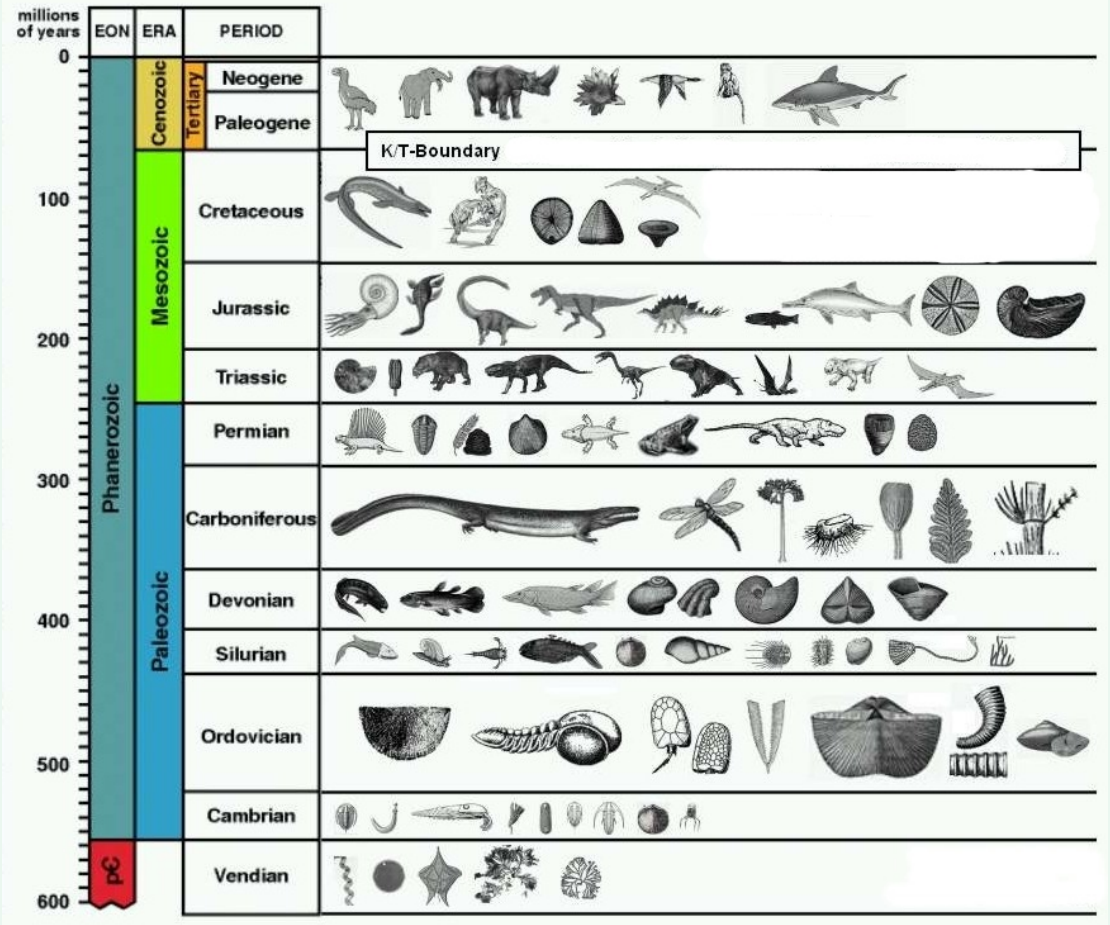
READING MUSEUM SERVICE

Hands On Learning
with Reading Museum Service

FOSSILS X1/B

The word fossil is derived from the Latin *fossilis*, which means 'dug up'. Fossils are the remains of creatures which existed long ago. Fossils range from thousands of years to many millions of years in age. The earliest fossils date from around 600 million years ago. However recent reports suggest bacteria may have existed up to 3,000 million years earlier. To put this in context, the dinosaurs became extinct just 65 million years ago. The earth itself is about 4,570 million years old. Geologists divide this vast time into various units according to events which took place in each period. The chart below gives the names of these periods, from the time of the first complex fossils through to the present. It also shows some of the living things (mainly animals) that lived in each period.



Reading BOROUGH COUNCIL

Heritage Lottery Fund

FOSSILS X1/B

Not all former life was preserved as fossils. The vast majority of living things simply vanished without trace. Fossils come in a variety of sizes, from the microscopic through to large dinosaur skeletons and are formed in a variety of ways.



