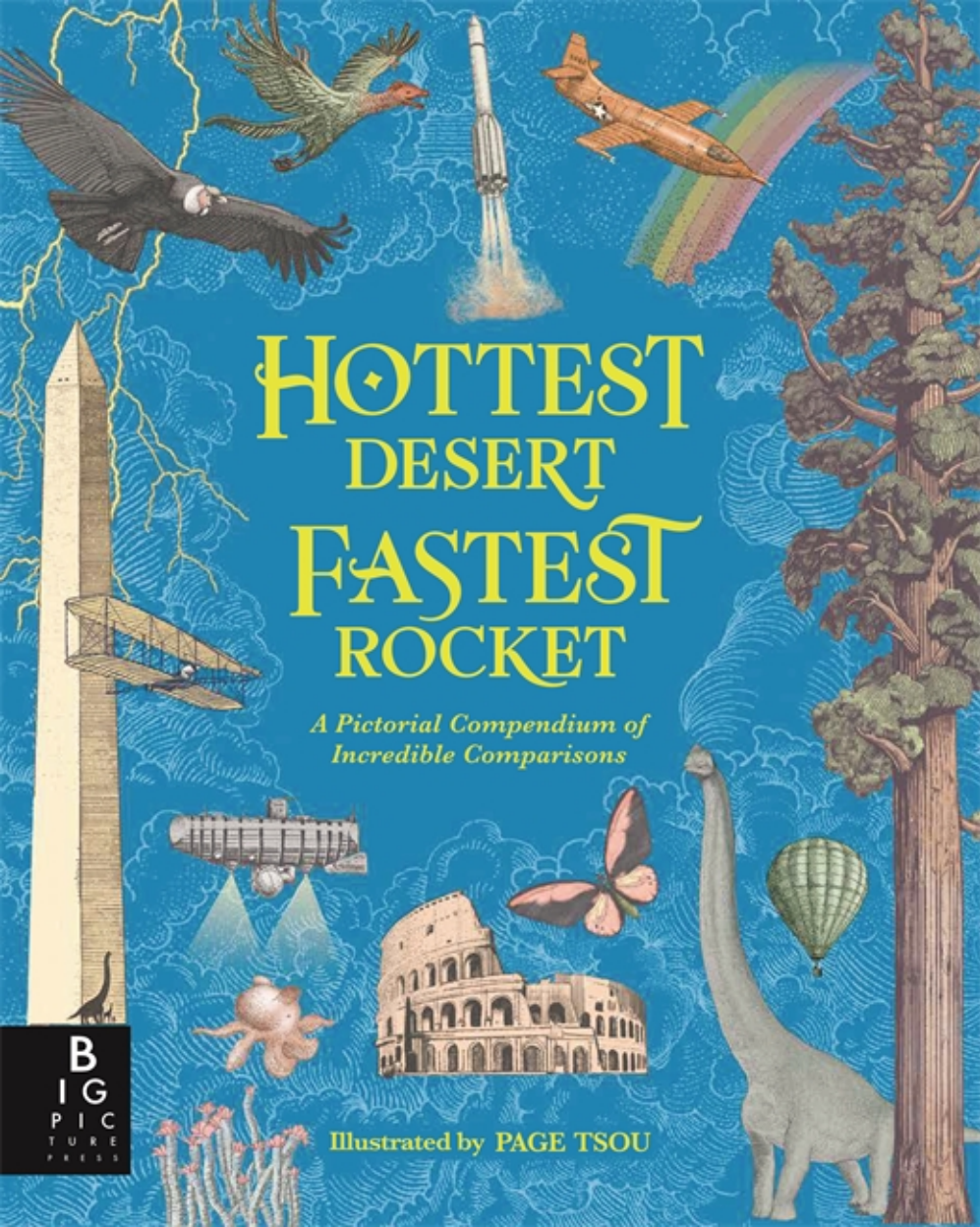

HOTTEST DESERT FASTEST ROCKET
A Pictorial Compendium of Incredible Comparisons
Illustrated by PAGE TSOU
BIG PICTURE PRESS

BIG PICTURE PRESS

This edition published in the UK in 2025 by Big Picture Press,
First published in the UK in 2016 and 2018 by Big Picture Press,
an imprint of Bonnier Books UK
4th Floor, Victoria House
Bloomsbury Square, London WC1B 4DA
Owned by Bonnier Books
Sveavägen 56, Stockholm, Sweden
www.bonnierbooks.co.uk



1 3 5 7 9 10 8 6 4 2



ISBN 978-1-83587-132-4

Designed by Winsome d'Abreu
Written by Kate Baker and Zanna Davidson
Expert consultants: Camilla de la Bedoyere and Dr Jonathan Tennant, Palaeontologist;
Prof. Raman Prinja, Professor of Astrophysics, University College London;
Dr Scott Rusch; and Robert Protheroe-Jones, National Waterfront Museum, Wales

Page 64–65 have been adapted from the Astronomical Society of the Pacific's UAYF,
from an idea popularised by Carl Sagan.

Printed in China

# HOTTEST DESERT FASTEST ROCKET

*A Pictorial Compendium of Incredible Comparisons*

ILLUSTRATED BY **PAGE TSOU**

# Contents

This is a visual feast of a compendium. With each turn of the page, you will marvel at our planet's superlatives – the largest-ever dinosaurs, biggest storms, tallest trees, deepest-dwelling sea creatures, longest insects and other astonishing feats of nature. You'll also discover some of humankind's greatest achievements in science and engineering – the tallest buildings, first automobile, longest trains and fastest aeroplane. Not only that, you'll see the whole history of life on Earth, and the amazing story of the formation of the universe. Packed with surprising comparisons and curious facts, this sumptuous compendium will help you to understand just how heavy, how strong, how small and how tall things really are.

# *Largest Herbivorous & Carnivorous Dinosaurs and Largest Pterosaur*

The biggest animals ever to have walked the Earth, these reptiles were some of the longest, heaviest and most terrifying creatures of all time.

*LARGEST* **HERBIVORES**

1 ***Argentinosaurus huinculensis*** Weight: 80 tonnes • Length: 35 m • Lived: Argentina, 97–94 mya (million years ago). It currently holds the record for being the heaviest land animal ever, and the longest.

2 ***Turiasaurus riodevensis*** Weight: 50 tonnes
Length: 30 m • Lived: Western Europe, 150–140 mya

3 ***Brachiosaurus altithorax*** Weight: 28-47 tonnes
Length: 20-22 m • Lived: North America, 157–145 mya

4 ***Paralititan stromeri*** Weight: 59 tonnes
Length: 25 m • Lived: Egypt, 98–93 mya

5 ***Dreadnoughtus schrani*** Weight: 49 tonnes
Length: 26 m • Lived: Argentina, 84–66 mya

*LARGEST* **CARNIVORES**

6 ***Spinosaurus aegyptiacus*** Weight: 7.4 tonnes
Length: 14 m • Lived: North Africa, 112–97 mya

7 ***Carcharodontosaurus saharicus***
Weight: 9 tonnes • Length: 13 m
Lived: North Africa, 100–94 mya

8 ***Giganotosaurus carolinii*** Weight: 14 tonnes
Length: 13 m • Lived: South America, 99–97 mya

9 ***Tyrannosaurus rex*** Weight: 8 tonnes • Length: 12 m • Lived: North America, 68–66 mya

10 ***Mapusaurus roseae*** Weight: 6 tonnes
Length: 12 m • Lived: South America, 100.5–93 mya

*LARGEST* **PTEROSAUR**

11 ***Quetzalcoatlus northropi*** Weight: 250 kg
Wingspan: 11 m • Lived: North America, 72–66 mya

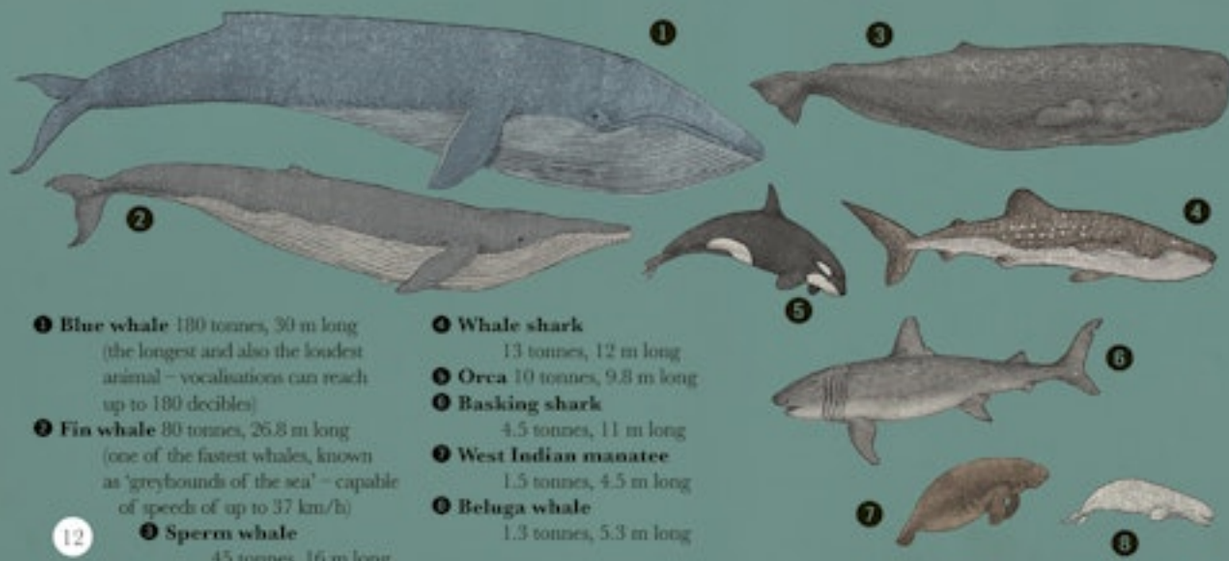
# *Some of the* LARGEST ANIMALS *on land ...*

The majestic blue whale is the largest animal ever to have lived. Its tongue alone weighs as much as an elephant; its heart as much as a small car. On land, the mighty African elephant is the largest animal, while the giraffe is the tallest.

Down in the deepest depths of the ocean, there are species that reach gigantic proportions, from the giant squid that grow large enough to battle sperm whales to the giant isopod, a cousin of the woodlouse, which can grow up to eight times the size of its shallow-water relatives.

*The weight of this motorcycle is equal to one Malayan tapir*

1. **African elephant** 6,300 kg, 4 m tall
2. **Common hippopotamus** 3,600 kg, 4.6 m long
3. **Saltwater crocodile** 770 kg, 4.5 m long
4. **Shire horse** 1,000 kg, 1.8 m tall
5. **White rhinoceros** 3,600 kg, 4.2 m long
6. **Grevy's zebra** 450 kg, 1.5 m tall
7. **Eurasian moose** 700 kg, 2 m tall
8. **Elephant seal** 4,000 kg, 6 m long
9. **Masai giraffe** 1,300 kg, 5.5 m tall
10. **Water buffalo** 1,200 kg, 2.7 m long
11. **American bison** 1,000 kg, 3.5 m long
12. **Bactrian camel** 690 kg, 2.1 m tall
13. **Siberian tiger** 200 kg, 3 m long
14. **Polar bear** 800 kg, 2.5 m long
15. **Malayan tapir** 500 kg, 1.2 m tall
16. **Brown bear** 600 kg, 3 m long
17. **Eastern lowland gorilla** 200 kg, 1.9 m tall



1. **Blue whale** 180 tonnes, 30 m long (the longest and also the loudest animal – vocalisations can reach up to 180 decibles)
2. **Fin whale** 80 tonnes, 26.8 m long (one of the fastest whales, known as 'greyhounds of the sea' – capable of speeds of up to 37 km/h)
3. **Sperm whale** 45 tonnes, 16 m long
4. **Whale shark** 13 tonnes, 12 m long
5. **Orca** 10 tonnes, 9.8 m long
6. **Basking shark** 4.5 tonnes, 11 m long
7. **West Indian manatee** 1.5 tonnes, 4.5 m long
8. **Beluga whale** 1.3 tonnes, 5.3 m long

## *... and at sea*

9. **Lion's mane jellyfish** 1 tonne, 30 m long, 2.3 m body diameter
10. **Giant squid** 900 kg, 16.8 m long
11. **Giant manta ray** 3 tonnes, 7 m wide
12. **Giant isopod** 1.7 kg, 50 cm long
13. **Japanese spider crab** 19 kg, 3.8 m claw to claw, 40 cm body diameter

# Among the World's Largest Butterflies

1. **Queen Alexandra's birdwing** (*Ornithoptera alexandrae*) wingspan can be in excess of 28 cm
2. **Goliath birdwing** (*Ornithoptera goliath*) wingspan can be up to 28 cm
3. **African giant swallowtail** (*Papilio antimachus*) wingspan 23 cm
4. **Rura opalescent birdwing** (*Troides prattorum*) wingspan 20 cm
5. **Palawan birdwing** (*Trogonoptera trojana*) wingspan 18 cm
6. **Rippon's birdwing** (*Troides hypolitus*) wingspan 20 cm
7. **Chimaera birdwing** (*Ornithoptera chimaera*) wingspan can be up to 18 cm in females
8. **Wallace's golden birdwing** (*Ornithoptera croesus (rubra)*) wingspan 20 cm
9. **Magellan birdwing** (*Troides magellanus*) wingspan can be 20-25 cm for females
10. **Queen Victoria's birdwing** (*Ornithoptera victoriae*) wingspan 18 cm

# Among the World's Largest Bugs

11. **Giant burrowing cockroach** (*Macropanesthia rhinoceros*) 8 cm long
12. **Hercules beetle** (*Dynastes hercules*) 17 cm long
13. **Titan beetle** *(Titanus giganteus)* 17 cm long
14. **Egyptian giant camel spider** *(Galeodes aruba)* 15 cm long (including legs)
15. **Giant walking stick insect** *(Pharnacia chinensis)* 64 cm long including extended legs – the world's longest insect
16. **Giant waterbug** *(Lethocerus americanus)* 10 cm long
17. **Elephant beetle** (*Megasoma elephas*) 15 cm long (including horn)
18. **Giant isopod** *(Bathynomus giganteus)* 50 cm long
19. **Giant long-legged katydid** *(Arachnacris corporalis)* 15 cm long, wingspan 25 cm
20. **Goliath beetle** *(Goliathus goliatus)* 11 cm long
21. **Little Barrier giant weta** *(Deinacrida heteracantha)* 10 cm long
22. **Atlas moth** *(Attacus atlas)* wingspan 25 cm

# THE TALLEST, LARGEST, STOUTEST AND OLDEST LIVING TREES

Tallest tree:
A **coast redwood** (*Sequoia sempervirens*), named 'Hyperion', stands 116.07 m tall. Located in Redwood National Park, California, USA

Oldest known clonal colony tree: 'Pando' or 'The Trembling Giant', is an enormous grove of **quaking aspen** (*Populus tremuloides*), estimated to be 80,000 years old. Located in Fishlake National Forest, Utah, USA

Oldest known individual vegetatively cloned tree:'Old Tjikko', a **Norway spruce** (*Picea abies*)is 9,556 years old. Located in Fulufjället National Park, Sweden

Oldest non-clonal tree: A **Great Basin bristlecone pine** (*Pinus longaeva*), known as 'Chronus', is 5,065 years old. Located in the White Mountains, California, USA

Largest tree (by volume): A **giant sequoia** (*Sequoiadendron giganteum*) known as 'General Sherman' is calculated to be 1,487 cubic metres. Located in Sequoia National Park, California, USA

Tree with the greatest circumference: A **Montezuma cypress** (*Taxodium mucronatum*) known as 'The Tule tree', is 11.5 m in diameter. Located in Oaxaca, Mexico

## *Largest seeds*

**Coconut** (*Cocos nucifera*)
1.4 kg, 15 cm long

**Coco de mer** (*Lodoicea maldivica*) 30 kg, 50 cm long

## *Largest leaves*

**Raphia palm**
(*Raphia regalis*)
Leaves reach a vast 25 m in length

# The Solar System

Our solar system is made up of the Sun and the planets that orbit around it. In addition, there are at least 239 moons, as well as comets, asteroids, minor planets, space rocks and dust and gas.

