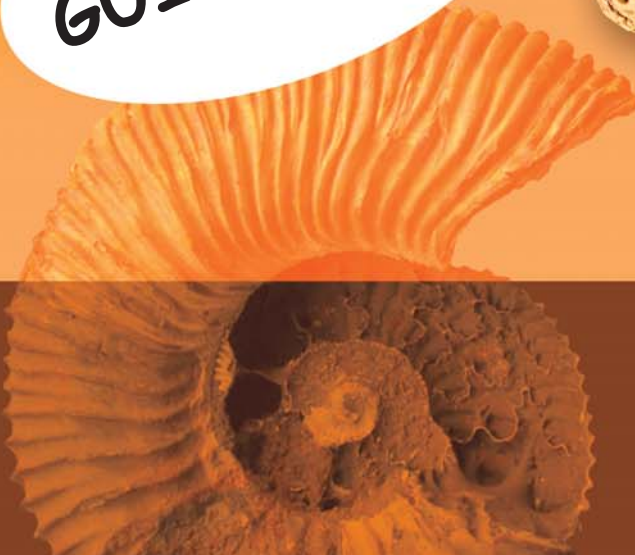
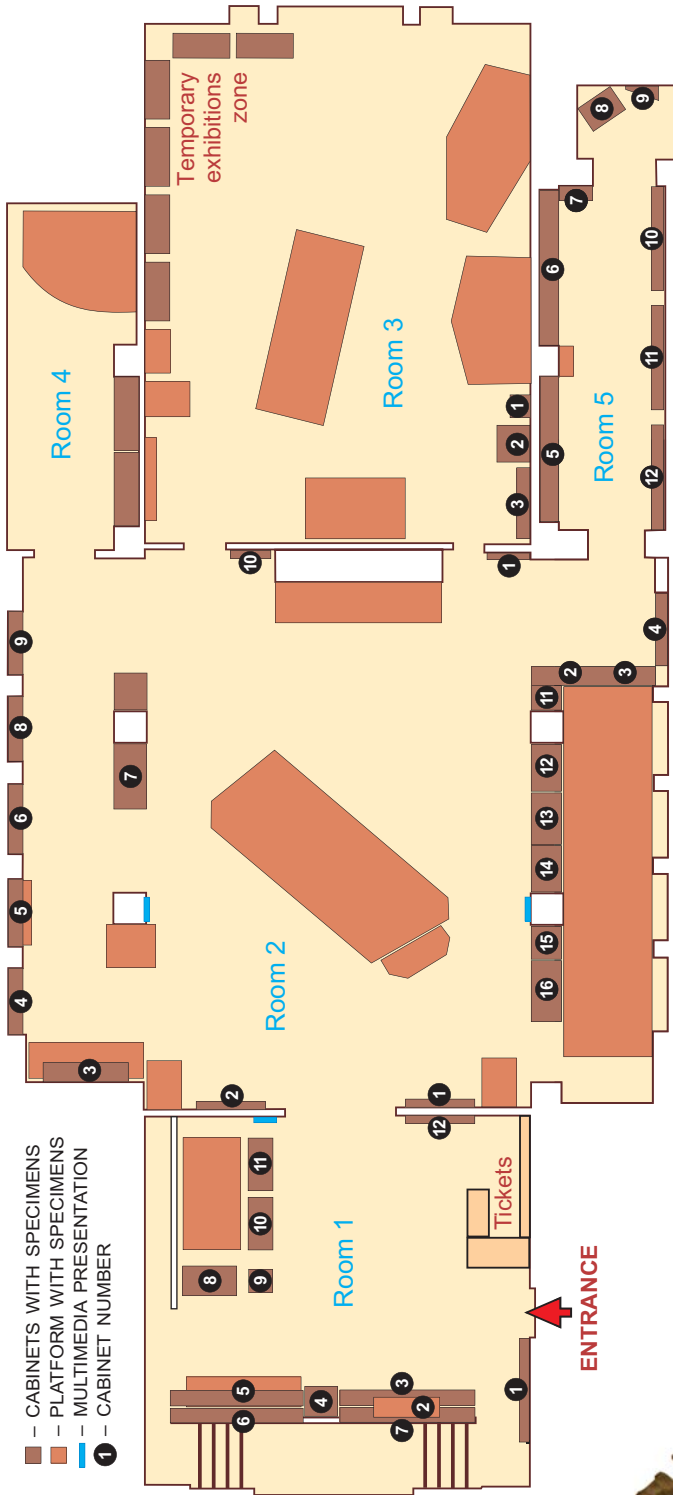


