Guide to the National Museum of Ireland
Natural History

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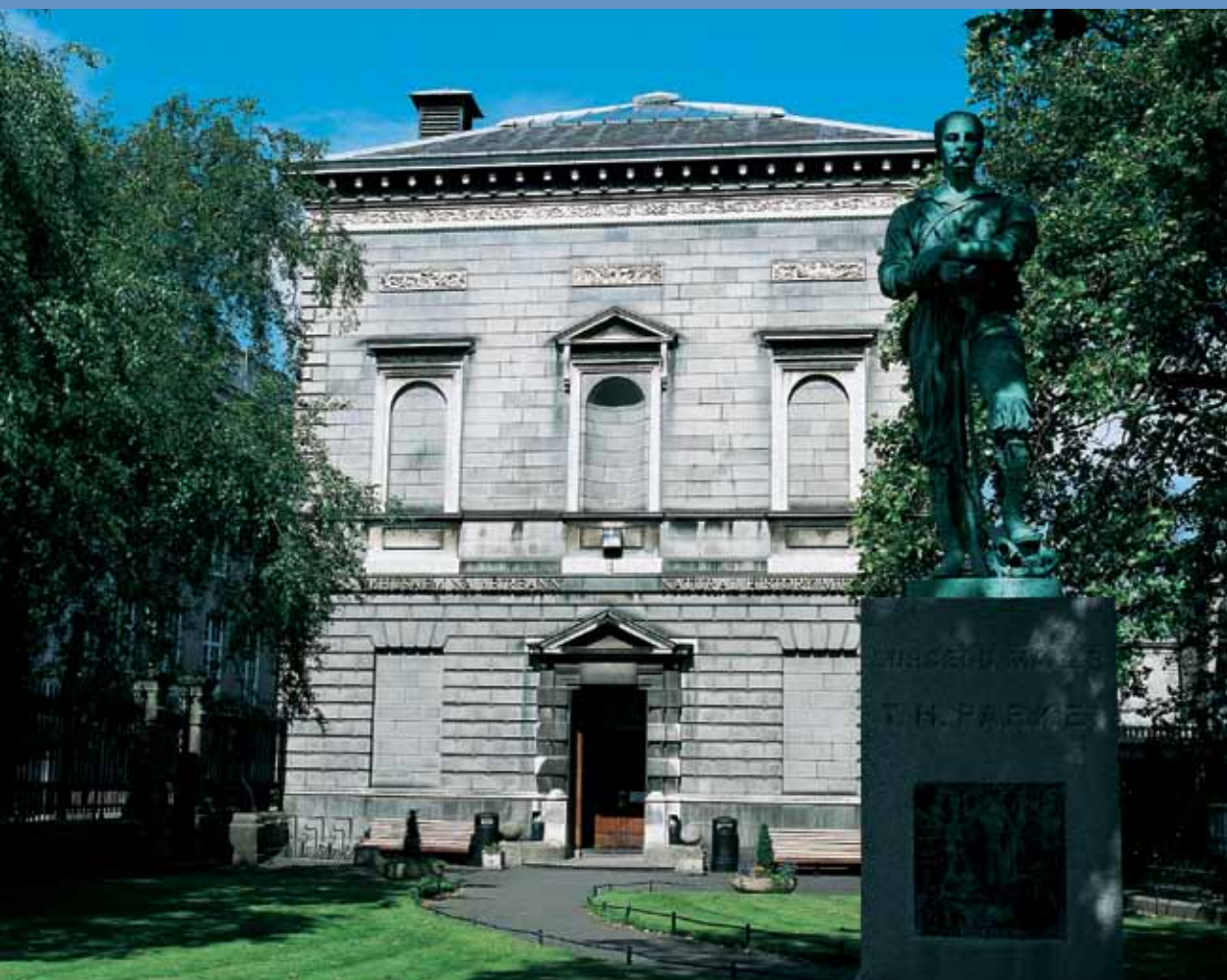
Ard-Mhúsaem na hÉireann

Natural History



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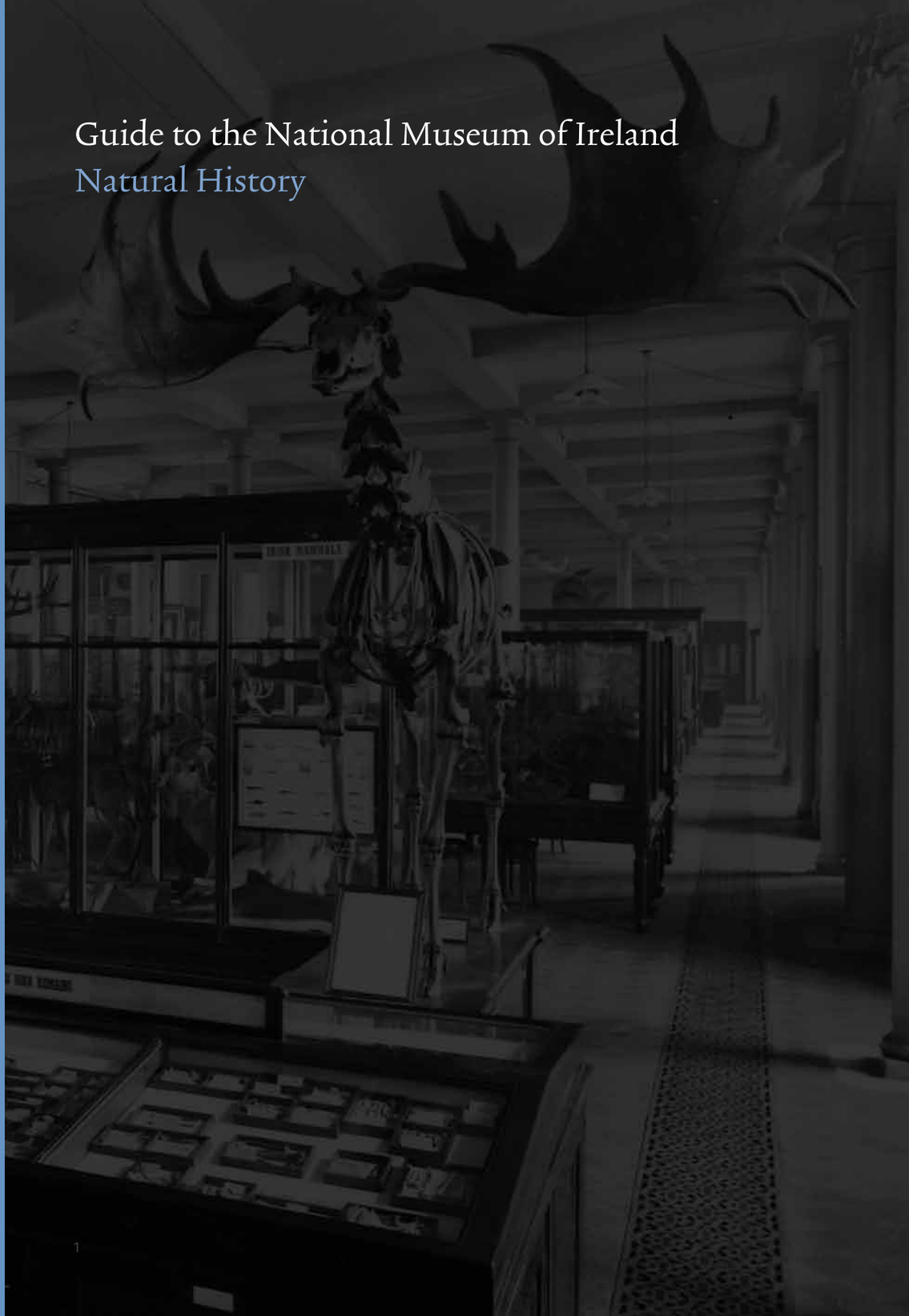

Guide to the National Museum of Ireland - Natural History

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A floor plan is included in the back of this guide book.

