

children's illustrated encyclopedia

# Animals

1: Invertebrates, Fish, Reptiles and Birds



 Orpheus

First published in 2009 by Orpheus Books Ltd.,  
6 Church Green, Witney, Oxfordshire OX28 4AW England  
www.orpheusbooks.com

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Created and produced by Orpheus Books Ltd

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ISBN 978 1 905473 42 7

A CIP record for this book is available from the British Library.

Printed and bound in Singapore



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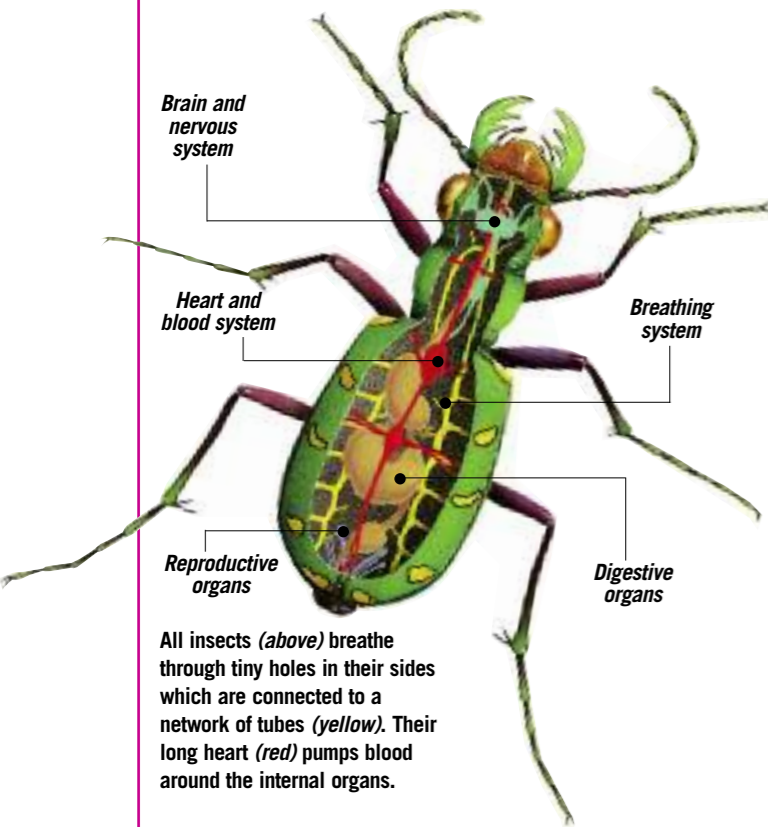
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# INSECTS I

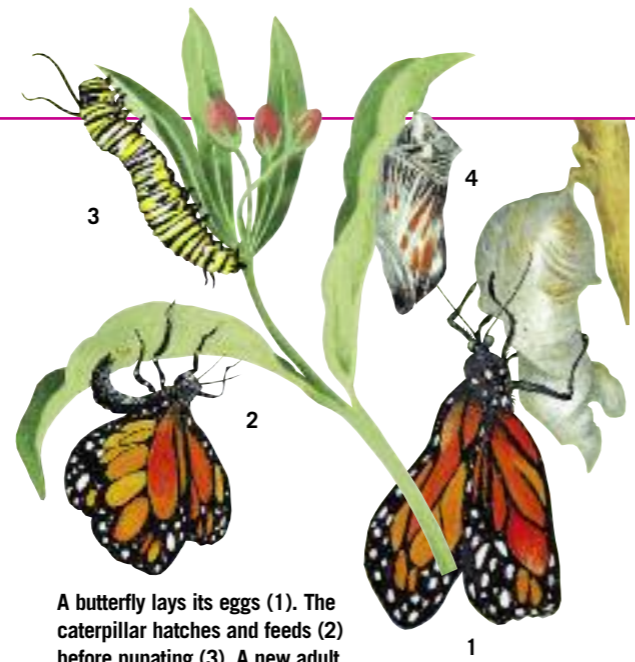
**I**NSECTS are invertebrates, animals that do not have backbones. Insects belong to a large group of invertebrates known as **arthropods**. Other members of this group include centipedes, spiders and scorpions, woodlice, crabs and shrimps. Instead of having an internal skeleton, arthropods have a hard outer skeleton. This is made of a light, strong material called chitin, that supports and protects their soft inner parts.