Permineralised fossils are organisms which became covered by sediment soon after death. As the organism slowly decayed, water infused with minerals passed through it, replacing the chemicals in it with rock-like minerals. Over millions of years the original organism was completely replaced by these minerals and what remains is a rock-like copy of the original. The fossil has the same shape as the original object, but is actually rock. This process results in loss of original colour. The photograph on the right shows the fossil of a huge tree that was formed by the permineralisation process.



In other cases the original remains of the organism completely dissolve and all that is left is an organism-shaped hole in the rock. This kind of fossil is called a mould fossil or typolite. If this hole is later replaced by new, unrelated minerals, it is called a cast fossil. In some cases replacement occurs so gradually that tiny features are preserved despite the total loss of original material. The photograph on the left shows a mould fossil of a shell.



Finally, there are trace fossils: marks in the rock which result from the activities or presence of animals and plants. Examples of these traces include footprints, burrows, root tunnels and even animal droppings (which are called coprolites) and vomit (regurgitaliths). The photograph on the right shows a fossilised dinosaur footprint.

Hands On Learning
with Reading Museum Service

FOSSILS X1/B

Carboniferous Limestone Fossils



The geological period between about 360 and 300 million years ago is called the Carboniferous Period. The Carboniferous Period is in turn divided into two parts called the Lower (earliest) and Upper (later) Carboniferous. In Britain the rocks of the Lower Carboniferous period were laid down under the sea, while those of the Upper Carboniferous period were made on dry land.

Much of the coal that is found beneath the landscape of Britain was created in the Upper Carboniferous period. At this time Britain and much of northern Europe was hot and was covered by a rainforest which looked superficially similar to that found in Brazil today. When trees die in a stagnant peat swamp environment low oxygen levels prevent their complete decay by bacteria. If these masses of undecayed plant remains are later buried under sediments (mud and sand swept over them by a river or the sea) then coal will form.

Limestones can form in many places, including river floodplains and lakes, but they are usually formed in clear tropical waters. Limestones are being made today in such places as the waters of the Bahamas and the Great Barrier Reef off Australia. In such locations the remains of countless sea creatures pile up on the sea bed over millions of years, then slowly change into rock as their chemistry alters. In some places beds of limestone are thousands of metres thick. Huge beds of limestone can be found in the Pennines in northern England, witnesses to the warm tropical waters that once covered the area. It is not known where this example comes from, but fossil shells can be seen embedded in it.

Sea Urchin



Living sea urchins (below left) are covered with spines, but these usually decay quickly after death leaving a shell, which is also called the test. Fossilised sea urchin tests are relatively common. The earliest sea urchins are found in the Ordovician Period.

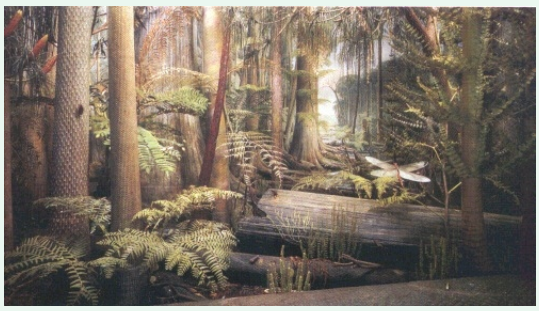


Two Coal Measure Fossils

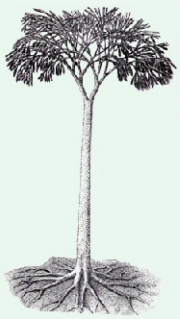


Although the environment that produced coal looked similar to that of Brazil today, the kind of plants that flourished in the Upper Carboniferous Period were, in fact, very different from those found in a modern rainforest.

Tree-sized plants dominated, but these were largely club-mosses - extremely fast-growing plants adapted to nutrient-poor, waterlogged soils. It has been estimated that their 1-2 metre wide stems could grow upwards at several metres per year, up to a height of 40 metres. They were not seed plants as are most large plants growing today; they reproduced by means of spores. Unlike true trees their trunk contained relatively small amounts of wood. Instead, much of the trunk consisted of soft tissue called periderm, which enabled the plants to grow much more quickly than woody trees. They grew into mature plants, reproduced, and then died. Most modern-day trees, in contrast, reproduce for many years after reaching maturity. For this reason, many palaeontologists call these extinct plants giant herbs rather than trees.



