Welcome to North America

JULY 2017

When did bison arrive in North America?

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Associate Editor:
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Abstract

Did you know that the North American bison (aka American buffalo) was once an immigrant? Its ancestors migrated from Asia. But when? We recovered and dated new fossils and extracted their ancient DNA to find out.

We analyzed ancient DNA from the two oldest bison fossils known in North America: a foot bone about 130,000 years old that we found in northern Canada and an arm bone about 120,000 years old from Colorado. We also analyzed younger bison fossils from Alaska and northern Canada. We compared their DNA, which showed they were closely related and had a common ancestor. This meant that we could use their DNA to reveal the evolutionary history of bison in North America.

Our study suggests that the first bison arrived in North America 195 - 135 thousand years ago over a land bridge between Asia and Alaska. They quickly spread and evolved (changed) into different forms to adapt to their new environments. Their invasion was so successful that they became the dominant mammal herbivore in North America and even changed entire ecosystems. Millions of these large, powerful mammals lived in many parts of North America until their near extinction in the late 1800s.

Introduction

During the ice age, large glaciers on the land stored so much of the earth's water as ice as to lower sea level by 120 m. This exposed part of the sea floor between Alaska and Siberia and created a large connection between the two continents: the Bering Land Bridge (Fig. 1). Animals like horses and camels, which both evolved in North America, used it to walk from Alaska to Siberia. Bison moved the other way (from Asia to America) to become one of the most iconic North American mammals.

Grazers such as mammoths and horses roamed North America for roughly a million years before bison entered the continent. But after their arrival, bison were so successful that they soon out-competed mammoths and horses and became the dominant grazers in North America.

The grazing habits of large herds of bison changed the landscapes they lived in. Their arrival marks the beginning of a different ecological period in the continent’s history that is recorded by a dramatic shift in the paleontological (fossil) record.

But exactly when did bison expand their territory from Siberia to North America? New fossils and ancient DNA helped us unravel this mystery.

Please see Figure 1 on Page 2

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Figure 1:
(A) Locations of bison fossils used in our study. The green dashed line outlines the **Bering land bridge** during the last ice age (this area is now under water).
(B & C) Study sites in Yukon, Canada. We found the ~130,000 years old steppe bison fossil at Ch'ji'e's Bluff.
(D) The ~120,000 years old giant long-horned bison fossil was found at Snowmass, CO.
Methods

We studied fossils from two sites in northern Yukon, Canada and one in Colorado (Fig. 1) where we could reliably determine the age of the fossils. Back in the lab, we extracted and analyzed the DNA from these two oldest fossils. We compared their genomes (genetic makeup) to those of other bison, including those of Siberian and North American fossils and to modern-day North American bison.

Results

At the first Yukon study site near the village of Old Crow, we found lots of other fossils (including giant beaver, ground sloth, horse, and mammoth), but no bison bones. This and similar results at other sites suggests that bison were not present in NW Canada before about 200,000 years ago.

However, at a second site (Ch’ijee’s Bluff), we found a roughly 130,000 year old foot bone of a steppe bison (Bison priscus); this is the oldest bison fossil ever found in North America. The second oldest fossil (from a site in Colorado) is a ~120,000 year old arm bone from the giant long-horned bison (Bison latifrons).

Ancient DNA from the fossils revealed interesting information about the history of North American bison:

- Steppe bison (Bison priscus) were the earliest descendants (evolved forms) of the Siberian bison in North America and evolved before the giant long-horned bison (Bison latifrons).
- Steppe bison and giant long-horned bison shared a common ancestor dating back to 195,000-135,000 years, and share most of their genes, even though they looked different (Fig. 2) and lived far apart from each other.
- Giant long-horned bison fossils have only been found in the continental U.S., but never in northern Canada, Alaska or Siberia. Thus they must have evolved in the continental United States after the first bison came into North America.
- A new group of bison showed up during the last ice age, between 45-21 thousand years ago. This indicates a second wave of migration across the exposed Bering Land Bridge from Siberia and dispersal into the continent at another time when sea levels were much lower than today.

Discussion

Our results suggest that there were two waves of bison migration to America from Asia:

- The first bison, which were steppe bison, crossed the Bering land bridge from Siberia into North America between 195,000

Figure 2:
We reconstructed the history of two bison only known from fossils (A & B) and compared these with the modern bison (C).

(A) Giant long-horned bison (Bison latifrons); adult may have weighed 2,000 kg (4850 lbs), and had horns that spanned as much as 2.2 m (7.2 feet) across.
(B) Steppe bison (Bison priscus); they were similar to modern day bison but slightly larger with wider and thicker horns.
(C) Modern bison (Bison bison); the largest living mammal in North America. An adult can weigh up to 1,000 kg and can be 2 meters tall.
and 135,000 years ago. Once bison arrived, they evolved quickly into new species that still shared most of their DNA (like the longhorn bison in the South). They colonized their new continent within 20,000 years, which is pretty quick in evolutionary time!