An early view of the Natural History Museum seen from Merrion Street. Note the lack of a door at what is now the entrance and the curved link to Leinster House in the distance

Introduction

The Natural History Museum was built in 1856 to house the Royal Dublin Society's growing collections, which had expanded continually since the late eighteenth century. The building is a 'cabinet-style' museum designed to showcase a wide-ranging and comprehensive zoological collection and has changed little in over a century. Often described as a 'museum of a museum', with its ten thousand exhibits it provides a glimpse of the natural world that has delighted many generations of visitors since the doors opened in 1857.

The building and its displays reflect many aspects of the history and development of the collections. The museum was originally built as an extension to Leinster House, where the Royal Dublin Society was based for much of the nineteenth century. In 1877 ownership of the museum and its collections was transferred to the state. New funding was provided for the building, and new animals were added from an expanding British empire during the great days of exploration. Today, the Natural History Museum is one of four branches of the National Museum of Ireland.

History

There is a long tradition of collecting specimens in all of the natural sciences – botany, geology and zoology. In the late eighteenth century the Dublin Society managed to obtain state funding for the purchase of a natural history collection. This included important mineral specimens, acquired as a reference set to aid the discovery of Irish natural resources in order to fuel industry. This natural history collection belonged to Nathanael Leske and cost £1,310 in 1792, a princely sum at the time. The Leske collection formed the nucleus for the society's museum, which was housed in a series of buildings, including Leinster House, before the present museum opened in 1857.

The museum collections grew through donations by various members of the Society, which was granted the title 'Royal' in 1821. Some came from surveys of Ireland, including the geological mapping by Richard Griffith that added a large fossil collection. Other collections reflected the diversity of wildlife seen throughout the world and were donated by Irish people who held civil and military positions in British colonies. Naturalists also provided collections, often operating on a commercial basis to fund their thirst for adventure. The collections include animals from such famous explorers as Charles Darwin, Alfred Russell Wallace and John Gould. It is only appropriate that when the museum building was inaugurated at a meeting of the British Association in Dublin in August 1857, David Livingstone gave a special address describing his travels in Africa.

Statue of Thomas Heazle Parke

Ireland had its own famous explorers, including Thomas Heazle Parke, whose statue stands guard at the front of the building. Parke acted as surgeon to an expedition led by Henry Morton Stanley in 1887 to rescue Emin Pasha, governor of the Egyptian province of Equatoria, after the fall of Khartoum to the Mahdi army. The expedition crossed Africa on an 8,000-kilometre journey up the Congo and through the Ituri rainforest before reaching Lake Albert.

Leopold McClintock from Drogheda, County Louth, was a veteran of Arctic ice travel. In 1852 he tracked down the remains of the ill-fated expedition of Sir John Franklin, whose ships had become icebound, resulting in the entire crew of 130 men starving to death. McClintock brought back the skin of a polar bear – you can see the bullet hole in the head to this day. His significant collection includes a musk ox mother and calf, two of a number of animals shot for provisions on his sledging treks.

Polar bear shot by Captain Leopold McClintock

The Building

The museum building was designed by architect Frederick Clarendon in harmony with the National Gallery on the other side of Leinster Lawn, designed at the same time. The foundation stone was laid on 15 March 1856 and the building completed in August 1857 by contractors Gilbert Cockburn & Son. It formed an annexe to Leinster House, connected to it by a curved closed Corinthian colonnade, which formed the access corridor to the building. At the west end of the museum, a large stone staircase connects the ground level with the first floor. Some rooms at this end of the museum serve as private offices. A new entrance door was constructed in 1909 at the east end facing Merrion Street, thus reversing the direction from which visitors had approached the exhibitions. This explains why some of the large exhibits still face what appears today to be the back of the building. It was too difficult to turn whales and elephants around to face the new entrance.

The Displays

The museum exhibits more than ten thousand specimens in its galleries. These represent only a tiny fraction of a collection that is estimated at about two million scientific specimens. Specimens are laid out in two main areas of the building, the Irish Room on the ground floor and the World Collection on the upper floors.

Interior circa 1883: upper floors

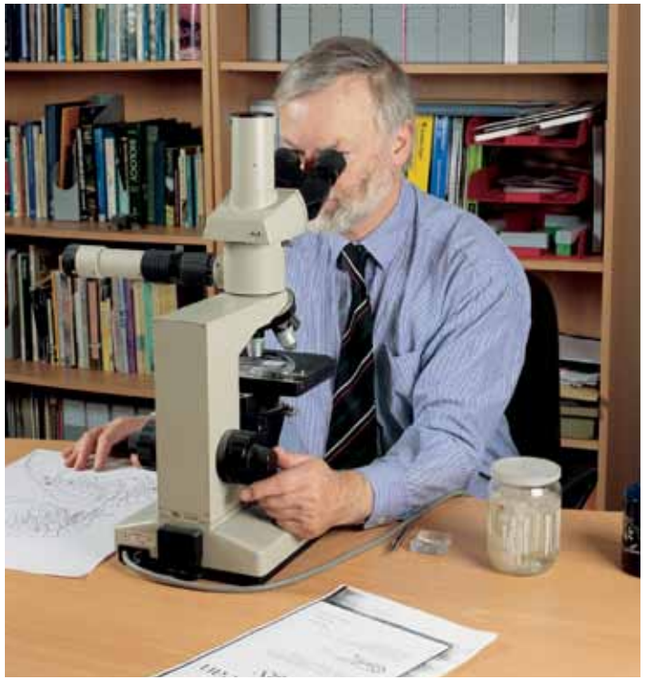
Interior today: note the large animals facing what used to be the entrance but is now the back of the gallery

The Collections

The museum has long been the centre where Irish scientists left their zoological or geological collections for safe keeping over the centuries. Staff are responsible for over two million scientific specimens kept in storage behind the scenes. These continue to form the basis of many research projects, by museum staff and by our numerous academic visitors. Research workers still use the museum as a repository for the specimens that provide the evidence underlying their science.

Preparing catalogues

Topping up alcohol in jars



Identifying new specimens

Butterfly, dried and pinned

European eel, choked on frog, preserved in alcohol

How are the animals preserved?
All animals decay rapidly after death, and the techniques used by scientists to preserve them are many and varied.

Dry Specimens
The simplest method of preservation involves simply drying the animal in a suitable pose. This is the way in which most insects are handled. The dead insect is 'relaxed' in a moist atmosphere and mounted on a drying board. A stainless steel pin is inserted, slightly off-centre to avoid damaging features on the mid-line. Larger animals such as crabs are cleaned of all flesh, washed and dried slowly. The outer 'shell' of a crab is known to scientists as an exoskeleton because it lies outside the soft tissues. Mammals have skeletons within their bodies; for exhibition these are stripped of flesh and the bones wired together.

Wet Specimens
For animals that have soft tissues, the best solution is often to immerse them in a liquid. The spirit used in the museum is a mixture of alcohol and water. The specimens often lose colours over the years, but soft tissues are well preserved and available for researchers to study. Even DNA may be well preserved in these specimens.

Preparing a giraffe skin for fitting over a form

Mounted Specimens

Many of the larger animals are 'stuffed', which gives the false impression that they are packed until the skin is filled with stuffing. The truth is more complicated. The art of taxidermy refers to the arrangement of skins in a lifelike pose (from the Greek words *taxis* – meaning 'arrangement', as in taxonomy – and *derma* – meaning 'skin', as in dermatitis).