Other plants also grew in the forests, but mainly in the less waterlogged areas, such as on the raised banks of rivers that threaded their way through the swamps. There were tree ferns, looking very similar to those growing today in places like New Zealand. There were also some seed plants belonging to a number of now extinct groups such as the cordaites (distant relatives of today's conifers) and the seed-ferns (distant relatives of the modern cycads).



These two fossils are witness to this lush, long-since-vanished landscape. One of them shows fern-like leaves. The other has the distinctive diamond-shaped patterning characteristic of a group of tree-like plants known as Lepidodendron. These 'trees' - an example can be seen on the right - were actually a form of club-moss and sometimes reached heights of over 30m, with trunks over 1m in diameter. Lepidodendron lived in densely packed groups in the wettest parts of the swamps.

Two Plesiosaur Vertebrae



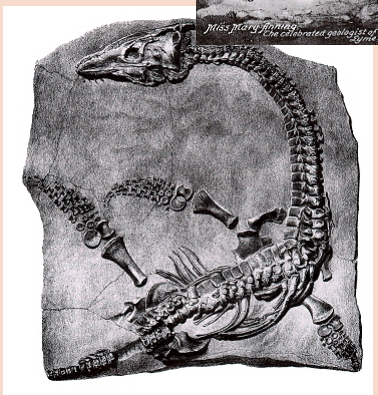
Plesiosaurs were aquatic reptiles that existed from the end of the Triassic Period 220 million years ago until the end of the Cretaceous 65 million years ago. Their remains have been found on every continent.

A typical plesiosaur had a long neck, a broad body, four large flippers and a relatively short tail. The smallest were about 2m long as adults, the largest were up to 20m long, comparable in size or even bigger than sperm whales.

Occasionally stomach contents are found inside well-preserved fossil specimens. This evidence shows that some fed on belemnites and ammonites. There is also a wide range in tooth shape, showing that they were adapted to feeding on different types of prey. Long, slender teeth may have been used to rake through sea-floor sediments in the way a swan dabbles on pond bottoms. Larger, more robust teeth seem to be adapted for feeding on armoured fish and cephalopds (squid, octopuses etc.). Some of the bigger members of the family had enormous, dagger-like teeth which were probably used to attack their smaller relatives. Other specimens show bite marks from larger predatory forms.



Plesiosaurs were discovered by Mary Anning, the famous professional fossil collector from Lyme Regis, Dorset, in 1821. The fossil she found was subsequently described, by William Conybeare as *Plesiosaurus dolichodeirus* and is the holotype - the defining example - of the species. Mary Anning can be seen on the right, along with the specimen she found. Specimens are still found in south-west England and in 2002 possibly the finest ever known was discovered on the coast of Somerset by someone fishing from the shore.





Above: An illustration of what one of the many species of plesiosaur - Cryptocleidus - may have looked like.

Ammonite



Ammonites were marine animals that ranged in size from under an inch (2cm) to about 9 feet (3m) in diameter. They were protected by a shell (usually spiral-coiled) that contained many air filled chambers. As the animal grew, new chambers were added behind the outer chamber. The animal lived only in the outermost chamber.

Despite the fact that they look like snails, ammonites did not move by crawling across the ocean floor. Air in the unused shell chambers allowed the animal to float and they moved by jet propulsion - expelling water through a funnel-like opening to propel themselves in the opposite direction. The modern nautilus (right) gives us some idea of what a living ammonite would have looked like.



Ammonites probably lived for about two years. A nautilus creates a new chamber in its shell at a rate of one every four weeks, equal to 13 each year. Using this as a guide an ammonite shell containing 26 chambers could be assumed to have housed the creature for two years. Evidence suggests that some female ammonites grew up to 400% larger than the males.

Ammonites began life as tiny planktonic creatures less than 1mm in diameter. In their infancy they would have been vulnerable to attack from other predators including fish. They quickly assumed a strong protective outer shell that would shield their soft interior from damage. However, fossilised adult ammonites have been found showing teeth marks from ichthyosaur attacks.

On the other hand, ammonites were themselves predators, feeding on most living marine creatures including molluscs, fish and even other cephalopods (octopuses, squids etc.). By analogy to modern cephalopods, their method of attack probably consisted of silently stalking their prey, then rapidly extending their tentacles to grasp the target. The photograph on the right shows a nautilus capturing a crab. Once caught the prey would be devoured by the ammonite's powerful jaws located at the base of the tentacles, between the eyes.