A second wave of migration took place during the last ice age when sea levels dropped again (between 45,000-21,000 years ago). At around this time, some of the Steppe bison that were already in North America began to gradually evolve into the smaller form of bison we know today.

Except for humans, bison were the most successful mammal that colonized North America since the onset of the ice age. They changed the ecosystem by feeding on grasses and woody plants. This unique grazing habit increased the biodiversity in the prairies, which eventually supported the continent’s first humans. Bison were present in the millions on the North American prairies up until historic overhunting nearly led them to extinction.

Further, we can determine how species and populations responded to dramatic climate changes in the past. Using this information, we can make better decisions to manage consequences of current and future climate change on today’s populations. After all, DNA from the past may help organisms in the future.

**Conclusion**

DNA extraction and sequencing from the fossil remains of ancient organisms is a new and promising technology. But what is it good for? By tracing the changes in fossil DNA, in combination with well dated fossils, we can watch the evolution of species over time and across continents. We can learn where they came from, what they looked like, why they went extinct, or how they became the way they are now.

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**Interesting facts about bison**

- In 2016, the bison became the first national mammal of the United States.
- There were tens of millions of bison in North America before the European settlers arrived. But by the end of the 19th century, hunters left only about 500 bison alive.
- Thanks to successful conservation plans, there are about 500,000 bison now.
- The male bison is called a bull, the female bison - a cow, and bison calves are called ’red dog’ because of their orange-red color. (Fig. 3)
- Bison are the largest living mammals in North America, but generally they are much smaller than their older ancestors.
- They are also very fast! They can run up to 50 kilometers (31 miles) per hour. Plus, they are extremely agile. They can jump high fences and swim.
- Bison can be aggressive and unpredictable. So getting too close to a bison is not a good idea..
- Bison “wallow”, which means they roll in the dirt to deter biting flies and shed fur.
- By feeding mostly on grass species and selectively avoiding other species, their grazing habit increases plant biodiversity, especially after a wildfire. Bison feed on the fast growing grasses, and help other species grow in the area.

**Figure 3:** Modern Bison (*Bison bison*). The current form of bison living in the US.
Glossary of Key Terms

**Ancestor** – An early type of animal or plant from which others have evolved. American bison evolved from Siberian bison. Therefore Siberian bison are the ancestors of American bison.

**Ancient DNA** – DNA recovered from non-living organisms, including fossils of mammals, insects, plants, or even bacteria.

**Bering Land Bridge** – During the last ice age, sea levels were lower because of the amount of water stored on the land by glaciers. This exposed the seafloor between Siberia and Alaska. This massive land connection is called Bering Land Bridge. It covered a pretty big area that was dry and inhabited by lots of plants and animals. Later, when the glaciers melted and sea level rose about 11,000 years ago, it was flooded and became part of the seafloor again. This land bridge formed many times over the last 2.6 million years.

**Biodiversity** – The variety of living organisms in an ecosystem. A high biodiversity (many types of plants and animals) helps the ecosystem to live longer.

**Descendant** – An organism that evolved from a particular ancestor.

**Dispersal** – Movement or transportation of things away from the center. Bison entered Alaska and Yukon via the Bering Land Bridge but then quickly dispersed throughout the continent.

**DNA** – Deoxyribonucleic acid is a molecule found in every cell and it carries genetic instructions.

**DNA sequencing** – The process of determining the precise order of the building blocks of DNA.

**Evolution** – The process by which different kinds of living organisms developed and diversified from earlier forms.

**Fauna** – All of the wild animal life of any particular region or time.

**Fossil** – The preserved remains or the traces of animals, plants, and other organisms from the past.

**Glacier** – Massive sheet of ice that is thick enough to move under its own weight.

**Gene** – A small section of DNA with the instructions for characteristics of the organism.

**Genome** – Complete set of genes in a cell or organism.

**Ice Age** – a time period between 2.6 million and 10 thousand years ago that is characterized by a cold, glacial period when global temperatures were reduced and glaciers advanced on the continents.

**Migration** – Movement of animals or plants from one region to another.

**Mitochondrial DNA – mtDNA** is the DNA found in the mitochondria, which are the ‘powerhouses’ of cells. mtDNA is passed on only from mother to offspring.

**Mutation** – A change that occurs in a DNA sequence and genes. These changes may result in variations in physical traits.

**Paleontology** – The study of what fossils tell us about the ecologies of the past, about evolution, and about the world.

** REFERENCES**


Check your understanding

1. How did bison and other land mammals migrate from Siberia to Alaska?

2. How did scientists calculate the arrival time of the first bison in America?

3. What are some of the lines of evidence that bison were very successful at invading North America?

4. How do we know that there were two waves of bison migration and dispersion?

5. Scientists believe that bison set the stage for the continent’s first humans. Why?

6. How could the information we obtain from ancient DNA help save modern species from climate change?