# MUSEUM OF EVOLUTION

## INSTITUTE OF PALEOBIOLOGY PAS

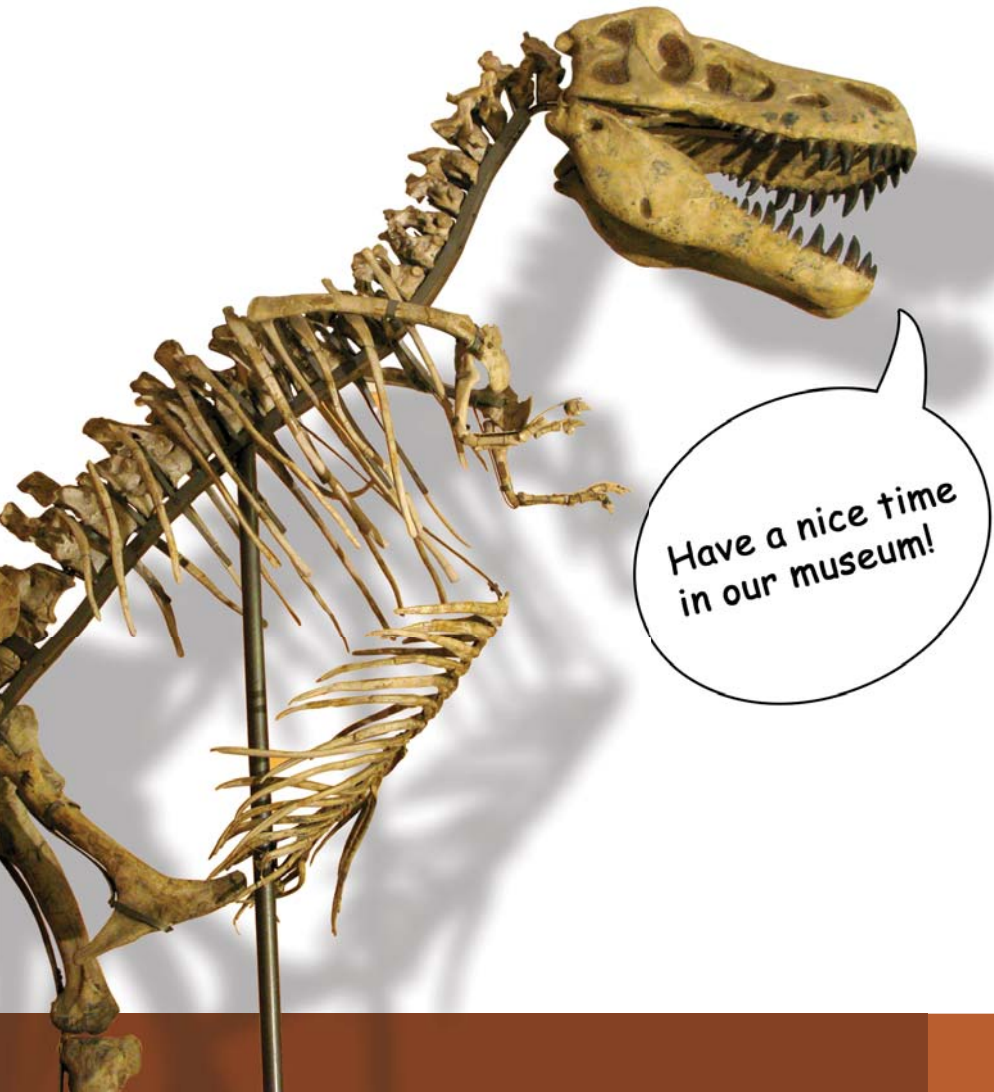
**GUIDEBOOK**





# Museum of Evolution Guidebook

This guidebook offers short descriptions of cabinets and large specimen in our exhibition. Each cabinet has a different number attached to its frame. The cabinets' descriptions are arranged according to these numbers in successive rooms.





## Room 1

### Cabinet 1

**The origins of life.**—The planet Earth formed about 5.0–4.5 billion years ago, as estimated by cosmologists. Life could have emerged after the heavy bombardment by meteorites ended, about 3.8 billion years ago. It is hypothesised that the complex DNA-based life, as we know it today, was preceded by organisms using RNA to catalyse life processes and as a medium of data storage, which did not require the genetic code. The first controversial traces of anaerobic life activity on Earth date from 3.8–2.0 billion years ago. The emergence of cyanobacteria, producing oxygen as a by-product of their photosynthesis resulted in development of the oxygen-rich atmosphere about 2.5–1.6 billion years ago. Sticky microbial mats growing in shallow waters were binding mineral grains and, as a result, building large layered structures—stromatolites. This initiated evolution of eukaryotic organisms, that is plants and animals with mitochondria in their cells enabling oxygenic physiology. Close to the beginning of the Cambrian period (about 550 million years ago) animals began to develop mineral skeletons which are easily fossilised.

In the cabinet there are stromatolites, imprints of cyanobacterial rolling balls and large pre-Cambrian animals lacking mineral skeletons, as well as traces of life activity of earliest Cambrian worms.

### Cabinet 2

**Latimeria.**—Latimeria is the only extant representative of a unique group of fish—the coelacanths that, together with lungfish, are the closest relatives to tetrapods (amphibians, mammals, reptiles, birds and others). As an adaptation to life in relatively deep marine environments Latimeria lacks lungs and has reduced skull bones, which makes it rather unlike the actual ancestor of tetrapods. The unusual anatomy and mode of locomotion of coelacanths developed in the late Devonian, about 360 million years ago, and has not substantially changed since that time.



### Cabinet 3

**Vertebrate conquest of land.**—Early life developed mainly in water. Also vertebrates were initially aquatic animals. During the Devonian period they diversified greatly. One of the groups of fish (related to modern lungfish and lobe-finned fish such as the coelacanths) gave rise to the tetrapods, i.e., land vertebrates, about 380 million years ago. Although the large, early labyrinthodonts died out in the Mesozoic Era, they gave rise to extant frogs and salamanders.

