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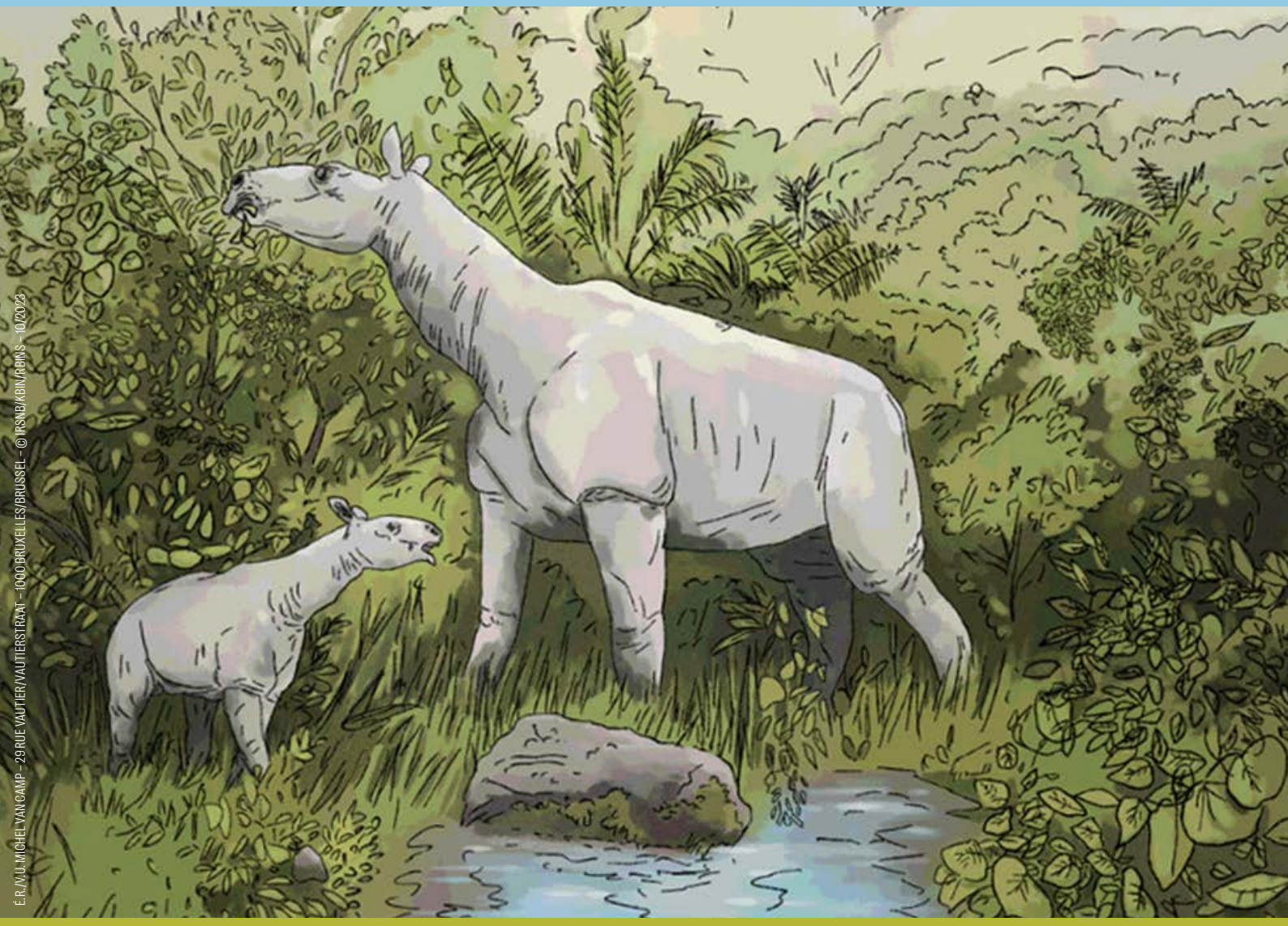

GIANTS

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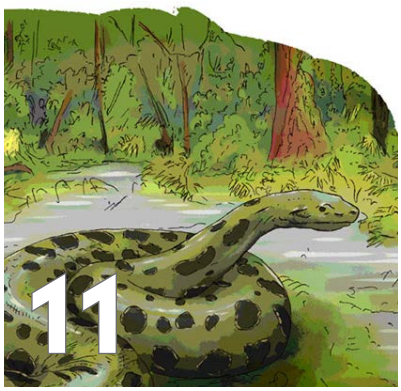
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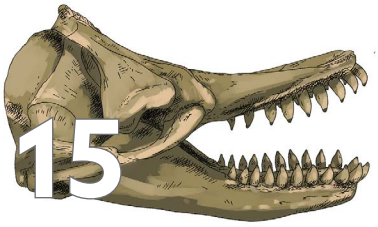
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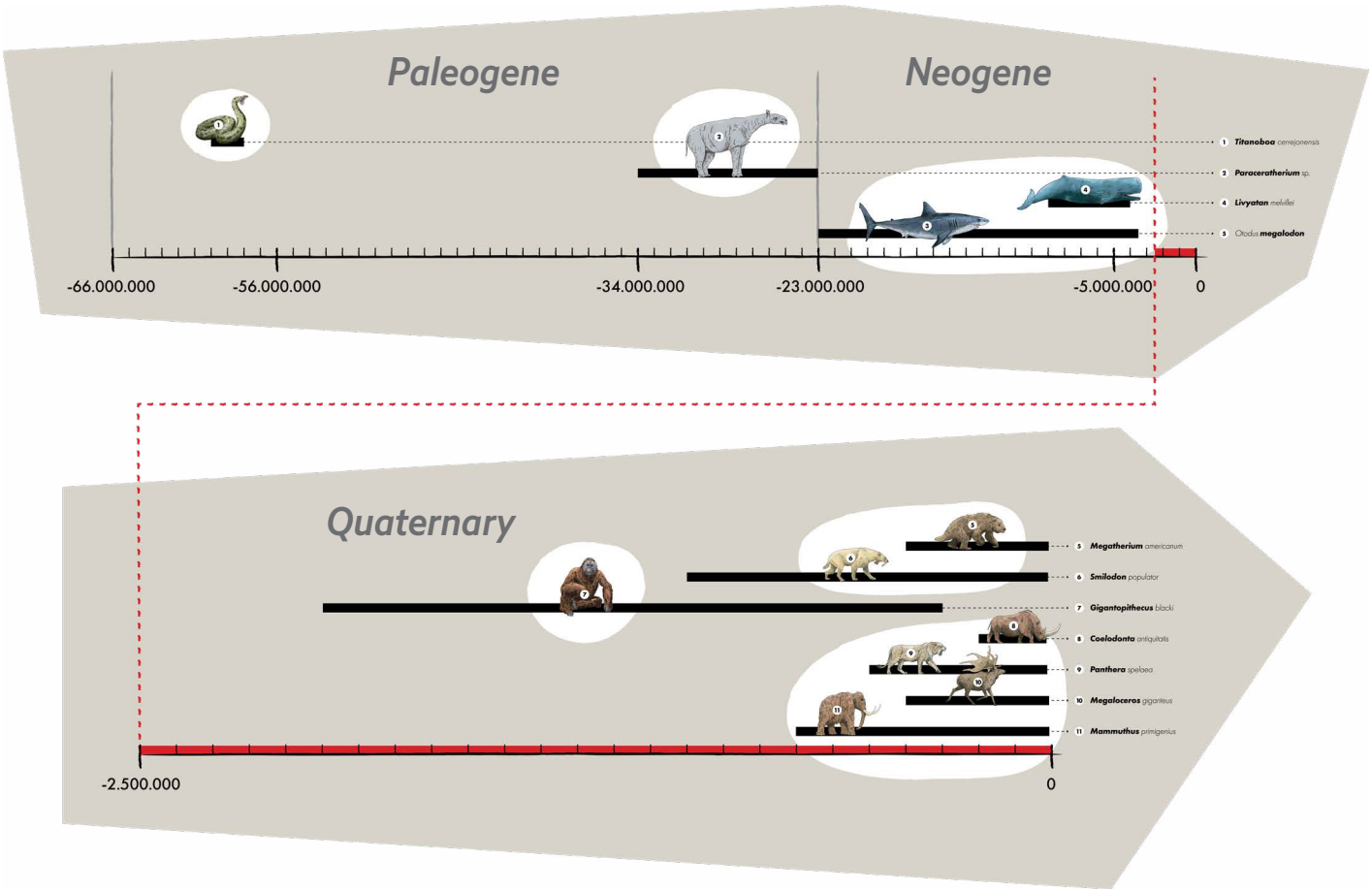
Presentation

TIMEFRAME

Giant animals have existed throughout earth's history. The first to come to mind are undoubtedly the great dinosaurs of the Mesozoic Era, but other giants populated the planet long before these dinosaurs, such as the Carboniferous arthropods (dragonflies with a wingspan of 70 cm, millipedes with a length of 2 meters, etc.).

After the disappearance of the large dinosaurs 66 million years ago, other animals in turn evolved into giants. The exhibit focuses on eleven of these animals, from the Cenozoic Era, the era beginning after the extinction wave of the end of the Cretaceous, 66 million years ago. This era is divided into 3 periods: Paleogene, Neogene and Quaternary.



But how could mammals have reached such proportions?
To understand this, let's go back in time...

About 66 million years ago, a meteorite crashed into Earth, triggering devastating events. The impact caused huge fires, released huge amounts of dust and gas into the atmosphere, and generated incredibly destructive tsunamis.

The event led to drastic changes in the environment, including climatic disturbances and reduced solar luminosity. These conditions had a direct impact on existing species, particularly non-avian dinosaurs, ending their reign on Earth that had lasted for millions of years.

Amidst the ruins of this mass extinction, new life forms will emerge, diversifying and occupying the ecological niches left vacant. Among the survivors were the multituberculates, a group of ancient mammals such as *Kryptobaatar*, which is shown here. These small animals proliferated during the Mesozoic, when dinosaurs were still alive, diversifying their forms and feeding habits. This small mammal had a skull 2.6 cm long and rodent-like teeth but was omnivorous and probably hopped around like a gerbil.

Multituberculates had unique adaptations, including specialized teeth and agile limbs, which allowed them to adapt to different habitats and feed on a variety of resources.

TO SEE:

Kryptobaatar sp.
Partial skeleton
Original
Bayan Mandahu, Inner Mongolia, China

The transition from the Cretaceous to the Cenozoic was a turning point in the evolutionary history of our planet. The extinction of the dinosaurs opened the way for new life forms, allowing the diversification of mammals and, later, the emergence of the ancestors of the species we know today. Some of these mammals, but also other vertebrates, reached impressive sizes during the Paleocene!

Paleogene and Neogene

The Paleogene and Neogene are two successive geological periods that together make up the largest part of the Cenozoic, the era of, among other things, modern fauna and flora.

The **Paleogene** (divided into the **Paleocene**, **Eocene** and **Oligocene**) lasted from about 66 to 23 million years ago and was a period of great changes on Earth. New species and ecosystems emerged after the mass extinction of the non-avian dinosaurs. It is also a period of tectonic activity and the formation of new mountain ranges such as the Andes, the Himalayas, the Alps and the Rocky Mountains.

The **Neogene** (divided into **Miocene** and **Pliocene**) followed the Paleogene and lasted from about 23 million to 2.6 million years ago. During the Neogene, Earth again underwent major changes, including the development of modern savanna ecosystems. In the animal world, the grazing mammals arose, and the first primates evolved.
It was also a period of climate cooling, which led to the formation of the ice caps on the North and South Pole. At the end of the Neogene there was a further cooling of the climate and the emergence of ice caps on a large part of the northern hemisphere, which eventually led to several ice ages.

Quaternary

The **Quaternary** is a geological period that began about 2.6 million years ago and continues to this day. The Quaternary is divided into two periods: the **Pleistocene** and the **Holocene**.