All insects (above) breathe through tiny holes in their sides which are connected to a network of tubes (yellow). Their long heart (red) pumps blood around the internal organs.

All insects have six legs and a body divided into three sections: the head, thorax and abdomen. The chitin covering the legs is jointed to allow the insect to move easily. Insects have a pair of antennae on their heads which they use to smell, touch and pick up sound vibrations. Most insects also have one or two pairs of wings.

Insects have two kinds of eyes: simple eyes, that detect changes in light, and compound eyes. The compound eyes are made up of thousands of tiny units, each of which sends an image to the insect's brain.

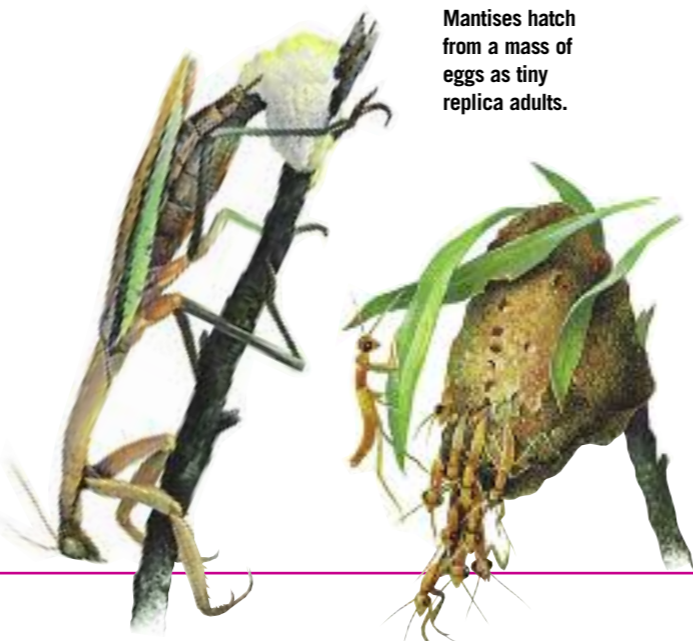


A butterfly lays its eggs (1). The caterpillar hatches and feeds (2) before pupating (3). A new adult emerges from the pupa (4).

This means that insects have good, all-round vision, and are able to sense movements and judge distances very accurately.

After mating, a female insect lays her eggs. The young are usually left to hatch and fend for themselves. Some insects, such as bugs or grasshoppers, look like tiny adults when they hatch. As they grow, they shed their hard outer skeleton several times, after a new one has grown underneath.

Other insects, such as butterflies or bees, hatch out as larvae (caterpillars or grubs). They shed their skin several times as they grow. Then they develop a protective coating inside which they pupate (change into their adult form).

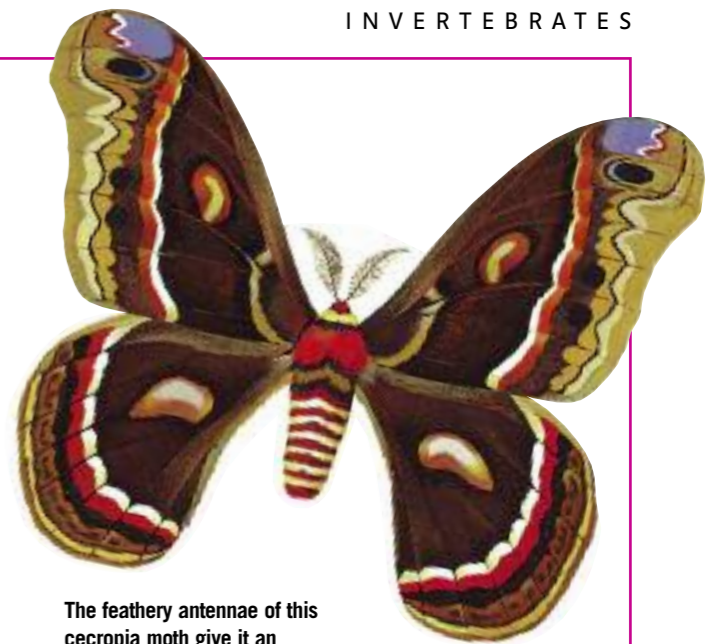


Mantises hatch from a mass of eggs as tiny replica adults.