In the cabinet, pay attention to *Ichthyostega*—a labyrinthodont, one of the first tetrapods in the fossil record. It has developed the neck and fingers on the limbs.

You can find more at the exhibition “Who gave me legs” in Room 4.

### Cabinet 4

**Scutosaurus.**—*Scutosaurus* is a pareiasaur, one of the largest Late Permian reptiles that had a peculiar bipolar distribution, being known from South Africa and northern Russia. The plaster cast skull in the exhibition was taken from a specimen collected by Vladimir P. Amalitzky, professor of the University of Warsaw, during his expeditions to the Northern Dvina region of Russia in 1895–1913 (the originals are now in Moscow)

### Cabinet 5

**Limnoscelis paludis.**—An Early Permian tetrapod from North America with its vertebrae resembling those of the reptile lineage but dentition of labyrinthodont amphibian aspects. Probably it is a distant relative of pareiasaurs. There is no evidence regarding its biology but it was probably transitional between amphibians and reptiles.

### Cabinet 6 and 7

**Marine amniotes.**—Ancient seas were ruled by many creatures of impressive size and anatomy. The ichthyosaurs and plesiosaurs were among the most successful of them. Both groups evolved from small reptiles living and reproducing on the land.

Although very similar to modern dolphins, the ichthyosaurs are not related to them. Ichthyosaurs were reptiles, whereas dolphins are mammals.



Thus, both groups evolved their peculiar body plan independently. This is a case of convergent evolution—independent origin of traits with a similar function.

The plesiosaurs were unlike anything that lives today. They had relatively long paddle-like limbs and jaws with long and slender to short and massive teeth. Some plesiosaurs, such as *Elasmosaurus*, had extremely long necks, superficially similar to those of the sauropod dinosaurs. Others, the pliosaurs, had short necks and massive skulls.

Ichthyosaurs and plesiosaurs were predators hunting on fish, invertebrates, and even other marine reptiles. Ichthyosaurs became extinct in the early Late Cretaceous. The last plesiosaurs died out at the end of the Cretaceous.

## Cabinets 8–11

**The lake of Krasiejów.**—One of the Europe's largest cemeteries of Triassic organisms is in Krasiejów (south west Poland). In the Late Triassic (approximately 225 million years ago) all the continents were combined into a single supercontinent, Pangea. A river meandered through the territory which is now Silesia. From time to time, this area was being flooded, and a freshwater lake formed and locally desiccated, in which remains of dead animals accumulated. Krasiejów is located where its southern shore was. The exceptional state of fossil preservation is caused by the calcium, brought from the Sudetes region by the river, which inhibited the decomposing activity of the humic acids.

In the Krasiejów lake there lived large amphibians, *Metoposaurus krasiejowensis*, and distant relatives of crocodiles—phytosaur. Their skeletons (original specimens) can be seen in several cabinets around the diorama.

## Cabinets 8–10

***Paleorhinus*.**—*Paleorhinus* (also called *Parasuchus*) is a member of the reptile group Phytosauria. These peculiar reptiles existed during the Late Triassic (around 230 to 200 million years ago). Although very similar to crocodiles, the phytosaurs are only distantly related to them. They differ in lacking bony palate and nares located close to their eyes. The fossils belonging to *Paleorhinus* were discovered at Krasiejów, a fossil site located near Opole, southern Poland.



## Cabinet 11

*Metoposaurus krasiejowensis*.—Metoposaurs were fully aquatic labyrinthodont amphibians. They are related to the ancestors of modern frogs, and they rarely, if ever, left the water. Unlike other large labyrinthodonts they had eyes located near the front of the head. They lived in Late Triassic in America, India, Africa, and Europe. In Krasiejów, numerous skulls and other parts of skeleton were found.

## Cabinet 12

**The origin of mammals.**—Mammalian evolutionary tree shows the appearance of the mammalian characters in succession of fossil forms. Exhibited are the Permian mammal-like reptiles, which evolved mammal-like teeth, probably fur and perhaps mammary glands, and more advanced Triassic cynodonts, the first to have the secondary palate. In the next stages of evolution the number of teeth replacements was one (from milk to permanent teeth), then three auditory ossicles developed by modification of the original reptilian jaw joint into the much simpler mammalian one.



*Metoposaurus krasiejowensis*  
from Krasiejów, Poland



## Room 2

### Center

*Nemegtosaurus mongoliensis* (*Opisthocoelicaudia skarzynskii*).—At about 15 metres long, this herbivorous sauropod is the largest dinosaur from the Cretaceous of the Gobi Desert. Its forelimb phalanges and wrist bones are reduced and most of its tail was stiff. The skeleton, lacking the skull and neck, was discovered in 1965 in the Nemegt Formation of Altan Ula by Polish-Mongolian paleontological expedition. The reconstruction combines this skeleton named *Opisthocoelicaudia* with the earlier found skull named *Nemegtosaurus mongoliensis* but probably belonging to the same species.

### Cabinet 1

**Plant history.**—Plants have conquered the lands in the Paleozoic Era. Initially minuscule and restricted to the humid coastal regions, they started forming forests already in the Devonian. In the Carboniferous the pteridophytes (tree ferns, clubmosses and horsetails) participated in deposition of the coal deposits. Later the gymnosperms (e.g., the conifers, ginkgoes and cycads) took over the reign, thanks to lesser dependence on water during fertilization. At the end of the Mesozoic Era angiosperms (flowering plants) gained the importance—partly due to the effectiveness of pollination by insects.