The Pleistocene spans most of the Quaternary, from about 2.6 million years ago to 11,700 years ago. The Pleistocene is characterized by several glacial and interglacial periods, during which the temperature on Earth alternates between falling and rising. During these ice ages, the Arctic and Antarctic ice sheets expanded, causing sea levels to fall and creating huge land bridges. This had important implications for the evolution of life on Earth, as species could spread to new continents. The end of the Pleistocene is marked by the extinction of many large mammals, such as the cave lion and the woolly rhinoceros. This extinction may have been the consequence of climate change and hunting by humans.

WHAT IS A GIANT?

We tend to take our own human size as the norm, and therefore consider an elephant very large and a rabbit very small. However, if we look at the average size of all mammal species, it turns out that the average weight is about 450 g, which corresponds to a small rat. This is because there are many more rodents and bats than, for example, antelopes and whales. This change of perspective turns a rabbit into a large mammal.

Despite the relativity of the term 'giant', it is still believed that a vertebrate must weigh more than 45 kg (or more exactly 100 pounds for the Anglo-Saxons!) to fall into the category of «megafauna». For mega-herbivores, a mammal must weigh even more than 1000 kg. Today they include elephants, rhinoceroses, hippos, bison, water buffaloes and giraffes. The giants of the Cenozoic era included Paraceratherium, Megatherium, the woolly mammoth, Gigantopithecus.

Animals pertaining to this megafauna have several things in common:

- **Few natural enemies, given their imposing size**
- **A long life**
- **A rather late sexual maturity**
- **A long gestation period**
- **Litter size often limited to one young**
- **Parental care**

Some of these features are relatively beneficial. First, the fact that they no longer have natural enemies. Second, their years of care for their offspring. In addition, there is the fact that they require less food in relation to their body mass, compared to small animals.

Being big and massive does not just have advantages, however. This is all fine and dandy in a stable, nutrient-rich environment, but it becomes a problem in times of famine or sudden changes in the environment, such as climate change. Feeding such a large body is no easy task and the slightest change in the ecosystem can have deadly consequences. These giants are therefore very vulnerable when their environment changes. The only alternative is to seek food elsewhere. If that is not an option, consequences will be dire. Since their low reproductive rate leads to a reduced rate of adaptation, this often means extinction. Such is the evolutionary rule: move, adapt, or die.

Since earth has always been subject to strong climate fluctuations, this quasi-permanent instability has put great pressure on megafauna. Over the course of the evolutionary history of our planet's fauna, many of these immense taxa have often become extinct.

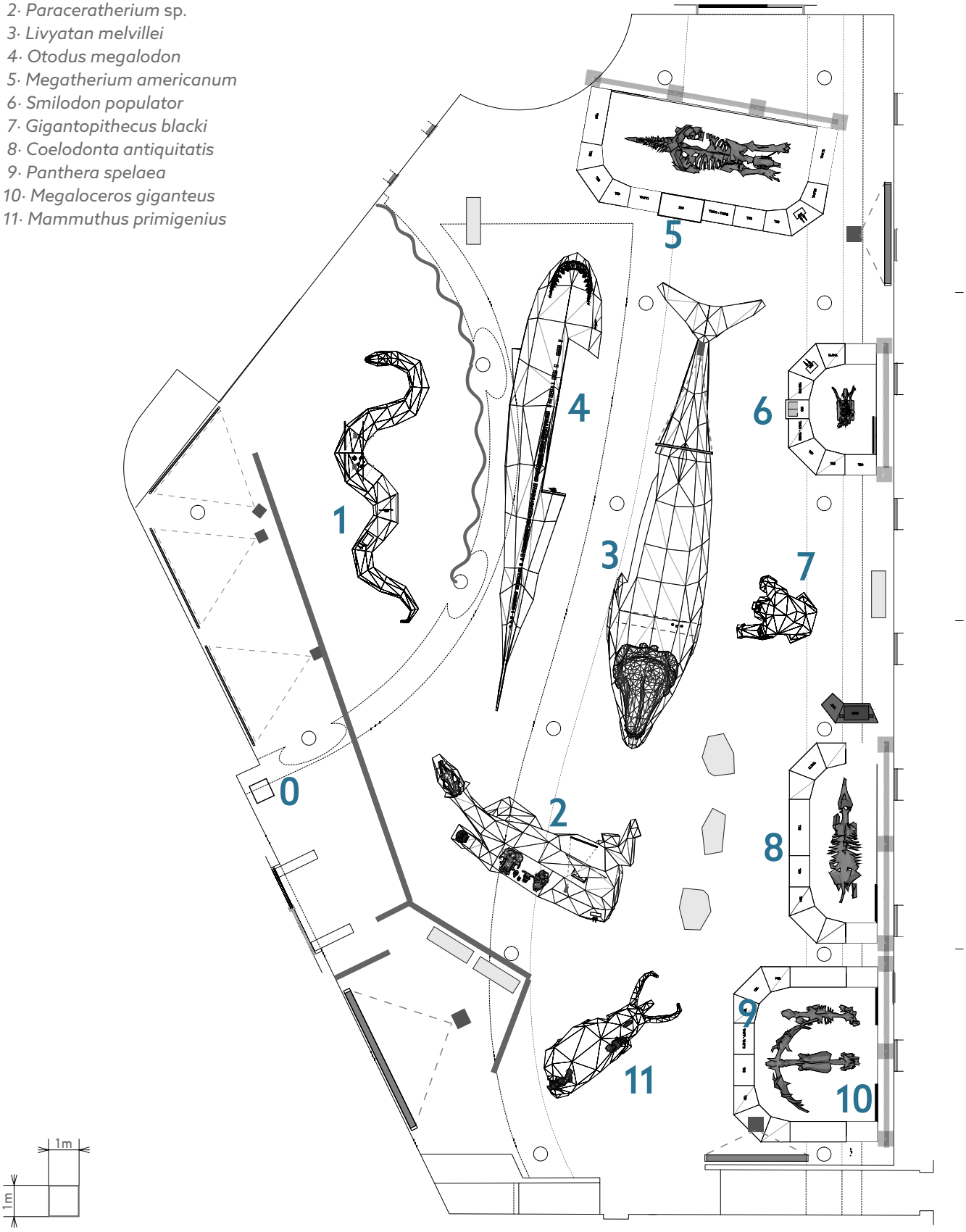
The time it takes for an animal species to evolve into a giant one depends on its environment. Growth is faster in an aquatic environment than on land because the constraints of the aquatic environment are less severe.

By comparison, if a terrestrial species grows to 100 times its original size, it takes 2.2 million generations to get there, while a marine animal takes half that time. Paradoxically, it takes a species 10 times less time to become a dwarf than it does to become a giant.

It must be said that although it is often the large animals that are noticed and admired, even if there is only a small number of species that assumes these proportions through natural selection.

Plan

0· Kryptobaatar sp.
1· Titanoboa cerrejonensis
2· Paraceratherium sp.
3· Livyatan melvillei
4· Otodus megalodon
5· Megatherium americanum
6· Smilodon populator
7· Gigantopithecus blacki
8· Coelodonta antiquitatis
9· Panthera spelaea
10· Megaloceros giganteus
11· Mammuthus primigenius

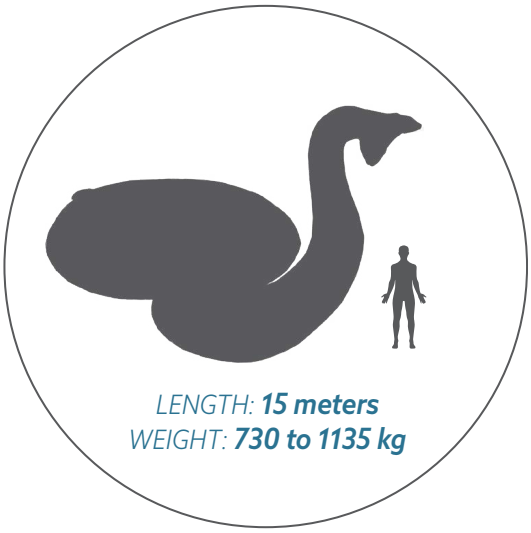



Parcours

GIANTS FROM THE CENOZOIC

Paleogene

1· GIANT SNAKE
Titanoboa cerrejonensis



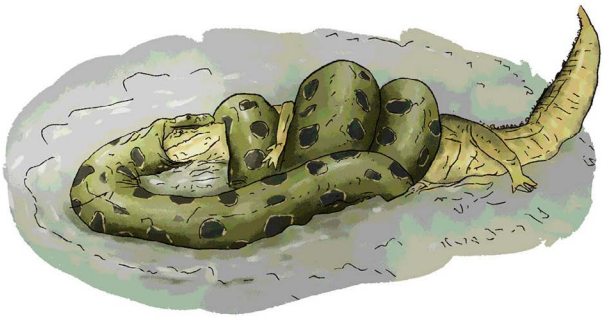
Titanoboa cerrejonensis is the largest snake known to date. It lived in the middle to upper Paleocene, about 60 to 58 million years ago. Titanoboa is estimated to have been 15 m long and to have weighed between 730 and 1,135 kg. This is three times the weight of the female green anaconda, the largest snake in the world today.

The length and mass of *Titanoboa* were initially calculated by determining the relationship between vertebrae size and body size in modern giant snakes. This relationship was then applied to the recovered vertebrae of Titanoboa to determine its body size. Later, based on the skull fragments found, the body length was even increased.

Titanoboa lived in a tropical rainforest with an extensive river system in present-day Colombia. It was a super-predator that ate everything it could find, including large fish, crocodiles and turtles. Like anacondas and boas, the *Titanoboa* did not use venom, but suffocated its prey by surrounding it with its body. It then swallowed its prey in one go.

Titanoboa was able to grow to gigantic proportions because the temperature in the tropics was 4-5 degrees higher than today. The same process has also been observed in other reptiles sharing the same environment as *Titanoboa*. The crocodile *Acherontisuchus guajiraensis* and the turtle *Puentemys* also had gigantic proportions.

Titanoboa was a heterothermic animal, Heterothermic animals take the temperature of their environment. When the ambient temperature rises, their internal temperature also rises, which allows them to grow faster, provided there is enough food. The reason for the extinction of the *Titanoboa* is unknown. A drying up or a change in the flow of rivers due to climate change could have been fatal.



TO SEE:

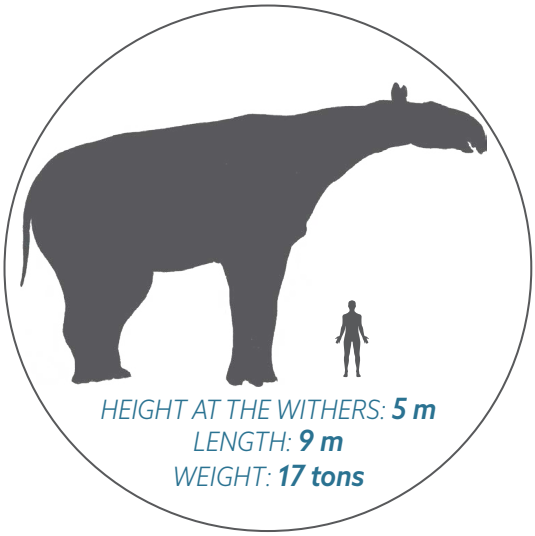
Titanoboa cerrejonensis
Vertebrae and ribs, 3D-prints
Cerrejón coal mine, Colombia
© Florida Museum of Natural History, USA / Museo Geológico Nacional José Royo y Gómez, Colombia

TO DO:

Take the detached vertebra from the Titanoboa and examine it carefully. Then compare it with the other vertebrae. You can rotate them around their axis to examine them more closely. With which vertebra does the *Titanoboa* vertebra correspond most morphologically?

2· PREHISTORICAL RHINO
Paraceratherium sp.

Paraceratherium is the largest known land mammal and lived in the Oligocene (between 34 and 23 million years ago), mainly in what is now China, Mongolia, Kazakhstan and Pakistan. Remains have also been found in Eastern Europe, Anatolia and the Caucasus. Over 15 million years, different species of *Paraceratherium* appeared on Earth. Also called «*Indricotherium*» or «*Baluchitherium*», they were a hornless rhinoceros species.