Sun

Mercury Venus Earth Mars

Asteroid Belt

Mercury
*Density:* 5.4 g/cm³
*Radius:* 2,440 km
*Distance from the Sun:* 57.9 million km

Venus
*Density:* 5.24 g/cm³
*Radius:* 6,052 km
*Distance from the Sun:* 108.2 million km

Earth
*Density:* 5.5 g/cm³
*Radius:* 6,371 km
*Distance from the Sun:* 149.6 million km

Mars
*Density:* 3.94 g/cm³
*Radius:* 3,396 km
*Distance from the Sun:* 227.9 million km

Jupiter

Saturn

Uranus

Neptune

Pluto

Pluto
(a dwarf planet)
*Density:* 1.88 g/cm³
*Radius:* 1,187 km
*Distance from the Sun:* 5.9 billion km

Neptune
*Density:* 1.64 g/cm³
*Radius:* 24,622 km
*Distance from the Sun:* 4.5 billion km

Uranus
*Density:* 1.27 g/cm³
*Radius:* 25,362 km
*Distance from the Sun:* 2.87 billion km

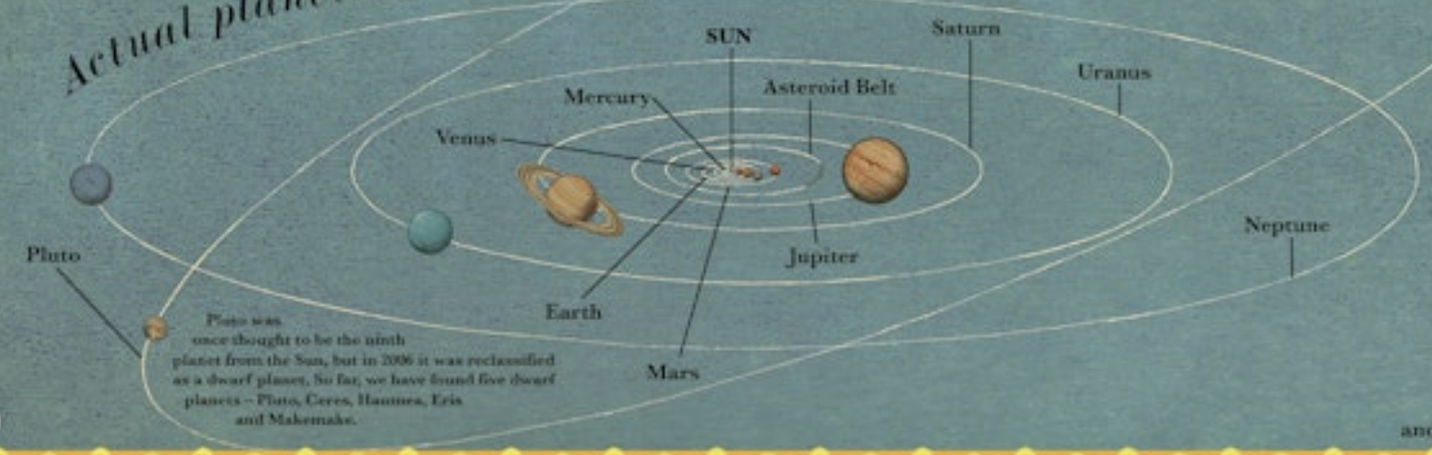
Saturn
*Density:* 0.7 g/cm³
*Radius:* 58,232 km
*Distance from the Sun:* 1.4 billion km

Jupiter
*Density:* 1.33 g/cm³
*Radius:* 69,911 km
*Distance from the Sun:* 778.3 million km

Between Mars and Jupiter lies the Asteroid Belt, which is filled with space rocks that range in size from 530 km to bodies that are less than 10 m across. These rocks are left over from the formation of our solar system, about 4.6 billion years ago.

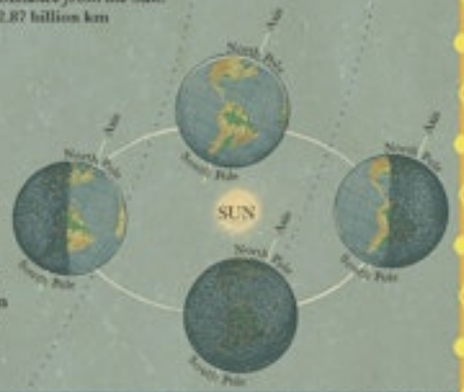
Days taken to orbit the Sun:
Mercury: 87.97 (0.24 Earth years)
Venus: 224.7 (0.62 Earth years)
Earth: 365.26 (1 Earth year)
Mars: 687 (1.88 Earth years)
Jupiter: 4,331 (11.86 Earth years)
Saturn: 10,747 (29.43 Earth years)
Uranus: 30,589 (83.75 Earth years)
Neptune: 59,800 (163.73 Earth years)
Pluto: 90,560 (247.94 Earth years)

## Actual planetary orbits around the Sun



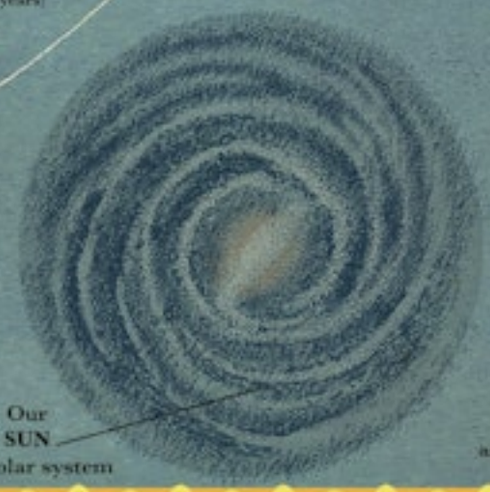

Pluto was once thought to be the ninth planet from the Sun, but in 2006 it was reclassified as a dwarf planet. So far, we have found five dwarf planets – Pluto, Ceres, Haumea, Eris and Makemake.

Every 24 hours, the Earth rotates around an imaginary line, known as an axis, that passes through the North and South Poles. As the Earth spins, light from the Sun falls on different parts of the Earth, causing day and night.





The equator is an imaginary line around the middle of the Earth. It is here the Earth is widest (40,075 km in circumference) and spins its fastest (1,670 km/h).



Our SUN and solar system

Our solar system is part of the Milky Way, a spiral-shaped galaxy which measures 120,000 light years across and may contain around 200 billion stars. One light year is equal to an astonishing 9.46 trillion kilometres.

# *From the Earth to the* MOON


## *Around 384,000 km to the Moon*

The Moon is believed to have formed after a massive collision between the Earth and an asteroid around 4.5 billion years ago. The debris left over from impact came together to form the Moon. At the time of its formation, the Moon sat much closer to the Earth – 22,500 km away, compared with 384,000 km between the Earth and the Moon today. The Moon is kept in orbit by the gravitational force of the Earth, but the Moon also exerts a gravitational force on our planet. It gives us our tides and has also slowed our rotation, giving us our 24-hour day. Thanks to the Moon, Earth's axis stays tilted between 22.1 and 24.5 degrees, even over thousands of years, giving us our seasons. But this won't always be the case. The Moon continues to spin away from the Earth, at the rate of 3.78 cm per year, about the same speed at which our fingernails grow.


It takes 27.3 days for the Moon to orbit the Earth, and the appearance of the Moon changes over the cycle. These changes are known as the phases of the Moon. Each phase depends on the amount of the Moon you can see from Earth as it is lit up by the Sun. This amount changes each day according to the Moon's position in relation to the Earth and the Sun.

### MOON RABBIT

For thousands of years humans have looked up at the Moon and imagined a host of characters gazing back at them. Chinese legends have long told of a curious rabbit that lives on the surface of the Moon. The Moon Rabbit – also known as the Jade Rabbit or the Gold Rabbit – is the faithful companion to the beautiful goddess Chang'e, who had floated to the Moon after she drank an immortality potion. Together they live in the Moon Palace and the rabbit spends its days pounding the elixir of life in a mortar.

In Japanese and Korean folklore, the Moon Rabbit is known as 'Tsuki no Usagi' and instead of the elixir of life, it pounds rice cake. Moon rabbits also appear in Mesoamerican myths. The Cree of North America tell of a rabbit that once longed to ride to the Moon. He asked birds large and small to help him but all refused, until one day a crane agreed to take him. The rabbit clung on so tightly to the crane's legs that they became elongated – just as crane's legs are to this day.

In many European cultures it is not a rabbit that lives on the Moon but an old man who was banished from the Earth for collecting firewood on a holy day of rest.

Scientists will tell you that the mysterious patterns and shapes are in fact produced by the contours on the surface of the Moon. The lighter areas are the mountains. The dark areas are the 'maria' (Latin for 'seas') – vast craters filled with volcanic rock.

*In December 2013 China landed a lunar rover named Yutu or 'Jade Rabbit' on the Moon.*

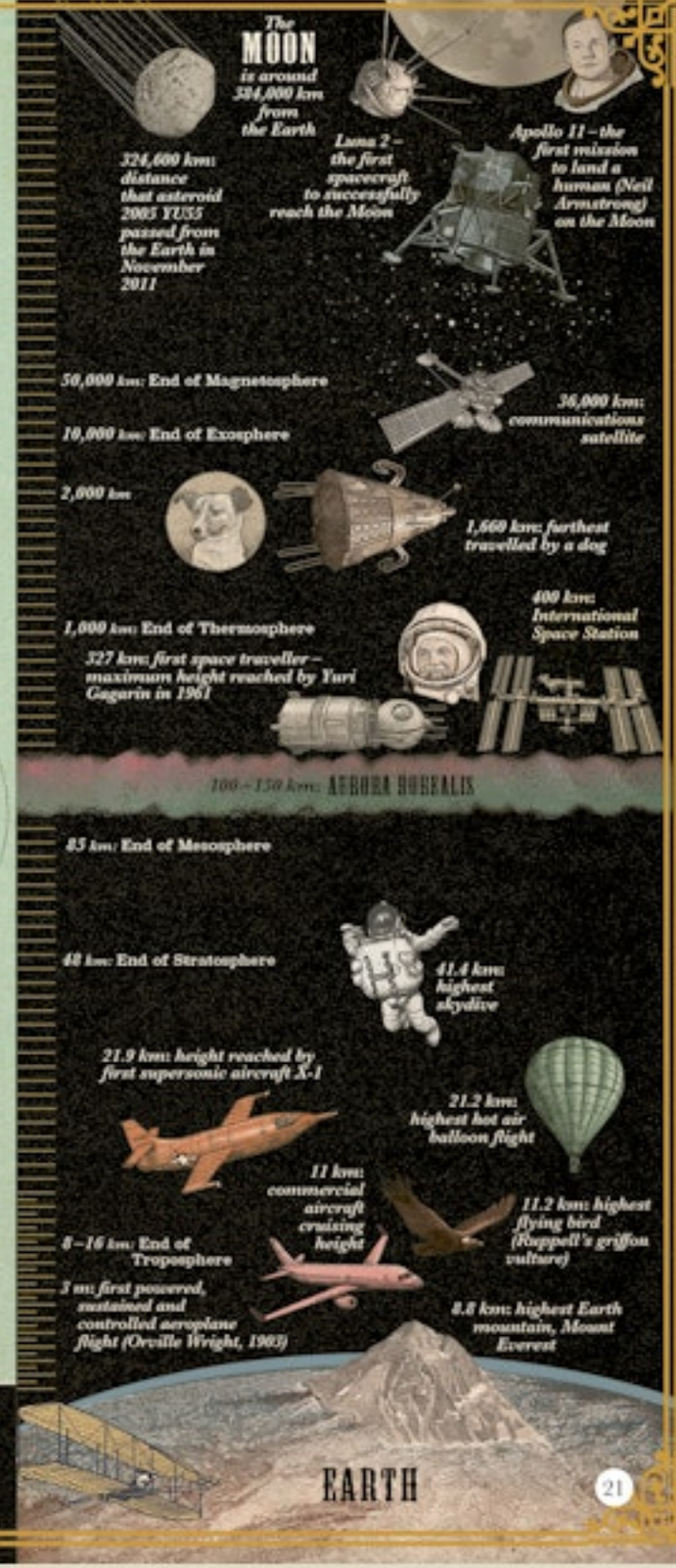

### SOLAR ECLIPSE

This occurs when the Moon gets between the Earth and the Sun, and the Moon casts a shadow over the Earth. It can only take place at the phase of new moon, when the Moon passes directly between the Sun and the Earth. The Sun's diameter is 400 times greater than that of the Moon, but the Moon also happens to be about 400 times closer to Earth than the Sun. As a result, the Moon is at the perfect distance to appear in our sky at the same size as the Sun, and therefore block it out.

### LUNAR ECLIPSE

This only happens when the Moon passes directly behind the Earth into its umbra (shadow), which casts the Moon into an eerie darkness. For a total lunar eclipse, the Sun, Earth and the full Moon need to be exactly or very closely aligned, with the Earth in the middle. Right now, the Moon is at the perfect distance for Earth's shadow to cover the Moon. Billions of years from now, that won't be the case.





# Longest Animal MIGRATIONS



17,000 km

*Globe skimmer dragonfly*

17,000 km – makes the longest migration of any insect, across four generations, from India to the Maldives, the Seychelles, Mozambique, Uganda and back again

16,600 km

13,560 km

*Humpback whale*

16,600 km – travels great distances during its seasonal migration; in a return trip from Saipan in the Mariana Islands to Sayulita in Mexico, it travels more than 16,000 km

*Bar-tailed godwit*

13,560 km – the longest non-stop flight of any bird, from Alaska to New Tasmania

5,000 km

*Caribou*

5,000 km – travels 70 km in a day

4,600 km

*Monarch butterfly*

4,600 km – from Canada to Mexico

4,500 km

*Semipalmated sandpiper*

4,500 km – migrates to the Southern USA from Canada

20,000 km

21,000 km

*Leatherback sea turtle*

20,000 km – travels across the Pacific between Indonesia and the USA

*Northern elephant seal*

21,000 km – migrates the vast distance between California and Alaska each year

22,500 km

*Grey whale*

22,500 km – its annual round trip from tropical to colder waters is the longest of any mammal

40,000 km

*Tuna*

40,000 km – makes three Pacific Ocean crossings, between the US and Japan, over 20 months

96,000 km

64,000 km

*Sooty shearwater*

64,000 km – travels between New Zealand and the North Pacific, covering as many as 1,000 km in a day

*Arctic tern*

96,000 km – the longest of all animal migrations, from the Arctic Circle to the Antarctic region and back again

*In medieval times, it was thought barnacle geese grew on trees.*

*Winter*

*Summer*

*Aristotle*

Before animal migration was fully understood, people had some interesting explanations for the seasonal movement of birds. For centuries, it was widely believed that birds spent the winter hiding in mud at the bottom of lakes and ponds. In Ancient Greece, Aristotle declared that winter robins were transformed into redstarts during the summer months and that blackcaps turned into garden warblers. During the Middle Ages, the sudden appearance of barnacle geese gave rise to the belief that they grew from the black and white shells of barnacles, or like fruit from a tree.

# *Some of the* HIGHEST MOUNTAINS

**Below are the top five highest mountain peaks, four of which are found in the Himalayas, the highest mountain range in the world. Sitting amid snowy peaks, majestic glaciers and fluttering prayer flags, the Himalayas span five countries in eastern Asia. The list continues with some of the highest, most famous and most striking mountains in the world.**

1. *Mount Everest, Himalayas, Asia* – 8,848 m
2. *K2, Karakoram, Asia* – 8,612 m
3. *Kanchenjunga, Himalayas, Asia* – 8,586 m
4. *Lhotse, Himalayas, Asia* – 8,516 m
5. *Makalu, Himalayas, Asia* – 8,462 m
6. *Mount Aconcagua, Andes, South America* – 6,962 m, highest mountain in the western hemisphere
7. *Ojos del Salado, South America* – 6,893 m
8. *Denali, Alaska Range, North America* – 6,194 m, highest mountain in North America
9. *Mount Logan, Saint Elias Mountains, North America* – 5,959 m
10. *Cotopaxi, Ecuador Andes, South America* – 5,897 m
11. *Kilimanjaro, Africa* – 5,895 m, highest mountain in Africa and highest free-standing mountain in the world
12. *Mount Elbrus, Caucasus, Europe* – 5,642 m, highest peak in Europe
13. *Pico de Orizaba, Cordillera Neovolcanica, North America* – 5,610 m
14. *Popocatépetl, Cordillera Neovolcanica, North America* – 5,452 m
15. *Dykh-Tau, Caucasus, Europe* – 5,204 m
16. *Mount Kenya, Africa* – 5,199 m
17. *Great Ararat, Asia* – 5,165 m
18. *Vinson Massif, Ellsworth Mountains, Antarctica* – 4,897 m, highest peak in Antarctica
19. *Puncak Jaya, Maoke Range, Oceania* – 4,884 m, highest mountain in Oceania
20. *Mont Blanc, Alps, Europe* – 4,807 m
21. *Matterhorn, Alps, Europe* – 4,478 m
22. *Mauna Kea, Hawaii, North America* – 4,205 m, the tallest mountain in the world from sea floor to peak (10,205 m)
23. *Mount Toubkal, High Atlas, Africa* – 4,165 m
24. *Mount Kinabalu, Asia* – 4,102 m, highest mountain in Borneo
25. *Mount Fuji-san, Asia* – 3,776 m, highest mountain in Japan
26. *Aoraki / Mount Cook, Southern Alps, Oceania* – 3,754 m, highest point in New Zealand
27. *Mount Olympus, Greek-Albanian Ranges, Europe* – 2,917m, highest mountain in Greece and home of the gods, according to Greek mythology
28. *Mount Sinai, Asia* – 2,640 m, a sacred mountain for Judaism, Christianity and Islam where it is believed Moses received the Ten Commandments
29. *Mount Kosciuszko, Oceania* – 2,228 m, highest mountain in Australia
30. *Mount Tai, Asia* – 1,524 m, historically important, it is one of the five holy mountains in China
31. *Ben Nevis, Scottish Highlands, Europe* – 1,344 m, highest mountain in the British Isles
32. *Mount Vesuvius, Europe* – 1,280 m, a volcano famous for destroying the Roman city of Pompeii
33. *Table Mountain, Cape Ranges, Africa* – 1,087 m
34. *Sugarloaf Mountain, Southern Brazilian Highlands, South America* – 395 m

**SMALLEST MOUNTAIN**

35. *Mount Wycheproof, Oceania* – 43 m

# DEEPEST OCEANS

## SUNLIGHT ZONE
**0–200 M**

Sunlight (euphotic) zone – there is enough sunlight for photosynthesis to take place. It is home to many creatures.

## TWILIGHT ZONE
**200–1,000 M**

Twilight (dysphotic) zone – sunlight decreases rapidly with depth and photosynthesis is not possible. No plant life exists.

## MIDNIGHT ZONE
**1,000 M+**

Midnight (aphotic) zone – the pressure here is immense, there is no sunlight and temperatures are near freezing.

At 4,000 m you reach the Abyssal zone – the deepest part of the ocean. Rising from the ocean floor, colossal hydrothermal vents spew clouds of toxic fluids that are hot enough to melt lead.

On 14 April 1912, the huge ocean liner *Titanic* hit an iceberg and later sank along with more than 1,500 passengers. The wreck was later discovered lying at a depth of 3,800 m.