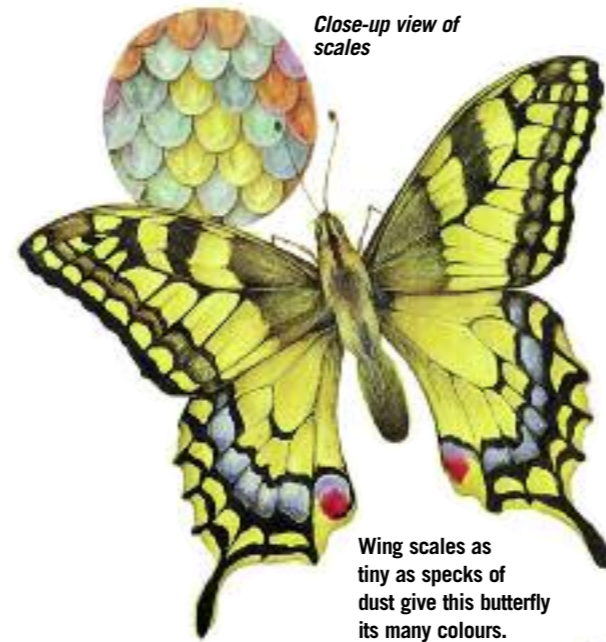
# BUTTERFLIES AND MOTHS

Butterflies and moths are a group of flying insects, with wings that are covered with tiny, overlapping scales. These scales give butterflies and moths their bright colours and striking markings. Most butterflies and moths have coloured scales. Others have scales that reflect the light to give an impression of colour.

The colours and patterns of butterflies and moths are used to attract mates, for camouflage, and also to deter predators. Large spots that look like the eyes of a large animal, or bright colours to warn that the butterfly or moth is poisonous, help these insects to avoid being eaten.



The feathery antennae of this cecropia moth give it an excellent sense of smell.



Close-up view of scales

Wing scales as tiny as specks of dust give this butterfly its many colours.

Butterflies generally fly during the daytime. They are usually more brightly-coloured than moths and have club-like antennae. Most moths are night-flyers, and have feathery antennae. Adult butterflies and moths have a long, hollow tongue called a proboscis. They use it to probe inside flowers and suck up nectar.

Butterfly and moth larvae are called caterpillars. They feed on leaves until they have grown large enough to pupate. Then they spin a protective cocoon of silk around their bodies, inside which they completely change their structure, and finally emerge as adults (see opposite). Some may migrate to warmer climates when winter comes, returning to breed and lay eggs.

The Hercules moth caterpillar (right) lives in the rainforests of Australia and Southeast Asia. It grows up to 17 centimetres in length before it pupates. The caterpillar has spikes on its back to deter predators. When it becomes an adult moth it is still a giant. Its wingspan can measure over 30 centimetres—larger than some birds.



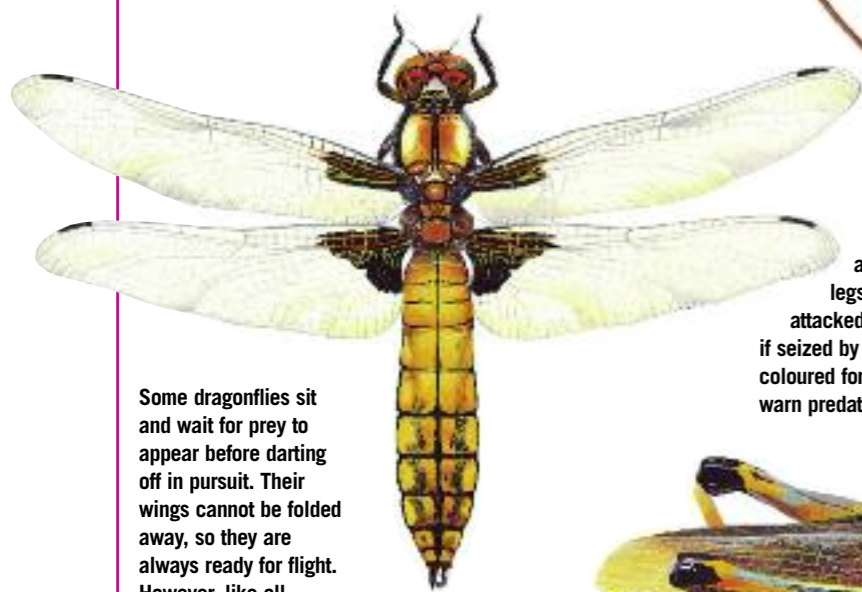


## INSECTS II

THERE ARE more kinds of insects in the world than all other animals put together. They live in every environment apart from the oceans. Some are pests, eating crops or spreading diseases, while others are vital to the survival of plants and animals. Many insects spread pollen between plants, helping them to reproduce. They are also prey for many animals, so are an important part of the food chain.