With its long neck, it could reach leaves inaccessible to others, just like giraffes today. Its height at the withers was about 5 metres, its length about 9 metres. Its weight is estimated to have been around 15 to 20 tonnes. Its long neck supported a skull of about 1.3 metres in length. They had large tusk-like incisors and a nasal incision suggesting that they had an upper lip with which it could grip. Its legs were long and pillar-like. *Paraceratherium*'s lifestyle was probably like that of modern large mammals such as elephants and rhinoceroses. Because of its size, it must have had few predators and a low reproductive rate. It was a herbivore that fed mainly on leaves, soft plants and shrubs. It lived in a variety of habitats ranging from arid deserts with a few scattered trees, to subtropical forests. The reasons for its extinction are not clear, but these animals had enormous requirements, eating between 800 kg and 1 tonne of leaves per day. This made them very vulnerable to global warming, as their food source gradually disappeared.

It may not be immediately obvious, but *Paraceratherium* is indeed a rhinoceros. Scientists have deduced this from the molars in its upper jaw. The surface of these molars

is shaped like the Greek letter pi, whereas the surface of the molars in the lower jaw is shaped more like an L. The first representations of *Paraceratherium* were therefore rhinoceroses, but new discoveries led to new representations: a cross between rhinoceros, elephant and giraffe. Since 1846, when the first *Paraceratherium* skeletal fragments were discovered in Pakistan, successive generations of palaeontologists have studied this giant. Complete skeletons were found in Kazakhstan and China.

TO SEE:

Paraceratherium grangeri
Skull, 3D print
Tsagan Basin, Mongolia,
© Natural History Museum, London

***Paraceratherium* sp.**
Mirrored 3D-print
Bugti hills, Pakistan
© Natural History Museum, London

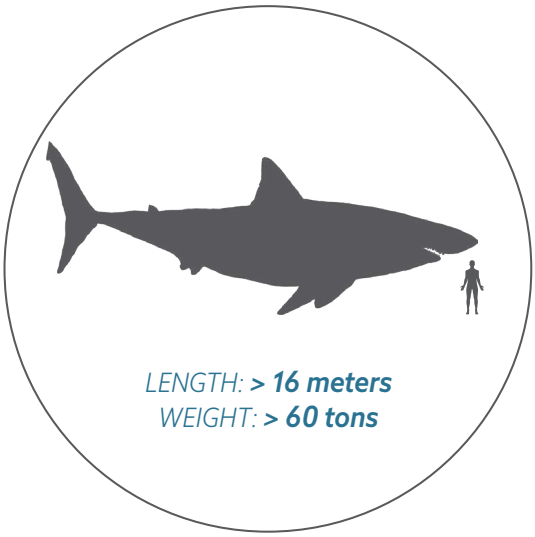
TO DO:

Take the molar from the upper jaw of *Paraceratherium* and examine it carefully. Then compare it with the other molars in the inverted skulls. Which teeth does the *Paraceratherium* molar most resemble morphologically?

Neogene

3· MEGATOOTH SHARK
Otodus megalodon

Otodus megalodon lived from the Early Miocene (23 million years ago) to the Early Pliocene (3.5 million years ago). It was the undisputed ruler of the prehistoric seas for 12.5 million years, and the biggest known shark of all time. Its triangular serrated teeth were the size of a human hand, and its jaws were wide enough to swallow a person whole. It hunted whales and dolphins and probably used the same hunting technique as today's white shark: stealthily approaching its prey from below and then darting upwards with its mouth wide open to bite. The most recent estimates suggest that megalodon could reach a maximum length of up to 20 meters, but lengths between 10 and 15 meters would have been more standard.



The exhibited fossil is an exceptional collection piece. It is one of the best preserved and most complete *Otodus megalodon* specimens in the world. It was excavated in Antwerp in the 19th century. The piece continues to fascinate scientists, who venture from all over the world to the museum to study it. Since the skeleton of sharks consists of cartilage, which typically mineralizes poorly, scientists must rely on the size of the teeth and comparison with living relatives to estimate the length

of megalodon. However, this exceptional find allows us to deduce its growth pattern and size from the growth bands in the vertebrae.

Sharks may have a fearsome reputation, but the largest species are not predators. They are filter feeders, filtering small organisms from large volumes of water. Predators must chase and then tear up prey. Speed and manoeuvrability are important here. Both factors are limited by size. So how come an apex predator like megalodon could grow so big?

It took 30 million years of evolution before the family of megatooth sharks, the Otodontidae, could reach such a size. Various factors played a role in this. Unlike other fish, they had the ability to maintain their body temperature, allowing them to hunt faster and better. Other factors that may have played a role were the shift from fish to high-fat mammals (dolphins and whales) as prey and, once they had evolved, eventually also baleen whales.

Fish are generally cold-blooded, but there are exceptions such as the great white shark. They generate heat through the contraction of their swimming muscles, and this heat is then used to raise the temperature of critical areas of the body above that of the surrounding water. Researchers hypothesize that megalodon managed its temperature in a similar way.

Exactly how megalodon became extinct remains unclear, but during the Pliocene, the world and the oceans cooled. Food became increasingly scarce, its habitat more fragmented. And then it had to compete against other predators, such as the great white shark.

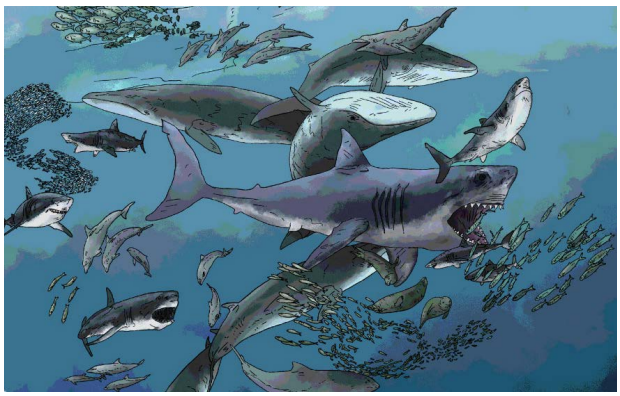
TO SEE:

Otodus megalodon
Spine, original
Antwerp, Belgium
© Royal Belgian Institute of Natural Sciences

Otodus megalodon
Jaw, original + 3D prints
Antwerp, Belgium
© Royal Belgian Institute of Natural Sciences

TO DO:

· Count the growth rings on the megalodon vertebra and determine the age.
· Determine which species each shark tooth belongs to using the identification key.



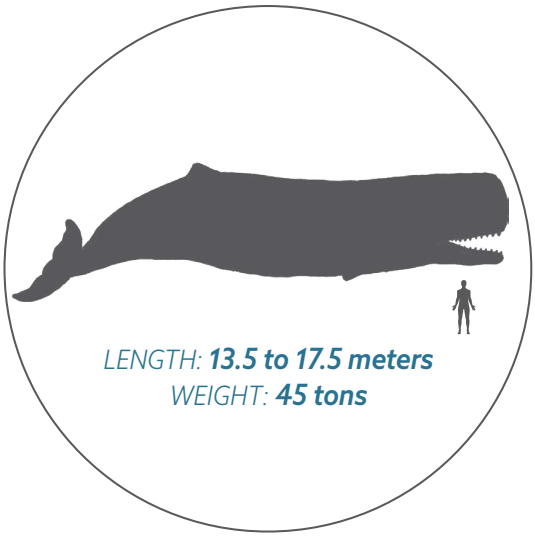
4· PREHISTORIC SPERM WHALE
Livyatan melvillei

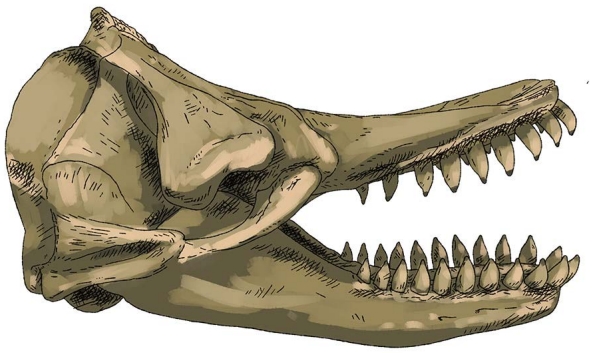
Livyatan melvillei has so far only been found along the coast of Peru in Miocene (9 million years ago) deposits, but isolated teeth that may be from *Livyatan* or related species have been found in the Miocene of Chile and in the Pliocene of Australia (4 to 5 million years ago).

Its skull reveals that *Livyatan* was an apex predator. The snout was short and broad, allowing it to restrain prey with its front teeth. This grip was further improved by the fact that the front teeth were tilted forward. The shallow depression on the side of the skull was huge and indicates massive jaw-locking muscles. The bite would have been the largest of any tetrapod. Scientists deduced from the shape of *Livyatan*'s teeth, which have a simple conical shape, that it was a sperm whale and not an orca. *Livyatan*'s teeth are much more robust however, the largest being over 35 cm long and 12 cm wide. They were firmly embedded in the jawbones and fitted together so that prey could be caught with a firm and powerful bite. The skull of *Livyatan melivillei* was only discovered in 2008 by a team led by one of the museum's scientists in Peru's Pisco-Ica desert. No other skeletal fragments have been found so far, but *Livyatan* was probably between 13.5 and 17.5 meters long. The estimation of the length was based on the length of the skull and the comparison with other sperm whales.

The evolutionary increase in size of the baleen whales, which were their main prey, probably contributed to the appearance of giant predatory sperm whales. *Livyatan*'s gigantic size provided protection against predators such as the shark O. megalodon, with which they shared the oceans. In addition, *Livyatan* was able to hunt large prey due to its gigantic size.

There were several marine mammals that were potential prey items for the gigantic predatory sperm whales, but they would have preferred baleen whales. After all, these formed an energy-rich bite with their fat, which allowed them to meet their very large energy needs.





Livyatan seems invincible given his size and strength and yet it went extinct. A climate change that led to the disappearance of medium-sized baleen whales, its most important prey, led to its demise. Its cousin, the current sperm whale, survived by specializing in a different kind of prey, namely large squids that live at great depths.
eurs importantes.

TO SEE:

Livyatan melivillei
Skull and lower jaw, cast
Pisco-Ica Desert, Peru
© Royal Belgian Institute of Natural Sciences

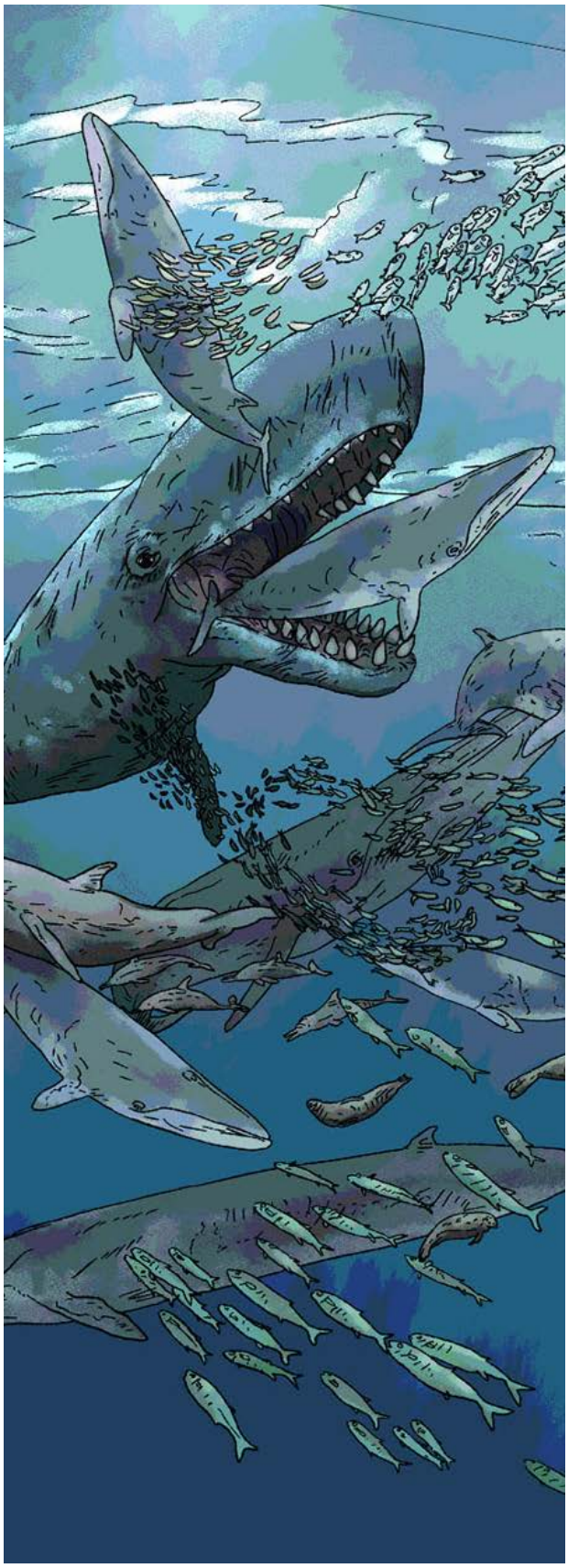
Livyatan melvillei
teeth, cast
Pisco-Ica Desert, Peru
© Royal Belgian Institute of Natural Sciences