A typical mammal, such as a giraffe, will be skinned shortly after death. The taxidermist has to make a model of the body known as a 'form', which is based on measurements taken from the animal before the hide is removed. In the nineteenth century the form was made from wood, and padded with straw or wood shavings. The outer layer was sculpted in modelling clay. Modern techniques work by moulding the skinned cadaver and making a plastic form that is an exact fit for that particular animal.

The skin is treated to remove fat and other tissues and is soaked in a chemical bath to kill bacteria and other agents of decay. The soft skin is then fitted over the form and stitched in place while features are worked into shape, particularly around the face. The head is

Spoticus, a male giraffe, installed in January 2003 by Dutch taxidermists

Taxidermists fitting giraffe skin over a form

Pins hold the skin in place while glue dries

fitted with glass eyes, and in some cases model tongues and teeth are inserted. Fish have more delicate skin than most mammals, and only some can be mounted successfully. Many fish are preserved as casts made in a variety of materials and painted to match their appearance in life.

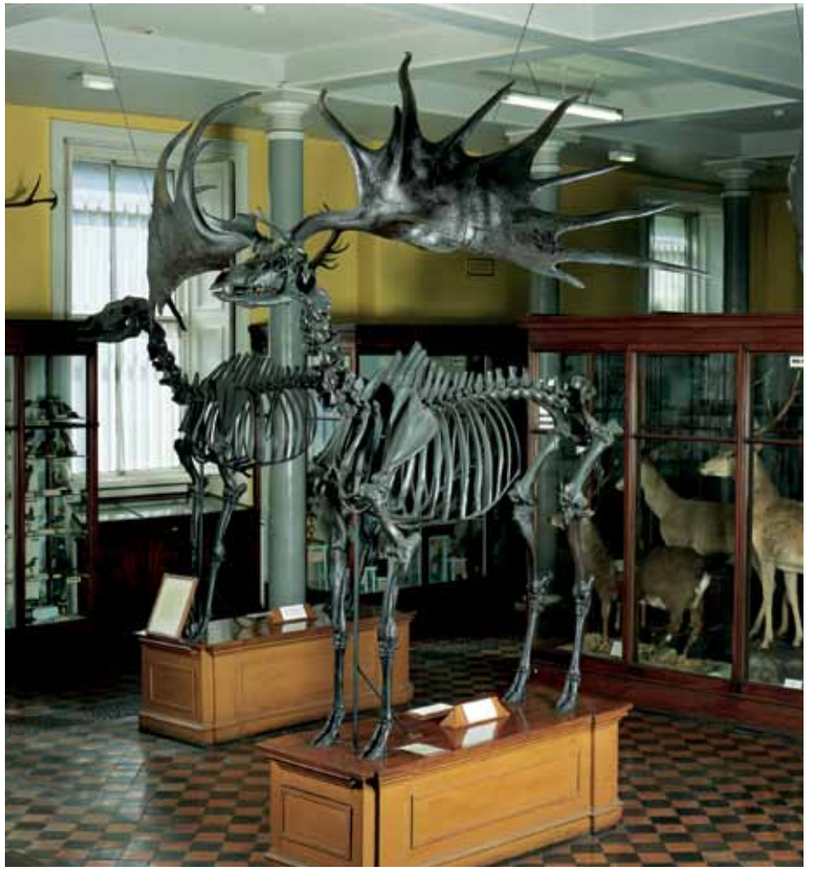
Models

For very small animals or those with soft tissues that are difficult to preserve, the only way to make an effective exhibit is to create a model. Some of the earliest models in the museum are made from coloured wax or plaster. The highest levels of model-maker's art are seen in the spectacular glass models by Leopold and Rudolf Blaschka of Dresden. These were acquired by the museum between 1878 and 1888 and include many marine animals such as jellyfish and anemones.

Wax model of slug *Limax maximus*

Irish Fauna: Ground Floor

The animals found in Ireland today inhabit a landscape that was scoured by ice on a number of occasions over the last 100,000 years. At the later stages of this Ice Age, animals such as the giant deer *Megaloceros giganteus* lived in a land with a climate similar to that which we experience now. They shared their environment with woolly mammoths, spotted hyenas and brown bears.



Giant deer *Megaloceros giganteus* from Lough Naglack, Co. Monaghan

Group of badgers *Meles meles* prepared by Williams & Son in 1911

Group of foxes *Vulpes vulpes* prepared by Williams & Son in 1910

This is one of a series of very popular exhibits made by the Dublin taxidermy firm of Williams & Son. They produced 'family groups' of badgers, otters and pine martens. These are the characteristic mammals of the Irish landscape. Ireland has few mammals, compared with other European countries. Only some species travelled into Ireland before the island was separated from Britain at the end of the Ice Age. Since then, many species have been introduced by humans, for example, the rabbit, which was introduced by Anglo-Normans in the twelfth century.

Badgers are active at night, seeking out pastureland where they feed on earthworms, as well as many other ingredients in a highly varied diet. This brings them into contact with livestock. They share a disease with cattle, which is known as bovine tuberculosis. The link between infection in badgers and cattle is not clear after many decades of research. However, the suspected role of badgers in the infection of livestock has put them under pressure, with many thousands killed in programmes aimed at controlling the disease.

Bitterns have a distinctive booming call, which may be heard over long distances in wetlands. As reed beds were reduced owing to the drainage of many Irish wetlands over recent centuries, the

Eurasian bittern *Botaurus stellaris*, Co. Carlow; now extinct in Ireland

Golden Eagle *Aquila chrysaetos* from Clare Island, Co. Mayo

bittern has ceased to breed here. Nowadays it is the turn of the corncrake *Crex crex* to be threatened by changing farming practices. These are the subject of a campaign that may see corncrakes survive as a breeding bird in Ireland.

Francis Ledwidge (1887–1917) wrote a lament for his friend Thomas MacDonagh, who was executed in Dublin in 1916 for his part in the Easter Rising. It opens with the famous lines:

He shall not hear the bittern cry
In the wild sky where he is lain
Nor voices of the sweeter birds
Above the wailing of the rain

Predators that compete with farmers have always been under threat. Brown bears and wolves have been cleared from Ireland over the centuries, but golden eagles were common until the late nineteenth century. By the late twentieth century, a programme to reintroduce golden eagles was under way in County Donegal.

Female peregrine falcon *Falco peregrinus* from Co. Donegal

Short-eared owl *Asio flammeus* with prey

Many mammals are most active at night and thus are a tempting food source for predators adapted to the dark. Their large eyes and sensitive ears give owls a head start in catching prey. The short-eared owl is one of many birds that live in Ireland for part of the year. Voles are its favourite food in other countries, but these are not native to Ireland. Bank voles were introduced to the Cork/Kerry region in the mid twentieth century, and short-eared owls are found in high densities in this area.

Female peregrine falcons are heavier than males. They use their weight to build up speed, dropping from a great height to crash into their prey with talons at the ready. Like many birds of prey, peregrine falcons have seen a dramatic reduction in their numbers during the twentieth century but are now making a comeback.

Sea horses are now under pressure through the demand for delicacies in the restaurants of Asia. These small fish not only appear bizarre but also have unusual mating habits. It is the males that raise the young, sheltering a mass of eggs in a brood pouch until they hatch. This specimen was collected during the course of ongoing fieldwork and research by museum staff.