Insects can run at speed, jump incredible distances, swim and fly. **Dragonflies** are among the best flyers. They are able to fly at speeds of over 50 kilometres per hour, carry out split-second changes of pace and direction, hover and even fly backwards. Dragonflies feed on other insects, chasing them through the air and catching them with their legs, or plucking them off plants.

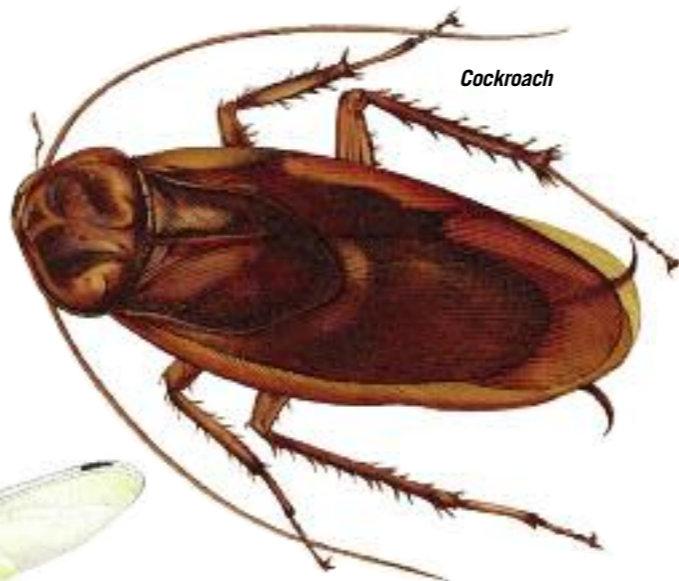
Dragonflies live near rivers, streams and ponds. Males patrol their territory and chase rivals away. Dragonfly young (nymphs) live in the water, feeding on tiny fish, tadpoles and other insects. They climb out of the water just before they shed their skin for the last time to become adults.



Some dragonflies sit and wait for prey to appear before darting off in pursuit. Their wings cannot be folded away, so they are always ready for flight. However, like all insects, dragonflies are cold-blooded animals. They have to sit in the sun to warm up before they are able to fly.

**Cockroaches** are extremely adaptable insects. They can live almost anywhere and many will eat any kind of food they can find. Some are tree-dwellers and have wings, while other, wingless kinds burrow into the ground or hide in small spaces, coming out to feed. Some kinds are found in houses, where they eat our food and spread germs and diseases.

Some kinds of **grasshoppers**, known as locusts, are also pests. They mass together and can eat whole cropfields. Most grasshoppers and crickets, however, are better known for their loud, chirping songs. These are usually made by the males to attract females, and are produced by rubbing both wings, or a leg and a wing, together.