### Left side

*Stegosaurus.*—The reconstruction of the *Stegosaurus* is according to the state of knowledge from the 1960s. This powerful dinosaur, reaching up to 9 metres in length and estimated 5 tons in weight, is one of the most easily recognisable due to the plates on its back and four spikes at the end of its tail. The arrangement of the plates is hypothetical. They were not attached to the underlying skeleton but anchored in the skin, and are therefore always found scattered. Initially it was thought that they were lying flat, imbricated on the back of the animal. Later found fossils have changed this view, but so far it is not known whether the plates were arranged in two parallel rows, or one median zig-zag, slightly overlapping. It is believed that the back plates were used for heat regulation; they might have also played a role in mating. Spikes on the tail probably were used for defence.





## Cabinet 2

**Reptile evolution.**—All the extant reptiles belong to groups that diverged during the Mesozoic Era—turtles, sphenodonts, lizards, snakes and crocodiles. Their ancestors and extinct cousins lived in the epoch of the dinosaurs. In this cabinet, showing the evolution of reptiles, a skeleton of a Late Cretaceous lizard and a shell of a turtle from the same period are shown. The skull of the recent crocodile can be compared with that of the giant Cretaceous *Sarcosuchus* in Room 3.

## Cabinet 3

**Armoured dinosaurs (Ankylosauria).**—These are massive dinosaurs with bony armour on their backs. During their evolution the bony plates in their skin were fused with bones of the skull, forming a unified armour. They were herbivorous, as evidenced by their serrated teeth. From the Late Cretaceous of the Gobi Desert several species are known:

*Pinacosaurus grangeri*—the oldest Mongolian armoured dinosaur with a massive mace at the end of the tail.

*Saichania chulsanensis*—an armoured dinosaur with massive armour not only covering the back but also sides of the body and belly.

*Tarchia gigantea*—the largest armoured dinosaur from the Gobi Desert (8 metres long).

## Cabinet 4

**Pachycephalosaurs (Pachycephalosauria).**—These herbivorous bipedal dinosaurs are characterised by a thickened skull roof, in some species up to 17 centimetres thick. Most likely, heavily arched skull, like in modern bovids, could be used for fighting by males during mating and for attacking predators. The group was geographically widespread and very diverse. From the Gobi Desert both the unusual flat-headed pachycephalosaurian *Homalocephale* and more advanced *Pachycephalosaurius* are known.

## Cabinet 5

**Protoceratops (Ceratopsia).**—This is an early horny dinosaur. Numerous skeletons found in the Djadokhta formation at the Bayn Dzak, Gobi Desert, enabled tracing its ontogeny. It has been suggested that the wide neck frill, high



skull, and horn on the nose are characteristic of the male; the female was likely lacking the horn and the frill. Accumulations of skeletons suggest that *Protoceratops* lived in herds. In the same strata skeletons of predatory *Velociraptor* were found. As other small herbivores, *Protoceratops* was often their victim. One of the most famous fossils, “fighting dinosaurs”, consists of *Protoceratops* and *Velociraptor* skeletons interlocked.

## Cabinet 6

**Duck-billed dinosaurs (Hadrosauridae).**—Duck-billed dinosaurs consist one of the best known groups of dinosaurs, known from many skeletons at all stages of development, from eggs and chicks in nests to adults. Among them the lambeosaurines possessed various crests on their skulls, shaped like fancy hats or horns. It is thought that these structures played the role of resonance chambers, and were used for communication. In the cabinet there is a jaw of *Saurolophus* full of tightly aligned teeth, forming batteries used for pulping plant food. The whole copy of skeleton of *Saurolophus* is exposed on the wall with cabinet 10.

## Cabinet 7

**Eggs.**—Through emergence of the shell, which protects eggs from drying out, and the abundant supply of yolk, reptiles could colonize the land. Usually 30 eggs were laid in the nest of dinosaurs (we do not know what species). They were often arranged in pairs, which means that they were laid simultaneously from two oviducts.

The oldest reptilian eggs date from 210 million years ago (late Triassic). The oldest dinosaur eggs, found in South Africa, have been laid about 190 million years ago by a prosauropods *Massospondylus*. The Gobi Desert yielded many nests of dinosaurs. One of the most interesting discoveries is a sand-covered breeding colony of oviraptors. The position of a skeleton found on one of the nests proves egg brooding.

## Cabinet 8

**Flying reptiles.**—Even though insects already mastered flight in the Carboniferous, it was not until the Triassic that the first flying vertebrates appe-



ared. They were the flying reptiles, the pterosaurs, with membranous wings stretched by the elongate fourth finger. Initially, they had teeth and long bony tails, but later in the Mesozoic toothless and tailless forms appeared. For nearly 150 million years the pterosaurs dominated the skies, colonizing every continent, inhabiting coasts, forests, mountains and even deserts. It is possible that they formed herds and breeding colonies, as indicated by fossils found in Chile. Teeth of most early pterosaurs suggest that they hunted fish. Small pterosaurs probably later adapted to become insectivores and larger species might have been scavengers. About 120 species of pterosaurs have been identified, including a great variety of forms and sizes. The smallest of them were the size of a sparrow (*Nemicolepterus crypticus* had wingspan of 25 centimetres) and the largest—of a small glider (*Quetzalcoatlus*—wingspan of 12 metres).