European sea horse *Hippocampus ramulosus,* Lough Hyne, Co. Cork

Freshwater pearl mussel *Margaritifera margaritifera*

Zebra mussel *Dreissena polymorpha,* an alien invader

Once common in some Irish rivers, the freshwater pearl mussel has been under pressure for many years because of the pearls that are occasionally enclosed in its shell. Just like oysters, these shellfish sometimes produce a small ball of shiny shell material around an irritating object. Freshwater pearls are not as highly prized as those from saltwater shellfish, being less lustrous. Most modern pearls are produced in shellfish farms.

New animals are still arriving in Ireland and making themselves at home here. Zebra mussels are freshwater shellfish that originated in rivers around the Black Sea and Caspian Sea. They spread across Europe as canals were built, reaching Britain in 1830. It was not until the 1990s that zebra mussels started to spread through Ireland. They are now a major pest, occurring in huge numbers, up to 100,000 animals per square metre. Alien species often upset the balance of nature when they are moved to new areas, without their normal predators.

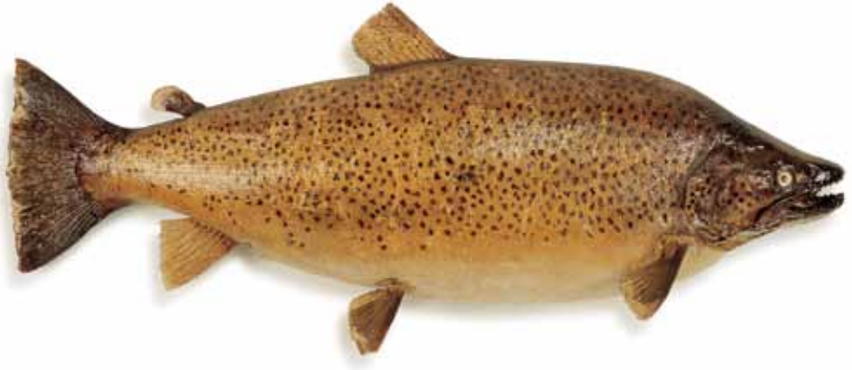
Lobster *Homarus gammarus*

Female common blue butterfly
Polyommatus icarus

The museum aims to show the variety of wild animals in Ireland and around our coastline. Among these are occasional oddities such as this lobster, which has developed with normal coloration only along one side.

Ireland has about sixteen thousand different species of insect. One of the key roles of the museum is to help scientists identify animals. It is important to identify each species correctly in order to control pests. Many insects play an important part in keeping nature in balance. They pollinate plants and control other harmful insect species. Regular monitoring of insects gives us a measure of the health of our environment. The common blue butterfly *Polyommatus icarus* is an indicator of healthy grasslands.

This record specimen of a trout was taken from Lough Ennell, County Westmeath, on 15 August 1894 by William Meares. It weighed 11.8 kilograms when caught and still holds the record despite many challenges. One challenge came from a salmon that was mistaken for a trout. This fish is known as Pepper's Ghost, and, at more than 13.8 kilograms, it had claimed the record since 1861. Scientific examination of its scales confirmed that Pepper's Ghost was in fact a salmon. This story shows another use for the museum's collection – finding the truth behind fishy tales!



Record specimen of trout *Salmo trutta* from Co. Westmeath

Mammals of the World: First Floor

Leopard cat *Felis bengalensis*

Cebus apella, the brown capuchin monkey, from South America

Arriving on the first floor of the museum, visitors are greeted by some of their nearest relatives, the lemurs, apes and monkeys that make up the group known as primates, to which we also belong.

Among these, monkeys such as the brown capuchin *Cebus apella* typify the characteristics that this group shares with us. The eyes face forwards, giving good vision in front, which developed for a life in the trees where the ability to judge distances is crucial. A second feature common to the animals in this group is the opposable thumb on each hand, which allows them to hold on to branches. Many of the primates can do this with their feet as well as their hands, and some have tails that can grasp branches and help them to balance in the forest canopy.

Another group with forward-facing eyes is the carnivores. Their vision is adapted for hunting prey. Some of the most skilful carnivores are cats such as the leopard cat *Felis bengalensis*, which is found throughout Asia, all the way from India in the west to the eastern islands, including the Philippines and Japan.

Tiger *Panthera tigris* from Nepal

Indian giant squirrel *Ratufa indica*

The largest of the cats is the tiger *Panthera tigris*, which can weigh more than 400 kilograms. Of eight subspecies of tiger at the beginning of the twentieth century, only three survive. The specimen on display is a Bengal tiger from Nepal that was given to the museum by King George V in 1913. Since then, tiger numbers have dropped dramatically. Although prized for their fur, they are also hunted for their bones, which are used in medicines popular in the Far East.

Rodents, including hamsters and squirrels, are characterised by sharp gnawing teeth at the front of their mouths. While there may be more than 250 species of squirrel, members of this group are instantly recognised by their characteristic bushy tails. This Indian giant squirrel can weigh up to 3 kilograms and is much larger than its familiar red and grey relatives seen in Ireland. Also known as the Malabar squirrel, the species *Ratufa indica* uses its tail to balance as it perches in trees, keeping its hands free for holding food as it eats soft fruits, nuts and shoots in its Indian forest home. Their tails enable squirrels to maintain stability when bounding through the forest canopy. This is a feature that squirrels share with some monkeys.

Skeleton of common hamster *Cricetus cricetus*, showing cheek pouches

Musk ox calf, eaten by McClintock's expedition party

The common hamster *Cricetus cricetus* has no shortage of supplies and can literally fill its face with food. This delicate skeleton shows the size of the cheek pouches where seeds or vegetation are packed. The pouches allow the animal to collect its harvest as quickly as possible and run back to the safety of its burrow to eat in peace, using its front paws to push out the food. In addition to eating plants, hamsters have been known to eat small animals, including frogs, mice and even snakes. This wild example is from Germany, where these animals get their common name meaning 'corn-weevil', but the species is found throughout central Europe and Russia. It is solitary and aggressive, but fortunately its close relative, the golden hamster *Mesocricetus aureus* of eastern Europe and the Middle East, is more friendly and is commonly kept as a pet.

One animal that has survived largely through its ability to live in a harsh environment far away from hunters is the musk ox *Ovibos moschatus*. This is an Ice Age survivor found today in various regions around the North Pole. The mother and calf in the museum were shot on Melville Island in northern Canada in the early nineteenth century by Arctic explorer Leopold McClintock. Adapted to extreme cold and poor-quality grazing, the musk ox is one of the few large animals to be found in this region. These animals were among several eaten by McClintock's party on its long trek across the frozen islands of the North-West Passage.

Small-scaled tree pangolin *Manis tricuspis* from the Congo

Oribi *Ourebia ourebi* from Angola

Animals of the open plains have very different body shapes from the tree dwellers. The oribi *Ourebia ourebi* is a small antelope with the characteristic long, straight legs of a fast runner, like all of its relatives. Another feature of grazing animals exposed to predators on the open plains is the position of the eyes at the side of the head. This gives good all-round visibility, which, together with living in a herd with many watchful eyes, helps to keep antelopes on the alert for danger. Oribi freeze in long grass when a predator is spotted, they make whistling calls to alert others to danger, and they run stiff-legged in a 'stotting' gait, bouncing around and confusing any attacker who may rush the group. This oribi is from the Longwe Salt Pans of Angola, in South West Africa.

Slower-moving animals often have to defend themselves against predators. The small-scaled tree pangolin *Manis tricuspis* is covered in scales formed of a material identical to your fingernails. When threatened, they roll into an armoured ball that is hard to attack. The specimen shown here is from the Huri forest in the Congo and is one of several species of pangolin in Africa. They have long tongues covered in sticky saliva, just the thing for catching ants and termites. Their powerful claws can tear open the nests where these insects live.

