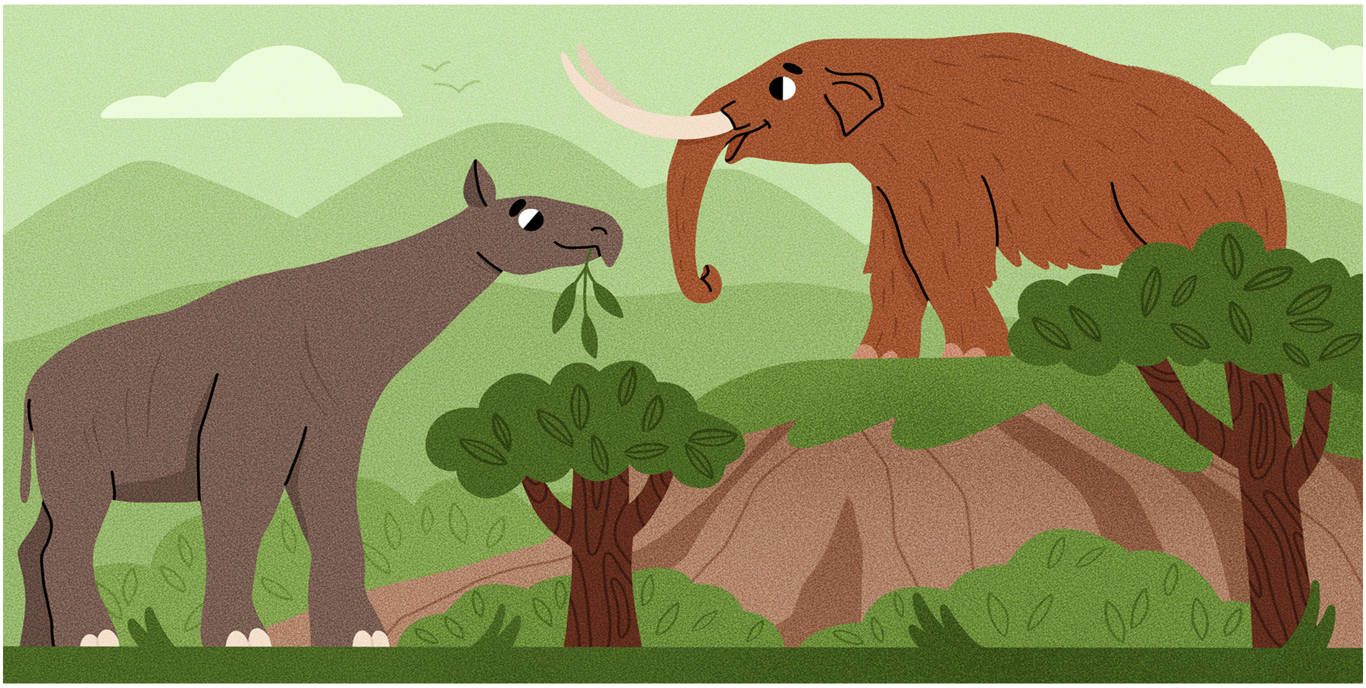
BIODIVERSITY
Published: 01 February 2024
doi: 10.3389/frym.2024.1225865



THE LATE PLEISTOCENE MEGAFAUNA: HUGE ANIMALS THAT USED TO ROAM THE EARTH

Luciano Varela[1,2*], *Martín Batallés*[1,2], *P. Sebastián Tambusso*[1,2] and *Richard A. Fariña*[1,2*]

[1] *Departamento de Paleontología, Facultad de Ciencias, Universidad de la República, Montevideo, Uruguay*

[2] *Servicio Académico Universitario y Centro de Estudio Paleontológicos (SAUCE-P), Universidad de la República, Sauce, Uruguay*

YOUNG REVIEWERS:


MAREN
AGE: 14


RAFF
AGE: 10


VINCI
AGE: 11


WOO
AGE: 10

Not so long ago, huge mammals weighing more than 1,000 kg existed practically all over the world. We call these giants the Pleistocene megafauna because they lived in a time period called the Pleistocene and were almost completely extinct around 11,700 years ago. These mammals lived on Earth for millions of years and were very important to almost all land-based ecosystems. However, natural climate change and humans decreased their ability to survive. Today, we find fossils of Pleistocene megafauna all over the world, including bones, hair, droppings, and even footprints. Scientists dig for these fossils to learn more about these animals and why they went extinct. Studying these ancient animals also gives scientists important information that helps them understand the risks that today's living animals face in our world.

