Abstract

Did you know that tusks are enormous teeth? Many animals have them, but the biggest ones belong to elephants and their relatives, including mastodons. Mastodons are now extinct, but paleontologists can use fossil tusks to study the lives of these ancient giants. For our study, we analyzed the right tusk of a male mastodon found in 1998. We also analyzed two chemical elements preserved in the tusks: oxygen and strontium. Using different forms of these elements (called isotopes), we tracked the season when a particular layer of tusk was grown, as well as where he grew it. We learned that he traveled long distances to mate with females. He also had fights with other mastodons and even died during his final battle!

Introduction

Mastodons went extinct around 12,000 years ago. They are distant relatives of living elephants as well as mammoths. And much like them, mastodons had trunks and tusks. Tusks are enormous teeth.

Mastodons and woolly mammoths were similar in size to modern African elephants but, unlike the modern variety, they were adapted to ice age temperatures.

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They grow like our teeth and are made of the same materials. But unlike most teeth, tusks can continue to grow throughout the animals’ entire lives. While we use our teeth to bite and chew food, tusks are used in other ways, including digging in the ground or stripping off tree bark for food. Males also use them to fight each other over access to mates.

Ever-growing tusks are also valuable to researchers. Tusks grow larger by adding new layers, similar to how trees grow larger by adding rings. But unlike tree rings, tusks grow as a set of nested cones, each stacked within the ones that came before. Layers grown earlier in life are towards the outside of the tusk. Each annual layer has a light and a dark band of tusk material. The dark bands form during the cold season and the light during the warm season, when growth is faster.

Mastodons ate parts of trees and shrubs. In all animals, the chemical elements in their food and water are incorporated in their bones and teeth. For mastodons, this includes their tusks. Analyzing those chemicals can tell us where they went during each season. Observing the tusk structure for damage can tell us when they fought in battles. The layers of tusks are like pages of a mastodon diary. Here, we analyzed the diary of a male mastodon found in Indiana in 1998.

**Methods**

- We split the right tusk in half lengthwise using a band saw.
- We estimated the age of our mastodon by studying the tusk layers and comparing them to other mastodons.
- We also studied the tusk to see how much it grew each year.
- We looked for signs of damage that can occur during battles with other males.
- Using a drill, we took small samples of the tusk. We used isotopes of two different elements (oxygen and strontium) to work out when different tusk layers were grown, and where the mastodon was when he grew them. We used a mass spectrometer to measure the isotopes.
- We compared the strontium isotopes in our mastodon’s tusk to strontium isotopes found in different places. Why? Well, the ratio of two isotopes of strontium is different in different types of rocks. So, as rocks change from place to place, so too do local strontium isotopes. When our mastodon ate plants in different places, those particular ratios of strontium isotopes were incorporated into the actively growing portion of his tusk. So, this meant we could figure out where the mastodon was when he grew different tusk layers.
- We examined the same tusk layers for oxygen. By studying how the oxygen isotopes changed, we could identify the season the tusk layer grew in.

With the help of a mathematical model, we combined all these data to discover where the animal could have lived during each season. We used this information to learn how his behaviors had changed between when he was a teenager and when he was an adult. We were particularly interested to know if he migrated seasonally like many animals do today.
Results

We discovered that our mastodon was 34 years old when he died. The layers of his tusk indicated that he was healthy early in life. During his 12th year, he suddenly grew much less tusk compared to past years. He was under stress, and he didn't eat very well. In today’s elephants, this happens when young adolescent males are pushed out of the herd and start to live on their own.

During his early adolescence, the strontium isotopes in his tusk hardly changed. As he got older, they became more variable as he started to expand his home range. Comparing the isotopes to each other, we found no link between the values of strontium isotopes (his locations when different portions of tusk were grown) and oxygen isotopes (the season of tusk growth). So, his travel was not influenced by the season.

As an adult, he expanded his home range even more (Fig. 1). Unlike during his adolescence, we found that he only went to certain areas during certain seasons. Specifically, we found that every warm season, he went to the same region – northeastern Indiana. Damage to the tusk indicates that he got into battles (likely with other male mastodons) for the last 8 years of his life. These battles happened during the warm season when we think mastodons were mating! A tusk-sized hole in his skull revealed that he died during one of these battles, likely over access to mates.

What is the difference in the movement of the adolescent compared to the adult mastodon?

Figure 1:
The shaded areas show the home range of the mastodon while he was (A) an adolescent and (B) an adult. The red point (as indicated by the cross) shows the location where the mastodon died. The inset graphs shows how much of his overall landscape use had a seasonal preference (summer or winter) or had no seasonal preference at all. Those specific areas can be seen in corresponding colors on the maps.
Discussion

We learned a lot about our mastodon! For the first 12 years, he lived happily with his family, likely in central Indiana. During adolescence, his mother and aunts kicked him out of the herd. He was under stress, but then started to move to find his place in the world. The season didn't influence where he traveled, and he didn't visit the place where he would later go every summer.

During his adult years, our mastodon traveled hundreds of kilometers a year! Every warm season, he went to the same region. We believe this was a mastodon mating ground. There, males fought with their tusks for the chance to mate. Because this is a region he did not visit when he was younger, we suspect this might have been to avoid conflict with aggressive, larger males. This is also where our mastodon died as a result of his final battle.

Conclusion

Fossils preserve evidence of the changes in the environment and in living creatures. They help researchers understand the evolution of animals and plants. They also tell us a lot about how climate changed through time. This could help us understand what to expect as our climate continues to change!

Find out what extinct animals used to live in your country. What have paleontologists learned about them and how?

Glossary of Key Terms

- **Home range** – the entire area an individual animal uses.
- **Isotope** – one of two or more forms of an element. Each has the same number of protons but a different number of neutrons.
- **Mass spectrometry** – a method for identifying the chemical composition of a substance (including its isotopes) by analyzing the mass-to-charge ratio of its ions.
- **Mastodon** (*Mammut americanum*) – an extinct distant relative of modern elephants (and mammoths, which are also extinct). Mastodons inhabited North and Central America from around 16 million years ago to around 12,000 years ago.
- **Paleontology** – the study of ancient life. Paleontologists study how ancient plants, animals, and other living things evolved through time.
- **Strontium** – a chemical element that is incorporated into the tissues of plants and animals (like leaves, bones, and tusks). The ratio between two of its isotopes is a bit like a passport stamp for a geographic area. The strontium in tusks or teeth can identify where an animal lived while it was growing.
- **Tree rings** – the growth rings of trees that can be studied to learn about their lives and their environments.
- **Tusk** – a giant tooth projecting from the mouth of some animals. Tusks are mainly used as weapons or for acquiring food.

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WHAT CAN TUSKS TELL US ABOUT THE LIVES OF MASTODONS?

Check your understanding

1. How can oxygen and strontium isotopes help us study mastodon behavior?

2. What else can we learn about mastodons from the layers of a tusk?

3. For male mastodons, what are some differences in behavior between adolescence and adulthood?

4. Can you think of other animals (other than elephants and mastodons) that have tusks? What do they use them for?

5. There is more than one theory about why mastodons became extinct. What do you think could have happened? In groups, discuss some ideas. You could also research this topic and discuss which theory you think is the most likely.

REFERENCES


Kiddle: Mastodon facts for kids https://kids.kiddle.co/Mastodon