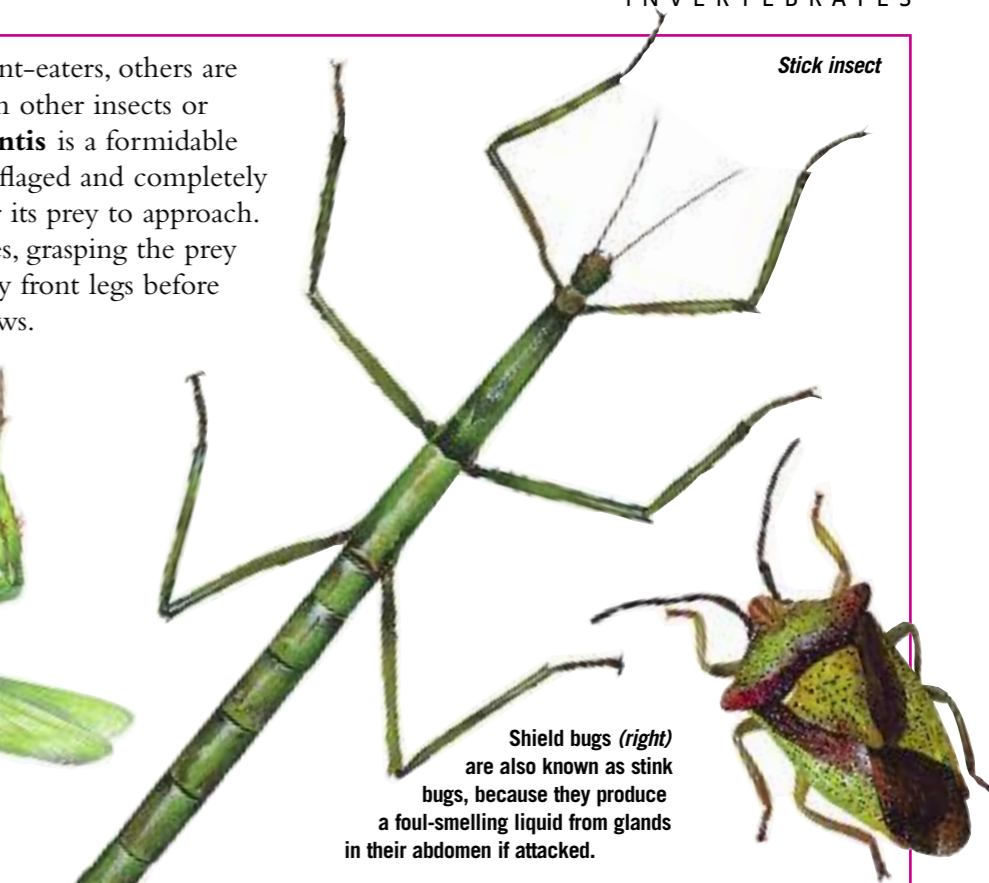
Cockroach

Grasshoppers and crickets that live above ground have long, powerful back legs that they use to spring to safety if attacked. They can also deliver a powerful kick if seized by a predator. Some of these insects are coloured for camouflage, or have bright markings to warn predators that they have a foul taste.



Some insects are plant-eaters, others are carnivorous, feeding on other insects or small animals. The **mantis** is a formidable predator. It sits, camouflaged and completely motionless, waiting for its prey to approach. Then the mantis strikes, grasping the prey between its sharp, spiny front legs before bringing it up to its jaws.

If threatened itself, a mantis may flutter away or spread its wings and strike out with its front legs at its attacker.



Stick insect

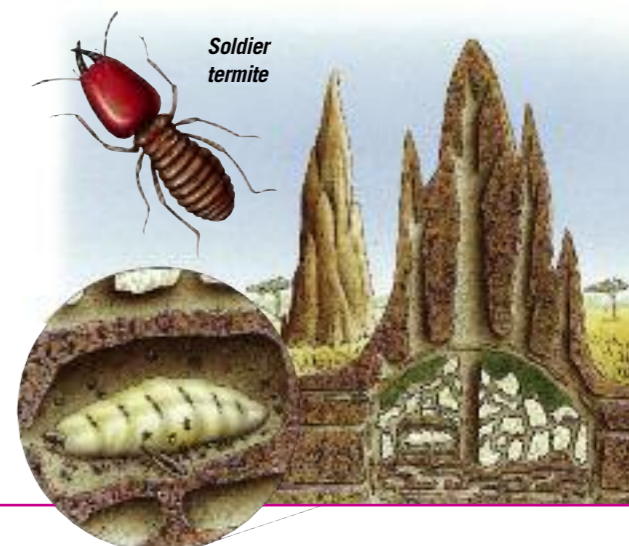
Shield bugs (right) are also known as stink bugs, because they produce a foul-smelling liquid from glands in their abdomen if attacked.

**Stick and leaf insects** are also masters of disguise, although their camouflage is used to hide from predators rather than for hunting. They live in trees, feeding on vegetation. They are coloured green or brown, and look very similar to twigs or leaves. They even sway from side to side if the tree is moved by the breeze.

**Bugs** differ from other insects because they have long, beak-like mouthparts instead of biting jaws. They use them to pierce their food and suck up the liquid contents. Most feed on plant juices, but some hunt and feed on other animals.

Carnivorous bugs either suck the blood of their victims or inject saliva into their bodies, liquefying the insides so they can be sucked out. Many live in water, either underwater or skipping across the thin film of the surface on their long legs. They grasp their prey with their forelegs in a similar way to a mantis.