WHAT ARE MEGAFAUNA?

You may have learned that the giant dinosaurs, which lived between 233–66 million years ago, were the biggest animals ever on land. But did you know that some of the **mammals** of the past were huge, too? All these huge animals, including dinosaurs and mammals, are called **megafauna**. Megafauna means “large animals”, and, by some criteria, the megafauna contains animals with an adult weight above 44 kg or 1,000 kg.

MAMMALS

A group of animals that are characterized by having milk-producing mammary glands for feeding their young, fur, and three middle ear bones.

MEGAFAUNA

Means “large animals” and refers to those animals that have an adult weight above 44 kg or 1,000 kg (depending on different criteria).

Among the marvelous array of living organisms, the diversity of mammals is fascinating (Figure 1). From small Sahara-dwelling rodents to the enormous blue whales in the oceans, today mammals are present on all continents and even in the most challenging environments. In particular, large mammals existed during many different times of the Earth’s history. Some mammals were already pretty big 50 million years ago, but the largest examples, comparable to the African elephants, did not roam the planet until late in a time known as the Eocene, between 41.2–33.9 million years ago. By the Oligocene, around 33.9–23 million years ago, large mammals were found all over the world, including the largest mammal to ever live on land, a 20-ton hornless rhinoceros. However, it was during the Pleistocene, between 2.58 million years ago and 11,700 years ago, when the age of giant mammals was at its peak, with many species present on all continents [1].

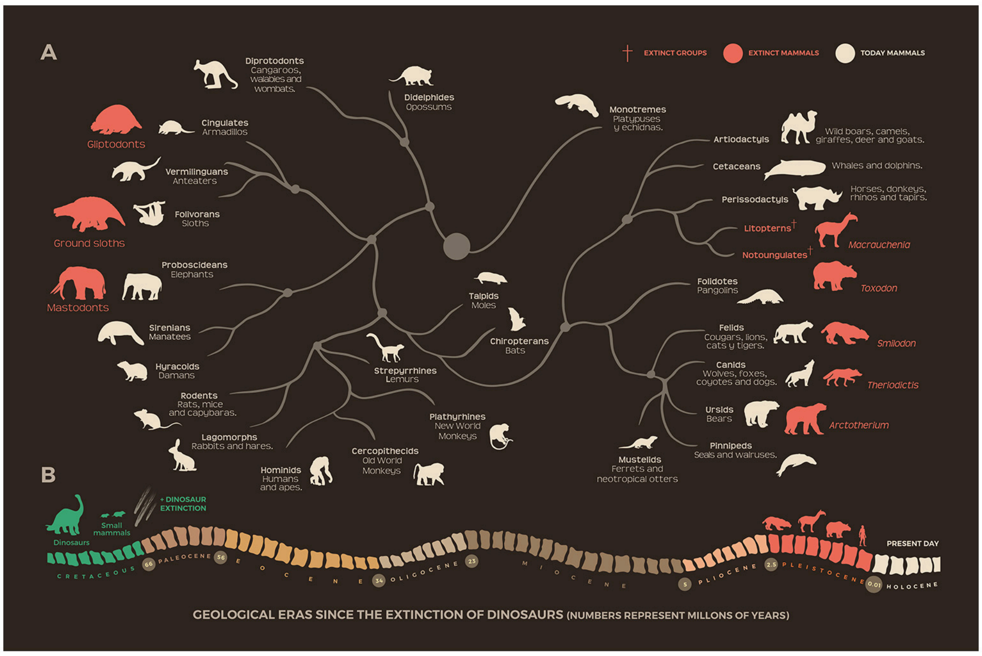


Figure 1

Figure 1

(A) A “tree of life” showing how mammal groups are related and where the late Pleistocene megafauna fits into the tree. **(B)** Timeline showing the geologic eras from the Cretaceous to the present day.