### AVERAGE DEPTHS OF THE WORLD'S OCEANS

ARCTIC OCEAN – 987 m
INDIAN OCEAN – 3,960 m
PACIFIC OCEAN – 4,280 m
ATLANTIC OCEAN – 3,330 m
SOUTHERN OCEAN – 4,500 m

*The Mariana Trench, situated in the western Pacific Ocean, is the deepest part of the world's oceans, at* **11,034 m**

Mount Everest is 8,848 m in height

The Mariana Trench is 2 km deeper than the height of Mount Everest

*The* **MARIANA TRENCH** *11,034 m*

HMS *Challenger* (1872–1876) – explored the world's oceans, discovering many new species. It also made the first recordings of the depths of the Mariana Trench.

US diver Daniel Jackson (2006) – wearing an atmospheric diving suit, known as the Hardsuit 2000, Jackson dived into the Pacific Ocean off California and reached a new record depth of 610 m.

Scientists believe that around 80 per cent of all volcanic eruptions take place in the ocean. The deepest eruption so far discovered is the West Mata volcano, in an area between Samoa, Fiji and Tonga, nearly 1,220 m beneath the surface of the Pacific Ocean.

The Perdido oil rig – the deepest floating oil rig. Located in the Gulf of Mexico, it stretches down through nearly 2,450 m of ocean.

1. 1–200 m **Tuna**
2. 365 m **Firefly squid**
3. 800 m **Barreleye fish**
4. 900 m **Vampire squid**
5. 1,200 m **Blobfish**
6. 1,750 m **Deep sea anglerfish**
7. 2,000 m **Giant Pacific octopus**
8. 3,800 m **Giant tube worms**
9. 4,000 m **Dumbo octopus**
10. 4,390 m **Pacific viperfish**
11. 5,000 m – deepest known **hydrothermal vents** at a site called 'Beebe', Cayman Trough
12. 8,145 m **Snailfish**

# BURROWING ANIMALS

All over the planet, animals make use of underground burrows to shelter from predators, to keep warm or to store their food. Some species spend their whole lives underground, others hide there to give birth and raise their young.

1 m
2 m
3 m
4 m
5 m
6 m
7 m
8 m
9 m

Townsend mole 0.4 m

Greater bilby 0.6 m

Syrian hamster 0.7 m

Australian eastern tarantula 1 m

Eastern chipmunk 1 m

Groundhog 1.5 m

Common earthworm 1.8 m

Meerkat 2 m

Gopher tortoise 3 m

Black-tailed prairie dog 3 m

European rabbit 3 m

Eurasian badger 2.7 m

Red fox 2.5 m

**Nile crocodile – 3.6 m** In mid-summer, this powerful reptile scrapes out a burrow to escape the worst of the African drought. There it lives in a state of suspended animation, its heart beating just twice a minute.

**Yellow-spotted monitor – 3.6 m** This species of lizard digs deep, spiralling burrows with a nesting chamber at the bottom. After laying her eggs, the female partially fills the upper parts of the burrow with soil, to help maintain a moist, stable environment for the eggs and to help keep predators out.

**Leafcutter ants – 8 m**
These tiny leaf-chewing creatures build vast cities deep in the earth with a complex system of tunnels, rooms and gardens. Colonies can consist of millions of ants that all work together to build and run the nest.

## DEEPEST LAND ANIMALS 980 METRES+

**1,400 m**
***Duvalius abyssimus*** **– a species of cave beetle, recently discovered in the world's second deepest cave, the Krubera, in the Western Caucasus, southern Russia.**

**1,980 m**
***Plutomurus ortobalaganensis*** **– the world's deepest-living arthropod – has long antennae and feeds on fungi and decomposing organic matter. At only 4 mm long, it lives in total darkness in the Krubera cave.**

**1,160 m**
**Little brown bats – Around 1,000 winter in a New York zinc mine at a record depth for any bat species.**

**980 m**
***Zospeum tholussum*** **– a tiny, fragile snail found in Croatia's deepest cave system.**

**3,600 m**
**Unnamed species of nematode – the deepest-living animal ever found, in a gold mine in South Africa, where the temperatures are as high as 48°C.**

**60 m**
**People have been known to live underground too. A 5,000-year-old underground city in Derinkuyu, Turkey, was carved out of the rock and is thought to have housed up to 20,000 people. It contained stables, cellars, storage rooms, wineries and even churches and schools.**

**68 m**
**Deepest tree roots**

**292 m**
**Deepest railway tunnel, Ryfylke Tunnel, Norway**

20 m
40 m
60 m
80 m
100 m
200 m
300 m
400 m
500 m
600 m
700 m
800 m
900 m
1,000 m
2,000 m
3,000 m
4,000 m

**3,106 m**
**Deepest single-shaft lift in Moab Khotsong gold mine, South Africa**

**3,900 m**
**The deepest point visited by human beings**

# HOTTEST, COLDEST, DRIEST, WETTEST PLACES

## Coldest Places on Earth

1. **Dome Fuji ridge**, East Antarctic Plateau: -93.2°C
2. **Dome Argus**, Antarctic Plateau: -93°C
3. **Vostok research station**: -89.2°C
4. **Scott South Pole Station**: -82.8°C
5. **Mount Denali**, Alaska: -73.3°C
6. **Klinck research station**, Greenland: -69.6°C
7. **Verkhoyansk**, Russia: -67.8°C
8. **Oymyakon**, Russia: -67.7°C
9. **North Ice**, Greenland: -66°C
10. **Snag**, Yukon, Canada: -63°C

COLDEST PERMANENTLY INHABITED PLACES ON EARTH: Nunavut, Canada has the lowest annual mean temperature at **-19.7°C**, while Verkhoyansk and Oymyakon, towns in northeastern Siberia, vie for the record of the absolute coldest.

## Hottest Places on Earth

1. **Death Valley**, USA: 56.7°C
2. **Ghadames**, Libya: 55°C
3. **Kebili**, Tunisia: 55°C
4. **Timbuktu**, Mali: 54.5°C
5. **Araouane**, Mali: 54.5°C
6. **Tirat Tsvi**, Israel: 54°C
7. **Mitrabah**, Kuwait: 53.9°C
8. **Ahwaz**, Iran: 53.7°C
9. **Turbat**, Pakistan, 53.7°C
10. **Aghajari**, Iran: 53.3°C
11. **Wadi Halfa**, Sudan: 53°C

HOTTEST PERMANENTLY INHABITED PLACE ON EARTH: **Dallol**, Ethiopia had an annual mean temperature recorded from 1960–66 of **34.4°C**. The average daily maximum temperature was **41.1°C.**

***The Earth's crust makes up just one per cent of the Earth's mass, but contains all known life in the universe.***

## *A few of the world's largest recorded volcanic eruptions*

*Volcanoes are measured using the Volcanic Explosivity Index (VEI). It uses variables such as volume and rate to quantify a volcano's power; the scale goes from 1 to 8, and each VEI is ten times greater than the last.*

**Novarupta,** Alaska Peninsula, 1912 (VEI 6) The largest terrestrial eruption of the 20th century.

**Mount Pinatubo**, Philippines, 1991 (VEI 6) The second-largest terrestrial eruption of the 20th century.

**Krakatoa**, Indonesia,1883 (VEI 6) About 13,000 times more powerful than the atomic bomb that devastated Hiroshima.

## *Supervolcanoes*

*The term 'supervolcano' is used to describe eruptions of more than 1,000 cubic kilometres of magma. Such volcanoes are devastating, but very rare. Eruptions are hundreds of thousands of years apart but can have catastrophic effects on the planet.*

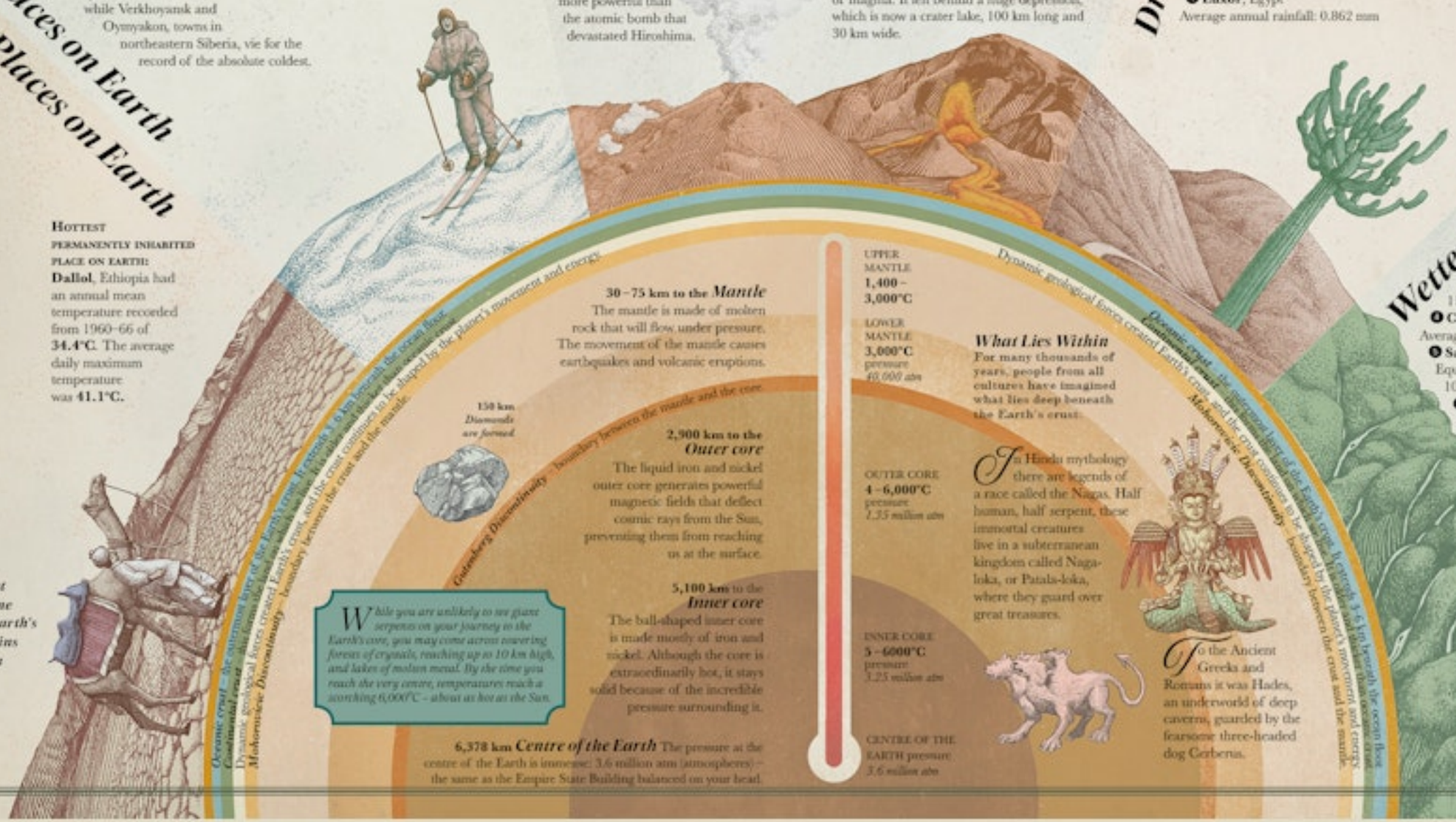
1. **Siberian Traps,** Siberia, Russia
***250 million years ago***
Erupted at the end of the Permian Era and is thought to have wiped out 90 per cent of life on Earth.
2. **Wah Wah Springs**, Utah, USA,
***30 million years ago*** (VEI 8)
3. **Yellowstone**, USA,
***640,000 years ago*** (VEI 8)
4. **Toba,** Sumatra, Indonesia,
***74,000 years ago*** (VEI 8)
The Toba explosions released 2,800 cubic km of magma. It left behind a huge depression, which is now a crater lake, 100 km long and 30 km wide.

## *Driest Places on Earth*

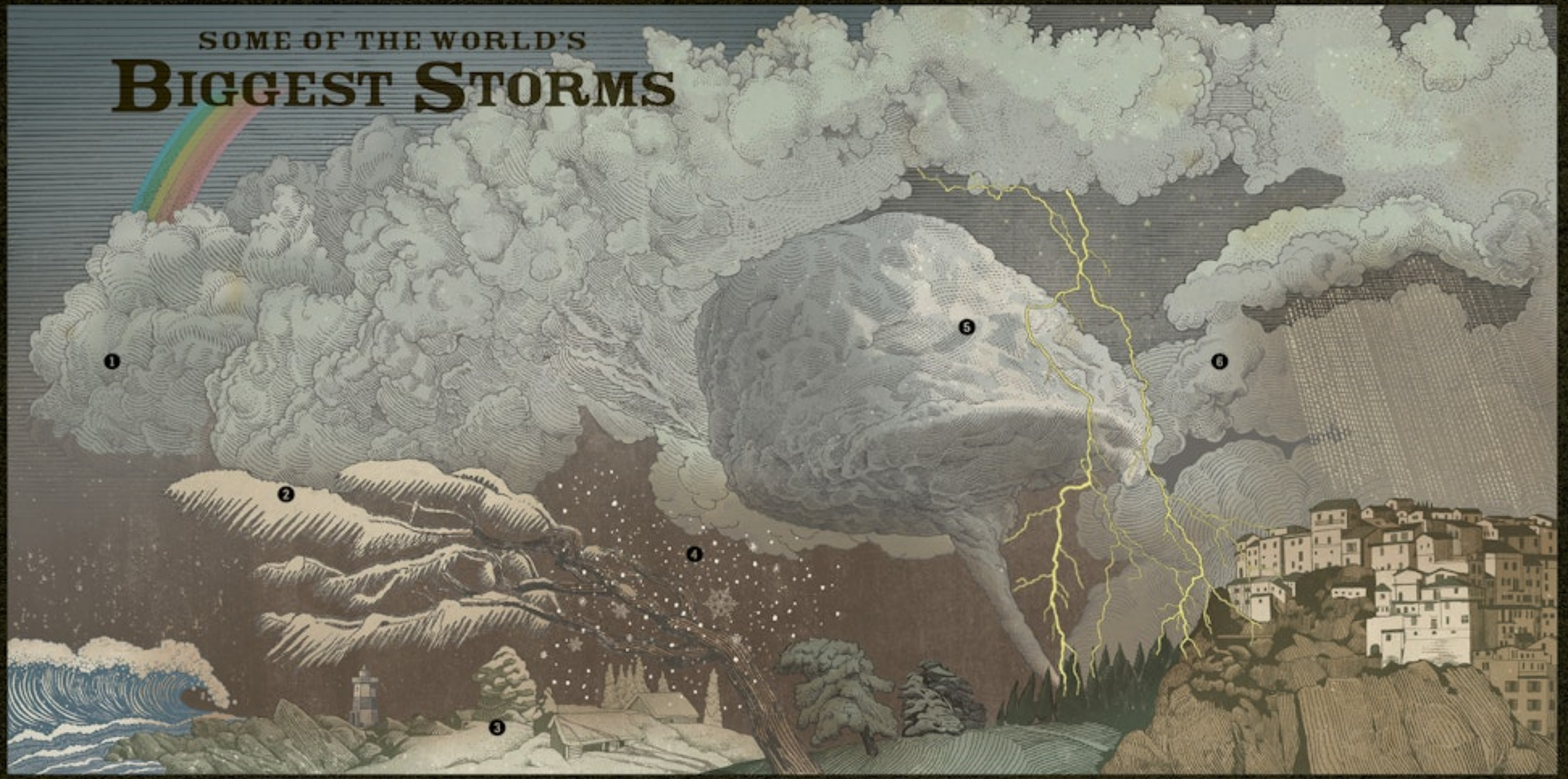
1. **Arica**, Chile
Average annual rainfall: 0.761 mm
*Located in the northern Atacama Desert, Arica holds the world record for the longest dry streak, having gone 173 months without a drop of rain in the early 20th century. The dryness is so extreme, that scientists study the soil in the surrounding Atacama Desert, as the conditions make the soil chemistry remarkably similar to that of Mars.*
2. **Al-Kufrah**, Libya
Average annual rainfall: 0.860 mm
The driest spot in Africa.
3. **Aswan**, Egypt
Average annual rainfall: 0.861 mm
4. **Luxor**, Egypt
Average annual rainfall: 0.862 mm
5. **Amundsen-Scott South Pole Station**, Antarctica
Average annual rainfall: 2 mm
6. **Ica**, Peru
Average annual rainfall: 2.29 mm
7. **Wadi Halfa**, Sudan
Average annual rainfall: 2.45 mm
8. **Iquique**, Chile
Average annual rainfall: 5.08 mm
9. **Pelican Point**, Namibia
Average annual rainfall: 8.13 mm
10. **Aoulef**, Algeria
Average annual rainfall: 12.19 mm

## *Wettest Places on Earth*

1. **Mawsynram**, Meghalaya, India
Average annual rainfall: 11,872 mm
2. **Cherrapunji**, Meghalaya, India. Average annual rainfall: 11,777 mm
3. **Mt Waialeale**, Kauai, Hawaii, USA. Average annual rainfall: 11,640 mm
4. **Cropp River**, New Zealand
Average annual rainfall: 11,516 mm
5. **San Antonio de Ureca**, Bioko Island, Equatorial Guinea. Average annual rainfall: 10,450 mm
6. **Debundscha**, Cameroon, Africa
Average annual rainfall: 10,287 mm
7. **Big Bog**, Maui, Hawaii, USA
Average annual rainfall: 10,272 mm
8. **Kukui**, Maui, Hawaii, USA
Average annual rainfall: 9,293 mm
9. **Quibdo**, Colombia
Average annual rainfall: 8,990 mm
10. **Emei Shan**, Sichuan province, China
Average annual rainfall: 8,169 mm



# SOME OF THE WORLD'S BIGGEST STORMS




**1 HURRICANES, TYPHOONS and CYCLONES**
Formed over warm waters, these tropical storms are one of the most powerful and destructive weather systems on the planet. They bring with them two major perils – powerful winds and torrential rain – and can be devastating when they strike coastal areas. They are known as 'hurricanes', 'typhoons' or 'cyclones' depending on where they occur. Hurricanes originate in the Atlantic and eastern Pacific, typhoons in the northwest Pacific and cyclones in the Indian or South Pacific Oceans.