**Termites** live in colonies that may number several million. They build large, complex nests underground or in dead trees. In hot, dry climates, termites build hollow mounds over the nest (*below*), allowing cool air to circulate. Inside the nest lie the large king and even larger queen, her swollen body full of eggs (*inset*). Soldier termites protect the colony from attack by enemy ants. Worker termites find food, feed the others and look after the young.



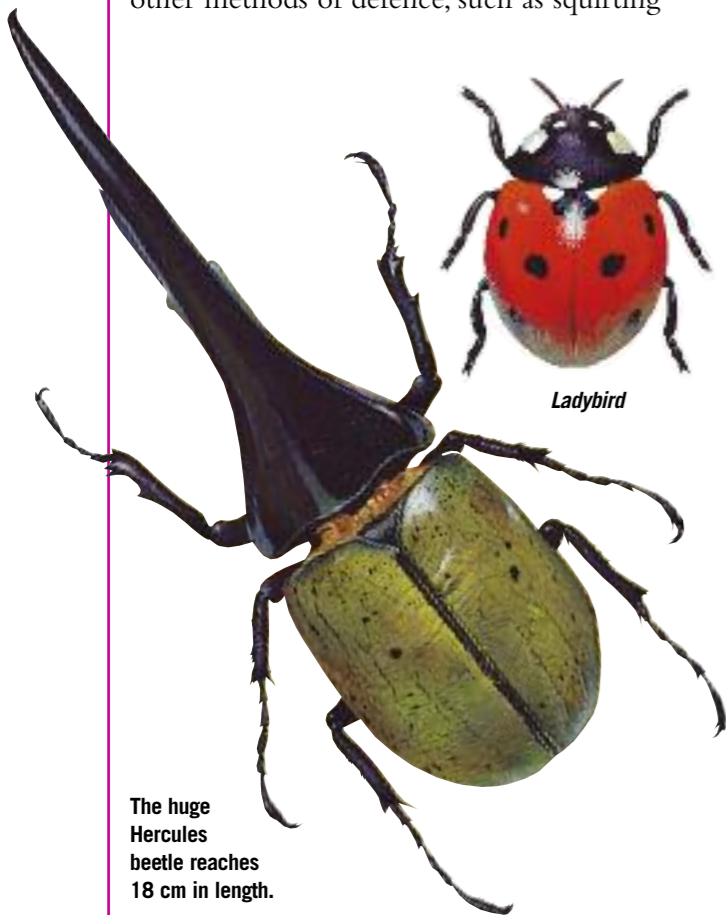
Soldier termite



## INSECTS III

**T**HE LARGEST and most successful group of insects are the **beetles**. All beetles have two pairs of wings, but only the back pair are used for flying. The front wings, called the elytra, form a hard, protective case. This folds over the fragile back wings when the beetle is on the ground. As the beetle takes off, the elytra open. Some beetles do not fly at all, so their elytra are fused together.

The hard elytra are good protection against predators. Many beetles also have other methods of defence, such as squirting

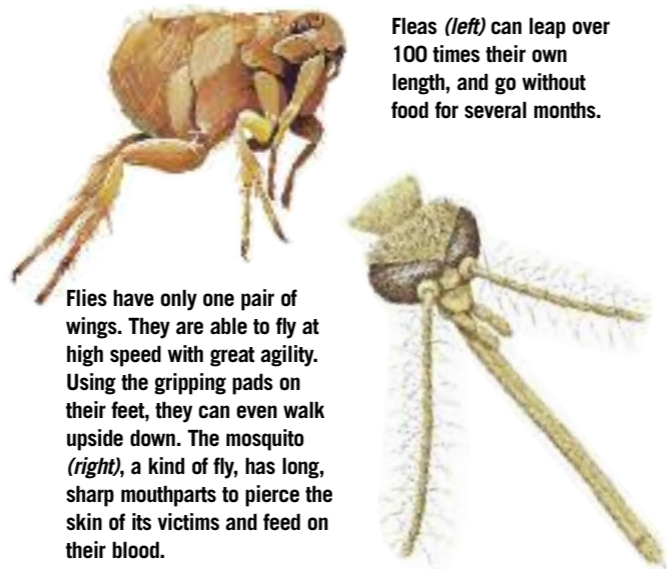


The huge Hercules beetle reaches 18 cm in length.

Ladybird

poisonous chemicals at their attackers, or startling them with loud noises.