Many mammal species have gone extinct through time, but the Late Pleistocene megafauna (in particular that of South America) has captivated the curiosity of many scientists, including Charles Darwin during his visit to Argentina and Uruguay [2], where more than 20 large fossil species have been recorded.

WHY DID MEGAFAUNA GET SO BIG?

There are many reasons why animals might become larger during their evolution, and scientists have proposed several hypotheses. One says that **evolutionary lineages** increase in body size over evolutionary time. Another proposes that, in islands, small species tend to increase in body size, while large species tend to decrease in body size. Another hypothesis says that **populations** and species found in colder regions have larger body sizes.

Scientists also found some reasons why it is advantageous for animals to be big. They observed that bigger animals usually have increased **fitness** during times of stability, for example when the climate stays relatively unchanged during long periods of time. Large animals can travel longer distances for food and are less likely to become the food of other animals. Large animals are also less affected by temperature changes, since their big bodies are more efficient at maintaining their internal temperatures.

EVOLUTIONARY LINEAGES

An evolutionary lineage is the sequences of species or populations that are connected by a continuous line of descent.

POPULATION

A group of individuals of the same species living in the same place at the same time.

FITNESS

How good a particular group of individuals (population) is at producing offspring.

WHERE AND HOW DID MAMMALIAN MEGAFAUNA LIVE?

For most of the last 30 million years, big mammals were vital parts of almost all land-based ecosystems. The fossils of giant species that are related to many existing mammals are found worldwide. For example, several giant **marsupials** related to wombats and koalas were common across Australia. In Europe and Asia, a gigantic deer roamed the continent, along with mammoths, cave lions, cave bears, and cave hyenas. In South America, a mixture of large native mammals, like xenarthrans and notoungulates (see the ground sloth, glyptodont, and toxodont pictured in Figure 2), coexisted with newly arrived North American species. This mixture occurred after the closure of the Isthmus of Panama around 10–5 million years ago, forming one of the most astonishing assortments of giant mammals in the world—with more than 20 species that weighed more than 500 kg [3]. These giant mammals had important roles for the healthy functioning of ecosystems, like redistributing nutrients through their poop and dispersing seeds.

MARSUPIALS

A group of mammals, found mostly in Australia, that have a special kind of pouch where they carry and raise their babies. Some famous marsupials include kangaroos, koalas, and opossum.

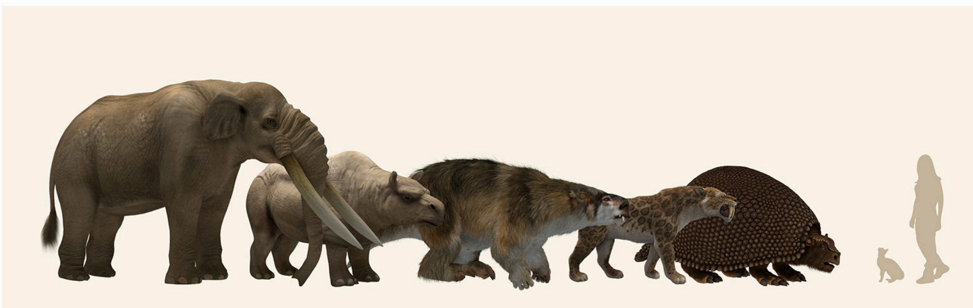


Figure 2

Figure 2

Some of the typical Late Pleistocene megafauna of the Americas, next to a person and a domestic cat for size comparison. From left to right: mastodont, toxodont, giant ground sloth, saber-toothed felid, and glyptodont.

However, being big comes with big challenges. For example, gigantic mammals needed huge amounts of food to survive. They could not produce many offspring because they needed many years to become adults and capable of reproduction, and the **gestation period** was quite long. These difficulties made large mammals more vulnerable to changes in their habitats declining populations because they would need long periods of time and a lot of resources to maintain or recover their numbers.

GESTATION PERIOD

Time of development of an embryo inside animals that give birth to "living" babies (like mammals).

WHEN AND WHY DID MOST HUGE MAMMALS BECOME EXTINCT?