*The Great Hurricane of 1780, Lesser Antilles, 10–16 October 1780*
The deadliest Atlantic hurricane in recorded history. An estimated 20–22,000 people were killed in the wake of this monster storm including some 4,000 French sailors whose ships were capsized off the coast of Martinique.

*Cyclone Mahina, Bathurst Bay, 4 March 1899*
The highest storm surge produced by a tropical cyclone (up to 13–14.6 m). More than 300 people were killed after Mahina hit the Queensland coastline in Australia, while fish and dolphins were reportedly found on top of 15 m-high cliffs.

*Super Typhoon Tip, northwest Pacific, 4–24 October 1979*
The largest and most intense typhoon ever recorded. At its peak, it reached a wind diameter of 2,220 km – almost half the size of the United States – and its central pressure dropped to 870 hPa, the lowest sea-level pressure ever observed on Earth.

**2 ICE STORMS**
*Quebec Ice Storm, Canada, 4–10 January 1998*
Producing more than 100 mm of freezing rain, this is often described as the 20th century's worst ice storm.

**3 SNOWSTORMS**
*Storm of the Century, North America, 12–14 March 1993*
This epic storm unleashed snow and wind on a wider area than any other in history. At its peak, it stretched from Canada to Central America. It left more than 300 dead. The Iran Blizzard of 1972 ranks as one of the deadliest snowstorms in history with around 4,000 killed.

**4 HAILSTORMS**
*Gopalganj, Bangladesh, 14 April 1986*
The heaviest hailstones ever recorded, weighing up to 1 kg and reportedly killing 92 people.

**5 SUPERCELLS and TORNADOES**
*2011 Super Outbreak, United States, 25–28 April*
The most extensive tornado outbreak on record to date, resulting in 362 tornadoes and more than 300 fatalities.

**6 LIGHTNING**
*Catatumbo River, Venezuela*
With 250 lightning flashes per square kilometre each year, Catatumbo is reported to have the highest concentration of lightning in the world. During the rainy season you can see an average of 28 lightning flashes per minute.

### COSMIC STORMS

On Jupiter, a tremendous storm, known as the Great Red Spot, has been raging for 400 years and is so huge that three Earths could fit inside it. Scientists meanwhile have observed the so-called 'perfect cosmic storm' – two vast galaxy clusters colliding together to create hurricane-like conditions and sending 100-million-degree gases spewing through space.

# FASTEST MOVING

## Peregrine Falcon VS Golden Eagle

**GOLDEN EAGLE**
When diving, this magnificent eagle is the second-fastest bird.

**PEREGRINE FALCON**
When making its high-speed dive in pursuit of prey, the peregrine is the fastest bird on the planet.

Peregrine falcons can glide at speeds of up to 193 km/h and have been recorded plunge-diving for prey at up to 250 km/h.

## THE HUM OF A HUMMINGBIRD'S WING

ANNA'S HUMMINGBIRD

During its spectacular courtship dive, the exquisite male Anna's hummingbird zooms through the air like an iridescent fireball. As it reaches its top speed – an extraordinary 385 body lengths a second – it produces an explosive squeaking noise with its tail feathers. Its blue-crowned cousin, the horned sungem (*Heliactin bilophus*), can beat its wings up to 90 beats per second.

### The Supercharged Swift

In dramatic mating displays known as 'screaming parties' the aptly named swift can hit top speeds of 111.6 km/h flying horizontally and soaring upwards.

THE COMMON SWIFT

A grey-headed albatross reached sustained speeds of 127 km/h for more than eight hours, while returning to its nest at Bird Island, South Georgia, in the middle of an Antarctic storm.

GREY-HEADED ALBATROSS

AUSTRALIAN DRAGONFLY – FASTEST INSECT IN THE AIR

## BUGS

### THE AERIAL BATTLES OF THE AUSTRALIAN DRAGONFLY

Taking the crown of the fastest insect on the planet is the Australian dragonfly. In an astonishing display of aerial acrobatics, these lethal hunters can hover, zig-zag and even fly backwards, at speeds of up to 58 km/h.

### SENSATIONAL SIX-LEGGED SPRINTERS

The Australian tiger beetle is the cheetah of the insect world, covering an incredible 2.5 metres per second.

AUSTRALIAN TIGER BEETLE - FASTEST INSECT ON LAND

### PARATARSOTOMUS MACROPALPIS

This minuscule mite from southern California, no bigger than a sesame seed, was recorded travelling at an extraordinary 322 body lengths per second. That's the equivalent to a human running at around 2,000 km/h.

PARATARSOTOMUS MACROPALPIS



# CHEETAH

## FASTEST ANIMAL ON LAND

The secret to the fastest runner on Earth is its long, flexible spine, which means it can stretch out and flex its body as it runs at top speed, while its blunt claws provide powerful traction on the ground. It can accelerate from 0 to 90 km/h in 3 seconds, which would leave most cars for dust, and can reach speeds of up to 95 km/h. The cheetah can make quick and sudden turns in pursuit of prey, but it needs to strike fast. These chases cost the hunter a huge amount of energy and are usually over in less than a minute.

PRONGHORN

### 2nd Fastest Animal on Land

Trailing just behind the nifty cheetah is the graceful pronghorn. When fleeing attack, it can hit speeds of around 86 km/h. Other fast-footed land creatures include the springbok, the blackbuck, the blue wildebeest, Thomson's gazelle and the brown hare.

## Fastest Reptiles

ON LAND SPINY-TAILED IGUANA

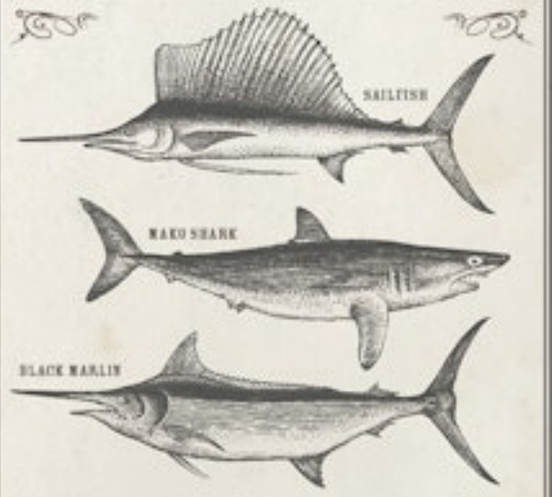
IN WATER PACIFIC LEATHER-BACK TURTLE

KANGAROO

## JUMPING ANIMALS

Red kangaroos are the world's fastest jumping mammals. They can travel at speeds of 56 km/h, covering 8 metres in a single leap and can jump 1.8 metres high. Males fight by leaning back on their tails and 'boxing' each other with their strong hind legs.

## FASTEST CREATURES IN THE SEA



SAILFISH

MAKO SHARK

BLACK MARLIN

Powerful and streamlined, the sailfish is considered the world's fastest fish and has been clocked leaping out of the water at speeds of more than 110 km/h. It is closely followed by the marlin, while the mako is the speediest of the sharks.

## Giant Forests under the Sea

Stretching along the Californian coasts, vast towers of giant kelp thrive in the summer sunshine. Anchored to the seabed by their 'holdfasts' they grow straight up towards the sunlight, forming a thick canopy on the surface of the water. They can grow by as much as 0.6 metres a day, making them one of the fastest growing organisms on Earth. Hundreds of creatures, from tiny fish and spiky sea urchins to sea otters and seals, seek shelter among the kelp's roots and leaves.

## BAMBOO

The world record for the fastest-growing plant belongs to a certain species of bamboo, which can grow up to 91 cm a day. Many animals, from mountain gorillas to giant pandas and spectacled bears, rely on bamboo for food, while bongo antelopes and bats take shelter between their woody stems.

# Longest-Living Animals

**Black coral**
Over 4,000 years

**Black coral** is the oldest marine organism living on Earth. Researchers collected the coral, found at depths of up to 488 m, and were able to determine its age much like they do a tree, as these corals have growth rings showing how long they have lived.

**The immortal jellyfish** ***(Turritopsis dohrnii)*** is a jellyfish that can transform itself from an adult back into a baby, and can do it over and over again. Only as wide as a human fingernail when fully grown, the immortal jellyfish is capable of turning itself into a blobbie cyst, which then develops into a polyp colony, an early stage in a jellyfish's life. However, it only does this when threatened with starvation, physical damage, or other crises that would lead to certain death.

## 1,001–3,000 years

**Ocean quahog**
(a species of clam) 507 years

## 351–1,000 years

**Tube worms**
250 years

Giant tortoises are famously long-lived. The oldest recorded individual was a **radiated tortoise**, named Tu'i Malila, of Tonga Island, who died aged 188. The **Galápagos tortoise** Harriet survived to around 176. Jonathan, a **Seychelles giant tortoise**, is currently the oldest living animal, at over 191 years old.

## 251–350 years

**Aldabra giant tortoise**
250 years (on anecdotal evidence)

**Koi fish**
228 years

**Bowhead whale** 211 years

A **koi**, named Hanako, is said to have reached the ripe old age of 228. Its age was estimated by counting the rings on its scales.

## 151–250 years

**Bowhead whales** live longer than any other mammal, in part due to their slow metabolism – an adaptation to the freezing oceanic waters of their Arctic habitat.

**Asian elephant**
86 years

**Tuatara**
100 years

**Greenland shark**
150 years

**Jeanne Calment**
122 years (the world's longest lived person on record)

## 86–150 years

**Greater flamingo**
83 years

**Major Mitchell's cockatoo**
82 years

**Siberian white crane**
82 years

**American alligator**
80 years

Muja, the world's oldest alligator, lives at Belgrade Zoo, Serbia. He has far exceeded the alligator life expectancy of about fifty years, and has also survived two bombing raids on the zoo during the Second World War, which destroyed most of the zoo's inhabitants.

**British barge horse**
62 years

**Laysan albatross**
65 years

## 70–85 years

Old Billy, a working barge horse, was 62 years old when he died on 27 November 1822. He was born in Lancashire and spent his life pulling barges along canals.

Japanese giant salamanders have the longest known lifespan of any amphibian.

**Japanese giant salamander**
55 years

**Bornean orangutan**
61 years

## 55–69 years

**Black rhino**
50 years

## 45–54 years

**European brown bear**
47 years

**Rockhopper penguin**
29 years

**Domestic cat**
38 years

**Polar bear**
42 years

## 20–44 years

In the wild, brown bears have a lifespan of around 25 years. Young bears are vulnerable, being blind and naked. Cubs grow quickly, reaching 25 kg by six months. The species continues to grow until they are 11 years old.

## *Some of the Shortest-Living Animals*

❶ The **mayfly** has the shortest adult lifespan of any insect – barely a few hours in some species. In its final winged stage, a mayfly's sole purpose is to mate and in most species, death ensues shortly after.

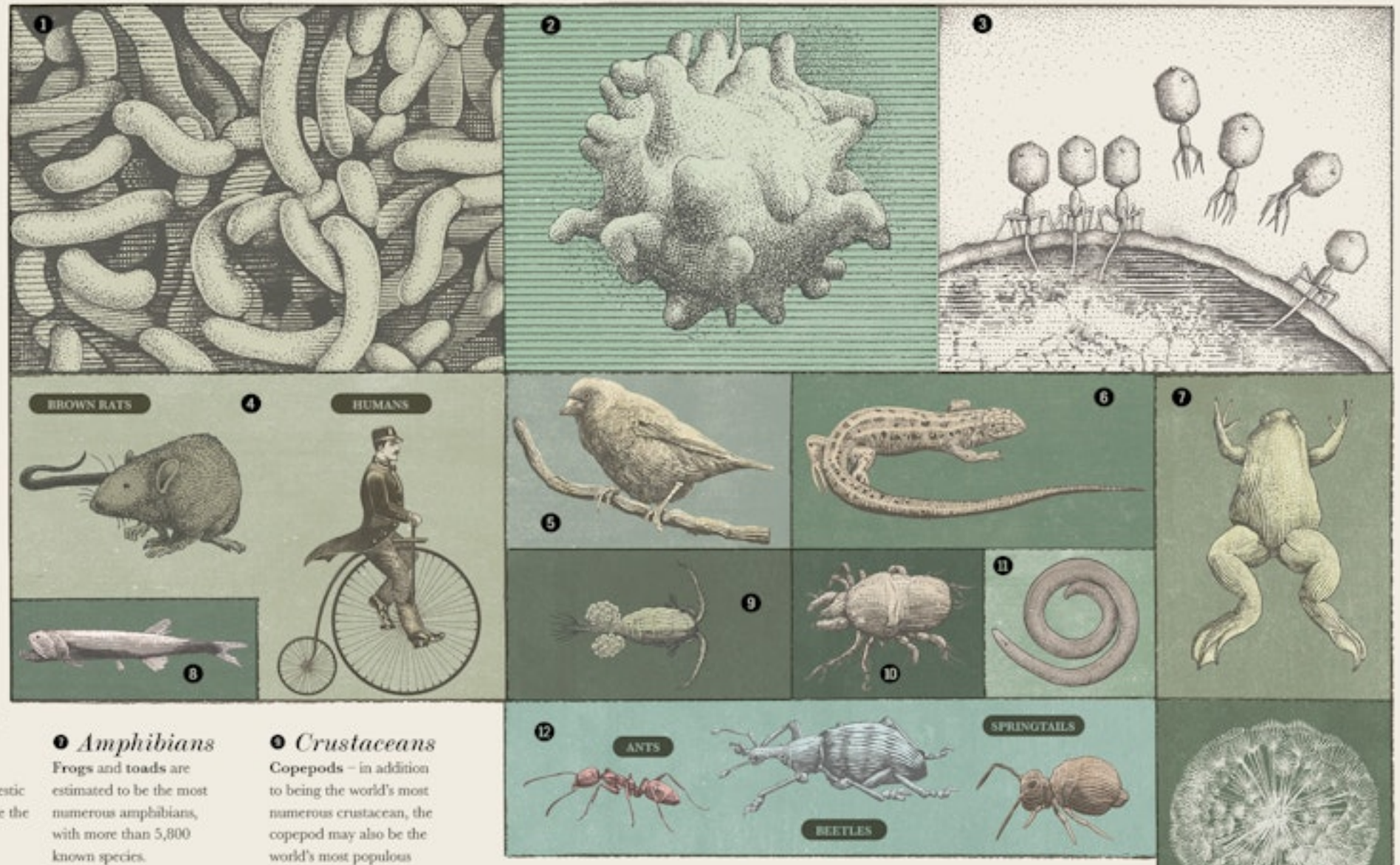
❷ The adult **house fly** only lives between 15 to 25 days. Some species can complete their entire life cycle in as little as 7 days.

❸ A **dragonfly** spends most of its life in its larval form, beneath the water's surface. As adults, most last only two to three weeks.

❹ On average, a **house mouse** lives 12–18 months, but it more than makes up for this reproductively, becoming sexually mature at 5–7 weeks and having up to 14 litters a year.

# Most Abundant Life Forms

**So far, scientists have catalogued 1.5 million species, but can only estimate the total number on Earth. Including species that are neither plants nor animals, such as lichens, mushrooms and bacteria, the total number of life forms could be more than 11 million.**




### ❶ *Bacteria*

One estimate put the number of bacteria at 5 million trillion trillion, making them the most abundant life form on Earth. The most numerous is thought to be *Pelagibacter ubique*, with an estimated 20 billion billion billion in the world's oceans.

### ❷ *Viruses*

Occupying a grey area, viruses are not clearly a life form, as they cannot replicate on their own but can do so in living cells. They reproduce at a phenomenal rate.

### ❸ *Bacteriophages*

If viruses are classified as life forms, then bacteriophages, the viruses that infect bacteria, are the most numerous of them all – a billion billion times more so than humans.

### ❹ *Mammals*

**Humans** – at a population count of 8 billion, closely followed, for wild animals, by the **brown rat**.

### ❺ *Birds*

**Red-billed queleas** – estimates put the number at 1.5 billion (population fluctuates from season to season). If including domestic birds, however, it would be the **chicken**, at 33 billion.

### ❻ *Reptiles*

There are few studies quantifying the most numerous reptile species, but it is most likely to be a **lizard** or a **snake**.

### ❼ *Amphibians*

**Frogs** and **toads** are estimated to be the most numerous amphibians, with more than 5,800 known species.

### ❽ *Fish*

**Bristlemouths**, or **lightfishes** – considered the most numerous fish, and the most common vertebrate on the planet, numbering in the hundreds of trillions.

### ❾ *Crustaceans*

**Copepods** – in addition to being the world's most numerous crustacean, the copepod may also be the world's most populous multi-celled organism.

### ❿ *Arachnids*

**Ticks and mites** – found in soil, water, and as parasites. The tiny mite outnumbers insects by 10:1.

### ⓫ *Worms*

**Nematodes** – vie with copepods for the title of most numerous multi-celled organism. A handful of soil will contain thousands of the microscopic worms.

### ⓬ *Insects*

**Ants** – around 10,000 trillion to a quadrillion individuals, closely followed by **beetles** – about 1 in 3 insects alive in the world today is a beetle. **Springtails** (relatives of insects) are even more numerous: there are typically around 10,000 per square metre of soil.

### ⓭ *Plants*

The biomass of plants on land has been estimated to be around 1,000 times that of animals. **Angiosperms**, or flowering plants, make up around 90 per cent of all plant species.