Exhibited are plaster casts of two rhamphorhynchoids from the late Jurassic of Solnhofen, Bavaria, characterized by a long tail and rather short bones of the forelimbs. The associated short-tailed pterodactyloid is among the first described pterosaurs, over 200 years ago.

## Cabinet 9

**Mesozoic birds, evolution of flight.**—Independently from the pterosaurs, birds conquered the air owing to their feathered wings. The late Jurassic bird *Archaeopteryx*, 145 million years old, still has toothed jaws and a long tail—traits of small predatory dinosaurs (such as its contemporary *Composognathus*). Discovered soon after the publication of Darwin’s “On the Origin of Species” (1859), it became one of the most famous “missing links” predicted by the theory of evolution.

*Archaeopteryx lithographica*—the first fossils of *Archaeopteryx* were found 150 years ago, and proved it to be “transitional link” between the dinosaurs and the birds. Recent discoveries have shown that there are more stages in the evolution from arboreal reptiles to birds. They are evolutionarily more primitive forms, which also had the hind legs turned into wings. Structures resembling feathers appearing in many dinosaurs proves dinosaurs belong to the evolutionary branch leading to birds.

In the same room skeletons of giant secondarily flightless birds can be found—the moa (*Dinornis*) and *Gastornis* (= *Diatryma*).



## Cabinet 10

***Lambeosaurus***.—The crests of lambeosaurines have given rise to a number of hypotheses. They could contain salt glands, olfactory organs, a helpful resonance chamber, and even air supply used during diving. Most likely these were resonance chamber, perhaps also an element of sexual dimorphism.

***Barsboldia sicinski***.—This is probably one of the largest known hadrosaurs discovered in 1970 during the Polish-Mongolian expeditions to the Gobi Desert—it could be up to 12–14 metres long.

## Cabinet 11

**Marine fauna from Cretaceous excavated in Kazimierz Dolny**.—These are Cretaceous marine invertebrates from Poland: mollusks (ammonites, gastropods, bivalves, and belemnites), brachiopods and sponges loaned from the nature museum in Kazimierz Dolny.

## Cabinet 12–16

**Terrestrial fauna and flora of Krasiejów**.—The Triassic floods deposited carcasses of dead terrestrial and amphibious animals in a temporary lake. The diorama shows the flora and fauna of the Triassic Krasiejów land from before 230 million years, and the skeletons in cabinets (original specimens).

## Cabinet 12 and 13

***Ozimek volans***.—Above head of Krasiejów terrestrial reptiles glide *Ozimek volans* with elongated neck and very thin limbs boned. On its skeleton in cabinet 12 you might see its elongated cervical vertebrae and bones of leg which are empty inside.

***Silesaurus opolensis***.—This was a small and agile reptile, adapted both to quadrupedal and bipedal running. Its dentition suggests that it was herbivorous or omnivorous. In the front of its jaw *Silesaurus* had a beak with a horny sheath. Several anatomical features put it close to the root of dinosaur evolutionary lineage.



## Cabinet 14

**Aetosaurus.**—These were omnivorous reptiles equipped with a dermal armour of bony plates on their backs. Fossil skulls of the Krasiejów species *Stagonolepis olenkae* enabled reconstruction of its brain, showing presence of big, well developed olfactory lobes. Most probably it depended on smell in searching for soil invertebrates and underground tubers as the main source of food.

## Cabinet 15

**Rauisuchians.**—The biggest predators from Krasiejów were rauisuchians of the species *Polonosuchus silesiacus*. Although these were distant relatives of crocodiles, they had skulls similar to those of the later predatory dinosaurs. *Polonosuchus* fossils are rare—so far only a single, incomplete skeleton has been found.

## Cabinet 16

**Capitosaurs.**—The capitosaur *Cyclotosaurus intermedius* was relative of the labyrinthodont amphibian *Metoposaurus*, common in Krasiejów. The Krasiejów species is intermediate in anatomy and geological age between two species known from Germany. Although related to frogs, *Cyclotosaurus* lived much like a crocodile. It was carnivorous and mostly terrestrial, as indicated by a weak development of the lateral line on the skull roof.



*Ozimek volans* from Krasiejów, Poland



## Room 3

### Right corner and center

*Tarbosaurus bataar*.—This great predatory dinosaur (Theropoda) lived in the late Cretaceous (Campanian–Maastrichtian) of Mongolia. It was a close relative to the North American *Tyrannosaurus rex*. The first specimen were discovered by Russian paleontologists but now there is about a hundred individuals in museums worldwide.

On the museum floor there is a skeleton of a juvenile *Tarbosaurus* cast in plaster before the bones were excavated from the rock. These original bones are mounted in a standing straight pose with the tail dragging, according to the convention followed in the 1960s. The large skeleton reconstruction in the room centre is based on the hind legs exhibited on the left wall and other isolated original bones in the collection. It is presented in a dynamic pose, with its torso horizontal and tail held high, in compliance with modern evidence.