Physeter macrocephalus
Sperm whale tooth, original
Unknown
© Royal Belgian Institute of Natural Sciences

Orcinus orca
Orca tooth,, cast
Unknown
© Royal Belgian Institute of Natural Sciences

TO DO:

Game: reconstructing a paleo-ocean and the food web



Quaternary

5· GIANT GROUND SLOTH
Megatherium americanum

For over 60 million years, South America was an island with favourable climatic conditions, abundant vegetation and few predators. This led to the evolution of unique giant herbivores, including this giant sloth *Megatherium americanum*. There were several types of ground sloths, but this was the largest. It picked leaves from trees by standing on its hind legs and using its tail for support. Its front legs were proportionally longer and ended in 30 cm long claws, which it could use to dig and fend off predators. Scientists managed to get a good representation of the giant sloth. They used complete skeletons, of which the femurs can be compared with those of other giant sloths, fossilized paw prints, faeces and even hair to study their palaeobiology. Examination of the inner ear and footprints confirmed that the sloth walked mainly on all fours and occasionally sat on its hind legs to rest or reach food high in the trees. Associated trackways also showed them to move in groups.

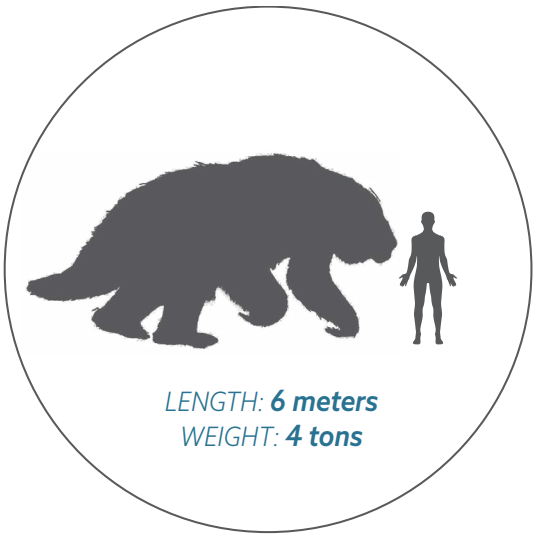
About 2-3 million years ago, tectonic plate movements formed a land bridge between North and South America (the Panama isthmus), increasing the exposure of South American herbivores to new predators from the north, such as Smilodon. In response to this threat, ground sloths grew even larger. This land bridge also caused changes in ocean currents, leading to lower temperatures. A larger body offered better protection against the cold. Among other things, but most notably, the availability of food resources and pressure from predators influence the size of herbivores. More food allows some herbivores to grow larger. A lower predation pressure allows them to diversify into different niches, each of which can be linked to a certain body size. Reduction in size and alteration of habitats may have contributed to the extinction of these giants. The decrease in size may have been caused by human activities, but also by climate change. .

TO SEE:

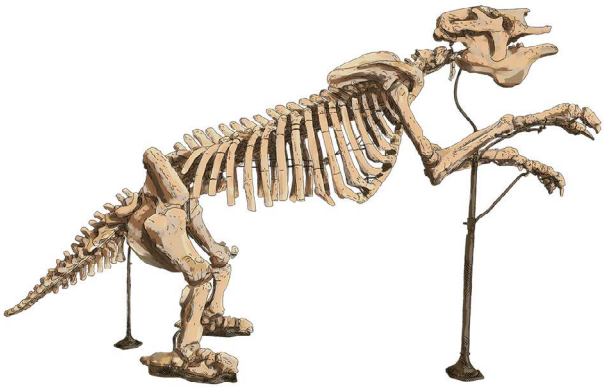
Megatherium americanum
Skeleton, cast
South America

TO DO:

Find the 5 paw prints with the brush. Which is from *Megatherium*? Which direction did it go?



LENGTH: ***6 meters***
WEIGHT: ***4 tons***



6· SABER-TOOTHED CAT
Smilodon populator

Saber-toothed cats were found all over the world, except for Australia and the polar regions. The most famous and largest of all was *Smilodon populator* from South America. With fangs measuring 11 inches (28 cm) long, it was an apex predator, hunting horses, sloths, camels, bison, and ratites in open grasslands. *Smilodon* lived between about 1 million and 10,000 years ago.

In addition to complete skeletons and footprints, many *Smilodon* bones have also been found in tar pits (e.g. La Brea in Los Angeles). When comparing them among each other and modern felines, scientists concluded that *Smilodon populator* was the largest. The finds in these deposits also provided a lot of information about its behaviour and life history: it took care of sick peers, and the mothers took care of their young for a long time.

Their fangs may look impressive, but they turn out to be very fragile. Especially if pressure is applied to the side of the teeth. This means they had to bite very carefully to make sure their fangs didn't touch the bones sideways, because then they could break.

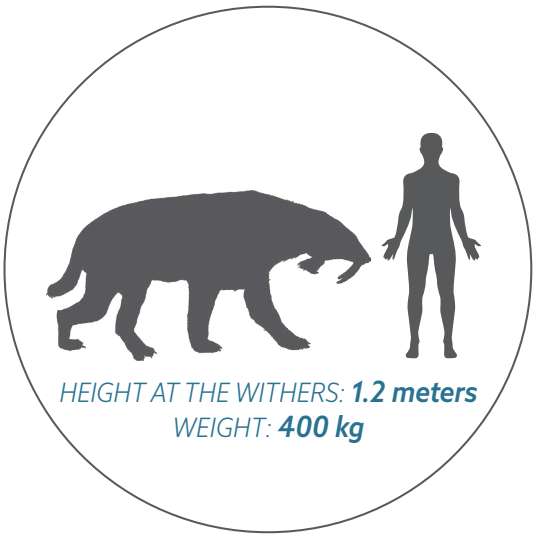
Smilodon populator was even bigger than its predecessor, *Smilodon fatalis*. When *Smilodon fatalis* migrated across the new land bridge from North America to the South, it met the giant sloths. Having a larger and even more robust body was an advantage when hunting. This resulted in an evolutionary arms race between predator and prey. The predator developed traits and behaviours to increase chances of capturing and killing its prey. The prey did the same, but to avoid predation. *Smilodon* and other species of the American megafauna all went extinct eventually. Life became increasingly difficult for the saber-toothed cats: their prey, the large herbivores, disappeared as their habitat changed. The climate became warmer and, moreover, man became a direct competitor.

TO SEE:

Smilodon populator
Skeleton, cast
Uruguay, South America

TO DO:

Flip through the book and look at the different clues. Which theory best fits *Smilodon*? Did it live in group or alone?



7· GIANT APE
Gigantopithecus blacki

This ape is known only from very fragmentary remains, mainly teeth and a piece of lower jaw, the size of which suggests that it was the largest primate that ever existed. Nonetheless, three species have been described: *Gigantopithecus blacki* (the largest), *G. bilaspuriensis* and *G. giganteus*. Contrary to its name, *G. giganteus* was the smallest. Fossils of Gigantopithecus have been found in Asia, especially in China and Vietnam.

G. blacki lived in the Pleistocene, from around 2 million to 300,000 years ago, perhaps even 100,000 years ago.

The males of *G. blacki* reached a height of 3.7 meters and a weight of more than 400 kilograms.

The first discovery of *Gigantopithecus* happened in 1935 by paleoanthropologist Ralph von Koenigswald, who bought a molar (sold as «dragon's tooth») from a pharmacist in Hong Kong, which was to be ground into a medicine. From this one remnant he described the genus. More than one thousand other teeth were subsequently found in such stores, as well as in caves in Vietnam, and China.

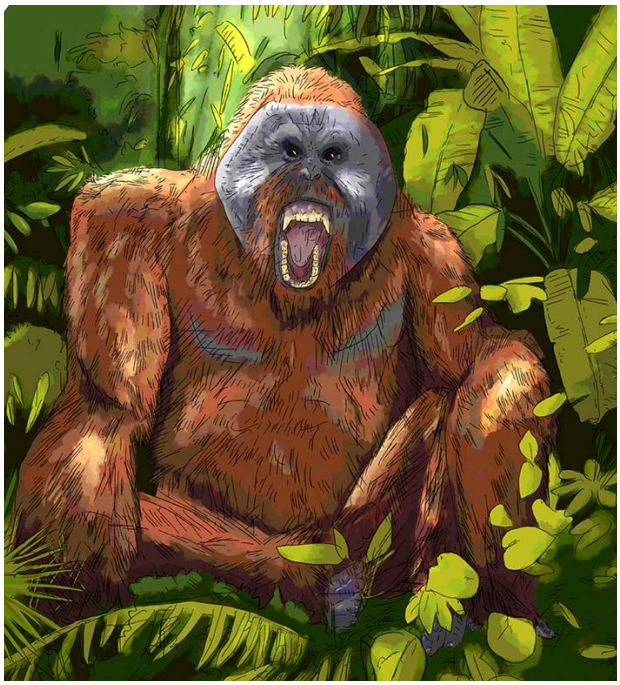
Gigantopithecus fed on fruits, seeds andleaves, as evidenced by the examination of its dentition. Its teeth and jaws are typical for a diet rich in tough plant fibers that require prolonged chewing before swallowing. Its large molars are covered with a thick layer of enamel, with a very worn surface. The fangs are large and not particularly sharp, unlike those of modern apes. The incisors are small and dome shaped.

Gigantopithecus probably walked on all fours, like gorillas, with the front phalanges resting on the ground (knuckle gait). Given its size, it was probably a terrestrial and not an arboreal ape. *Gigantopithecus* is a cousin of the orangutan. We know this from the DNA analysis of a two-million-year-old molar.

The fact that *Gigantopithecus* grew so large may have to do with reproduction and sexual selection. Large individuals are more attractive mates than smaller individuals of the same species. They can more easily defend their young from predators and chase off other animals in the fight for food. Scientists based this reasoning on the jaws and teeth of males and females, which show the same ratio of size differences as gorillas.

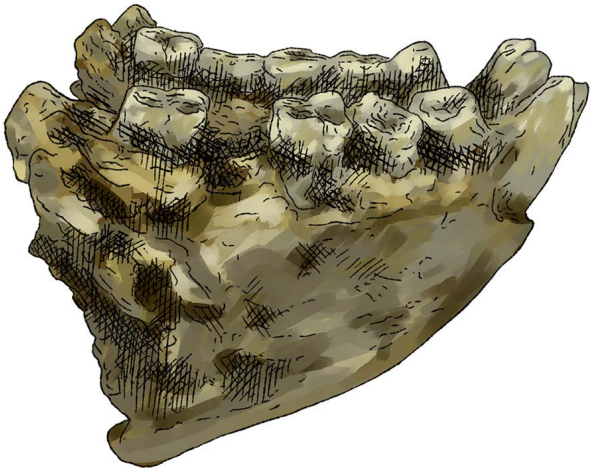
Gigantopithecus probably lived in a harem structure: a number of females were protected by a strong male. His genes were passed on to the next generation until a bigger, stronger male took over. If the larger male continued to reproduce, the offspring also grew larger.
Unlike its cousin the orangutan, *Gigantopithecus* needed a lot of food for energy. When the ice ages turned many forests into grassy landscapes, this giant ape could no longer find enough food and eventually became extinct.