Continued on next page.

Much of an ammonite's life was spent in shallow waters. The evidence to support this includes their diet, which could be found in the greatest volumes in the warm shallows. It is also unlikely that their shells could withstand the high pressures present in deep water (over 100 meters). Another theory based around their assumed social behaviour suggests that their shells were decorated by an array of patterns, indicating that colour/good light played a large part in their lives.

Ammonites first appeared in the late Silurian to early Devonian Periods (about 400 million years ago) and were abundant in the seas for 300 million years. At several points in this long history they faced major extinction events, with often only a few species surviving. Each time, however, this handful would diversify into a multitude of forms. Ammonite fossils became less abundant during the latter part of the Mesozoic Era (from 251 to 65 million years ago), with none surviving into the Cenozoic Era.

Sponge



Sponges are one of the most primitive multicellular animals, lacking internal organs, nervous tissue, a circulatory system, or a gut for digesting food. To obtain food, the sponges filter the water around them as it passes through tiny pores located on their outer walls. To support and protect their soft bodies, sponges produce skeletons of calcium carbonate, silica, or a soft organic material called spongin.



Sponges date back to a period known as the Neoproterozoic Era, which began 1,000 million years ago, well before the explosion of life forms in the Cambrian Period. It is not known how old this example is or where it originates from. The fossil record of sponges is not abundant, although a famous locality for them is the Cretaceous Faringdon Sponge Gravels in Faringdon, Berkshire (now Oxfordshire). A photograph of a fossil sponge (*Raphidonema farringdonense*) from this locality can be seen on the left.

The example in this box, however, is embedded in a flint nodule. Such flint nodules are common in the chalk-rich soils around Reading. When they are split open they are sometimes found to have a cavity in the centre in which there are fossil remains. This is the case here.

Belemnite

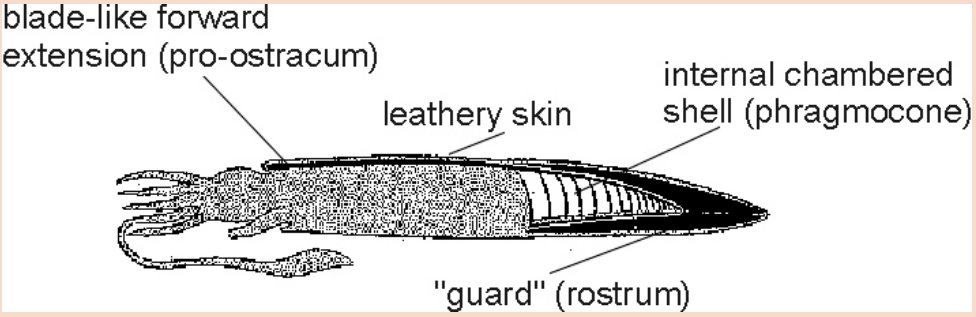


Belemnites are an extinct group of marine animals, similar in many ways to the modern squid and cuttlefish. Like them, the belemnites possessed an ink sac, but, unlike the squid, which has eight arms and two tentacles, they possessed ten arms and no tentacles. Also, unlike the modern squid, whose arms have suckers, belemnite arms carried a series of small hooks for grabbing prey. Belemnites were carnivores that caught small fish and other marine animals with their arms and ate them with their beak-like jaws. Belemnites themselves appear to have formed part of the diet of marine reptiles such as ichthyosaurs, whose fossilised stomachs frequently contain many belemnite hooks.



Normally only the back part of the belemnite shell (called the guard or rostrum) is found. The guard is elongated and bullet-shaped, being cylindrical and either pointed or rounded at the rear end. The front of the guard would have been hollow and would have enclosed a chambered section of shell. This section, which seldom survives, was divided into chambers that were gas-filled and which caused the animal to remain buoyant. The diagram below shows the structure of a typical belemnite. The picture on the right shows what a belemnite may have looked like in life. Like ammonites, belemnites moved by squirting out a jet of water which propelled them forwards.

Belemnites reached their greatest abundance and diversity during the Jurassic and early Cretaceous Periods, but, like the ammonites, disappeared at the end of the Cretaceous Period.