Although giant mammals were successful for millions of years, they are now almost absent, except in Africa and regions of southern Asia. So, how did that happen? A great extinction event that led to the disappearance of most of the megafauna occurred at the end of the Pleistocene, the **geologic epoch** preceding the one we live in (called the Holocene), some 11,700 years ago. Before this time, many giant species were common in Europe, Asia, Australia, North America, and South America. The reason for their rapid extinction remains a subject of research.

GEOLOGIC EPOCH

A way to divide history into parts based on when certain things happened, like extinctions. It helps us understand how things have changed over a really long time.

Around 23–5 million years ago, during the last part of the Miocene, the climate turned increasingly cold, with cycles of freezing periods (glacial periods) interspersed with warmer periods (interglacial periods). So, one hypothesis proposes that when warmer periods became more common and stable around the world, the megafauna species were too adapted to cold environments and were negatively affected by the new warm conditions and the changes in plants that these conditions caused. Thus, a warming climate may have made megafauna more susceptible to extinction, since populations might have struggled to find sufficient food or suitable habitats. Another hypothesis proposes that the extinction of most of the megafauna coincided with the arrival of the first modern humans on each continent, because humans hunted these animals.

Recent investigations have shown that the causes for the extinction of megafauna are complex. The combination of natural climate change and human activities had different impacts in different parts of the world, but both probably played an important role in the extinction of these giant animals [4]. In Africa, where large mammals evolved along with humans, many mammalian megafauna species were not affected by the extinction at the end of the Pleistocene. However, many species have become extinct or endangered during the last few centuries because of modern humans.

HOW DO WE STUDY EXTINCT MAMMAL MEGAFAUNA?

Scientists use several techniques to study extinct mammalian megafauna. Most of the time, they study fossils. In a few cases, the humans who saw these enormous animals left us drawings of them on rocks inside caves or elsewhere. Ancient humans also used the bones of these mammals to make tools. From fossils, scientists can hypothesize how a species looked and moved, how much the animals weighed, what they ate, if they lived in herds, and many other things.

In general, the fossils of Pleistocene megafauna are well preserved because they became extinct so "recently" compared with dinosaurs, which disappeared 66 million years ago. So, many of the bones are in good condition, preserving tiny details and even traces of DNA and other molecules [5]. Scientists know the complete skeletons of almost all the extinct Pleistocene megafauna and, in some cases, other remains were also preserved. In icy places, like in Siberia in northern Russia, mummified mastodons with skin, hair, and even internal organs have been found. In caves in southern Chile, the remains of the fur, claws, and poop of a giant sloth were found. The footprints that these animals left were also fossilized, such as the tracks of a giant ground sloth found on a beach in Argentina.

When scientists dig for megafauna fossils, they record the entire process, noting everything they find, where they found it, and what the conditions were like. They take photographs, measure the fossils and the depths at which they were found, draw pictures, and write everything down. All these records are crucial to know how old the fossils are, how the animals died, if the bones had deteriorated, or if the fossils were moved around. Once fossils are removed from the soil and taken to the laboratory, they must be treated with great care and preserved so that they can be studied long into the future by other scientists or displayed in museums. Fossils may need to be cleaned of soil and sand, dried if they are too wet, or rebuilt if they are cracked or broken (Figure 3). We call this process preparation, and it is a task that requires special tools and products like small tweezers, needles, brushes, and glues—and above all, a great deal of patience and observation. Then, fossils must be cataloged, that is, given a number that identifies them, so that they can be found among other fossils in the collection, along with all the information collected about them. Moreover, experts must try to keep fossils in the best possible conditions, with as few changes in temperature and humidity as possible. The same is true for all notes, photographs, and drawings. Conserving the fossils and the notes is as essential as digging because only by saving all this information will the questions about these animals be answered—even questions that have not yet been thought of. Scientists also make 3D models of the fossils, which you can see here.

Figure 3

Figure 3

(A) Late Pleistocene fossils are often encountered in soft sediments, which makes them easy to dig up using simple tools or sometimes just by hand. However, these fossils are fragile and require preparation after they are recovered. **(B)** Preparation is a crucial part of studying fossils. Here, a canine tooth of a saber-toothed felid suffered severe breakage when drying up after excavation. **(C)** The tooth was then patiently reconstructed.

WHY IS IT IMPORTANT TO STUDY EXTINCT MEGAFAUNA?