# Lost World of Giants

Fossil discoveries have revealed an amazing world of extinct megafauna – enormous versions of creatures that live today. Imagine beavers the size of bears, sloths as large as elephants and armadillos as big as a car. Many of these creatures lived alongside early humans and their cousins, and may have either hunted them or been hunted by them. Most megafauna species died out due to dramatic climate changes around the end of the last Ice Age 11,700 years ago.


## CREATURES THEN

**1 *Hyracotherium***
Shoulder height: 30–60 cm | Weight: 9 kg
Lived: Europe, N. America, c.55–33 mya
Not all prehistoric creatures were bigger than they are today. This early horse was around the same size as a small dog.

**2 *Mammuthus primigenius***
Height: 3–3.5 m | Weight: 6.6 tonnes
Lived: Asia, Europe, N. America, c.700,000–4,000 ya
The 'woolly mammoth' was similar in size to the average elephant. Unlike its modern relative, it had a coat of thick, curly fur to keep it warm in the cold temperatures, and long, twisted tusks that could grow more than 4 metres long. It was once thought that the mummified remains of mammoths discovered in the Siberian permafrost belonged to giant burrowing animals that died as soon as they were exposed to sunlight.

**3 *Titanoboa cerrejonensis***
Length: 13–14.6 m | Weight: 1 tonne
Lived: S. America, c.60–58 mya
These monstrous snakes lived in the rainforests of South America millions of years ago. They were longer than a bus and were capable of swallowing a crocodile whole.

**4 *Paraceratherium***
Shoulder height: 5.5 m (up to 8 m with its head raised) | Weight: 15–20 tonnes
Lived: Europe and Asia, c.30–16.6 mya
This enormous plant-eating rhinoceros was perhaps the largest land mammal of all time. With its head raised it stood around two times taller than an elephant. It used its long, thick neck to reach leaves high in the treetops.

**5 *Castoroides***
Length: 2.5 m | Weight: 125 kg | Lived: N. America, c.1.4 mya–10,000 ya
These bear-sized beavers had cutting teeth that could grow up to 15 cm long.

**6 *Megalania prisca***
Length: 5.5 m | Weight: 600 kg
Lived: Australia, c.1.8 mya–40,000 ya
Fossil finds suggest that this terrifying ancient lizard feasted on komodo dragons and giant kangaroos. It is thought that – as well as having very sharp teeth – it had toxic saliva that sent its victims into shock.

**7 *Glyptodon clavipes***
Length: 3.5 m | Weight: 2 tonnes
Lived: S. and N. America, c.5.3 mya–11,700 ya
This huge armadillo was roughly the same size and shape as a Volkswagen Beetle car. It was armed with a thick, rigid shell and a powerful spiked tail that it could swing like a baseball bat. To get past the *Glyptodon*'s armour to its soft belly, predators would have needed to flip it over onto its back – no easy task given that it weighed up to 2 tonnes!

**8 *Megatherium americanum***
Length: 6 m | Weight: 3.8 tonnes
Lived: S. America, c.1.8 mya–10,000 ya
This mega-sized sloth usually walked on all fours, but its fossilized footprints show that it could also walk on two legs for short distances, leaving its arms and claws free to grab twigs and leaves. When standing upright it would have been as tall as a two-storey house.

## CREATURES NOW

**A. *Equus ferus caballus* (Horse)**
Shoulder height: 1.7 m | Weight: 900 kg
Lives: Worldwide, except polar regions

**B. *Loxodonta africana* (African elephant)**
Height: 4 m | Weight: 6.3 tonnes
Lives: Africa, Asia
Elephants are the biggest and heaviest land creatures alive today.

**C. *Boa constrictor* (Boa constrictor)**
Length: 4 m | Weight: 45 kg
Lives: Central and S. America

**D. *Ceratotherium simum* (White rhinoceros)**
Shoulder height: 2 m | Weight: 3.6 tonnes | Lives: Africa, Asia

**E. *Castor canadensis* (American beaver)**
Length (not including tail): 0.9 m
Weight: 32 kg | Lives: N. America

**F. *Varanus niloticus* (Nile monitor lizard)** | Length: 2.4 m | Weight: 15 kg | Lives: Africa

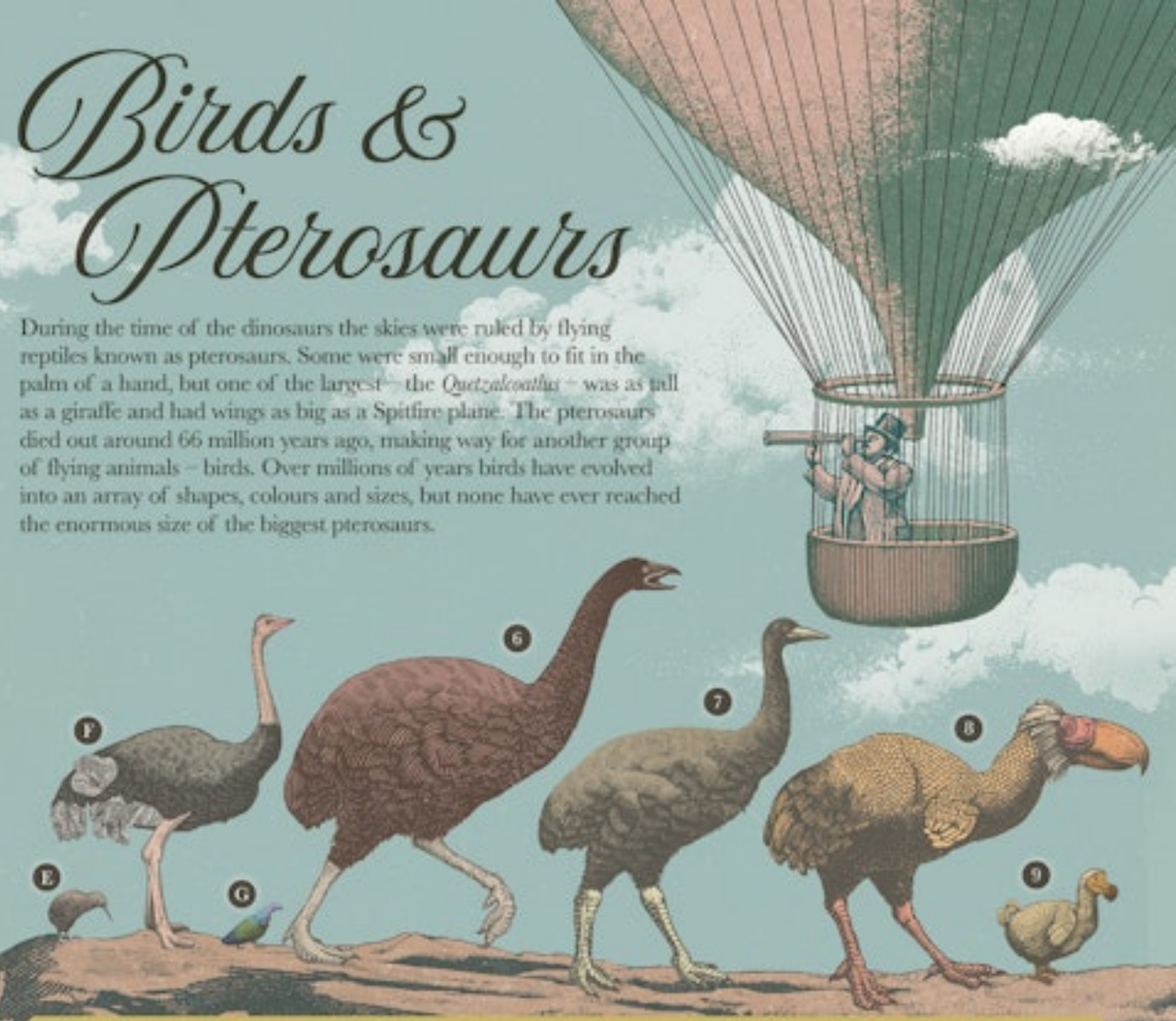
**G. *Priodontes maximus* (Giant armadillo)**
Length (not including tail): 1 m
Weight: 32 kg | Lives: S. America

**H. *Choloepus hoffmanni* (Hoffman's two-toed sloth)**
Height: 74 cm | Weight: 9 kg
Lives: Central and S. America

**ya = years ago**
**mya = million years ago**
**Megafauna** – The term megafauna is used to describe large ('mega') animals ('fauna') with an adult body weight of over 45 kg. Humans are actually megafauna, as are elephants, giraffes, whales and lions.

# Birds & Pterosaurs

During the time of the dinosaurs the skies were ruled by flying reptiles known as pterosaurs. Some were small enough to fit in the palm of a hand, but one of the largest – the *Quetzalcoatlus* – was as tall as a giraffe and had wings as big as a Spitfire plane. The pterosaurs died out around 66 million years ago, making way for another group of flying animals – birds. Over millions of years birds have evolved into an array of shapes, colours and sizes, but none have ever reached the enormous size of the biggest pterosaurs.


## BIRDS TODAY

**A. *Diomedea exulans* (Wandering albatross)**
Wingspan: 3.5 m | Lives: Southern Hemisphere
Has the longest wingspan of any living bird

**B. *Vultur gryphus* (Andean condor)**
Wingspan: 3.2 m | Lives: S. America

**C. *Aquila chrysaetos* (Golden eagle)** | Wingspan: 2.3 m
Lives: Africa, Asia, C. and N. America, Europe

**D. *Pica pica* (Common magpie)**
Wingspan: 57 cm | Lives: Africa, Asia, Europe

**E. *Apteryx* (Kiwi)**
Length: 45 cm | Lives: New Zealand
The closest living relative of the elephant bird

**F. *Struthio camelus* (Common ostrich)**
Height: 2.8 m | Lives: Africa
The largest bird alive today

**G. *Caloenas nicobarica* (Nicobar pigeon)**
Length: 40 cm | Lives: Asia and the Pacific
The dodo's closest living relative

## FLYING THINGS THEN

**1 *Quetzalcoatlus northropi***
Wingspan: 10–11 m | Lived: America, c.68–66 mya
When the fossilized remains of this giraffe-sized pterosaur were found in the Texas desert, people marvelled that creatures that large could fly. Its secret lay in its hollow arm bones, which made it very lightweight. It also kept its wing beats to a minimum and used its wings of toughened skin to glide great distances. It was probably a scavenger and used its long neck to reach into the carcasses of dead dinosaurs.

**2 *Pelagornis sanderi***
Wingspan: 6.1–7.4 m | Lived: N. America, c.28–25 mya
This enormous seabird glided over ancient oceans millions of years ago. With a wingspan longer than a stretch limousine, it competes with the *Argentavis magnificens* for the title of largest flying bird of all time.

**3 *Argentavis magnificens***
Wingspan: 6.5–7.5 m | Lived: S. America, c.6 mya
This huge bird is an ancestor of the giant condor.

**4 *Archaeopteryx lithographica*** – 'The first bird'
Height: 0.3 m | Lived: Europe, c.150 mya
Birds did not evolve from pterosaurs but from small, meat-eating dinosaurs. The magpie-sized *Archaeopteryx* is often thought of as the 'missing link' between dinosaurs and birds. It was a primitive bird with feathers, but unlike modern birds it had a long tail and a full set of teeth. It is likely that it could fly at least short distances.

**5 *Harpagornis moorei*** or 'Haast's eagle'
Wingspan: 3 m | Lived: New Zealand, c.1.8 mya–AD 1400 | One of the largest eagles that ever existed.

## FLIGHTLESS BIRDS THEN

**6 *Dinornis robustus*** or 'giant moa'
Height: Up to 3.6 m | Lived: New Zealand, c.8.5 mya–ca. 1450 | The giant moa was one of the biggest flightless birds to have ever lived. They had large legs, but no wings, and were hunted to extinction by Māori settlers, who ate their meat and used their skin, feathers and bones to make clothes, fish hooks and pendants.

**7 *Aepyornis maximus*** or 'elephant bird'
Height: 3 m | Lived: Madagascar, c.2 mya–ca. 1650
Hundreds of years ago, adventurer Marco Polo came back from his adventures with stories of a bird so big that it could swoop down to snatch an elephant in its talons and fly through the air with it. In truth, the 'elephant bird' was a herbivore and it was flightless.

**8 *Titanis walleri***
Height: 2.5–3 m | Lived: N. America, c.4.9–1.8 mya
One of the last of the 'terror birds', the *Titanis* was one of the top predators of its day. One theory is that it pinned prey to the ground with its claws, then swung its massive hooked beak at the creature like a pickaxe.

**9 *Raphus cucullatus*** or 'dodo'
Height: up to 1 m | Lived: Mauritius, until c.ca 1662
These flightless birds lived and nested on the ground. They were discovered in the 1500s by Dutch explorers and around 100 years later they were extinct. Many had been eaten by the settlers, while their eggs had been eaten by pigs, cats and other animals that had been introduced to the island.

# Sea Creatures Then and Now

For hundreds of years people have told tales of colossal sea creatures that could tear apart ships and drag sailors to a watery grave. Step back in time millions of years and the oceans were home to real live monsters – fearsome predatory whales, giant crocodiles and mega-toothed sharks that were three times the size of a great white shark. The largest animal ever to have lived – the blue whale – still lives in our oceans today. Despite its size, it is harmless to humans and lives on a diet of tiny crustaceans.


## SEA CREATURES THEN

**1** ***Livyatan melvillei*** Length: 18 m | Lived: S. America, c.13–12 mya
Named after the Biblical sea monster and Herman Melville, the author of *Moby Dick*, this predatory whale had gigantic teeth more than 36 cm long. It is thought that it patrolled the world's oceans feasting on baleen whales.

**2** ***Basilosaurus isis*** (meaning 'king lizard') Length: 18 m | Lived: N. Africa, N. America and Asia, c.40–30 mya
Despite their name, these fearsome predators were not reptiles – they were enormous, ancient whales. They had long snakelike bodies and a powerful bite capable of crunching through bones. There is evidence that, like modern killer whales, they even preyed on other whales.

**3** ***Carcharocles megalodon*** (meaning 'megatooth') Length: 18 m | Lived: Oceans around the world, c.15.9–2.6 mya
These colossal sharks were around three times longer than a great white, and their jaws were 2.7 m tall – big enough to swallow a human whole. A single *Megalodon* tooth was more than 16 cm long and was used to tear into the flesh and crush the bones of other sea animals. Many years ago, fossilized shark teeth, found washed up on the shore, were thought to be the petrified tongues of dragons or snakes.

**4** ***Shonisaurus sikanniensis sp.*** (meaning 'lizard from the Shoshone Mountains') Length: 21 m | Lived: N. America, c.220 mya
One of the largest marine reptiles that has yet been found, the *Shonisaurus* was longer than most modern whales. It had a short, toothless snout and is thought to have been a filter-feeder, sucking in food through its open jaws.

**5** ***Machimosaurus rex*** (meaning 'fighting lizard-king') Length: 10 m | Lived: Africa, c.152–129 mya
This ancient crocodile ancestor was as long as a bus and its skull alone was as long as a person is tall. Its massive jaws were filled with sharp bullet-shaped teeth that it used to crunch through the shells of turtles.

## SEA CREATURES NOW

**A.** ***Balaenoptera musculus*** **(Blue whale)**
Length: 32 m | Lives: All oceans except enclosed seas and the Arctic
Bigger than any dinosaur, the blue whale is as long as a Boeing 737 plane.

**B.** ***Carcharodon carcharias*** **(Great white shark)**
Length: 6 m | Lives: Oceans around the world

**C.** ***Crocodylus porosus*** **(Saltwater crocodile)**
Length: 5.46 m | Lives: Indian, Pacific oceans

# LAND OF THE DINOSAURS

For over 160 million years, dinosaurs dominated our planet. They came in many different forms – from giant, peaceful plant-eaters to sturdy armoured stegosaurs and carnivorous theropods. Many of them would have towered over even the biggest creatures alive today. Others were surprisingly small – like the chicken-sized *Compsognathus*.

DINOSAURS CAN BE GROUPED INTO THREE MAIN TYPES:

**Theropods** – *mostly meat-eaters with powerful legs and short arms*
**Ornithischians** – *bird-hipped, herbivorous and often armoured dinosaurs*
**Sauropods** – *herbivores with long necks and tails; walked on four feet*

***Tyrannosaurus rex***
A fierce hunter and scavenger, and one of the most famous of the theropods
TYPE: **Theropod**
LENGTH: 12 m
HEIGHT: 5 m

***Triceratops horridus***
A four-legged ceratopsian dinosaur with three horns and a bony frill
TYPE: **Ornithischian**
LENGTH: 8–9 m
HEIGHT: 3 m (top of head)

***Stegosaurus stenops*** – The most famous of the stegosaurs, a group of slow-moving, plant-eating dinosaurs with bony plates or spikes on their backs
TYPE: **Ornithischian**
LENGTH: 9 m
HEIGHT: 3.5 m
PLATES: 60 cm wide and tall

***Iguanodon bernissartensis***
An example of an ornithopod dinosaur, which walked and ran on two back feet
TYPE: **Ornithischian**
LENGTH: 10–13 m
HEIGHT: 3.3 m

***Sauroposeidon proteles***
TYPE: **Sauropod**
LENGTH: 34 m
HEIGHT: 18 m
Thought to be the tallest dinosaur to have ever walked the Earth, this massive herbivore was bigger than a six-storey building and had legs as thick as tree trunks. Despite its size, its head was around the same size as that of a horse.



# LOOKING AT THE EVIDENCE

**GIANT BONES**
Measuring as much as 2.4 m, the thigh bone of the monster-sized *Titanosaur* is bigger than a fully grown person.

**DINOSAUR TEETH**
Dinosaur teeth hold many clues about what and how these creatures ate. The meat-eating *Tyrannosaurus* had teeth as long as bread knives and its bite was at least three times as powerful as that of a lion. The plant-eating Triceratops, meanwhile, may have had as many as 800 teeth, stacked in columns, although only a small number of these were in use at any one time.