Hands On Learning
with Reading Museum Service

READING MUSEUM SERVICE

FOSSILS X1/B

Fossilised Leaves from the Reading Beds





The Reading Beds are layers of clay and sands, mixed with pebbly beds and masses of fine sand converted into quartzite, that were deposited between 56 and 55 million years ago, during the Paleogene Period. These beds were created when the area was a river estuary receiving river sediment from land lying to the west. They are named after the town of Reading, Berkshire, although they (and other related formations) are found throughout the London Basin. Faint traces of leaves can be seen on these two samples.

Wood Fragment



This is a good example of fossil wood formed by permineralisation.

Fossil Shells from the London Clay





The London Clay consists of a stiff, bluish coloured clay which becomes brown when weathered. The bed was laid down between 54 and 48 million years ago on the shallow shelf of a semitropical sea near the estuary of a major river system. Fossil evidence suggests that the nearest land mass lay approximately 100 kilometres to the north and east, and was probably fringed by mangrove swamps and palms. Behind, a tropical rain forest was teeming with a diversity of plants and animals. Offshore, islands and mud banks clad with palm trees harboured birds, turtles and crocodiles. The seas would have supported large populations of sharks, rays and fish including swordfish and sturgeon. The many logs that floated out to sea formed rafts which slowly became waterlogged and sank to the bottom. Crabs, lobsters, gastropods and bivalve molluscs all thrived in this environment.

One of these examples shows a scattering of shells and shell-fragments.The other is a shark's tooth. The fossil record of sharks extends back over 450 million years. Estimates suggest that over a span of a few years a shark may grow tens of thousands of teeth, which explains the abundance of such fossils. As the teeth consist of mineral apatite (calcium phosphate), they are easily fossilised, whereas the cartilaginous skeleton of the shark seldom survives.

Horse Tooth



Horses first evolved in the Americas, but became extinct there until reintroduced by Europeans. While isolated domestication may have occurred as early as 10,000 years ago, the first clear evidence dates to about 5000 BC, and becomes widespread only after 2000 BC. Selective breeding since that time has produced numerous breeds.

The only true wild horse alive today is Przewalski's Horse (*Equus ferus przewalskii*), a rare Asian species. Most 'wild' horses today, such as the American Mustang are actually animals that were once domesticated, but escaped and reverted to an apparently wild status. The Przewalski's Horse, on the other hand, has never been successfully domesticated and remains a truly wild animal today. A photograph of Przewalski Horses can be seen below - perhaps the teeth in this box once belonged to a similar animal.



Ichthyosaur Vertebrae & Tooth



Ichthyosaurs were giant marine reptiles resembling fish and dolphins that appeared about 250 million years ago (earlier than the dinosaurs, who put in an appearance about 230 million years ago) and which became extinct about 90 million years ago (about 25 million years before the same thing happened to the dinosaurs). Ichthyosaurs evolved from as-yet unidentified land reptiles that moved back into the water in a development parallel to that of dolphins and whales. The late Triassic and early Jurassic Periods were the heyday of the ichthyosaurs, which are represented by four families and a variety of species, ranging from one to ten meters in length.



Ichthyosaurs are important in the history of palæontology (the study of prehistoric life forms), as their fossil remains are relatively common in southern Britain and they were one of the first groups of extinct species to be studied. They were first described in 1699 from fossil fragments discovered in Wales. The first complete ichthyosaur fossil was found in 1811 by Mary Anning in Lyme Regis, along what is now called the Jurassic Coast. She subsequently discovered three separate species. The ichthyosaur skeleton on the right was found in Dorset.

The jaw and tooth specimens in this box indicate the carnivorous feeding habits of ichthyosaur species. Ichthyosaur jaws were typically studded with even rows of pointed conical teeth. Ichthyosaur teeth are often striated (grooved), like these examples. In most species the teeth were so closely spaced that when the jaws closed they meshed together, leaving no gaps - perfect for catching fish. Modern porpoises and dolphins have teeth and jaws similar to those of ichthyosaurs. We also know about the diets of some ichthyosaurs from the stomach contents preserved in fossils, which indicate that many of the fish-shaped ichthyosaurs relied heavily on belemnites. Some late ichthyosaur stomachs have been found to contain bony fish and hatchling-sized baby turtles.

When ichthyosaurs first appeared they probably swam like eels, by undulating the entire body, and had flat-ended vertebrae. The vertebrae in this box are indented at their ends, which suggests they belonged to a more fish-shaped ichthyosaur from later in their history.