Giant anteater *Myrmecophaga tridactyla*

Black rhinoceros *Diceros bicornis* from Southern Maasai Reserve, Kenya

Extinct thylacine *Thylacinus cynocephalus* from Tasmania

The giant anteater *Myrmecophaga tridactyla* from South America shares some features with African pangolins, even though it evolved on a different continent and is not related to them. The similarity has come about because these animals have similar lifestyles. Anteaters too have strong claws and a long sticky tongue over 60 centimetres in length, which can lap up ants at the rate of 150 licks a minute. At 32.7 Celsius, their body temperature is the lowest of any land mammal; ours is 37 Celsius. This specimen is an adult from Cheique, in the Sucre province of Bolivia.

Large herbivores on the open plains are often little more than stomachs on legs. The large belly of the black rhinoceros *Diceros bicornis* is a sign of diet. Poor-quality food needs large stomachs to act as a processing plant, filled with bacteria and other organisms that help to break down food to release nutrients. Black rhinos live a fairly solitary existence and mark out their territories with scent. They have a keen sense of smell and relatively poor vision. They can be distinguished from white rhinos in Africa by their lips. White rhinos are not white; the name comes from the Afrikaans word for 'wide' because they have straight, wide lips that allow them to take in grass from a large area, rather like a vacuum cleaner. Black rhinos have pointed lips, more suited to picking fruits and shoots from trees. This trophy was taken in 1913 in what is now a game reserve. Both species of African rhino are hunted for their horns, which are used in Far Eastern medicines or for decorative carvings, particularly in Yemen, where dagger handles of rhino horn are highly prized. Threatened by poachers, the African rhinos are still more abundant than the other three species in India, Java and Sumatra, which are close to extinction.

Wild animals in conflict with people are often persecuted, some to the point where they have been exterminated. This was the fate of the thylacine *Thylacinus cynocephalus* in the early twentieth century. Shot by sheep farmers as a threat to livestock, the last thylacine died in a Tasmanian zoo in 1935 at a time when so little was known about their biology that the captive animal, 'Benjamin', turned out to be a female. They were the largest carnivores native to Australia, similar in size and appearance to a dog or the introduced dingo. There the similarity ends, as these 'Tasmanian tigers' or 'wolves' were in fact marsupials. They had the pouch and slightly hopping gait associated with their relatives the kangaroos. This specimen, one of the last seen in the wild in Australia, was killed in the Tyema District of Tasmania in 1917.

Steps in Evolution:
Second Floor (Lower Balcony, South Side)

Blaschka glass model of sea squirt
Halocynthia pyriformis

Wax model of lancelet *Branchiostoma*

Many millions of years ago, animals evolved with a nerve chord running along their length carrying instructions from their brains to the nerves driving the muscles in the rest of their bodies. In most cases this nerve chord runs inside a protective tube formed by the spine, which is made up of bones called vertebrae. All animals in this grouping are known as chordates; the majority with bony skeletons are known as vertebrates. The second-floor balcony of the museum houses a range of chordates, laid out in evolutionary sequence from the most primitive to the more complex.

Tunicates are among the most simple chordates and lack the bony vertebrae of their more complex relatives. Also known as 'sea squirts', they live on the sea floor and, as their name suggests, pump water through sieves in their body walls, filtering food from seawater. It is not possible to stuff such delicate creatures for display, and the example shown here is a model of *Halocynthia pyriformis* made from glass. It is only in their larval stage that they reveal their relationship with fish and other vertebrates. Tunicate larvae are elongate with gill slits like a fish, can swim and bear little resemblance to their adult stage.

Students of biology the world over are familiar with one of the least complex animals in the chordate group – the amphioxus, also known as the lancelet. The museum display shows the development of this animal in a series of enlarged wax models, from egg to full-grown adult. Like tunicate larvae, they have no bone or cartilage. The fifteen species in the genus *Branchiostoma* are all small and live half-buried in sea-floor sediments in many parts of the world, but are particularly common in Chinese waters. They filter small organisms from water, which is streamed in through the mouth.

Fish form the main series of animals along the south side of the lower balcony. They have been around for about 500 million years, and over that immense time period many evolved specialised bodies and complex patterns of behaviour. The porcupine fish *Diodon*

Porcupine fish *Diodon hystrix* from Cuba

Piranha *Serrasalmus rhombeus* from the Amazon River

Plastic model of a perch *Perca fluviatilis*

hystrix is one of a number of puffer fish, which can inflate their bodies to many times their normal size. This is a strategy to scare off would-be predators. If a predator did manage to sneak up on a puffer fish and swallow it, the result could be both painful and fatal.

The Amazon River is home to several species of fish known as piranha, including *Serrasalmus rhombeus* shown here. They form shoals and have been known to attack animals entering the river to drink, using their ferocious teeth to reduce their prey to a skeleton in minutes. Piranha are caught and eaten by the people of the Amazon Basin. If you have less dangerous prey in mind, you should consider fish such as the perch *Perca fluviatilis*, which is a popular target of anglers in Ireland. Here it has been introduced, as is also the case in countries as far away as Australia and New Zealand. Described as both sporting and palatable, perch are native in continental Europe. A German perch served as the original from which this modern plastic cast was made. This reproduction technique allows faithful attention to detail and true-to-life colours.

Black swallower *Chiasmodon niger* with stomach filled with a larger fish

The bowfin *Amia calva* from North America

Fish may have reason to fear larger predators, but few would expect to be swallowed by an animal smaller than themselves. This specimen of the black swallower *Chiasmodon niger* has managed to fit a larger fish into its mouth. When it was found floating on the surface of the ocean near Dominica in the West Indies in 1865, a specimen of *Scopelus macrolepidotus* was visible in its extended stomach.

In addition to highly developed fish, there are primitive forms with ancient fossil relatives, such as the hagfishes, and 'living fossils', including the bowfin *Amia calva* illustrated here. These belong to fish groups that were abundant in the distant past but are represented today by only a few species – hence the name 'living fossil'. The features of its ancient ancestors may still be seen in the bowfin. It can survive in almost stagnant, oxygen-poor water because it is able to extract oxygen by gulping at the surface, unlike most fish, which can breathe only by passing oxygen-rich water across their gills. Like many fish specimens, this bowfin is preserved as a painted plaster cast because its skin is too delicate and oily to be stuffed effectively.

The most famous 'living fossil' fish is the coelacanth *Latimeria chalumnae*, thought to have died out along with the dinosaurs until the first living example was discovered in 1938. Fish gave rise to the first vertebrates with limbs over 400 million years ago. The strong, bony fins of the coelacanth and its ancient relatives were ideally designed to evolve into limbs, thus providing an essential feature of land-based animals – the ability to walk. The oldest footprints in the world are to be found in rocks on Valentia Island, County Kerry, where tracks of a four-legged amphibian were discovered in 1992.

The coelacanth *Latimeria chalumnae*, a 'living fossil'

Variegated dwarf chameleon *Bradypodion pumilum*

Armadillo lizard *Cordylus giganteus*

Life cycle of the midwife toad *Alytes obstetricans*

Giant tortoise *Geochelone ephippium elephantopus* from Pinzon, Galapagos Islands

Amphibians include frogs, newts and salamanders. They show their evolutionary origins as they develop from eggs through to adulthood. The midwife toad *Alytes obstetricans* exhibits an unusual version of this process in that the male collects the eggs on his back and cares for them until they hatch into tadpoles. Amphibians lay their eggs in water, just like their ancestors, the fish. Their descendants, the reptiles, evolved eggs with a waterproof coating that allowed them to be laid on land away from the numerous fish predators of the ancient rivers.