**1. *Spinosaurus***
**22.5 cm**
Long and spear-like, for catching fish

**2. *Tyrannosaurus***
**20 cm**
Had serrated edges for tearing flesh and crunching bones

**3. *Diplodocus***
**8 cm**
Narrow and peglike, for stripping leaves from trees and raking through vegetation

**4. *Triceratops***
**5 cm**
Used for shearing vegetation

**5. Lion**
**10 cm**

**6. Human**
**1.25 cm**

**MONSTER EGGS**
The smallest dinosaur eggs were the size of tennis balls; the biggest were like giant footballs. Compared to their enormous size, the mighty sauropods laid surprisingly small eggs – in fact, not much larger than an ostrich's egg. Scientists think that these smaller eggs may have taken less time to hatch and so reduced the risk of them being eaten by predators.

**1. Chicken egg – 5.7 cm**

**2. Ostrich egg – 15 cm**

**3. *Titanosaur* (sauropod) egg – 22 cm**

# HOW BIG?

See how these different giants measured up...

20 m
18 m
16 m
14 m
12 m
10 m
8 m
6 m
4 m

*Triceratops* *Iguanodon* *Stegosaurus* *Diplodocus* *Giraffe* *Tyrannosaurus* Human *Spinosaurus* *Sauroposeidon*

# Tall Structures *Then & Now*

**Dinosaurs may have been the tallest creatures ever to have roamed the Earth, but they look mouse-like when compared to some of the great buildings of the world. Throughout history, humans have built some extraordinary structures – from the mysterious columns of Stonehenge to the white marble domes of the Taj Mahal. Towering over all for around 3,800 years was the Great Pyramid of Giza – a glittering monument of the mighty Ancient Egyptian civilization.**

1. **10 m** – Stonehenge, Wiltshire, England, c.2500 BC
2. **12 m** – Statue of Zeus, Olympia, Greece, c.430 BCE *
3. **18 m** – Temple of Artemis, Ephesus, Turkey, c.550 BCE; rebuilt in c.356 BCE *
4. **21 m** – Cleopatra's Needle, Heliopolis, Egypt, c.1460 BCE, now located in London, England
5. **24 m** – El Castillo, Chichén Itzá, Mexico, c.CE 1000–1200
6. **32 m** – Colossus of Rhodes, Rhodes, Greece, c.294–282 BCE *
7. **38 m** – Christ the Redeemer, Rio de Janeiro, Brazil, CE 1931 (height includes the pedestal)
8. **48 m** – Colosseum, Rome, Italy, CE 80
9. **50 m** – Arc de Triomphe, Paris, France, CE 1836
10. **55.7 m** – Leaning Tower of Pisa, Pisa, Italy, CE 1360
11. **57 m** – St Basil's Cathedral, Moscow, Russia, CE 1554–1560
12. **60 m** – Big Wild Goose Pagoda, Shaanxi province, China, CE 652
13. **73 m** – Taj Mahal, Agra, India, CE 1653
14. **93 m** – Statue of Liberty, New York, USA, CE 1886 (height includes the pedestal)
15. **110 m** – Lighthouse of Alexandria, Egypt, c.280 BCE (the tallest lighthouse ever built) *
16. **111.3 m** – St Paul's Cathedral, London, England, CE 1711
17. **132.5 m** – St Peter's Basilica, Rome, Italy, CE 1626
18. **138.8 m** – Great Pyramid of Giza, Cairo, Egypt, c.2560 BCE (the only surviving Ancient Wonder, and the tallest human-made structure in the world for about 3,800 years; when built it stood 146.5 m tall) *
19. **169.1 m** – Washington Monument, Washington, D.C., USA, CE 1884 (the world's tallest structure from 1884 to 1889)

* Ancient Wonders of the World

**The Jewel of the Nile**
Rising out of the deserts of Egypt, the Great Pyramid of Giza was once covered with highly polished limestone blocks. As the sunlight reflected on the pyramid's white surface it glistened like a jewel.

Thousands of workers and artisans were used to build the pyramid and it is estimated that it consists of around 2.3 million stone blocks.

**Skyscrapers of the Future**
Soaring skywards, far above the wonders of the ancient world, is Dubai's needle-shaped Burj Khalifa. At a dizzying 828 m, it is the same height as around 488 people, or 45 *Saurophaganax* dinosaurs stacked on top of one another.

Today's record-holder will soon be surpassed by even taller buildings. The Jeddah Tower, under construction in Jeddah, Saudi Arabia, is set to reach a height of around 1,000 m.

170 m
160 m
150 m
140 m
130 m
120 m
110 m
100 m
90 m
80 m
70 m
60 m
50 m
40 m
30 m
20 m
10 m

**800m** THE TALLEST STRUCTURE EVER BUILT

**700 m**

**828 m**
Burj Khalifa, Dubai, UAE, 2010 (world's tallest structure to date)

**600 m**

**500 m**

**400 m**

**300 m**

**324 m**
Eiffel Tower, Paris, France, 1889 (held the record of the world's tallest structure from 1889 to 1930)

**200 m**

100 m

# Towers, Waterfalls and Mountains


## Towers and Waterfalls

Peeping through the clouds, hundreds of metres above the streets below, skyscrapers dominate the skyline of cities around the world. Rising higher still, is the magnificent Angel Falls. Hidden deep in the jungle of Venezuela, shrouded in mist, this spectacular waterfall is one of the greatest natural wonders on Earth.

### Towers

**1 828 m** – Burj Khalifa, Dubai, UAE, 2010
*The world's current tallest structure*
**2 632 m** – Shanghai Tower, Shanghai, China, 2015
**3 601 m** – Makkah Clock Royal Tower, Mecca, Saudi Arabia, 2012
**4 541 m** – One World Trade Center, New York, USA, 2014

### Waterfalls

**5 979 m** – Angel Falls, Bolívar State, Venezuela
*The world's highest uninterrupted waterfall*

**Rivers of Gold and Devil Spirits**

In 1937, the aviator and adventurer Jimmy Angel crash-landed his 4-seater plane on a mountaintop. He was searching for a legendary river of gold, but what he discovered instead were the Angel Falls. The Falls were already well known to the local Pemón people as Kerepakupai-Meru, or 'waterfall of the deepest place'. The Pemón believed that it was home to devil spirits called *wanaari*, who stole the souls of the living.

## Mountains

The world's tallest towers and waterfalls pale in comparison with the largest mountains. Mt Everest is the same height as more than ten Burj Khalifas stacked on top of one another. Yet even the mighty Himalayas look tiny compared to the highest mountain in our Solar System – Olympus Mons.

**6 979 m** – Angel Falls

### Earth Mountains

**1 4,884 m** – Mt Puncak Jaya or Carstensz Pyramid
*Highest peak in Oceania*
**2 4,892 m** – Vinson Massif
*Highest peak in Antarctica*
**3 5,642 m** – Mt Elbrus
*Highest peak in Europe*
**4 5,895 m** – Mt Kilimanjaro
*Highest peak in Africa*
**5 6,191 m** – Mt Denali (also known as Mt McKinley)
*Highest peak in N. America*
**6 6,961 m** – Mt Aconcagua
*Highest peak in S. America*
**7 8,848 m** – Mt Everest
*Highest peak in Asia and highest mountain peak on Earth from sea level*
**8 10,205 m** – Mauna Kea, Hawaii, N. America
*Tallest mountain peak on Earth measured from its base*

Although Mount Everest is the highest mountain on Earth measured from sea level, the tallest when measured from its base is in fact Mauna Kea. The peak of this million-year-old volcano rises 4,205 m from sea level, but its base plunges a further 6,000 m deep under the sea.

### Tallest mountain in the Solar System

**9** 25,000 m
Olympus Mons, Mars

**OLYMPUS MONS, ON THE PLANET MARS, IS ALMOST THREE TIMES TALLER THAN MT EVEREST AND COVERS AN AREA THE SIZE OF ARIZONA.**





• Towers, Waterfalls and Mountains • Towers, Waterfalls and Mountains • Towers, Waterfalls and Mountains •

# Ships, Trains and Trucks

*Ships, trains and trucks are used around the globe to transport people and haul all kinds of things from gold and iron ore, food and coal, to cars, tanks, aircraft parts and even rubbish. They have allowed people to travel further and carry heavier loads than ever before, to explore new worlds and to discover treasures from distant lands.*

## SHIPS

### SANTA MARIA (1460)

**TYPE**: Carrack **COUNTRY**: Galicia
**LENGTH**: Estimated 30 m

The *Santa Maria* was the biggest of Christopher Columbus's three ships on his 1492 voyage to 'the Americas'. It was designed for carrying lots of cargo and there were more than 40 men on board – including a carpenter, a painter, a goldsmith, a tailor and four known criminals.

### CUTTY SARK (1869)

**TYPE**: Clipper **COUNTRY**: UK
**LENGTH**: 64.8 m

Built to transport tea from China to London, this famous cargo ship could carry as many as 10,000 tea chests – enough for 200 million cups. As well as tea, she carried everything from coffee, coal, cocoa beans and beer, to wool, whale oil, shark bones, sardines and straw hats.

### RMS TITANIC (1911)

**TYPE**: Ocean liner **COUNTRY**: UK
**LENGTH**: 269 m

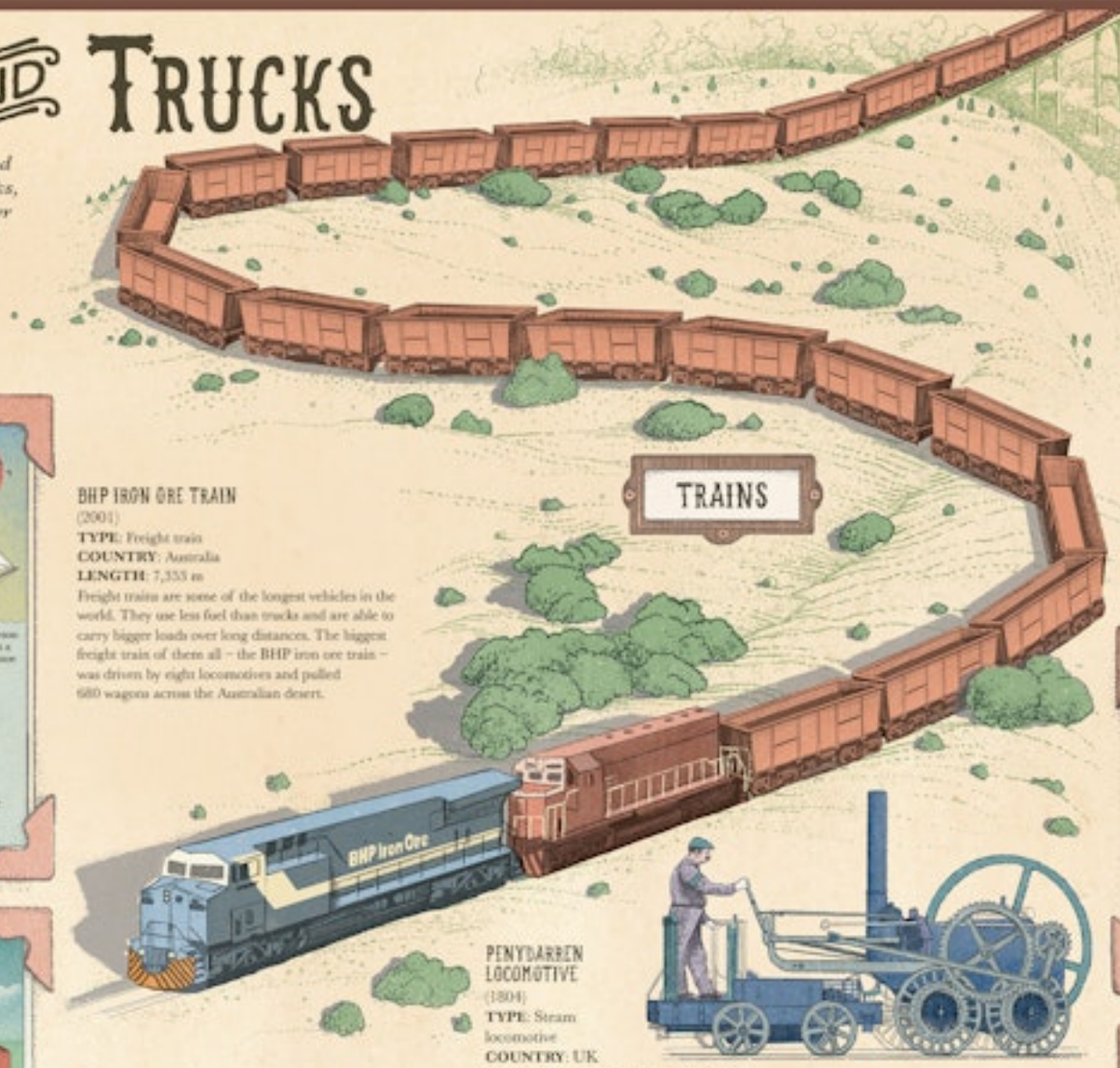
This famous steamship was the biggest and most luxurious ocean liner of its day. Stood on its end it would have been the same height as three Statue of Liberys stacked on top of one another and almost as tall as the Eiffel Tower.

### SEAWISE GIANT (1979)

**TYPE**: Crude oil tanker
**COUNTRY**: Japan **LENGTH**: 458 m

This supertanker was the longest sea vessel ever built. Stood on its end it was 15 m taller than the Empire State Building, and its holds were big enough to swallow up four St Paul's cathedrals.

## TRAINS




### BHP IRON ORE TRAIN (2001)

**TYPE**: Freight train
**COUNTRY**: Australia
**LENGTH**: 7,353 m

Freight trains are some of the longest vehicles in the world. They use less fuel than trucks and are able to carry bigger loads over long distances. The biggest freight train of them all – the BHP iron ore train – was driven by eight locomotives and pulled 680 wagons across the Australian desert.



### PENYDARREN LOCOMOTIVE (1804)

**TYPE**: Steam locomotive
**COUNTRY**: UK
**LENGTH**: 7.57 m (including the tender)

On 21 February 1804, Richard Trevithick's 'Penydarren' locomotive hauled five wagons loaded with 10 tonnes of iron ore and 70 people. It was the world's first-ever steam locomotive journey on rails.


### UNION PACIFIC 'BIG BOY' (1941)

**TYPE**: Steam locomotive
**COUNTRY**: USA
**LENGTH**: 40.47 m (including the tender)

One of the largest steam locomotives ever built. In its heyday, this powerful engine pulled heavy freight trains over the mountains of Wyoming and Utah.

## TRUCKS

### BIGFOOT 5 (1986)

**TYPE**: Monster truck **COUNTRY**: USA
**LENGTH**: Around 6.5 m long, 4.7 m tall

Bigfoot 5 was the largest monster truck of all time. Its tyres alone stood 3 m tall. The hefty tyres once belonged to a US military vehicle called the Snow Train, which took supplies over deep snow to remote Arctic locations.

### BELAZ 75710 MINING DUMP TRUCK (2014)

**TYPE**: Haul truck **COUNTRY**: Belarus **LENGTH**: 20.6 m

The world's biggest mining truck hauls loads of metal ore weighing more than 40 tonnes from open cast mines. Temperatures in the mines can range from -50°C to +50°C.

### AUSTRALIAN ROAD TRAIN (2013)

**TYPE**: Heavy truck **COUNTRY**: Australia **LENGTH**: 53m

Australian 'power trains' are some of the world's longest trucks. They are used to carry heavy goods such as machinery, fuel, cattle or gold for thousands of kilometres across the Australian desert.

# Great Lengths

## Mountains and Reefs

**Great Barrier Reef, Australia – 2,300 km**
This natural wonder is the world's biggest reef and the largest living structure on the planet. Built over centuries by minuscule colonial animals called polyps, it is so big it can be seen from space. It is home to an extraordinary range of sea life, from tiny fish, to turtles, rays, sharks and whales.

**Great Himalaya Range, Asia – 2,300 km**
The Great Himalayas contains many of the biggest peaks on Earth, including the world's highest – Mt Everest. The mountains were formed some 70 million years ago when two massive tectonic plates collided. According to legends it is home to the yeti, a giant ape-like creature, and in Hindu mythology it is the home of the God Shiva.

**The Andes Mountains, S. America – 8,900 km**
The world's longest mountain chain was populated long ago by the indigenous Andean peoples, who farmed its steep slopes. Today about a third of all the people in South America live in the Andes. Its most famous animal inhabitants include llamas, alpacas, vicuñas, chinchillas and condors.

## Rivers

**Yangtze River, China – 6,300 km**
The Yangtze River is the longest and busiest river in Asia. Along its course you will find some of the world's biggest cities, one of the deepest gorges (Tiger Leaping Gorge) and the world's biggest dam (Three Gorges Dam).

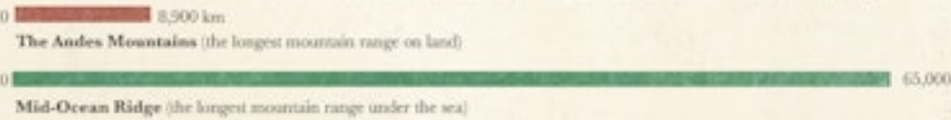
**Amazon River, S. America – 6,400 km**
The Amazon is one of the richest habitats on the planet. It is home to pink dolphins, anacondas, alligators, sloths and thousands of species of birds and fish. Around one in ten of all known species of wildlife live in the Amazon River Basin.

**Nile River, Africa – 6,695 km**
The longest river in the world, the Nile has been an important part of Egyptian life since ancient times. Each spring, the Nile floods, spreading fertile soil around its banks. This soil makes farming possible and brings life to the dry desert lands.



