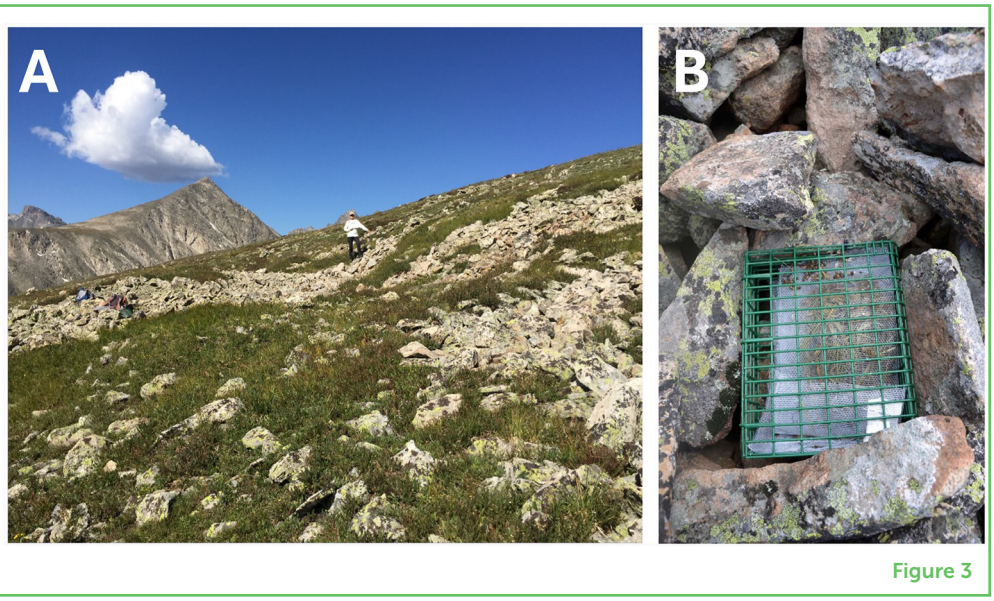

Figure 3

Experimental haypiles at Niwot Ridge. **(A)** One of the authors, Johanna Varner, marks the location an experimental haypile on Niwot Ridge. **(B)** The experimental haypiles were placed in wire cages and were positioned in the rocks, just like a real pika haypile.

we dried and weighed what was left in the cages to see how well the plants preserved.

Finally, we compared our results to Dr. Dearing's 1992 study, to see if there were any differences in the amount of phenolics in alpine avens or in how well the plants preserved in pika haypiles.

CHANGES AT A PIKA'S DINNER TABLE

It turned out that alpine avens has been changing a lot! First, this plant had more than twice the amount of phenolics at the time of our study

than it had in 1992 (Figure 2). In fact, in 1 year of our experiment (2013), the alpine avens was almost three times more toxic than it used to be! The extra phenolics also made the plants preserve better. In our experimental haypiles, there was about 10% more food left at the end of winter compared to 25 years ago.

This is both good news and bad news for pikas. The fact that their favorite snack is more toxic now might make it less tasty to eat fresh. But on the other hand, alpine avens also stays fresh longer. So, pikas might have to wait longer to be able to eat alpine avens with more phenolics, but having more phenolics can help preserve alpine avens and maybe even other snacks in the haypile. This means that, even if they do not store as much food, pikas could still have more to eat in late winter. We also know that alpine avens has become less common in the meadows at Niwot Ridge, which are becoming drier due to climate change [3]. Instead, the meadows have more grasses, which pikas like to eat fresh. So, while pikas today may not be able to find as many alpine avens as the pikas that lived 25 years ago, they might not need to store as much food, either.

WHAT DOES IT ALL MEAN?

The way climate change affects pikas' favorite foods is like a tricky puzzle. In some ways, climate change could make life harder for these cute creatures as they change what they eat. But on the other hand, the foods they collect might last longer in storage, which could make life easier. In the future, the changing climate might even change the food choices pikas have. Warmer temperatures are already changing mountain meadows to have more grasses and fewer flowers like alpine avens. Imagine if you had to eat only one thing forever, like pandas that eat bamboo or koalas that eat eucalyptus. That might happen to pikas!

As we keep studying pikas and their snacks over a long period of time, we can learn how climate change is making things different for these animals. It is like reading a history book about pikas and discovering that the foods they eat now are different than what they used to eat. Just like we compared our results to Dr. Dearing's, maybe in 25 years YOU will be studying how pika snacks have changed compared to now!

So, the next time you are having dinner, think about how climate change might be changing the foods on your plate. Just like for pikas, climate change can change our favorite foods, too. It is a reminder that we all share this planet, and taking care of it is important—both for us and the animals!

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ORIGINAL SOURCE ARTICLE

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CONFLICT OF INTEREST: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

YOUNG REVIEWERS

IZZY, AGE: 13

Hi! I am Izzy! I am a Conservation and Environmental Stewardship Apprentice with the National Park Service, and I love science!!! I have an insatiable curiosity, and I absolutely love new challenges!

LUCINDA, AGE: 15

My name is Lucinda and I am a sophomore in high school. Not only do I adore science but I also love reading, swimming, and being outdoors! In terms of science, my favorite subject is biochemistry which I have always had a huge interest in. In the future, I hope to use my love of biochemistry to help study and research how we can conserve and protect our natural ecosystems and native species. I am so grateful for this opportunity!

SAM, AGE: 10

I am Sam, I am 10, and I am in year 5. I like animals and sport. My favorite subjects at school are PE and maths.

AUTHORS

EMILY MONK

Emily studied pikas during her undergraduate degree at the University of Colorado Boulder, where she focused on how pika habitats have changed over time. She is now a graduate student at Memorial University of Newfoundland in Canada, studying how animals that live in snowy places are impacted by climate change. Emily loves being outdoors, watching and photographing wildlife, and climbing to the tops of tall mountains.

KARLI WEATHERILL

Karli is an undergrad student who studies biology at Colorado Mesa University. She loves all animals, especially pikas! One day, she hopes to be a conservation biologist and continue studying and helping animals. In her free time, she likes traveling to new places and jamming out to Taylor Swift with her friends.

CHRIS RAY

Chris has studied pikas for 36 years, and never gets tired of visiting pikas in the wild. Studying pikas has taken her around the world and helped her land some really fun jobs that have led to a very enjoyable career. She is a research associate at the University of Colorado Boulder and a research scientist at The Institute for Bird Populations.

ASHLEY WHIPPLE

Ashley is a biologist with the United States Geological Survey, where she researches how environmental change influences wildlife and their habitats. She loves seeing and hearing pikas but gets extra excited when she finds their poop! While earning her master's degree in ecology at the University of Colorado Boulder, Ashley collected pika poop from different habitats and measured stress hormones in the poop to understand if stress levels vary with habitat quality. In her spare time, Ashley likes to be outside searching for interesting critters.

JOHANNA VARNER

Johanna, who also goes by the nickname "Pika Jo", is a pika biologist who also teaches biology at Colorado Mesa University. She grew up in the mountains near Utah, where she loved hiking and watching animals as a kid. Although she took a quick detour as an engineer in college, she now studies pikas so that she gets to spend a lot of time outside in the mountains with the animals. In her free time, she likes to go for runs with her dogs. *jvarner@coloradomesa.edu