### Between the doors

*Deinocheirus mirificus*.—The arms of *Deinocheirus* with a total length of 2.4 metres and 25 cm-long claws, and partial ribs with vertebrae were found during the Polish-Mongolian expedition in 1965 in the Nemegt Valley of the Gobi Desert. The Nemegt Formation in which the fossils were preserved is about 70 million years old. The remains of *Deinocheirus* were so incomplete, that the paleontologists for a long time could only speculate on its mode of life. Some suggested that *Deinocheirus* was a predator and used its long front limbs to tear the prey. Others said that the claws are too blunt to kill and could be used only for defense.

The new discoveries (in 2014) of almost complete skeletons by Korean paleontologists confirmed what many scientists had suspected: *Deinocheirus* was one of the ostrich-like ornithomimosaur. It reached 11 meters in length and probably up to six tons in weight. It was not a ferocious predator, though. It could not move quickly or bite strongly, and most importantly of all, its long, duck-like snout had no teeth. In fact, bite marks on the original bones suggest that it was a prey of *Tarbosaurus*.



### Cabinet 1

**Dinosaur claws.**—The cabinet shows the claws of predatory and herbivorous dinosaurs. Note the differences in their construction. The long, sharp claws were used for hunting or holding the victim. Some herbivorous dinosaurs could use their claws to scramble through branches during feeding. The biggest claw belonged to herbivorous *Therizinozaurus*. The long, sharp claws perhaps facilitated food intake or were used for defense against predators.

### Cabinet 2

***Sarcosuchus imperator*.**—That Late Cretaceous giant river crocodile originated in the Tenere region of Niger. The skull is 1.78 metres long, and the body reached length of 12 metres. Compare with the mandible of an extant Nile crocodile. *Sarcosuchus* fed on big fish and possibly dinosaurs coming to the waterhole.

### Cabinet 3

***Coelophysis*.**—A cast of the skeleton is displayed here. This Late Triassic dinosaur was found in 1947 in the USA state of New Mexico. Due to the occurrence of small reptile bones in the abdominal region, *Coelophysis* was thought to be cannibalistic. Re-examination of his remains, using modern techniques, showed that the bones in the gastrointestinal tract in fact belonged to a small crocodile.

**Dinosaur tracks.**—On the basis of tracks scientists can learn about the life of dinosaurs and study the way they moved, cared for their young and behaved socially. Also, thanks to tracks we know that some dinosaurs were feathered. Analysis of footprints helps to reconstruct the layout of the bones in the foot.



*Deinocheirus mirificus*  
from Gobi Desert



## Room 4

### “Who gave me legs”

**The conquest of land by vertebrates.**—Before life appeared on land, it existed in the aquatic environment. The arthropods conquered the lands first. The starting point for the development of tetrapod limbs were fins of Sarcopterygii (lobe-finned fish), which contain most of the bones that primitively build limbs of tetrapods (amphibians, reptiles, mammals and birds). For a long time the only link between the fish and the amphibians was *Ichthyostega*, but subsequent discoveries brought some other transitional forms, i.e. *Tiktaalik* and *Panderichthys*.

The central part of the exhibition is the reconstruction of the Late Devonian (375 million years ago) lake. The lands were then covered with forests formed by *Archaeopteris*—the fern-like ancestor of gymnosperms. Oxygen deficiency and perhaps low tides promoted air-breathing amphibious fishes in the coastal waters, such as the sarcopterygian *Tiktaalik*, which was able to use its muscular pectoral fins to lift up its body to draw oxygen from the air. Just like the Atlantic mudskipper today, tiktaalics could leave water and crawl on land, probably in search of food.

There is a fossil fern wood and casts of *Acanthostega* and *Ichthyostega* and a variety of extant tetrapods (Tetrapoda) in the cabinets next to the diorama.



*Tiktaalik roseae* from the Canadian Arctic





## Room 5

### Cabinet 1

**Mammals during the age of the dinosaurs.**—The development of three auditory ossicles was a breakthrough in the evolution of mammals. Their subsequent evolution step was directed towards reduction of the number of the main cusps on their teeth to three and development of the ability to chew their food. The modern morphology of mammalian teeth emerged during the Cretaceous.

**Multituberculates.**—Mammals living in the shadow of great reptiles were of small sizes. The omnivorous multituberculates had several rows of tubercles on their molars and ground food through longitudinal movements of the mandible. As shown by their narrow pelvis, they were viviparous. The Cretaceous stage in the evolution of mammals is relatively well-known thanks to numerous findings from the Gobi Desert and research by Zofia Kielan-Jaworowska (1925–2015).

### Cabinet 2

**Monotremes.**—This group of mammals is a relic which is present only in Australian realm today. Anatomy of both platypus (*Ornithorhynchus anatinus*) and echidna (*Tachyglossus*) is very specialized. Its genital and urinary ducts open to the final section of the intestine distinguishing them from placental mammals (except for tenrecs). Monotremes are the only oviparous extant mammals. The young are fed by licking milk from the mammary glands located on their mother's stomach. Extant platypus has only primary dentition, although his ancestor *Obdurodon* had permanent teeth as well. Platypuses have a venom-producing spur, active only in males. They differ from the Mesozoic monotremes in the structure of molars. Monotremes diverged from the lineage of mammals and developed only on Gondwana.