## Mid-Ocean Ridge

**Mid-Ocean Ridge – 60–65,000 km**
The longest and largest mountain range on Earth is in fact hidden from view beneath the sea. Starting in the Arctic Ocean, the Mid-Ocean Ridge system runs through the Atlantic, past Africa, Asia, Australia and Antarctica, then across the Pacific to North America. With a total length of around 65,000 km, it is more than seven times longer than the longest ranges on land.




## Human-Made Structures

**Trans-Siberian Railway (Moscow to Vladivostok) | Built: 1891–1904 | Length – 9,258 km**
One of the longest railways in the world, this famous route connects European Russia with the Asian port of Vladivostok, near the border of China. Today, it carries millions of passengers and about 100 million tonnes of freight each year.

**Great Wall of China | Built c. 259 BCE–CE 1644 | Length – 21,196 km**
Built to keep northern invaders out of China, the Great Wall is the longest structure ever constructed. It is thought that up to a million people died while building it, and it has been discovered that the mortar used to bind the stones was made with sticky rice.

# SPEED on Land and in the Air

Before the invention of planes, trains and flying machines, people travelled on land no faster than they could ride on a galloping horse. When the first steam trains were built, some feared it would be impossible to breathe while moving at such speed, or that the vibrations would be so powerful you might go blind. These fears were soon proved wrong and, ever since, people have strived to reach ever-greater speeds. On 26 May 1969, the Apollo 10 astronauts returning from their Moon mission zoomed to Earth at 39,937 km/h – around twelve times faster than a rifle bullet and more than thirty times faster than the speed of sound.

**FASTER THAN A SPACE SHUTTLE?** When diving through the air, the tiny Anna's hummingbird can fly a mind-boggling 385 body lengths per second (blps). Relative to its size, that's even faster than a space shuttle on re-entry into the Earth's atmosphere (207 blps).

Apollo 10: 39,937 km/h

Thrust SSC (the current holder of the official land-speed record, set in the Nevada Desert, USA in 1997): 1,227.98 km/h

North American X-15A-2 (fastest non-space aircraft of all time, 3 October 1967): 7,270 km/h

Bluebird CN7 car (broke the world land-speed record on 17 July 1964): 648.73 km/h

Japanese LO Series maglev (fastest passenger train, 21 April 2015): 603 km/h

Commercial aircraft cruising speed: 920 km/h

LNER class A4 no.4468 Mallard (fastest steam train, 3 July 1938): 202 km/h

Westland Lynx (fastest helicopter, 11 August 1986): 400.87 km/h

Peregrine falcon (when diving): 250 km/h

Gordino-Brillié motorcar, 1904: 160 km/h

Spirit of St Louis (flown by Charles Lindbergh on the first solo transatlantic flight, in May 1927): 200 km/h

Family car: 112 km/h

Although they can't fly, ostriches can run at speeds of around 72 km/h – faster than a racehorse.

Hindenburg zeppelin airship: 135 km/h

Cheetah: 95 km/h+

On 19 September 1783, the Montgolfier brothers demonstrated their invention, the hot-air balloon, to a crowd of dignitaries. Its first passengers were a duck, a rooster and a sheep called Montauciel (meaning 'climb-to-the-sky'). The first manned flight travelled 9 km and took 25 minutes: around 20 km/h.

Stephenson's rocket, 1829: 45 km/h

Wright Flyer, 1903 (the world's first successful heavier-than-air flying machine): 15.58 km/h

Benz Patent Motorwagon, 1885–1886 (the world's first automobile): 16 km/h

# POWERFUL CREATURES

## THE WORLD'S STRONGEST HUMANS

### PULL

On 5 July 2017, Reverend Kevin Fast broke the world record by pulling a vehicle weighing 99,060 kg. That's almost 600 times his body weight and equivalent to the weight of eight buses (84,000 kg) plus seven family cars (7,000 kg) and one light aircraft (5,670 kg).

### BACKLIFT

In 1957 it was claimed that Paul Anderson, one of the world's strongest people of all time, backlifted around 2,840 kg. That's the same weight as more than five polar bears.

### DEADLIFT

The world's strongest human in 2016, Eddie Hall, deadlifted a 500 kg bar above his head – about the same weight as one polar bear or a large grand piano.

## Mammals

For thousands of years, animals have been used for carrying or dragging heavy loads. They have ploughed fields, pulled wagons and carts, and transported people across deserts and mountains. But, when it comes to brute strength, the African elephant is the strongest of all land animals. A large bull elephant can carry as much as 9,000 kg – the same weight as around 140 people – and is able to lift logs weighing up to 300 kg using its trunk.

### POWER-LIFTING ANTS

Some species of ant can lift 50 times their own body weight using their powerful mandibles (jaws). If humans were as strong as an ant, they would be able to lift three family cars above their head.

## BUGS

### THE MIGHTY DUNG BEETLE

A species of dung beetle called *Onthophagus taurus* can pull 1,141 times its own body weight. That's equivalent to a person pulling six double-decker buses full of people.

### WORLD'S STRONGEST

A mite called *Archegozetes longisetosus* is only 1 mm long, but it can hold 1,180 times its weight using its tiny claws. Imagine carrying around nine elephants and you'll have some idea of what this mite can do.

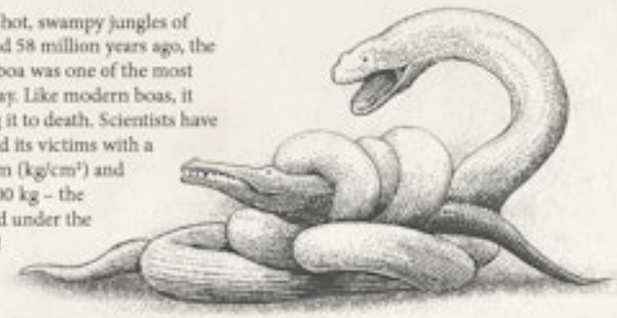
### OTHER CHAMPION WEIGHT LIFTERS

**Elephant** – can carry 9,000 kg (equivalent to 140 people)
**Gorilla** – can lift 2,000 kg (equivalent to 32 people)
**Ox** – can pull and carry 900 kg (equivalent to 14 people)



## DEATHLY GRIP OF THE TITANOBOA

Slithering through the hot, swampy jungles of South America around 58 million years ago, the 14-metre-long titanoboa was one of the most powerful predators of its day. Like modern boas, it killed its prey by squeezing it to death. Scientists have estimated that it constricted its victims with a force of 28 kg per square cm (kg/cm²) and a total force of up to 600,000 kg – the equivalent of being crushed under the weight of almost ten tanks!



## Powerful Jumpers

Thanks to their tiny but extra-powerful leg muscles, copepods can 'jump' through the water at a speed of 300–1,000 body lengths per second. That's equivalent to a 1.7 m-tall person leaping around 1,700 m in one second.

## Winged Creatures

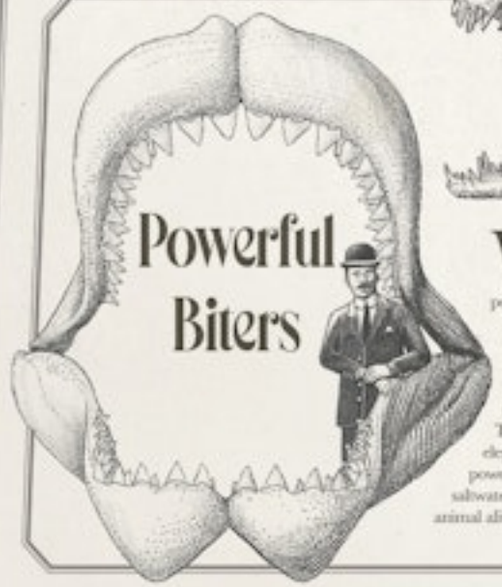
### TIGER OF THE SKIES

With its large legs and talons as big as a tiger's claws, the Haast's eagle was one of the most powerful birds that ever lived. It preyed on much bigger flightless birds like the giant moa, crushing the moa's pelvis with its feet. Experts say it may even have been capable of swooping down and killing a small child.

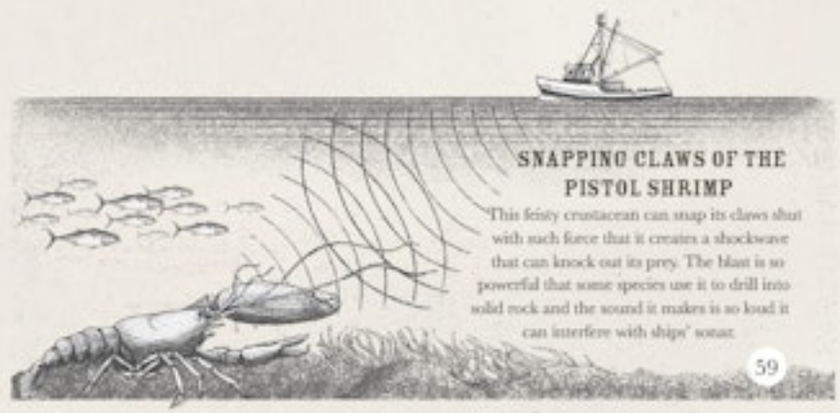
### AFRICAN CROWNED EAGLE

One of the strongest birds alive today, the crowned eagle can kill animals more than four times its own body weight.

## Powerful Biters



With an estimated bite force of more than 5,000 kg, the fearsome T.rex was the most powerful biter of any land animal. But this is nothing compared to the megalodon, which lived in ancient oceans around 16 million years ago. It is thought that these giant sharks could close their jaws around their prey with a force of about 18,100 kg. That's equivalent to four medium-sized elephants sitting down on the ground and powerful enough to crush a small car. The saltwater crocodile has the strongest bite of any animal alive today (around 1,600 kg).



### SNAPPING CLAWS OF THE PISTOL SHRIMP

This feisty crustacean can snap its claws shut with such force that it creates a shockwave that can knock out its prey. The blast is so powerful that some species use it to drill into solid rock and the sound it makes is so loud it can interfere with ships' sonar.

# HOW HEAVY?
## NATURAL WORLD

### OSTRICH EGG
WEIGHT: 1.4 kg

Ostriches lay the largest eggs of all living birds. One egg can weigh as much as 24 chicken eggs (57 g each), or two basketballs (620 g each).

### SUMO WRESTLER
WEIGHT: 265 kg

Weighing more than four times the weight of an average person, Ryuichi Yamamoto is thought to be the heaviest Japanese sumo wrestler of all time. Sumo wrestlers reach their gargantuan size by eating vast quantities of chankonabe – a type of Japanese stew.

### AFRICAN BUSH ELEPHANT
WEIGHT: up to 4.5–6 tonnes

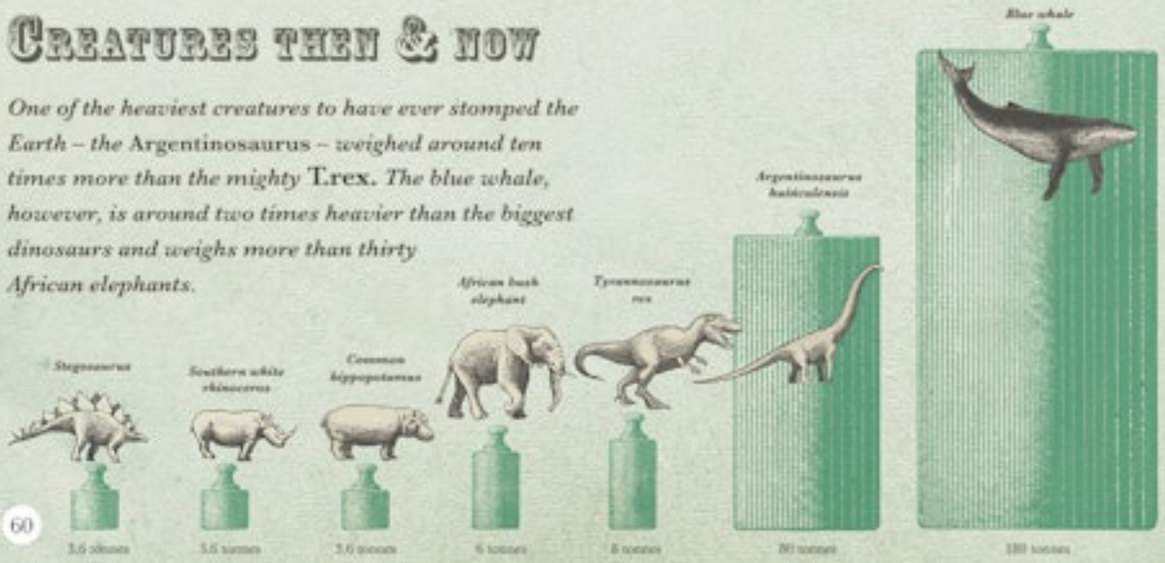
The biggest land mammal – the African bush elephant – weighs the same as around 100 people (with an average weight of 62 kg).

### BLUE WHALE
WEIGHT: up to 180 tonnes | tongue: 4 tonnes | heart: 180–680 kg

The heaviest animal on Earth grows to an estimated 180 tonnes – which is even more than four Boeing 737 planes (each weighing about 40 tonnes). Its tongue can weigh as much as an elephant and its heart as much as a small car. It feeds by taking in massive gulps of seawater full of krill, but, despite its size, it can't swallow anything bigger than a beach ball.

## CREATURES THEN & NOW

*One of the heaviest creatures to have ever stomped the Earth – the* Argentinosaurus *– weighed around ten times more than the mighty* T.rex. *The blue whale, however, is around two times heavier than the biggest dinosaurs and weighs more than thirty African elephants.*



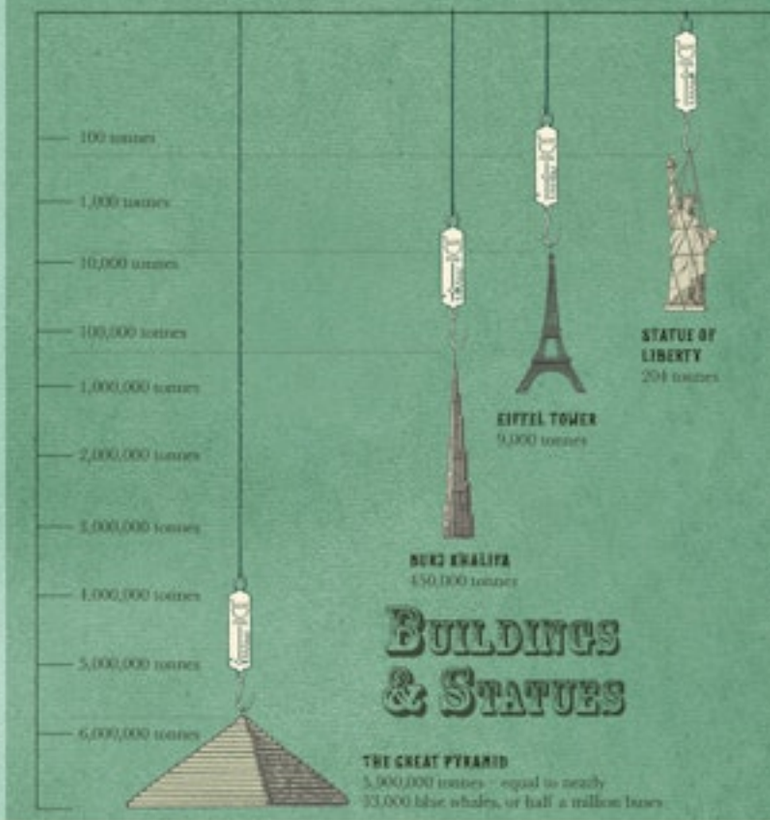



## THE WEIGHT OF THE WORLD

Scientists have concluded that Earth's mass is approximately **5,972,190,000,000,000,000,000,000 kg, or 5.9 sextillion tonnes.**

So, when we build really big things – a skyscraper, an oil tanker or a space rocket – do we make the Earth heavier? The answer is no. Humans and things are made with the matter that is already in the planet. All we're doing is simply moving atoms from one place on the Earth to another.

## BUILDINGS & STATUES




## PYRAMIDS & MEGALITHS

*Carved from stone hundreds and thousands of years ago, enormous monuments can be found in many countries around the world. Each giant stone had to be transported – sometimes hundreds of kilometres – before being heaved into position. Exactly how our ancestors managed to carry out these amazing engineering feats remains a mystery to this day.*

**GREAT PYRAMID OF GIZA, EGYPT**
**Built:** c.2580–2560 BCE
**Each stone block:** 2.5–15 tonnes

**STONEHENGE, WILTSHIRE, ENGLAND**
**Built:** c.3000–2500 BCE
**Heaviest stone:** 25–30 tonnes

**EASTER ISLAND STATUES, CHILE**
**Built:** c.CE 1100–1600
**Heaviest moai (statue):** 74 tonnes

## BUSES & SHIPS

The average bus weighs around 11 tonnes – the same as about three hippos.

One of the most famous ships ever built – RMS *Titanic* – weighed more than 46,000 tonnes and was the biggest moveable structure of its day. Scientists believe the mega-iceberg that sank the ship had a mass of around 1.5 million tonnes.

# HUMAN HISTORY *in a week*

*If we were to condense all of human history into a* **SINGLE WEEK** *– with the first Homo sapiens arriving in the first second of the first day – the Ancient Egyptian civilization would last just 2.5 hours and Neil Armstrong would take his first steps on the Moon at 2.5 minutes to midnight on the final day...*

**DAY 1**
00:00:01

**c.200,000 YEARS AGO**

First modern humans
*(Homo sapiens)*

**DAYS 1–6**

**c.200,000–9000 BCE**
Early humans live a nomadic lifestyle, scavenging or hunting wild animals like sabre tooth tigers and woolly mammoths. Stone tools are used for hunting, fishing, building shelters and making clothes.