Beetles hatch from their eggs as grub-like larvae. They grow and then pupate, emerging as fully-grown adults. Some plant-eating beetle larvae are legless grubs, while predatory beetle larvae have large jaws and legs which they use to catch their prey.



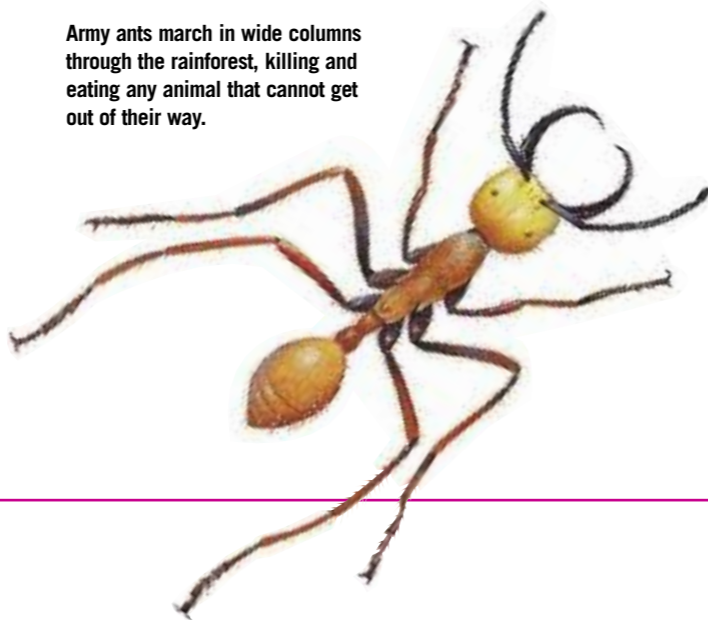
Fleas (left) can leap over 100 times their own length, and go without food for several months.

Flies have only one pair of wings. They are able to fly at high speed with great agility. Using the gripping pads on their feet, they can even walk upside down. The mosquito (right), a kind of fly, has long, sharp mouthparts to pierce the skin of its victims and feed on their blood.

**Fleas** live on or near the bodies of animals, feeding on their blood and so often spreading diseases from one animal to another. Fleas carried on the bodies of rats were responsible for the plague in the 14th century, known as the Black Death. Fleas have a powerful “trigger” in their hind legs that allows them to travel over 100 times their own length in a single leap.

Some **flies** also feed on blood, biting animals and humans and spreading disease. However, most flies are very useful insects. Many help to pollinate flowers by feeding on nectar and pollen, while others are scavengers. They actually help to keep our environment clean and healthy, by feeding on dung or rotting material such as dead plants and animals.

Army ants march in wide columns through the rainforest, killing and eating any animal that cannot get out of their way.



## ANTS, BEES AND WASPS

Like termites, **ants** live in large colonies with a winged queen and king, wingless workers, and sometimes soldier ants. Their nests have separate chambers for eggs, larvae and sometimes even food stores.

**Bees** nest underground or in hollow trees and other small spaces. They feed on pollen and nectar which they collect from flowers using their long tongues.