### Cabinet 3

**Marsupials.**—The present-day marsupials differ from placental mammals in a short duration of pregnancy. Immediately after the birth, the tiny young crawls up to the mother's pouch and continue development there, being permanently



attached to her nipple. They have larger number of molar teeth than placentals and tooth replacement restricted to just one location (third premolar). Such pattern of permanent premolars eruption is known since the late Cretaceous but it is a matter of dispute when exactly the lineages of placental and marsupial mammals split to begin independent evolution of gestation.

In the cabinet there is a rare specimen of the wolf-like marsupial—Tasmanian wolf (*Thylacinus*), which became extinct in 1936, due to hunting and competition with the dingo.

#### Cabinet 4

**Placentals.**—Most mammals belong to this group. In contrast to marsupials they extended the length of pregnancy and formed a more elaborate placenta complex, so their young comes to the world as an almost fully developed animal. Infants suck the mother's milk excreted from the mammary glands through a nipple. They separated from monotremes about 100 million years ago in Asia from where they spread to other continents.

#### Cabinet 5

**Odd-toed ungulates (perissodactyls).**—This group includes equines, tapirs and rhinos. The oldest remains of an equine are known from the early Eocene, 56 million years ago, but the group was the most diversified during the Pliocene. The following Pleistocene ice age brought most equines to extinction.

The cast of an ancestor of the horse *Propalaeotherium hassiacum* is presented. This species was discovered in Germany in strata 53 million years old. It was relatively small (height at the withers of 60 cm) and its skull was similar to that of tapir, which shares ancestry with horses. *Propalaeotherium* had four toes in their hind legs and three in their forelegs. It fed on fruit and leaves of deciduous trees which grew in Europe during the Eocene.

**Even-toed ungulates (artiodactyls).**—The oldest fossils of even-toed ungulates are known from the Eocene, 55 million years ago, but the largest biodiversity of this group was during the Miocene and Pliocene epochs.

Thanks to the presence of symbiotic microorganisms in the gastrointestinal tract of hoofed animals, the digestion of plants became possible. Plants eaten by ruminants (for example antelopes, cattle and camels) after initial fermenta-



tion in stomach, are returned to their mouth, where are finely chewed and then swallowed again. Fermentation of plant material could be also performed in the large intestine. This occurs in pigs.

Many representatives of even-toed ungulates develop horns of various shapes. They may initially be covered by skin (in giraffes). In the deer family the skin is subsequently removed and bony antlers are changed every year.

In the family of bovids (antelopes and cattle) the horns are an integral part of the skull and are covered by keratinous (horny) tissue.

## Between cabinet 5 and 6

**Elephants and sirenians.**—Elephants and sirenians share ancestry with some other African mammals. Their closest relatives are hyraxes, sharing hooves and plant eating behaviour with them. Only two species of elephants and four species of sirenians survived to our days.

The most characteristic for elephants is the trunk (which is actually a muscular nose connected with the upper lip) and tusks (which are modified upper incisors).

The sirenians are the only herbivorous marine mammals. They lack the hind legs, have very broad ribs and reduced dentition.

Figures next to the cabinets show the course of evolution of this once diverse group of animals. Some elephantine teeth and the tusk of the African elephant are exposed.

## Cabinet 6

**Human origin.**—The exposition compares the Pliocene and Pleistocene environments and shows the impact of climatic conditions on human evolution.

At the beginning of the human history, in the Pliocene, about 3.5 million years ago, the Isthmus of Panama, linking the North and South America, did not exist yet and the less saline water of Atlantic mixed with the water of Pacific. The North Atlantic Current warmed up the climate in the north and led to emergence the large areas of savannas in Africa. Our ancestor *Australopithecus* lived in this environment. He was accompanied by savanna animals such as *Deinotherium*—ancestor of elephants, *Sivatherium*—ancestor of the giraffe, herbivorous extinct *Chalicotherium*, *Hipparion*—ancestor of horses,



and *Megantereon*—an early saber-toothed cat. The savannah environment was more oppressive than the primeval forest inhabited by our earlier ancestors and forced them to change mode of life and reproduction. As a result the upright posture developed freeing forelimbs, which after the next million years of evolution permitted them to create and use tools.

About 3 million years ago the Isthmus of Panama connected North and South America and the North Atlantic Current stopped to warm the Northern Hemisphere. During this time the ice cap of the Arctic was formed. The climate cooled. Eurasia gradually got covered in steppe-tundra. In the Pleistocene, about hundred years before, humans adapted to this new cold environment and expanded northward. Many other large mammals, adapted to the freezing climate of the Pleistocene in their own way, and wandered the frozen lands with humans. Among them were: an elephant adapted to icy climate—the mammoth *Mammuthus primigenius*, the woolly rhinoceros *Coelodonta antiquitatis*, the Irish giant deer *Megaloceros giganteus*, the cave lion *Panthera spelaea*, and the cave hyena *Crocota spelaea*.

**Human evolution.**—The evolutionary split between African apes and humans occurred in the late Miocene about 6–7 million years ago. The modern human has many features that indicates his/her evolutionary origins in apes. However, bipedalism, the large brain in proportion to the rest of the body and the lack of the fur are the most characteristic features of humans that distinguish them from other primates. Those features evolved only a few million years ago. The board on the right shows the evolution of humans from *Australopithecus afarensis* to *Homo sapiens* and evolution of their skulls.

## Cabinet 7

**Fossils found by collectors in the Warsaw area.**—Mammoth tooth (*Mammuthus primigenius*), fragment of the steppe bison horn (*Bison priscus*), vertebra and fragment of the lower jaw of cattle (*Bos taurus*).