Reptiles occupy a wide variety of habitats, mostly in warmer areas of the world. The turtles and tortoises were around long before the dinosaurs and have shells as a very effective defence against predators. The giant tortoises of the Galapagos Islands off the coast of Ecuador sparked the imagination of Charles Darwin in 1835 when the local governor explained that animals on each island had a distinct shell shape. This example of the subspecies *Geochelone ephippium elephantopus* from Pinzon (Duncan Island) has a high front, allowing the tortoise to stretch its neck steeply upwards to reach the shrubs on which it feeds.

While some reptiles have ancient fossil histories, others are highly advanced. The chameleons, such as *Bradypodion pumilum*, can change colour to blend in with their backgrounds. They move slowly, swaying as if they were leaves in the breeze, to get within a tongue's reach of their insect prey. Lizards show a great variety of behaviour; the armadillo lizards, such as *Cordylus giganteus*, roll up to expose their spiny skins. This puts off many a potential predator.

Rattlesnake *Crotalus viridus*

Skull of adult gharial *Gavialis gangeticus*

Snakes are highly evolved reptiles. The rattlesnake *Crotalus viridus* is a classic predator. Dried scales at the end of the tail produce the noise that gives this famous snake its common name. The tongue flicks out to taste the air for the scent of prey, while the head is held back in an S-shaped coil, ready to strike out and deliver a fatal bite. The fangs are thrust out as the snake opens its mouth, and the pressure on poison glands in the roof of the mouth delivers a fatal dose to small prey. The windpipe extends to the front of the mouth, allowing the rattler to swallow the drugged prey head first while still being able to breathe.

The crocodiles and their relatives have been successful predators for hundreds of millions of years. Among these, the gharial *Gavialis gangeticus* is specialised for stealth. The skull shows the lump of bone at the end of the snout, which supports the nostrils. Only these and the eyes are above water, allowing the gharial to breathe and search for prey without being spotted.

The evolution of vertebrates is a long story. Ancient species of crocodiles and turtles witnessed the rise and fall of dinosaurs. The only close dinosaur relatives to survive the extinction of 65 million years ago were the birds.

Juvenile gharial *Gavialis gangeticus*

Birds of a Feather:
Second Floor (Lower Balcony, North Side)

Birds are a very diverse group of vertebrates but share some common features. The most obvious of these is the coat of feathers that allows most species to fly. The birds on the north side of the lower balcony are arranged in groups of close relatives. Their bodies give clues to their lifestyles, and each has a beak shape determined by its evolutionary inheritance and its approach to feeding.

Kiwi *Apteryx australis* from New Zealand

The largest birds are unable to fly. This is seen today in the ostrich of Africa but is a more common feature on islands where birds are the top animals in the food chain. *Apteryx australis* is one of three species of kiwi in New Zealand, an island with no native mammals. Kiwis are small ground-dwelling birds with unusual feathers that are suited to insulation. The combined lack of a tail, large wings and strongly built feathers would make flight impossible. Kiwis are creatures of the night and have small eyes, relying more on their good sense of smell and long, sensitive bills to hunt out worms, small insects and fallen berries. Their eggs are large, up to one-sixth of the mother's body weight. When nestlings hatch, they have to learn rapidly to fend for themselves.

Red-crested pochard *Netta rufina*

Freshwater lakes and streams are havens for wild birds for good reason: they are rich in food. The red-crested pochard *Netta rufina* is a member of the well-known duck family and has a typical duck bill shape. It also shares the common feeding habits of dabbling in shallow water and upending in search of water plants. This particular bird is from introduced stock, found in central Dublin but more at home in a belt stretching from southern Europe across Asia to China.

Secretary bird *Sagittarius serpentarius* from South Africa

Many water birds are easily recognised by their bills, the shape of which is closely related to feeding habits. The typical dabbling shape of a duck's bill contrasts with the long, probing bill of the curlew *Numenius arquata*. This is a common and widespread bird, familiar on mudflats and coastal grasslands anywhere from Ireland to Japan and as far south as Africa.

Even birds that are good fliers may spend much of their lives on the ground. The secretary bird *Sagittarius serpentarius* has long legs that are ideal for its hunting technique of stamping on snakes and other animals in short grassland. It has long wings, which are outstretched to defend its body against snakebites, and is a most graceful flier. The strongly hooked beak reveals its diet as a meat-eater. The feathers on its head resemble the quills that would have been used as pens by an eighteenth-century secretary – hence its common name. The scientific name reveals its more vicious streak as the 'archer of serpents'.

Curlew *Numenius arquata* from Japan

Pied falconet *Microhierax melanoleucus* from Assam, India

The most impressive predators among the birds are in the falcon family. They have evolved strong, curved bills for tearing meat, sharp claws for attacking prey and very high speeds in flight. This group includes the more delicate falconets, such as *Microhierax melanoleucus* of India and South-East Asia, which feed on small prey but display the highly evolved flying skills of their larger relatives.

Turkey vulture *Cathartes aura* from Chile

Some birds are less involved in the killing of animals, and prefer to spot their food from the air. The turkey vulture *Cathartes aura* is a widespread carrion feeder of North and South America. Like their giant relative, the condor, vultures have large nostrils and a keen sense of smell that can detect a dead animal from considerable distances. Their naked head region is useful in keeping this area clean, an advantage in a bird that feeds on entrails.

One of the commonest birds in the world must be the red junglefowl *Gallus gallus* of India and South-East Asia. It is the species that has been bred over thousands of years to give numerous varieties of what most of us would recognise as a domestic chicken. First bred in captivity three thousand years ago in India, and later in China, these birds had become common in Egypt and Crete by 1500 BC, thereafter spreading steadily westwards across Europe. Cockerels appeared on coins as early as 700 BC, but it seems that in Europe they were valued initially for use in sacrificial offerings and cockfights.

Birds form a very successful and widespread group of animals today. They have had their failures, however, as well as their triumphs. Birds that competed with people often had a sad end. The passenger pigeon *Ectopistes migratorius* was so common in North America when Europeans arrived that some single flocks were estimated at over a billion birds. They migrated like locusts, destroying the agricultural efforts of settlers, and this led to their persecution on a large scale. By 1870 large flocks were no longer to be seen, and the last wild specimen was recorded in 1899. Just one bird survived in a zoo up to 1914, after which the species became extinct.

The classic symbol of extinction is of course the dodo *Raphus cucullatus*. A flightless, ground-dwelling relative of pigeons, found

Red junglefowl *Gallus gallus* from India

Extinct passenger pigeon *Ectopistes migratorius* from North America

Kakapo *Strigops habroptilus* from New Zealand

Skeleton of the dodo *Raphus cucullatus* from Mauritius

only on the Indian Ocean island of Mauritius, the dodo was abundant when the first sailors arrived in 1598 and extinct less than a century later. In the early days of sailing ships, many islands were used as stop-off points and stocked with animals to provide a supply of familiar food for passing sailors. The introduction of pigs and goats gave dodos competition for food and threatened the safety of nesting sites. They were also easy to catch for the cooking pot.

The kakapo *Strigops habroptilus*, like the dodo, is a flightless bird and is still competing with introduced animals. Kakapos are native to New Zealand, an island where birds such as the extinct moa were the dominant animals until people introduced mammals. The kakapo is a type of parrot of which fewer than a hundred are left in the wild, and they have survived only because of a breeding programme on Whenua Hou (Codfish Island) reserve in New Zealand. Here the rats and other mammals have been removed to give the kakapos an environment free of competitors.