**c.2560 BCE**
The Great Pyramids are built



**c.1200–500 BCE**
**Start of THE IRON AGE**

**DAY 7**
21:29

**1000 BCE**

**c.566–410 BCE**
Life of Buddha and birth of Buddhism

**DAY 7**
16:30

**9000 BCE**

**DAY 6**
23:00

**30,000 BCE**

**c.9000–3300 BCE • NEOLITHIC ERA**
People begin to live in settlements and learn how to grow crops. The first animals are domesticated for their milk, meat and hides. Farming tools, pottery and weaving are developed.

**c.31,000–28,000 BCE**
Some of the earliest known examples of rock art

**DAY 7**
22:19

**ca 1**

**c.570**
Birth of Mohammad and the rise of Islam

**THE FINAL HOUR**

**DAY 7**
20:39

**2000 BCE**

**c.1600–1046 BCE**
**CHINESE SHANG DYNASTY**
The first recorded Chinese dynasty. The earliest examples of Chinese writing are from this period.

**c.1100–146 BCE**
**ANCIENT GREECE**
The Ancient Greeks are famous for being great warriors, poets, politicians and philosophers.

**c.776 BCE**
The first ever Olympic games are held in honour of the Greek god Zeus.

**753 BCE–CE 476**
**ANCIENT ROME**
At their most powerful, the Romans ruled over much of Europe, North Africa and Asia.

**c.206 BCE**
Invention of the magnetic compass in Ancient China

**c.4 BCE–CE 30**
Life of Jesus

**c.CE 80**
Thousands of gladiators and animals are killed in the opening ceremonies of the Roman Colosseum.

**c.CE 105**
Invention of papermaking in Ancient China

**c.CE 250–900**
**MAYAN CIVILIZATION**

**c.476–1500**
**MIDDLE AGES**

**c.800**
Gunpowder is invented by the Chinese.

**c.800–1050**
**THE VIKING AGE**
The Vikings sail all over Europe and to the Americas in their longboats. Some raid villages and kill the local people. Others settle as farmers, fishers and artisans.

**DAY 7**
23:09

**CE 1000**

**DAY 7**
23:39

**CE 1600**

**CE 1596**
The first flushing toilet is invented by John Harington.

**CE 1532**
The Spanish begin a hostile takeover of the Incan Empire, leading to its destruction.

**DAY 7**
23:34

**CE 1500**

**CE 1519–1521**
Spaniard Hernán Cortés leads a violent expedition that overthrows the Aztec Empire, leading to further colonization of the Spanish in the Americas.

**CE 1492**
Christopher Columbus sails to the Americas, launching a wave of European colonization.

**CE 1440**
Invention of the printing press by Johannes Gutenberg.

**CE 1405–1433**
The Ming Dynasty admiral Zheng He sails to Asia and Africa, bringing back all kinds of objects including pearls, spices, camels, zebras and giraffes.

**DAY 7**
23:29

**CE 1400**

**1368–1644**
**MING DYNASTY**
The Chinese Ming finish the Great Wall and build a huge palace called the Forbidden City.

**c.1350–1600s**
**RENAISSANCE & THE AGE OF DISCOVERY**
Art, literature and new ideas about mathematics, philosophy and science flourish. Nations explore the world and discover new trade routes.

**1347–1351**
The Black Death kills around a third of the population of Europe.

**c.1325–1521**
**AZTEC EMPIRE**
A powerful nation with an advanced and innovative agricultural system.

**DAY 7**
23:24

**CE 1300**

**c.1700–1532 • INCA EMPIRE**
Gold was sacred to the Inca, who believed it came from their sun god. According to legends, the emperor of Cusco built an entire city with temples, buildings, plants and trees all made of gold.

**DAY 7**
23:44

**CE 1700**

**CE 1608**
Invention of the telescope by Hans Lippershey.

**CE 1620 • English**
pilgrims aboard the *Mayflower* arrive at Cape Cod, America.

**c.1680–1820**
**THE AGE OF ENLIGHTENMENT**

**CE 1776**
The American colonies gain independence from the British Empire.

**AD 1789**
French Revolution

**THE FINAL 10 MINUTES**

**DAY 7**
23:49

**CE 1800**

**1800s • INDUSTRIAL REVOLUTION**
The manufacturing of goods moves from small shops and homes to large factories. Many people move from the countryside to cities, and new technologies and types of transport are introduced.

**1885–1886**
The first automobile

**1903 •** The world's first heavier-than-air flying machine

**DAY 7**
23:54

**CE 1900**

**1914–18**
First World War

**1939–1945 •** Second World War; the first atomic bomb is dropped on the city of Hiroshima.

**1969**
The first human on the moon

**DAY 7**
23:59

**AD 2000**

**PRESENT DAY**
Robots are sent to Mars to look for signs of life.

# History of the Universe

If the whole lifetime of the universe were compressed into a single year, modern humans wouldn't arrive until eight minutes to midnight on the 31st of December – the very final day. The past 400 years would pass in the blink of an eye and a single human life would last just a fraction of a second.

**The calendar begins with the Big Bang on the 1st of January . . .**


On this scale:
Each day = 37.5 million years
Each hour = 1.56 million years
Each minute = 26,000 years
Each second = 434 years

**JANUARY**

**1 January, 12am – The Big Bang** (c.13.7 bya)

**1 January, 12:15am – The first neutrons form (400,000 years after the Big Bang)**

**19 January – First stars and galaxies begin to form (c.13 bya)**

**FEBRUARY**

**MARCH**

**APRIL**

**MAY**

**11 May – Milky Way galaxy is formed (c.8.8 bya)**

**JUNE**

**JULY**

**AUGUST**

**SEPTEMBER**

**1 September – Birth of our Sun (c.4.6 bya) and the formation of our Solar System (c.4.56 bya)**

**22 September – First simple life on Earth (prokaryotes) (c.3.8 bya)**

**OCTOBER**

**1–26 October – Photosynthesis and oxygenation of atmosphere (c.3.5–2.5 bya)**

**NOVEMBER**

**9 November – First cells with internal organs develop on Earth (c.2 bya)**

**DECEMBER**

**11–17 December – First multicellular life and simple animals: sponges, jellyfish, sea anemones and corals (c.800–580 mya)**

**18 December – First vertebrates (creatures with back bones) and trilobites, the first hard-bodied animals (c.520 mya)**

**19 December – First non-vascular land plants (without roots, stems or leaves) (c.470 mya) and first insects (c.479 mya)**

**20 December – First vascular plants (c.430 mya) and first fish with jaws, such as *Entelognathus* (c.419 mya)**

**21 December – First flying insects (c.400 mya) and first trees (c.380 mya). As plants grow taller, insects develop flight. By 300 million years ago, there are species of damselflies as big as a seagull.**

**22 December – First amphibians (c.360 mya). Animals develop adaptations for living on land as well as in water.**

**23 December – First reptiles (c.312 mya). Animals, such as the lizard-like *Hylonomus*, evolve to live entirely on dry land.**

**24 December – Mammal-like reptiles, such as the bizarre-looking *Edaphosaurus*, begin to thrive on land. They have chewed feet, sharp teeth, and large sails on their back (c.300–288 mya).**

**24–25 December – The continents join together in a supercontinent called Pangaea, allowing animals to roam more freely (c.299–272 mya)**

**26 December – The first dinosaurs evolve from reptiles (c.230 mya). Early types include the plant-eating *Plateosaurus*.**

**27–28 December – Jurassic period (c.201–145 mya). The high point of the dinosaurs. Species include *Allosaurus*, *Stegosaurus* and *Diplodocus*.**

**27 December – First 'true' mammals (c.160 mya). The earliest known placental mammals, such as the *Juramaia*, are small and shrew-like.**

**28 December – First birds evolve from small carnivorous dinosaurs (c.150 mya)**

**28–30 December – Cretaceous period (c.145–66 mya). The age of the giant dinosaurs and pterosaurs continues – including *Tyrannosaurus*, *Argentinosaurus*, *Triceratops*, *Iguanodon* and *Quetzalcoatlus*.**

**28 December – First flowers (c.130 mya). Thought to be one of the most important moments in the history of life on Earth. Green forests become filled with colour, and new species of insects, birds and animals flourish.**

**30 December – At 00:01 a huge asteroid or comet collides with Earth causing the mass extinction of 65–75 per cent of all species, including all non-bird dinosaurs and marine reptiles (c.66 mya). Mammals diversify and at about 16:00 the first mammals – such as the *Ambulocetus* (or 'walking whale') – take to the seas (c.50 mya).**

**THE FINAL DAY – 31 December**

**Mammals continue to diversify on land and at sea, and reach enormous sizes (giraffes, mammoths, whales).**

**18:54 – Expansion of grasslands around the world (c.8–3 mya)**

**20:10 – First human-like apes (c.6 mya)**

**21:26 – Early hominids first walk upright on two legs (c.4 mya)**

**22:24 – Ice Age begins, first use of stone tools, rise of megafauna (c.2.5 mya)**

**23:52 – *Homo sapiens* (c.200,000 ya)**

**23:57 – Human migration around the world (c.80,000 ya)**

**23:59 – Early cave paintings (c.33,000 ya)**

**THE FINAL MINUTE**

**23:59:33 – End of Ice Age (c.11,600 ya)**

**23:59:33 – Farming begins (c.10,000 ya)**

**23:59:45 – Wheel invented (c.5,500 ya)**

**23:59:48 – Stonehenge built (c.5,000 ya)**

**23:59:49 – Great Pyramids (c.4,500 ya)**

**23:59:55 – Colosseum built (c.2,000 ya)**

**23:59:58 – Columbus sails to the Americas (c.525 ya)**

**THE FINAL SECOND**

**In the final second humankind has invented the telescope, the microscope and the first flushing toilet. We have built palaces and skyscrapers; discovered penicillin and cured diseases; invented cars, trains, planes, the telephone and the internet. We have had revolutions and wars, dropped the first atomic bomb, put a human on the Moon and sent probes to the planet Mars!**

ya = years ago • mya = million years ago • bya = billion years ago

# Small Creatures and Microscopic Life

## Mammals

**Berthe's mouse lemur**
*Microcebus berthae*
Length: 9 cm (excluding tail)
Notes: Smallest primate. Lives in the forests of Madagascar and has very large eyes that help it to see in the dark.

**Bumblebee bat**
*Craseonycteris thonglongyai*
Body length: 2.9 cm | Forearm length: 2.2 cm
Notes: Smallest mammal by length. About the size of a large bumblebee, it is also known as the hog-nosed bat because of its distinctive snout.

**Baluchistan pygmy jerboa**
*Salpingotulus michaelis*
Length: 3.6 cm (excluding tail)
Notes: Smallest rodent. With long hind legs and large feet, it looks like a cross between a mouse and a kangaroo.

**Etruscan shrew**
*Suncus etruscus*
Length: 3.5 cm (excluding tail)
Notes: Weighs 1.8 g, making it the smallest mammal by mass. Has a huge appetite and can eat twice its body weight in food every day.

**Long-tailed planigale**
*Planigale ingrami*
Length: 5.5 cm (excluding tail)
Notes: Smallest marsupial. Has a wide, flattened head that it uses to burrow into small cracks in the soil to search for prey.

## Birds

**Bee hummingbird**
*Mellisuga helenae*
Length: 5.7 cm
Notes: Smallest bird. Drinks eight times its own body weight each day and weighs 1.6 g – about the same as three goose feathers.

## Molluscs & fish

x 100 zoom

**1 Water snail**
*Ammonicera minortalis*
Length: 0.32 mm
Notes: One of the smallest of all molluscs.

**2 Satomi's pygmy seahorse**
*Hippocampus satomiae*
Length: 13.4 mm
Notes: One of the world's smallest seahorses.

**3 *Pandocypris progenetica***
Length: 7.9 mm
Notes: The smallest known fish and vertebrate.



## Reptiles, amphibians & butterflies

**Dwarf gecko**
*Sphaerodactylus ariasae*
Length: 1.6 cm
Notes: The smallest reptile and smallest lizard.

**4 *Paedophryne amauensis***
Length: 7.7 mm
Notes: Tiny frog that lives in the rainforests of Papua New Guinea. No bigger than the average housefly, it is the smallest known amphibian.

**5 Western pygmy blue**
*Brephidium exilis*
Wingspan: 12 mm
Notes: One of the smallest butterflies in the world.

## Microorganisms

Microorganisms are so small that we can only see them with a microscope. They live all around us – in the soil, in the oceans, in the air, on our skin and inside our bodies. Many are harmless, but some are deadly.

**6 Fairyfly or Fairywasp**
*Dicopomorpha echmepterygis*
Length: 139 microns (0.139 mm)
Notes: Parasitic wasp that lives inside the eggs of other insects. Smallest known insect.

x 100 zoom

**7 *Pelagibacter ubique***
Length: 0.37–0.89 microns (0.00037–0.00089 mm)
Notes: One of the smallest free-living bacteria. More than 5,000 of them could fit on a single grain of sand.

x 50,000 zoom

**Diatoms (various species)**
Length: Typically between 2–500 microns (0.002–0.5 mm)
Notes: Microscopic algae that live in nearly every habitat where water is found. They are eaten by all kinds of animals from tiny microorganisms to fish and whales. Hundreds of them could fit on a single grain of sand.

x 500 zoom

### How small is an atom?

Everything in the universe – from the tallest tower to the smallest microorganism – is made up of tiny things called atoms. They are the building blocks of all matter and they are very, very small. They are around a million times smaller than the thickest human hair and are so small that if the atoms in an apple were enlarged to the size of an apple, the apple itself would be as big as the Earth.


Radius of a typical atom: 100 picometers (0.0000001 mm)

# Stars and Galaxies

## Stars

Stars come in all different sizes and colours, from red dwarfs and neutron stars to blue and red supergiants – the biggest stars in the universe. Our star – the Sun – is at the centre of our Solar System. Without its heat and light, no life could survive on Earth.

## Giant Stars

Our Sun is the largest object in our Solar System, but compared to some stars it is no bigger than a fleck of dust. The biggest stars in the universe are the monster red supergiants – dying stars that have bloated to many times their original size. Eventually they will explode and become neutron stars or black holes.

## Smallest Stars

*(The numbers in brackets show the solar radii. 1R = Radius of the Sun)*

**Sun**
(main sequence star)
Radius: 695,700 km
Our Sun is a main sequence star – one of the most common types of star. It is fuelled through 'nuclear fusion'; as its hydrogen atoms crash together they become helium and produce energy.

**Rigel**
(blue supergiant)
Radius: 54,790,000 km (78R)
Blue supergiants are the hottest and brightest stars in the universe. Rigel is more than 70 times bigger than the Sun and emits 60,000 times more light.

**Pollux**
(red giant)
Radius: 6,122,160 (8.8 R)
As a star like our Sun runs out of fuel it grows bigger and redder, turning into a red giant. Eventually it will collapse and become a white dwarf.

Sun

Rigel

**Betelgeuse**
(red supergiant)
Radius: 870,926,000 km (1,180 R)
This supergiant is more than a thousand times wider than our Sun.

**UY Scuti**
(red supergiant)
Radius: 1,182,690,000 km (1,700 R)
The biggest known star by radius is more than 1,700 times the size of the Sun. If Earth were shrunk to the size of a marble, the Sun would be the size of a child and UY Scuti would be taller than two Burj Khalifa skyscrapers.

Around the Earth on a rocket: 1 hour

**2MASS Jo523-1403**
(red dwarf star)
Radius: 59,830 km (0.086 R)
Red dwarfs are main sequence stars like our Sun, but are smaller and cooler.

**Jupiter**
Radius: 69,911 km (0.1 R)
The biggest planet in our Solar System

**Earth**
Radius: 6,371 km
(0.009 R)

**Neutron star**
(Not visible on this scale)
Measuring as little as 20 km across, neutron stars are the smallest stars known to exist.

**Sirius B** (white dwarf star)
Radius: 5,844 km (0.0084 R)
As an average star like our Sun dies, it becomes a white dwarf – a small, hot and very dense star.



### *Death of a Star*

As a massive star nears the end of its life it explodes as a supernova – an explosion so big that it briefly shines more brightly than an entire galaxy.

A star that is born 8–20 times more massive than the Sun ends its life as a neutron star.

As it explodes, the star's core is squashed down into a tiny ball known as a neutron star. It is so dense that one cubic cm might weigh around a billion tonnes. That's the mass of Mt Everest, but squeezed into a space the size of a sugar cube.

A star that is born at least 20 times more massive than the Sun ends its life as a black hole.

The star's core is compressed into a space no bigger than an atom and its gravitational pull is so strong that nothing can escape it – not even light.

### *To the Edge of the Universe*

Scientists have estimated that the observable universe – in other words the part that we can see – has a diameter of 93 billion light years. Our Milky Way would fit inside it 10 million million million (10,000,000,000,000,000,000) times.

Across the known universe on a rocket: 2.5 quadrillion (2,500,981,500,000,000) years

Milky Way

### *How Big is the Universe?*

So how big is the entire universe? No one really knows if the universe stretches on forever, or even if ours is the only universe that exists.

## Galaxies

Until a hundred or so years ago, few people imagined that anything existed beyond our galaxy – the Milky Way. We now know that it is just one of billions of galaxies in the universe. Some are very small. Others are much, much bigger than our own.

### *Galaxies Compared*

**Messier 33**
(spiral galaxy)
Diameter:
50,000 light years

Across the Milky Way on a rocket: 2.7 billion (2,699,980,203) years

**Milky Way**
(spiral galaxy)
Diameter:
100,000 light years
There are around 200 billion stars in the Milky Way.

**Andromeda**
(spiral galaxy)
Diameter: 220,000 light years
Our nearest galaxy.
Andromeda is expected to collide with the Milky Way in around 4.6 billion years to form a giant elliptical galaxy.

**IC11-01**
(super giant elliptical galaxy)
Diameter: 6,000,000 light years
Over billions of years, galaxies like our Milky Way have collided and merged together to form this super galaxy. It is around 50 times wider than the Milky Way and may contain as many as 100 trillion stars.
At its centre is a supermassive black hole.