HEIGHT: ***1.8 to 3.7meters***
WEIGHT: ***400 kg***



TO SEE:

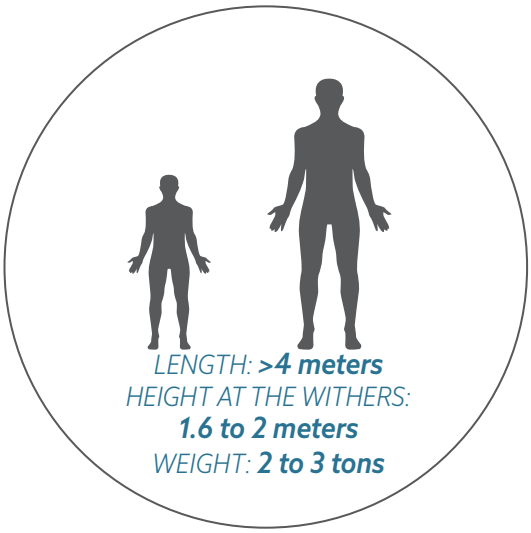
Gigantopithecus blacki
Lower jawbone, 3D print
Liucheng, China
© Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China



TO DO:

One tooth belongs to Gigantopithecus. Can you identify which one? Tip: imagine what your own molars look like.

8· WOOLLY RHINO
Coelodonta antiquitatis



The Rhinocerotidae family appeared in Eurasia about 30 million years ago. The oldest traces of woolly rhinoceroses in Europe date back to 200,000 - 14,000 years ago. It was the last representative of the Rhinocerotidae in Western Europe and one of the largest mammals of the European Paleolithic, after the woolly mammoth. It occurred throughout Eurasia but was never found on the American continent. The woolly rhinoceros has also been found mummified in the frozen ground (permafrost) of Siberia.

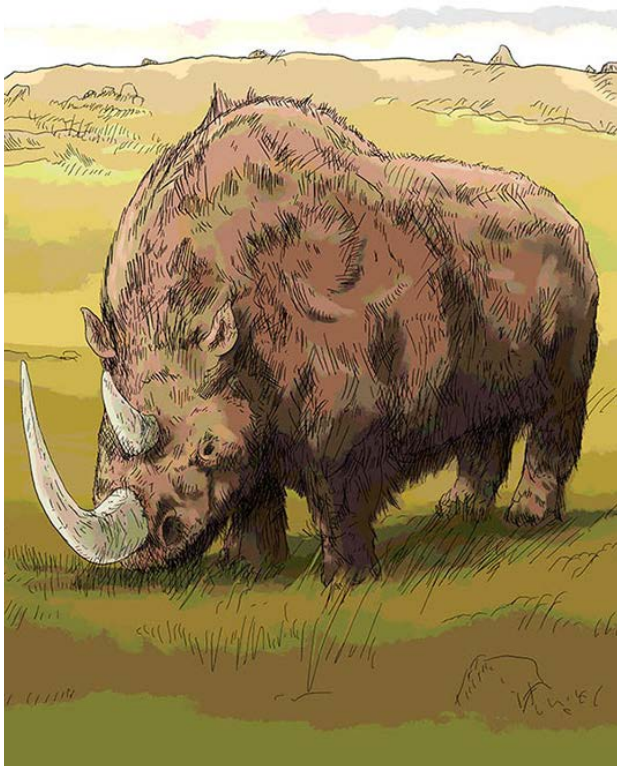
Like the mammoth, it was adapted to the cold, arid steppes of the Pleistocene. It was also a mega-herbivore requiring large amounts of grasses to feed on. Its hypsodont dentition (teeth with a high crown and long or constant growth) was in fact perfectly adapted to the consumption of plants with a high fibre and silicon content, such as those found widespread on the mammoth steppes of the time.

Although its size (between 1.6 and 2 m at the withers and 4 m in length) did not make it seem particularly large, it was very robust and could weigh more than 2 tons.

Its thick skin, large woolly fur (tan to blond with a dark brown mane), and a fold of skin covering his anus were all features that aided his thermal insulation. It also had a reserve of fat above the spine, which enabled it to cope with climatic hazards or nutritional deficits.

Its skull, massive and carried rather low (it eats short grass), was equipped with two horns, a small one, the rear one, averaging 90 cm long, and a large one, in the front, about 1.30 m long. Among other things, these horns were mostly used to clear the snow or to impress females.

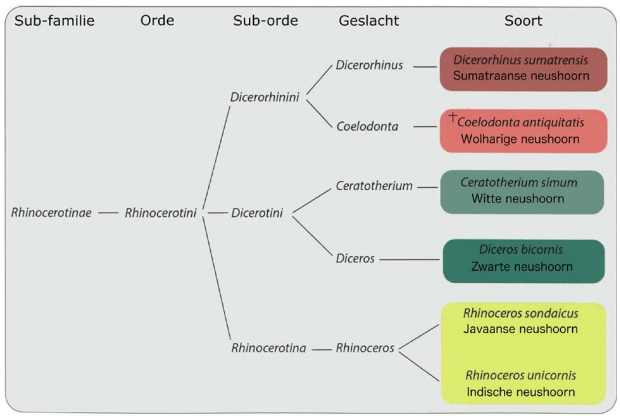
Despite its imposing character, it was hunted by a variety of predators, including the cave hyena and certain hominin human species in the Middle and Upper Pleistocene. Analysis of plaque on the teeth of Neanderthals from Spy, Belgium, confirmed that the woolly rhinoceros Woolly Rhinoceros was one of their prey items.
From 30,000 years ago, the woolly rhinoceros became increasingly rare in Western Europe. The last known specimens date back to 14,000 years ago and were found in Eastern Siberia.



The exact causes of this disappearance are difficult to determine. As with the woolly mammoth, a combination of several factors must be considered. Hunting does not seem to have had a major influence on its disappearance. The warming of the climate and the resulting decline in biomass are likely to have accelerated the demographic fragmentation of rhinoceros populations and their retreat to the east of the continent.
Several representatives of the Rhinocerotidae family still exist today, divided into 4 different genera and 5 species: 2 African and 3 Asian species. The woolly rhinoceros was closely related to the Sumatran rhinoceros, which is also covered in hair.

TO SEE:

Coelodonta antiquitatis
Complete skeleton, original (horns, casts)
Siberia, Russia
© King Baudouin Foundation



Simplified phylogeny of present-day rhinocerotines and position of the Woolly Rhinoceros.
In: Pierre Cattelain, et al, Disparus? Les mammifères au temps Editions du Cedarc, 2018.

9· CAVE LION
Panthera spelaea

The last Ice Age also saw many carnivores. Lions, hyenas, wolves, lynxes, foxes and wolverines lived in and around the mammoth steppes.

Panthera spelaea resembles today's lions, but it was larger and probably lacked a mane. It had a massive, powerful body, a broad head with a short muzzle, small, rounded ears, thick fur and a long tail. This information is gathered among other things from fossil remains, but also from the graphic evidence left by Paleolithic humans.

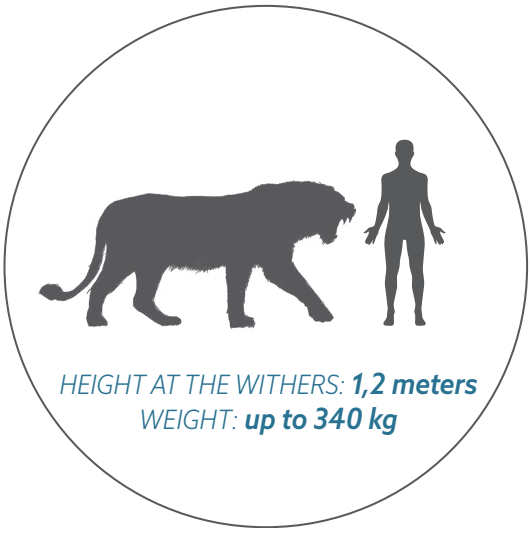
Genetic research has meanwhile led to the definitive conclusion that *Panthera spelaea* represents a separate species. The cave lion is genetically closer to current African and Asian lion species than to the other big cats (tigers, panthers, jaguars), but its DNA shows a significant percentage of differences from current lions. So, it is indeed an extinct species, to be distinguished from the modern lion, *Panthera leo*.

Contrary to what its name suggests, cave lions lived in open environments in temperate or cold temperate regions. Its main prey were horses, reindeer, aurochs and bison, as well as young mammoths and woolly rhinoceroses.

The cave lion lived in Western Europe until about 12,000 years ago, but it may have survived longer in the Balkans and Asia.

TO SEE:

Panthera spelaea
Skeleton, original
Cave of Goyet, Belgium
© Royal Belgian Institute of Natural Sciences



10· IRISH ELK
Megaloceros giganteus

Megaloceros, the giant Irish elk is the largest deer that ever existed.

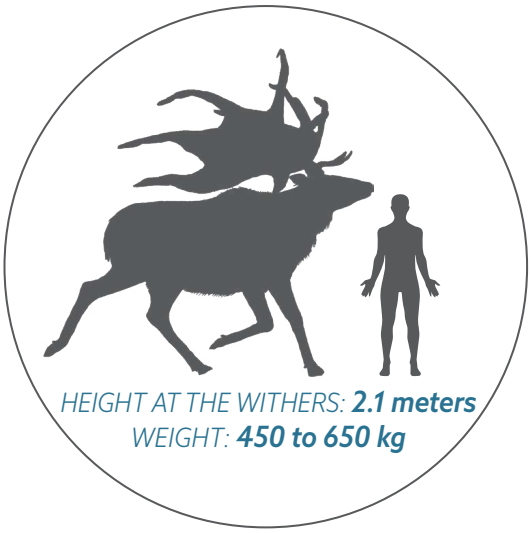
Surprisingly, dwarf species also existed within this genus, for example *Megaloceros algarensis* (Sardinia), *Megaloceros cretensis* (Crete) or *Megaloceros cazioti* (Corsica), but only on islands (see chapter on dwarfism). *Megaloceros giganteus* were particularly abundant during the last ice age, reaching an impressive size during the coldest period.

Abundant remains have been found in Northern Europe and Ireland. The species is best known from a dozen complete specimens found in the bogs of Ireland, hence its nickname «great bog deer».

The Irish elk lived on the edge of forests and on swampy plains. Its huge antlers prevented it from moving into dense forests. The male was, on average, 1.60 m in height, but specimens reaching up to 2.10 m have been found. They had gigantic, widely branched and laterally spreading antlers with a span of up to 3 m. With such antlers, they were visible from afar and could impress the females as well as rivals. Irish elk also had a massive body (650 kg for the males), a long neck, a very prominent withers (large dorsal hump), long legs and large feet. It fed on grasses, herbs, leaves, twigs and branches.

Although humans lived alongside the Irish elk in the Paleolithic era, they rarely hunted, ate or exploited it, unlike other deer such as the reindeer.

The Irish elk disappeared in our region between 11,000 and 9,000 years ago and continued to thrive in Siberia where it finally disappeared around 7,000 years ago.