The birds along this gallery of the museum can be found in a variety of habitats.This can be seen from the adaptations developed to exploit these different environments. Extinction is a fact of life, but it is increasing at an alarming rate as people compete with animals for resources on our crowded planet.

Mating Game:
Second Floor (Lower Balcony, East End)

Eagle owl *Bubo bubo*, Europe

Birds illustrate perfectly a critical issue for all animals: the need to reproduce. Without healthy offspring growing up in a suitable habitat, there would be no descendants.

Birds are more often heard than seen, their calls may be more identifiable than their plumage. The eagle owl *Bubo bubo* of European forests is the largest of a group of birds well known for their calls. The hooting of owls serves a number of purposes, as do the calls of most birds. They advertise the bird's presence but also run the risk of attracting predators, so they must be of benefit to be worth the danger. Calls may be used to mark out territories. Each bird needs an area of its own that can supply enough food for its needs and is free of birds of the same species competing for that food. Calls also indicate the health and sex of birds and are key factors in the mating game.

Many tropical birds are brightly coloured and visually striking, none more so than the toucan, with its enlarged bill. There are thirty-seven species in the toucan family, including *Ramphastos vitellinus*, which inhabits rainforests of the Amazon River banks in Brazil.

Channel-billed toucan *Ramphastos vitellinus* from Brazil

Bower bird *Ptilonorhynchus violaceus* from eastern Australia

Male lyre bird *Menura superba* from Australia

The large bills are specially adapted for picking fruit from awkward places; the fruit is then swallowed by tipping the head back with the bill upright. Bright patterns help to confuse predators by breaking up the outline of birds in the dappled light of the forest. Males of many bird species are brightly coloured, a feature that can be used by females to judge health as a measure of freedom from parasites. A healthy male is always preferred for breeding purposes and gives a greater chance of sturdy offspring.

Colour is not the only feature that female birds use to judge potential suitors. Bower birds, such as *Ptilonorhynchus violaceus* from eastern Australia, make elaborate stages on the forest floor on which to perform. First the male lays a path of twigs along the ground, followed by two rows of vertical twigs meeting at their tips to form an enclosure reminiscent of a shady avenue. The structure is decorated with brightly coloured objects scavenged from the neighbouring forest. This behaviour illustrates the health and success of males, as those with the most impressive bowers are obviously good providers with additional energy available for showing off. A female bird convinced by this display will mate in the bower and retire to the nest in a nearby tree to lay her eggs.

Image is not everything in bird mating rituals. The lyre birds are dull-coloured by comparison with many birds but make up for this with impressive tail feathers, which the male uses for display during courtship. Females of *Menura superba* are similar to males but without the lyre-shaped tail feathers. Males are superb mimics of bird songs of other species and use a variety of sounds to impress friend or foe. Song is a good indicator of health and is often used by other birds to assess the size, health or strength of potential competitors or mates.

Baya weaver bird *Ploceus philippinus* from India

Nests of swiftlets, used for making soup

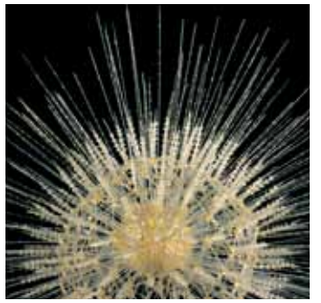
One of the most impressive displays to be seen in birds is found in New Guinea among the various birds of paradise. Popular in the hat-making trade since 1522, the feathers of *Paradisaea raggiana* are in fact designed to be used in a stunning display in which the male hangs upside down from a branch. This allows the feathery plumes to cascade around his body, which vibrates to the accompaniment of a complex song.

Birds' nesting behaviour is as varied and complex as their mating rituals. The Baya weaver bird *Ploceus philippinus* is native to India, Pakistan and South-East Asia – but not to the Philippines, as mistakenly assumed by the scientist who came up with the name. Weaver bird nests are amazing mixtures of design and functionality. The opening is at the base of a long woven tube that leads to a chamber where the nestlings are safe and out of sight of predators. The shape of each nest is peculiar to a particular species of weaver bird.

Bird nests are famous for one use, which is of little interest to birds but has caused endless fascination for people over the centuries – bird's nest soup. The most popular and highly valued nests come from caves in South-East Asia. One famous cave is in the island of Sarawak, where cave swiftlets of the genus *Collocalia* glue their nests to the walls, high above ground level and beyond the reach of predators. This is a challenge to the harvest, which is carried out with blades at the end of long poles. The nests are made of bird saliva, perhaps not to everyone's taste. Those with the least amount of feathers and other nest debris fetch the highest prices. They are virtually tasteless on their own but are mixed with chicken, spices, sauce and sweets to form the delicacy popular in China for over a millennium.

Raggiana bird of paradise *Paradisaea raggiana* from New Guinea

Crystal Jellies:
Third Floor (Upper Balcony, East End)



Blaschka glass model of a radiolarian *Aulosphaera elegantissima*

Blaschka glass model of jellyfish *Podocoryne*

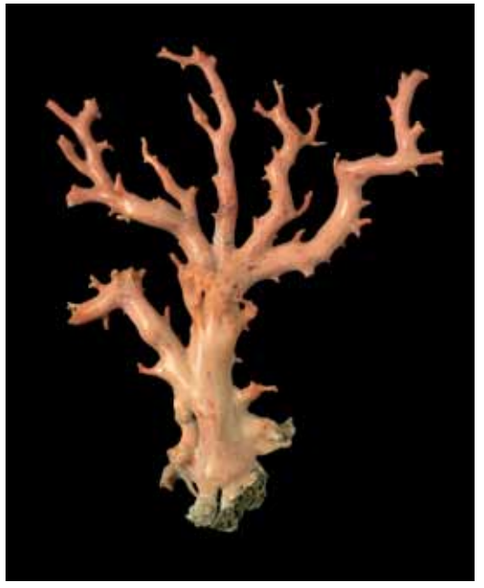
Blaschka glass model of anemone *Anthopleura artemisia*

The stunning glass models on this floor were manufactured in Dresden in the late nineteenth century by the father-and-son team of Leopold and Rudolf Blaschka. Their animal models were based on descriptions in the textbooks of the day and were true to every detail visible to the scientists who studied the real creatures under the microscope.

Much of the magic of the ocean is hidden from view simply because it is microscopic. This radiolarian *Aulosphaera elegantissima* is made from a single cell and would be far too small to see with the naked eye. It is one of a huge variety of animals living among the plankton of the world's oceans.

Jellyfish and sea anemones are close relatives. In many species they are simply different forms of the same animal at various stages in its life cycle. In the jellyfish, or 'medusa', phase the organism can swim freely by contracting its bell-shaped body and squirting water to jet forwards. Sea anemones are fixed to the sea floor. They can be thought of as upside-down jellyfish, with a central mouth surrounded by tentacles. Just as with jellyfish and corals, these tentacles can give a poison sting, to assist with capture of prey.