Studying extinct megafauna is exciting because we can discover amazing things about the strange animals that lived on our planet thousands of years ago. It also gives us vital information about how the animals went extinct, which can help us understand the risks that animals now face. Whether these giants of the past disappeared because of a changing climate or our human ancestors, their extinction should be one more reason for us to question our role as the dominant species on the planet. Unlike our ancestors, we certainly have the information and tools to make wiser decisions.

ACKNOWLEDGMENTS

This work was supported by a grant by the Comisión Sectorial de Posgrado (CAP), UdelaR to LV.

REFERENCES

1. Fariña, R. A., Vizcaíno, S. F., and De Iuliis, G. 2013. *Megafauna: Giant Beasts of Pleistocene South America*. Bloomington, IN: Indiana University Press.
2. Darwin, C. 1933. *Charles Darwin's Diary of the Voyage of H.M.S. "Beagle"*. New York, NY: Macmillan.
3. Croft, D. A., and Simeonovski, V. 2016. *Horned Armadillos and Rafting Monkeys*. Bloomington, IN: Indiana University Press.
4. Koch, P. L. and Barnosky, A. D. 2006. Late quaternary extinctions: state of the debate. *Annu. Rev. Ecol. Evol. Syst.* 37:215–50.
5. Baleka, S., Varela, L., Tambusso, P. S., Paijmans, J. L., Mothé, D., Stafford, T. W., et al. 2022. Revisiting proboscidean phylogeny and evolution through total evidence and palaeogenetic analyses including *Notiomastodon* ancient DNA. *iScience* 25:103559. doi: 10.1016/j.isci.2021.103559

SUBMITTED: 20 May 2023; **ACCEPTED:** 18 January 2024;
PUBLISHED ONLINE: 01 February 2024.

EDITOR: Didone Frigerio, University of Vienna, Austria

SCIENCE MENTORS: Jacob Gardinier Scott and Maria Olivia Casanueva

CITATION: Varela L, Batallés M, Tambusso PS and Fariña RA (2024) The Late Pleistocene Megafauna: Huge Animals that Used to Roam the Earth. Front. Young Minds 12:1225865. doi: 10.3389/frym.2024.1225865

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

MAREN, AGE: 14

I am a student who loves to read, run, and sing. I participate in my school's theater program, as well as a choir outside of school involved with my local orchestra.

RAFF, AGE: 10

I am a 10-year-old boy Italian boy that attends the same school and I love rocket science and chemistry and physics.

VINCI, AGE: 11

I am a Portuguese 11-year-old boy, same school and I really like evolution, natural history and history.

WOO, AGE: 10

I am a 10-year-old Korean boy, that boards in a school in Cambridge, I love sciences specially chemistry and physics.

AUTHORS

LUCIANO VARELA

I am a paleontologist from Uruguay, South America. I am focused on studying aspects related to the evolution of xenarthrans, one of the most important groups of the South American native megafauna. My interests are related to the processes that have made these animals so big and successful for millions of years. I also work using 3D models of fossil bones to answer various questions about these animals, like what they ate or how hard they bit. *luciano.lvr@gmail.com

MARTÍN BATALLÉS

I am a designer, illustrator, and photographer from Montevideo, Uruguay. I also have a degree in museum studies. I work in a fossil excavation and collection site near Montevideo with thousands of fossils from extinct mammals. My work involves things like fossil cleaning and repair, as well as taking pictures of fossils and drawing them. During excavations, I take lots of pictures and take notes to register all our work for future generations (and when I can, I dig for bones too). I like to create images that inspire others to imagine how life was in the deep past.

P. SEBASTIÁN TAMBUSSO

I am a vertebrate paleontologist from Montevideo, Uruguay. I have a Ph.D. in biology and my main focus of investigation is related to xenarthrans paleobiology. My research interests include anatomy, biogeography, macroevolution, and 3D reconstruction, with the main objective of understanding the lifestyles, evolutionary processes, and the extinction of these fossil vertebrates.

RICHARD A. FARIÑA

The oldest paleontologist in this group, I have a Ph.D. in biology and have done research on megafauna since my doctorate, especially on subjects as biomechanics, paleoecology, biology of size, and extinction. *dogor@netgate.com.uy