TO SEE:

Megaloceros giganteus
Skeleton, original
Ireland

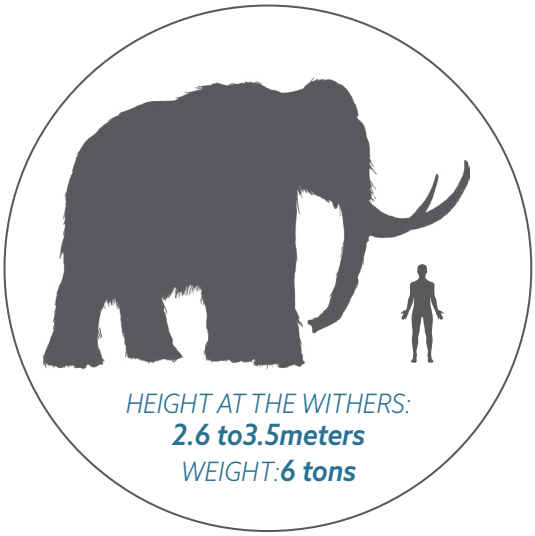
11· WOOLLY MAMMOTH
Mammuthus primigenius

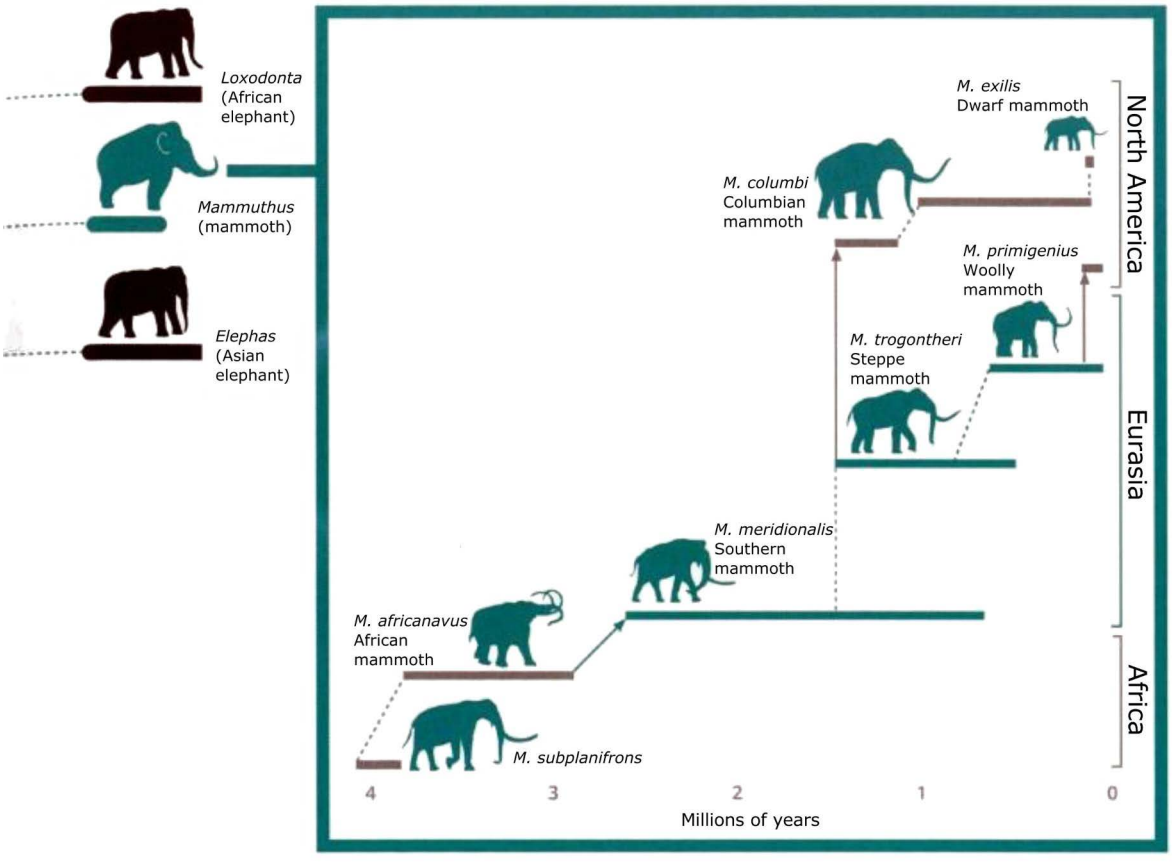
The woolly mammoth is an iconic animal of prehistoric times and one of the most impressive terrestrial animals ever seen by humans. The woolly mammoth was one of the last mammoth species to roam our planet. The species name, *primigenius*, which means «first of its kind», is therefore a bit unfortunate.

Contrary to popular belief, mammoths are not the ancestors of today's elephants. Mammoths, Asian and African elephants share a common ancestor and have been contemporary lineages for the last 5 million years.

Today the order of the proboscideans or trunk-bearing animals consists only of the Asian and the African elephants, whose appearance is very similar. Through the Tertiary period this group was much more diverse. Since the origin of the proboscis about 55 million years ago, more than one hundred (fossil) species have been named.

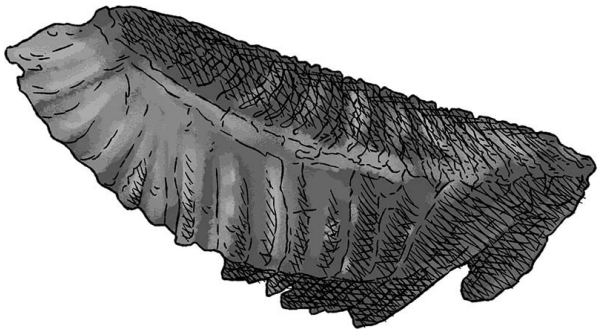
In fact, the woolly mammoth species was also the smallest species, rarely exceeding 3.5 m, while the Southern and Steppe mammoths could grow up to 4.5 m.





Un temps de mammouth, portrait d'un géant disparu, Plume de carotte, 2020.

The woolly mammoth was well adapted to its environment. It had a thick skin, a layer of fat of around 10 cm thickness and a coat of hair consisting of three different layers (down, filling and jug). The ears were very small, and it had an anal flap (a fold of skin covering his anus). All these adaptations allowed it to keep its body warm and insulate it from wind, cold and humidity.



Its long, double-curved tusks grew continuously and could reach up to 4 m in length.

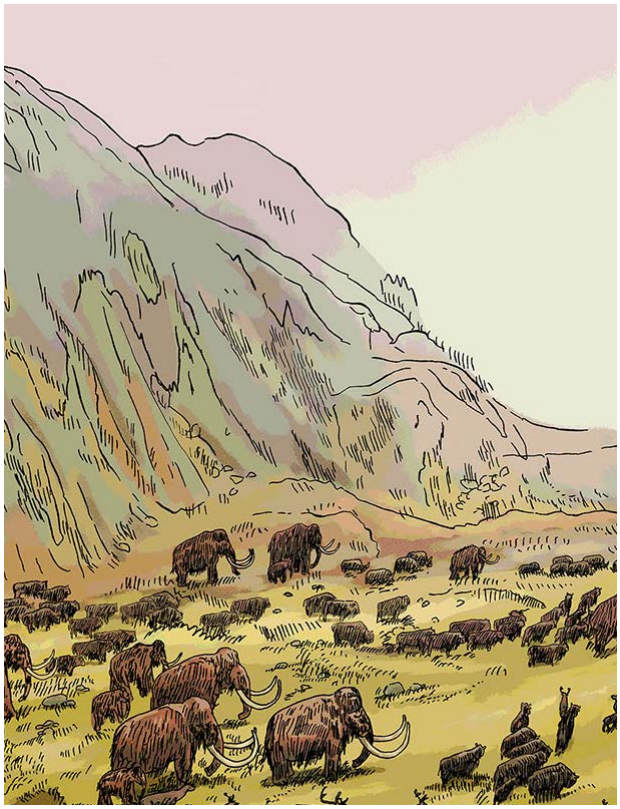
Mammoths were also born with deciduous premolars, which were gradually replaced twice by new deciduous premolars and then by permanent molars. Throughout the Mammoth's Life, these teeth were renewed a maximum of six times during the mammoth's life, and when the last teeth were completely worn out, it died of starvation.

A study of the stomach contents of some frozen mammoths confirms that the young were suckled for more than two years.

The woolly mammoth was adapted to a harsh climate and a special environment, with no equivalent today, called the «mammoth steppe». This was, a vast plain consisting mainly of grasses but with some patches of forest consisting of conifers and birches.
The very last mammoths (which were quite small by the way) survived on the island of Wrangel in the Arctic Ocean before going completely extinct 4,000 years ago.

The causes of this disappearance are in fact multiple. It would be far too simplistic to see it as the result of climate change or human hunting alone.

Ecologically, the woolly mammoth was highly specialized and closely associated with its environment. Its strict diet (grasses and herbs) made it dependent on the mammoth steppe habitat that dominated Eurasia in the Pleistocene. However, after the last glacial maximum 20,000 years ago, the climate started to change. It got warmer and wetter, and the flora changed. The xeric species (those living in an arid environment) typical of this steppe became rarer. They were replaced by deciduous forests in the south, and coniferous forests in the north, creating the Siberian taiga. Even further north, the humidity and cold caused the expansion of what is now the tundra. The woolly mammoth could not survive in this environment, because the plant biomass mainly consisted of mosses and lichens. Caught between the expansion of the forest and tundra, the mammoths saw increased competition for steppe resources. With their need for 200 kg of food per day, the mammoths quickly fell into this ecological trap. This means it is likely that global warming is the main cause of the disappearance of these species.



Nonetheless, the importance of humans in the disappearance of the mammoth (and other large animals of this period) is still under debate. To determine the extent to which our hunting activities may have influenced the disappearance of these Quaternary species, it is necessary to determine whether there is a relationship between the demographic collapse of the extinct species and the density of archaeological sites intersecting the ecological niche of these species. The results show that there is no rule, but that the situations differed per species. While hunting as such does not fully explain the mammoth's disappearance, it played an important role in accelerating the process. The disappearance of the mammoth symbolizes the animals that have disappeared due to climate change and hunting, reminding us of the decline of biodiversity today and of the responsibility of humans for these disappearances. Unfortunately, the mammoth's cousins, the Asian and African elephants, are threatened in a similar fashion today.

Did you know that giant animals also lived in Belgium? For example, the woolly mammoth lived in our regions during the last ice age, about 120,000 to 12,000 years ago. These bones were found in Hofstade, near Mechelen, but remains have also been found in many other places in Belgium, such as in Spy, Goyet, Warneton, Dendermonde, Lier and Hoboken. A complete mounted skeleton can be admired in the Gallery '250 years of Natural Sciences'.

TO SEE:

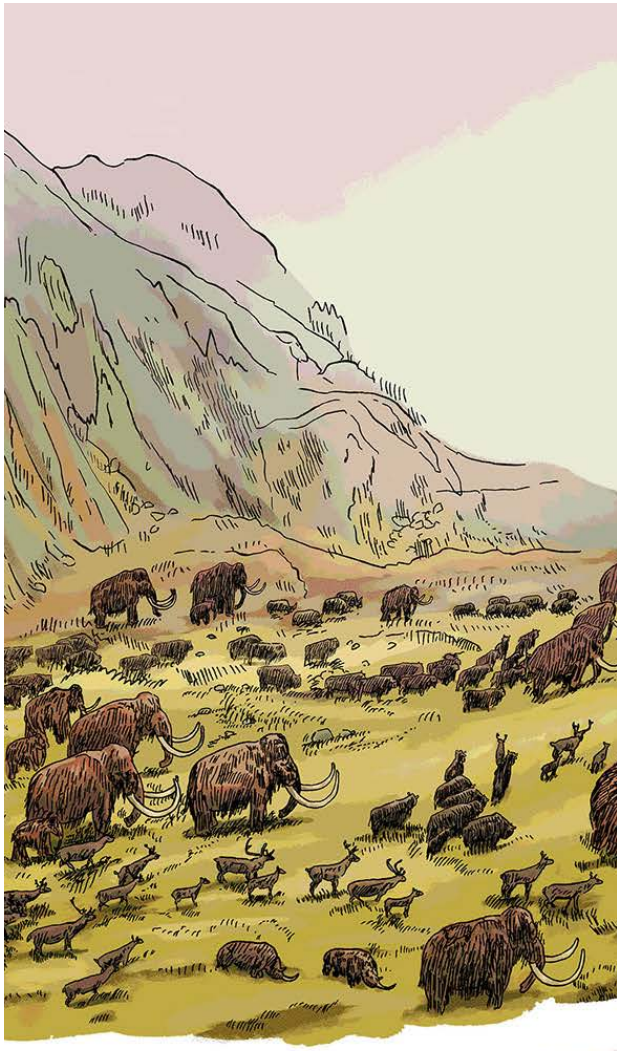
Mammuthus primigenius
· Humerus, original
· Radius, original
· Ulna, original
· Foot, mirrored 3D print
Hofstade, Belgium
© Royal Belgian Institute of Natural Sciences

Mammuthus primigenius
· Femur, 3D mirror print
· Tibia, original
· Foot, mirrored 3D print
Hofstade, Belgium
© Royal Belgian Institute of Natural Sciences

Mammuthus primigenius
Molar, original
Yakutia Region, Russia
© Royal Belgian Institute of Natural Sciences

TO DO:

Game: reconstruct the Ice Age fauna



A BRIEF NOTE ON PALAEOGENOMICS

Since the 2000s, palaeogenomics has made tremendous progress. While it is still not possible to obtain DNA from animals as old as the Mesozoic dinosaurs, the same cannot be said for Cenozoic animals.