## Cabinet 8

**Lucy.**—The cabinet shows a reconstruction of *Australopithecus afarensis*, which lived 3.2 million years ago. It is based on the famous most complete skeleton of *Australopithecus*, nicknamed Lucy, found in 1974 in Ethiopia. It



belonged to a young female. She was characterized by a short stature (was about 1 m tall), small braincase, strong molar teeth and well-developed temporal muscle reaching the top of the skull. She already walked on two legs. Australopithecines probably fed mainly on seeds and fruits. They gave beginning to the human lineage.

### Cabinet 9

**Human skull evolution.**—The cabinet shows evolution of the skull in hominids, especially in respect of the size of the braincase. The temporal muscle attachments, that reached the parietal bones in *Australopithecus*, became separated by the expanding braincase and are restricted to the temple. Meanwhile, the facial region further shortened in relation to the status in apes. The hominid intelligence was probably a side effect of the braincase development. The growth of the brain had stopped before the cultural evolution begun and it was probably a precondition for emergence of civilization.

### Cabinet 10

**Primates.**—Among the primates there are the most primitive prosimians (lemurs, lorisooids, and adapiforms), the New World monkeys common to the tropics of South America and the Old World monkeys living today mostly in Africa and warm parts of Asia. More advanced are apes, which include gibbons, orangutans, gorillas, and chimpanzees. Prosimians developed anatomy similar to their present-day Malagasy successors in the Early Eocene. The oldest New World monkeys are known from the Late Oligocene.

**Xenarthrans.**—These are mammals living exclusively in both Americas, with simplified teeth or completely devoid of teeth. Sloths, anteaters and armadillos belong to this group. Fossils of armadillos, which still have simplified teeth, have been found dating from the Paleocene, about 66 million years ago. Their evolutionary origin remains unknown. The toothless sloths and anteaters have been found dating from the Eocene, about 56 million years ago. Most of the species of xenarthrans went extinct in the Pleistocene including the huge armadillos (glyptodonts) and the great sloths (*Megatherium*).



## Cabinet 11

**Carnivores.**—The common ancestor of carnivores and relict pangolins was insectivorous. During their evolution carnivores increased their body size, developed carnassials (the upper fourth premolar and the lower first molar modified in such a way as to allow enlarged and often self-sharpening edges to pass by each other in a shearing manner) and reduced the number of teeth.

In cats carnassials are used for meat cutting, in hyenas and canines to crush bone. Bears have a secondary set of teeth adapted to herbivorous diet and pinnipeds to cut the fish.

The skull of “saber-toothed cats” is worth seeing. Their large saber-like canines were used for killing and ripping prey. Several genera of this animals were widespread from Miocene (about 23 million years) to Pleistocene (about half million years).

## Cabinet 12

**Rodents and lagomorphs.**—Both orders are close related. Like many other herbivores they developed diastema—a gap between the incisors and premolar teeth. Well-developed incisors growing continually throughout their whole lives and the double-digestion process (coprofagy of soft feces) are the lagomorphs adaptations to ingesting plants, mainly grasses. Primitive rodents rely on high-caloric seeds, but their more advanced groups developed complex pattern of permanently growing molar teeth as an adaptation to eat grass.



*Smilodon populator* from USA

# Geologic Time Scale

EON	ERA	PERIOD	EPOCH	MILLION YEARS PAST	
Phanerozoic	Cenozoic	Quaternary	Holocene	23	
			Pleistocene		
		Neogene	Pliocene		
			Miocene		
		Paleogene	Oligocene		
			Eocene		
	Paleocene				
	Mesozoic	Cretaceous		66	
		Jurassic		145	
		Triassic		201	
		Permian		252	
	Paleozoic	Carboniferous	Pennsylvanian subperiod	299	
			Mississippian subperiod	323	
		Devonian		359	
		Silurian		419	
		Ordovician		443	
		Cambrian		485	
		Proterozoik		541	
		Archean		2500	
					4000

Desing by Aleksandra Hoida-Michalska



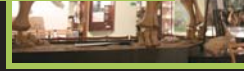
Holocene



Neogene



Cretaceous



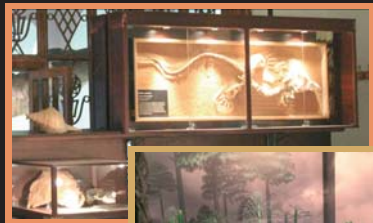
Jurassic



Triassic



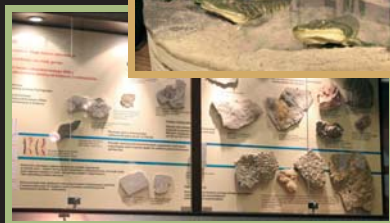
Permian




Devonian



Cambrian





**Authors:** Beata Cymerman, Ewa Jachowska  
**Photos:** Urszula Sumińska, Agnieszka Kapuścińska  
**Graphic design:** Agnieszka Kapuścińska  
**Geologic Time Scale design:** Aleksandra Hołda-Michalska  
**Typesetting and layout:** Aleksandra Szmielew

**Institute of Paleobiology PAS**  
**ul. Twarda 51/55, 00-818 Warszawa**

**Warszawa 2017**