Black coral *Dendrophyllia nigra*, Red Sea



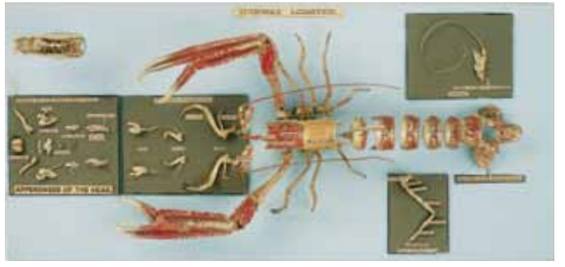
Red coral *Corallium rubrum*

Coral colonies look like plants at first glance, but they are in fact animals. Coral animals, or 'polyps', are generally small, with a set of short tentacles surrounding a central mouth. They are related to sea anemones and jellyfish. They live in tubes that form a 'skeleton' made of lime, the same as in many shellfish. Red coral *Corallium rubrum* was once widely used in jewellery but is now a protected species. Only the skeleton is preserved in these examples, and without the Blaschka models, visitors would have little idea that they were seeing only part of these animals.

Blaschka models are used for many animals around this balcony. Most of these animal groups are not familiar to the public. Exhibition cases of worms, including parasites, would be much less graphic without the skills of the Blaschkas!

Taxonomy Trail:
Third Floor (Upper Balcony, North Side)

Nephrops norvegicus, also known as Norwegian lobster, Dublin Bay prawn or langoustine



Taxidermy (from the Greek for 'arrangement of skin') is the obvious task of a natural history museum. The main work of most museum curators is, however, taxonomy (from the Greek for 'arrangement of names'). The science of taxonomy is the naming of animals and their arrangement into groups. It is our way of making sense of the incredible diversity of the natural world.

So what's in a name? Many animals are familiar to all of us and have common names in our own language. This works well until you travel to countries with other languages or until a scientist encounters several animals within a group with only one common name. The international standard in science is to use names with two parts based on Latin or Greek words. One person's Norwegian lobster is another's Dublin Bay prawn or even langoustine. In this way the scientific name *Nephrops norvegicus* avoids the confusion of the fishmonger's counter or the restaurant menu and serves as the name for this animal in all scientific works in all languages. The first part of the name indicates the genus, or group of animals that are close relatives, just like a surname. The second part of a scientific name indicates the particular species, or grouping of identical animals.

Lobsters and prawns are similar in appearance and are close relatives. They are arthropods, a term used to describe animals with jointed legs, including crabs, spiders and insects. Arthropods form the largest grouping of animal species and show incredible diversity. A small part of this diversity can be seen on part of the top balcony level in the Natural History Museum.

Tarantula *Acanthoscurria geniculata* from Brazil with hummingbird

Edible crab *Cancer pagurus*

Swimming crab *Zosimus aeneus*

Arthropods come in a wide variety of shapes and sizes. Crabs such as *Cancer pagurus* show some of the features seen in all members of this group. Legs are in pairs along either side of the body and are specialised for different functions. Crabs are decapods ('ten legs'), with four pairs of legs for walking and a pair of specialised legs with pincers at the front. Some walking legs may be adapted for swimming, as in the paddle-shaped legs of *Zosimus aeneus* of the Indo-Pacific region. Like all arthropods, crabs wear their skeletons on the outside. This is good for protection but means that in order to grow they must shed their outer layer from time to time and grow a new one.

Spiders are also arthropods and share the jointed legs of crabs as a feature of the group. One main difference is inside their bodies – unlike crabs, they have lungs and breathe air. Spiders evolved more than 500 million years ago and became some of the first animals to leave the sea and conquer the land. They are found in a wide range of habitats and are complex and fascinating creatures. Tarantulas such as *Acanthoscurria geniculata* are predators of the rainforest floor in Brazil.

Grasshopper *Tropidacris dux* from South America

Leaf-like insect *Phyllium cruorifolium* from Sri Lanka

Harlequin beetle *Acrocinus longimanus* from Peru

The most diverse group within the arthropods is that of the insects. With a wingspan of 18 centimetres, the grasshopper *Tropidacris dux* from South America is one of the largest examples in its group. Like other grasshoppers, they can communicate by means of sound. This is done by rubbing the strong, muscular hind legs against the outer cases of the wings when the latter are closed and folded along the animal's back. Grasshoppers can recognise other specimens of their own species by these sounds, which are also used by entomologists to identify species that may appear very similar at first glance.

Insects show amazing variety in the ways in which their versatile body materials have evolved to different ways of life. Camouflage is a feature highly developed in some larger insects, some of which have evolved body shapes that mimic their surroundings. The leaf-like insects include *Phyllium cruorifolium*, which is hard to distinguish from a leafy background in its native Sri Lanka.

Beetles form the largest group of insects. There are hundreds of thousands of species worldwide. Many are highly specialised, concentrating on a particular food source or way of life. The harlequin beetle *Acrocinus longimanus* from South America has the longest legs of any beetle. Spectacular insects such as this can be under threat from collectors. Museums have played their role in capturing endangered species in previous centuries; now it is the souvenir hunter who threatens such animals in the wild. You can buy a harlequin beetle over the Internet – but please don't!

Underwater Worlds:
Third Floor (Upper Balcony, South Side)

Blaschka glass model of sea cucumber *Psolus phantapus*, North Sea

The greatest variety of body shapes and lifestyles is seen on the top floor of the museum among the many groups of invertebrate animals. Many of these are marine creatures or land-living relatives of animals that show their greatest diversity in the world's oceans. Echinoderms are animals with five-fold symmetry, the most obvious examples being starfish. Sea cucumbers such as *Psolus phantapus* are less obvious members of this group. They live on the sea floor and can spray out their internal organs if attacked by a predator. Being entangled in this sticky mess keeps the predator occupied while the sea cucumber moves away.

Sea urchins have a hard outer casing and use spines to deter predators. One of the most beautiful examples is the slate pencil urchin *Heterocentrotus mammillatus* from the Gilbert Islands in the Pacific Ocean.

Shellfish come in an amazing variety of shapes and sizes, mostly related to their lifestyles. This biological diversity is placed into three major groups within the molluscs – gastropods, bivalves and cephalopods. Molluscs with coiled shells are known as gastropods, a term that covers familiar snails, the limpets with their simple shells and even slugs without shells at all. The Australian red triton *Charonia lampas* seen here is cut to show the internal spiral structure of a typical gastropod. Emperor helmet shells of the species *Cassis madagascariensis* from the West Indies were popular among Italian cameo workers who carved delicate intaglios, which stand out on the coloured layers of the shell.

Slate pencil urchin *Heterocentrotus mammillatus*, Gilbert Islands

The Australian red triton *Charonia lampas*

Emperor helmet shell *Cassis madagascariensis*

Blaschka glass model of white-spotted octopus *Octopus macropus*

Bivalves have two halves to the shell and include the familiar cockles and mussels. Tropical waters have a dazzling array of coloured bivalves including the Pacific thorny oyster *Spondylus princeps* of the western American coast. The noble pen shell *Pinna nobilis* attaches its shell to the sea floor with strands of strong tissue known as byssus. A nineteenth-century fashion in Italy was to make gloves with this gold coloured thread.

Cephalopods are also molluscs, even if few living species apart from the nautilus have shells. Their ancestors include the famous ammonites, which thronged the seas when dinosaurs were alive. Modern cephalopods are highly intelligent creatures and include the white-spotted octopus *Polypus macropus*, modelled here in coloured glass. Like other octopuses they can find their way through a laboratory maze and squeeze their soft bodies through the tightest gap. This allows them to escape predators but also to hunt their prey, which they bite with a horny beak.

Pacific thorny oyster *Spondylus princeps*

Noble pen shell *Pinna nobilis*

Gloves made from the threadlike byssus clipped from the noble pen shell

These are just some of the ten thousand specimens on display in the museum. There are many millions of species of animals on our planet today, although that number is decreasing every year. The museum aims to highlight the variety of creatures that share our world, in the hope that we will be inspired to create a better balance between people and the rest of nature.

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