In 2008, scientists succeeded in sequencing the entire genome of the woolly mammoth. This made it the first extinct animal whose entire genome had been reconstructed. This reconciled palaeogeneticists with their palaeontological colleagues: full genome analysis shows that the Asian elephant is a close relative of the woolly mammoth, in line with palaeontological hypotheses.

Thanks to these analyses, we know much more about the origin of the mammoth, its physiology, its diet, and potential causes of its extinction.

Palaeogenomics also confirmed the coexistence of several mammoth species, which had already been suggested by fossil finds. Paleogenomic work on the remains of M*ammuthus columbi* has shown that they interbred with woolly mammoths as they joined them in the Americas. In Eurasia, ancient genomics of woolly mammoths also indicate interbreeding with the southern mammoth and the steppe mammoth. Interestingly, these results are reminiscent of what happened in the human lineage, where modern humans, Neanderthals, and Denisovans mixed in Eurasia in the Pleistocene.

Palaeogenomics has also provided information on mammoth haemoglobin. This molecule, which carries oxygen from the blood to the organs, requires a relatively high body temperature to function. In the woolly mammoth, the sequence of a gene responsible for this molecule shows mutations that distinguishes them from other mammals. The mammoth's haemoglobin could thus have continued to function at much lower temperatures. This adaptation would have been a great benefit as the soles of mammoths came in direct contact with the frozen ground, whereas other herbivores at least had hooves to protect them from the cold.

Paleogenomics also helps clarify how the woolly mammoth went extinct. Indeed, the genetic diversity of individuals is influenced by demographic changes in populations. Analysis of the genomes of the last representatives of the mammoths on Wrangel Island confirms that this was a very small population with major genetic abnormalities (particularly in development) due to a very strong influence of inbreeding. Paleogenomics shows that this collapse in mammoth genetic diversity was very rapid starting from the last glacial maximum. Rapid climate change at the end of the Pleistocene prevented the mammoths from adapting to the new environmental conditions.

For the disappearance of the cave bear, palaeogenomics allows us to come up with another hypothesis. While brown bear demography has remained stable for the last 100,000 years, so does the cave bear's until it starts to decline around between 50,000 and 40,000 years ago. This was the time when our ancestors spread across Europe. The cave bears' decline continued until the species' final extinction some 25,000 years ago. It's hard to blame the climate for this decline (there was no major climate change at the time), just as it's hard to blame humans (why only hunt the cave bear and not the brown bear?).

Cave bear remains found in the same cave show surprising genetic relationships: they often carry the same mitochondrial DNA. Brown bears, on the other hand, show a mixture of mitochondrial sequences within the same locality. It turns out that related cave bears all hibernated in the same cave, a practice known as «homing.» This behaviour offers an unexpected explanation for their extinction. With the arrival of humans in the region, competition for access to caves may have increased, as it was not uncommon for humans to seek refuge and protection in caves. Brown bears, not limited to the choice of a particular cave, would always have found shelter somewhere. But cave bears would have had a harder time responding and finding a new home. So, more than hunting or climate, competition for resting places, coupled with this particular hibernation behaviour, may have been the cause of the cave bear's disappearance. It is also certain that these brown and cave bears interbred. About 1 to 2% of the cave bear genome is still found in Eurasian brown bear populations, in those areas where the two species once lived together. This again reminds us of the situation between modern humans and Neanderthals in the Pleistocene.

In addition to DNA, proteins can also continue to exist and survive us. Mass spectrometer technology has evolved tremendously in recent years. They no longer allow the characterization of single peptides, but of the proteome as a whole, i.e., all proteins present in a biological tissue. With this technology, scientists succeeded in reconstructing the sequence of several peptides from a cousin of the woolly rhinoceros that lived at the Dmanisi site in Georgia. Other scientists even managed to characterize 2-million-year-old peptides from the tooth enamel of Asian Gigantopithecus, which was exposed to the tropical climate of China. The information obtained clarifies that it is related to the orangutan. This could not be confirmed based on morphological tooth characteristics alone.

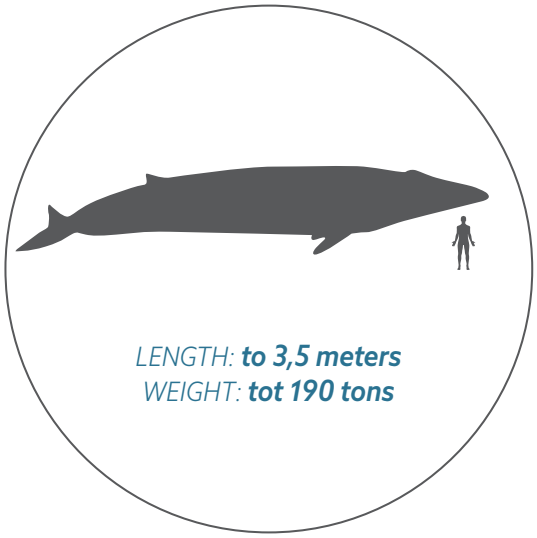
TODAY'S GIANTS

The gigafauna of the past was way bigger than those of today. You had to weigh several tons to become a member, whereas nowadays, 45 kilos is enough for a vertebrate.

Some animals alive today still manage to compete with the ancient species.

1· BLUE WHALE

Balaenoptera musculus



The blue whale has been swimming in our seas and oceans since the Pleistocene. It is the largest mammal living on our planet today, but also the largest that has ever existed. While it was long thought that these baleen whales developed their gigantic size early in their history, recent discoveries suggest otherwise: the baleen whales appeared about 30 million years ago and were between 5 and 9 meters long (about the length of a minke whale today). It was not until 4.5 million years ago that they reached the dimensions we know today. The different types of baleen whales we know today therefore evolved simultaneously and in a very short time.

The sudden diversification of baleen whales coincided with the cooling of the climate and the formation of large ice caps in the northern hemisphere. In the spring and summer, the nutrients trapped in the ice were released into the open water and accumulated near the coast. Transported by currents, plankton gathered in these areas and grew considerably in contact with the nutrient-rich water. From that moment on, the distribution of food in the oceans was turned upside down. Plankton, hitherto scattered across the ocean, began to form seasonal concentrations, sometimes thousands of miles apart.

Faced with this new dynamic, size became a trait under strong selection pressure. Thus, the larger individuals, with more reserves, could travel longer distances and take advantage of these new food supplies. The smaller ones, on the other hand, gradually disappeared, giving way to the age of giants.

Today, whales swim through the oceans and regularly migrate from cold waters, where they feed, to warmer waters, where they give birth. They can swim at different depths depending on their activities and habitat. However, they usually swim in surface water or at shallow depths.

During migration, the blue whale follows surface currents and usually swims in upper, shallow waters. When diving for food however, it can reach depths of 500 meters or more.

It is characterized by its slim body, U-shaped head and grooves in the neck. It has a huge mouth that can be up to six meters long. The mouth contains baleen plates, flexible comb-shaped plates of keratin that filter food from water.

They are also known for producing complex and melodic sounds that can be heard from miles away.

Before the early 1900s, numbers of blue whales were particularly high, but their numbers have plummeted since being hunted for nearly a century. The number of specimens, protected by the international community since 1966, is now estimated at 5,000 to 15,000. However, according to IUCN reports, the species is still endangered.

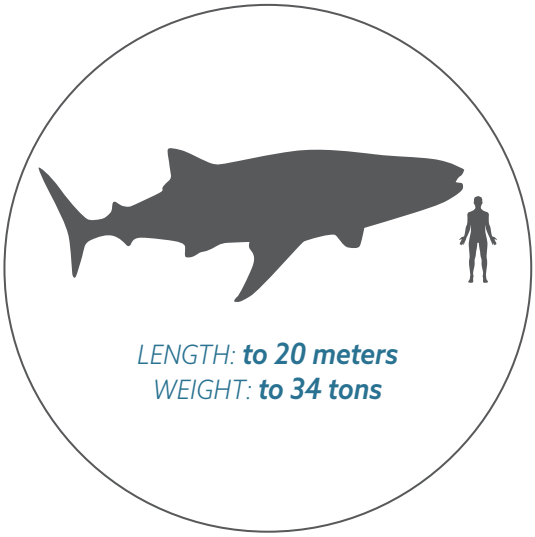
2· WHALE SHARK
Rhincodon typus

The whale shark was discovered in 1828 by scientist Andrew Smith and has long lived in our oceans and temperate seas. Whale shark teeth have been found that are about 15 to 20 million years old. This means that the species could have lived alongside another giant of the sea, the megalodon. Except for some whale species, this is the largest animal currently living on our planet.

The whale shark is a cartilaginous fish (chondrichthyan) that can easily reach 10 meters and sometimes even 20 meters in length when fully grown. It has a unique and easily recognizable appearance with a characteristic skin pattern resembling leopard spots. Like all sharks, its skin feels rough due to the presence of tiny dermal denticles. The whale shark's head is broad and flat, with a huge mouth that can grow over 5 feet (1.5 m) wide. The mouth is filled with numerous rows of small teeth, which are useless for feeding, because the whale shark filters more than 2,000 tons of water per hour through special gills that allow it to catch plankton and small crustaceans.

The whale shark is known as a pelagic species, which means that it lives off the coast in deep waters. However, in search of food, it surfaces during the day or visits coral reefs rich in biodiversity. It is mainly found in tropical to temperate seas and oceans, where the global temperature exceeds 20 degrees Celsius. 75% of its populations are in the Indian Ocean. It can live up to 150 years.

Although the whale shark has virtually no natural predators in its environment, pollution and overfishing are the main threats to the whale shark today.



LENGTH: ***to 20 meters***
WEIGHT: ***to 34 tons***

3· AFRICAN BUSH ELEPHANT
Loxodonta africana

The African bush elephant is the largest living land animal and the largest of today's elephants. It can be recognized by its long front legs and its large ears, with which it can regulate body temperature. Other impressive features include its ever-growing tusks (in both males and females), its wrinkled skin that helps retain moisture, and of course its long flexible trunk.

Like the forest elephant, the Asian elephant and the extinct mammoths, the African bush elephant belongs to the family Elephantidae and the order of the proboscideans. It is estimated that there have been about 352 species of proboscidean in the course of evolution. Creatures of this order have inhabited all continents except Australia and Antarctica. They are all extinct except for the two species of African elephants and the Asian elephant.

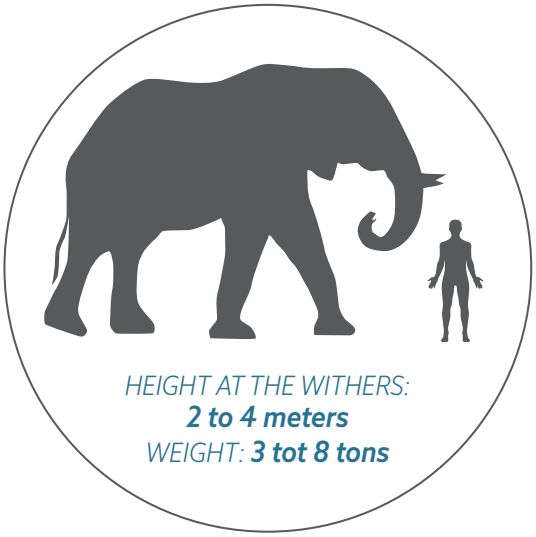
African elephants appeared around 1.5 million years ago. They are evolutionarily the «newest» elephant species and differ from the Asian elephant in that they are larger and have tusks in both males and females.

African elephants are herbivores and feed on a variety of plants, including grasses, shrubs and tree leaves.

They live in social groups called herds, which are led by a dominant female, the matriarch. Elephants are known for their strong social cohesion, empathy, and intelligence.

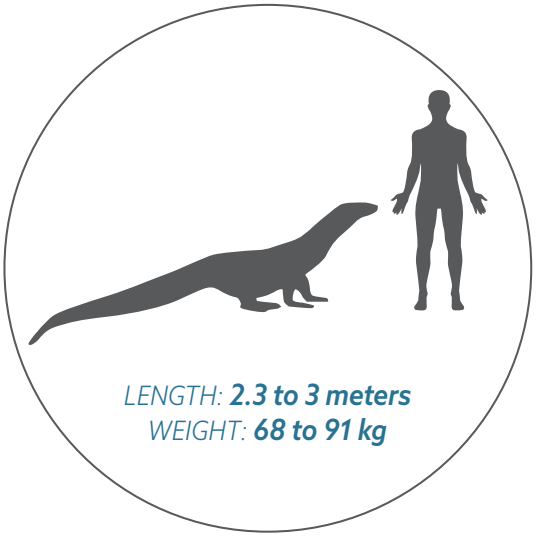
The bush elephant is the most widespread species and is mainly found on the grassy plains and savannas of East, South and West Africa. The largest populations are found in national parks and nature reserves, although bush elephants can also be found outside these protected areas. The forest elephant (Loxodonta cyclotis) is smaller than the savanna elephant and is mainly found in the dense forests of Central and West Africa, although populations also exist in parts of East Africa.

As of March 2021, African elephants are classified as critically endangered due to habitat loss, ivory hunting, and other threats such as conflict with human populations.



HEIGHT AT THE WITHERS:
2 to 4 meters
WEIGHT: ***3 tot 8 tons***

4· KOMODO DRAGON
Varanus komodoensis



The Komodo dragon can only be found in Indonesia, on the islands of Komodo, Rinca, Gili Motang, Gili Dasami and Flores. The Komodo dragon is not a small lizard, on the contrary, this reptile belonging to the monitor lizard family is the largest land lizard in the world. It can grow more than 3 meters in length and weigh more than 100 kg.

The evolution of the Komodo dragon dates back to the appearance of the first monitor lizards in Asia about 40 million years ago, who migrated to Australia. About 15 million years ago, a collision between Australia and Southeast Asia allowed these lizards to move to what is now the Indonesian archipelago. The Komodo dragon is said to have originated 4 million years ago, distinguishing itself from its Australian ancestors and expanding its range to the island of Timor. A large drop in sea level during the last ice age exposed large areas of the continental shelf that the Komodo dragon colonized, then became isolated on these islands as sea levels slowly rose again.

The Komodo dragon is primarily terrestrial, inhabiting the dry forests, grasslands, and tropical savannas of these islands. These animals need a warm, dry environment to survive, with daytime temperatures of up to 35°C.

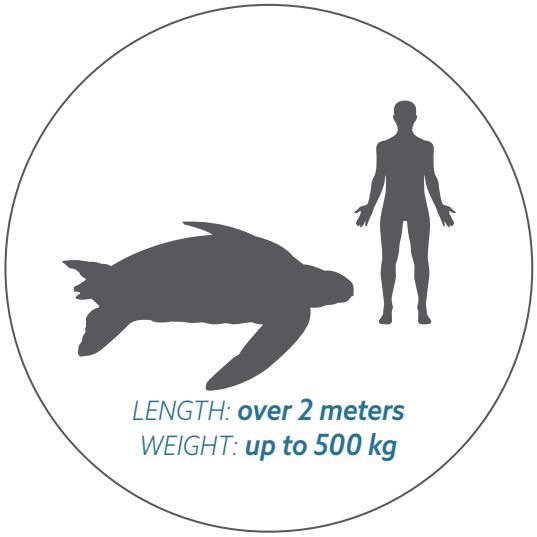
With its large jaws, the Komodo dragon attacks its prey by surprise, usually biting them in the stomach or throat. Then he leaves them to die of deep wounds. Furthermore, the bacteria in its saliva infect the blood of its victims, and its venom, secreted by the venom glands under the gums, prevents the blood of the victim from clotting.

The Komodo dragon is a solitary animal that is active during the day. When night falls, it usually shelters in its den. Although they are excellent swimmers, Komodo dragons generally stay in one place for a relatively long time.

Although male Komodo dragons need females to reproduce, the females can reproduce without males. They do parthenogenesis (asexual reproduction) and can therefore reproduce on their own, but in that case, they only get male offspring.

Komodo dragons are classified as vulnerable by the International Union for Conservation of Nature (IUCN), due to habitat destruction and illegal hunting.

5· LEATHERBACK TURTLE
Dermochelys coriacea



With a length of up to two meters and a weight of over 500 kilos, the leatherback turtle is a true giant of the oceans. It is the largest of the seven current species of sea turtles and the largest of turtles in general.

It has the particularity of not having a bony carapace like the other marine turtles. Its shell is made up of a thin skin covering a thick layer of fat, giving it the appearance of leather. This unique carapace, devoid of bony plates, allows it to dive deeply in search of food (to more than 1000 meters).

It is the only contemporary representative of its family (Dermochelyidae, turtles with armored backs). It is the sea turtle with the best hydrodynamics due to its shape and its ability to swim extremely fast (peaks recorded at nearly 40 km/h).

The leatherback turtle is also known for its massive, elongated head. Its powerful jaw allows it to feed on jellyfish and cephalopods, its main food source. Thanks to its specialized diet, the leatherback plays a crucial role in regulating jellyfish populations, helping to maintain the balance of marine ecosystems.

In addition to its imposing size, the leatherback turtle is famous for its incredible migratory abilities. They can travel thousands of kilometers across the oceans to reach nesting sites, often returning to the beaches where they were born.

Unfortunately, the leatherback turtle is an endangered species. Threats such as marine pollution, habitat loss, accidental capture in fishing nets and illegal hunting for its meat, eggs and shell have jeopardized the species' survival. Conservation efforts are underway around the world to protect and preserve the leatherback turtle, including the creation of marine reserves and public education on the importance of preserving these iconic species and their environment.

The leatherback turtle is a poignant symbol of the richness and fragility of our current marine biodiversity.

AND THE OPPOSITE? DWARFISM

While giantism has often existed in the history of living beings, the reverse has also occurred, and some species have been characterized by their very small size. This is an adaptation to a biogeographical context or, for example, the result of the formation of islands.

Island conditions can have strange effects on animal size. It turns out that large mammals tend to get smaller (this is known as «island dwarfism») and small mammals tend to get bigger.

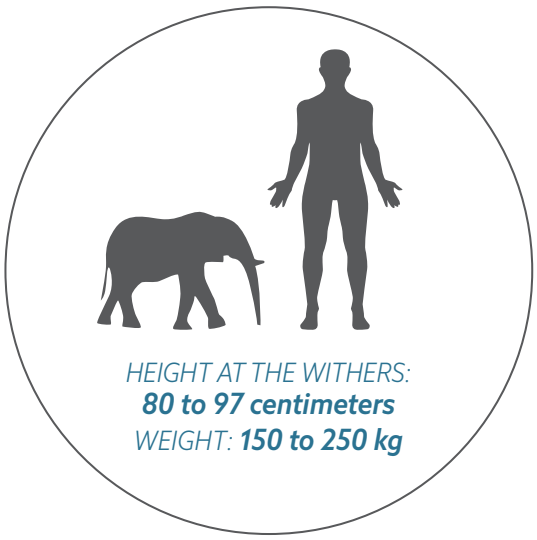
For example, during the Pleistocene on the Mediterranean islands, some elephants and hippos grew small, while some rodents grew larger. The fossil record shows that these changes can occur quite quickly, in some cases within a few thousand years.

Giantism and nanism (also dwarfism) are thus two well-known adaptations on small, isolated islands over very long periods. These two processes can be explained by the absence of predators, so that small species grew large. Species with large mainland ancestors that became dwarfs, can be explained by the fact that large animals cannot survive long in restricted areas without disappearing within a few generations, due to a lack of space and sufficient food sources.

1· SICILIAN DWARF ELEPHANT
Elephas falconeri

More than 12,000 years ago, dwarf elephants lived on most of the Mediterranean islands (Sicily, Malta, Sardinia, Cyprus, Crete, etc.). They would have come from the mainland by swimming or overland during sea level fluctuations. These elephants grew much smaller than the continental species. Some fossils from Sicily and Malta show that the adult animal reached less than 1 meter in height and weighed about 200 kg, while their continental ancestor was more than 3 meters high at the withers.

The Sicilian dwarf elephant is believed to have lived the longest, dating back to ancient history, as evidenced by some hieroglyphics depicting such dwarfs.

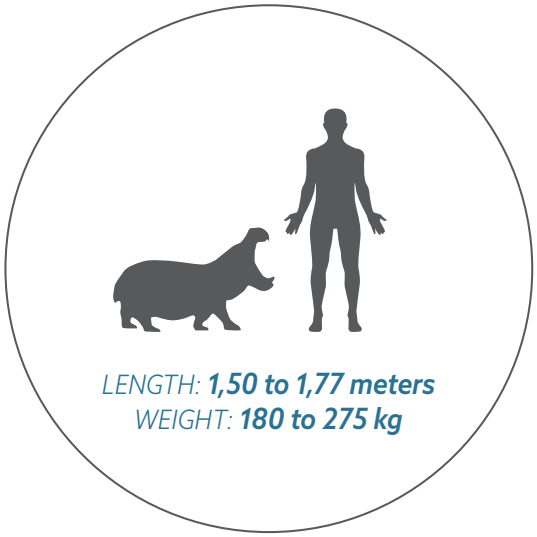


HEIGHT AT THE WITHERS:
80 to 97 centimeters
WEIGHT: ***150 to 250 kg***

2· MALAGASY PYGMY HIPPO
Hippopotamus lemerlei

The pygmy hippopotamus from Madagascar is not the only one of its kind. Other pygmy hippos lived on Mediterranean islands such as Cyprus and Crete and disappeared around 10,000 years ago. The West African pygmy hippopotamus still exists today.

*H. lemerle*i fed on roots and fruits. To avoid any activity during the hot hours of the day, it fed at night. As soon as the sun rose, it returned to the water and mud to cool off in the water and mud. This animal is commonly present in Malagasy stories and legends.



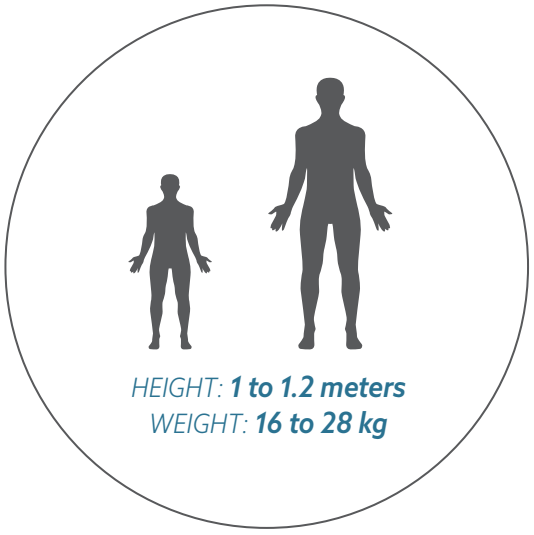
LENGTH: ***1,50 to 1,77 meters***
WEIGHT: ***180 to 275 kg***

3· FLORES MAN
Homo floresiensis

Homo floresiensis, sometimes referred to as «the Hobbit,» is a small hominid human species found in Liang Bua Cave on the island of Flores, Indonesia.

With a length of just over 1 meter and a cranial capacity of about 400 cm3, it probably evolved from an earlier Pleistocene population that arrived on the island. Its peculiar morphology makes it difficult to draw parallels with its closest relatives.

The island of Flores was separated from Australia and Asia for a long time. The isolation over a long period may have led to a «shrinkage» of the island species compared to their mainland relatives.



HEIGHT: ***1 to 1.2 meters***
WEIGHT: ***16 to 28 kg***

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Podcasts

Baleine sous Gravillon (BSG), La gigafaune du passé, 4 épisodes.