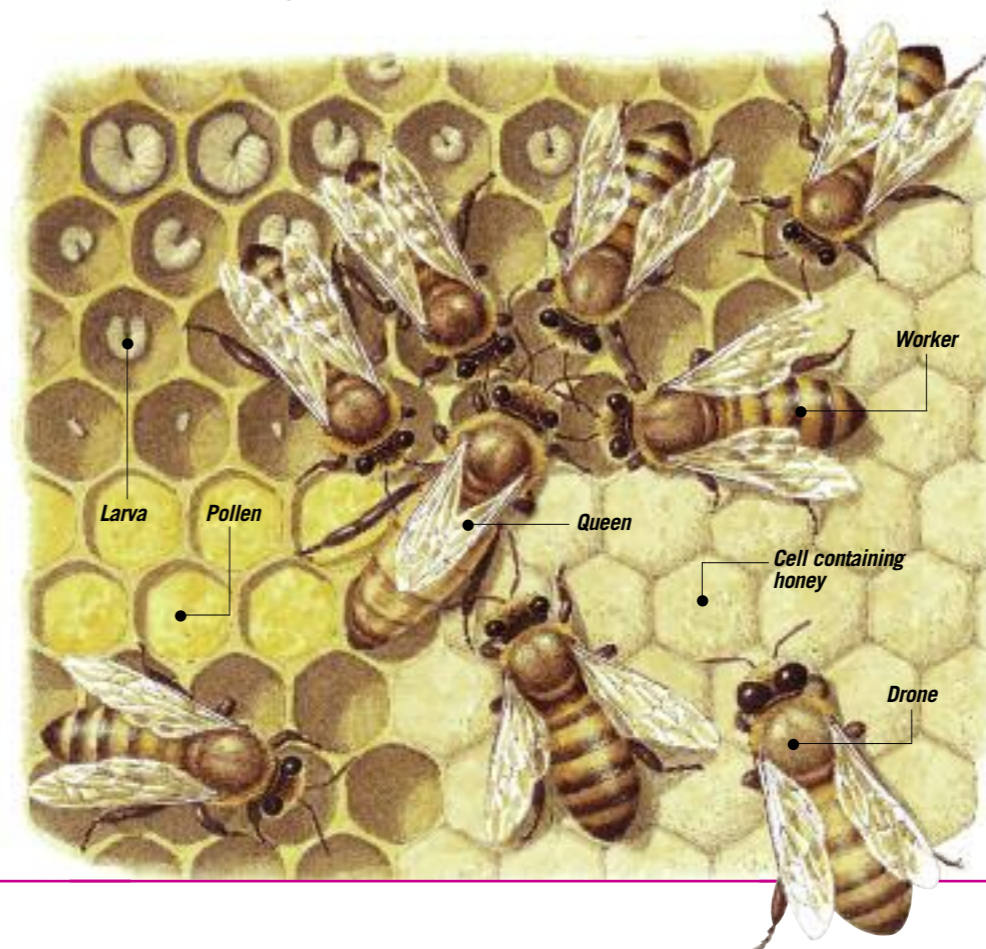
**Wasps** are carnivores. Some solitary-living wasps lay their eggs on or inside hosts, often butterfly or moth caterpillars. The larvae feed on the host as they grow, usually killing it in the process. Other wasps build nests from mud, or paper nests made out of chewed-up wood. These kinds of wasps bring their insect prey to the nest to be fed to the grub-like larvae.

Unlike a queen bee, which always has workers in attendance, a queen wasp finds a nest site by herself and raises the first brood of workers. The workers then continue the nest-building and other tasks.



The tarantula hawk wasp has a 12-cm wingspan. The female hunts bird-eating spiders, paralysing them with her sting.

The black and yellow stripes of bees and wasps are a warning sign to predators. Both bees and wasps have a sharp, pointed sting on their abdomen which injects painful venom into an attacker’s skin. Honeybees defending their nests are able to sting only once, as the act of stinging also kills them.



Honeybees live in large, colonies that may contain thousands of bees. Their nest is built up out of many small, hexagonal cells made of wax produced by the bees. Each compartment contains either larvae, or stored food.

The worker bees, which are all female, have different tasks to do throughout their short lives. They build the network of wax cells (honeycomb), guard the nest and attack any intruders. They go out to collect pollen and nectar and bring it back to the nest. Then they “chew” the nectar until it turns into sticky honey. This is then stored in cells as food for the winter.

The workers also feed and look after the queen bee and the larvae. Most of the larvae will become workers. Some will be new queens, one of which will take over the nest. Others will be males, or drones. They do not work, but one will mate with the queen.



## ARACHNIDS

**S**PIDERS and scorpions are arachnids. They differ from insects because they have two, rather than three, body sections, eight legs instead of six, and no antennae or wings. Most arachnids also have eight simple eyes and no compound eyes. They rely more on sound than sight. Most have bristles on their legs that are sensitive to vibrations in the air or through the ground.

Arachnids feed by piercing their prey with their sharp fangs, paralysing or killing it. Their saliva turns the body tissues of the prey into liquid that can then be sucked up.



Spiders' webs are made from strands of silk, a strong, stretchy material that is produced inside the spider's abdomen. It draws out the silk with its legs and stretches it into an intricate web.

**Spiders** are carnivores, feeding mainly on insects and other spiders. Many spiders use webs to catch their prey. Any insect that flies into a web is caught in the strands, which are often sticky. As the insect struggles to free itself, the spider, sitting at the edge of the web, feels the vibrations and comes to claim its prey. It avoids becoming caught in the threads itself by walking on the claw-like tips of its feet.

Spiders that do not spin webs either chase down or ambush their prey. Many, such as the jumping spiders, have much sharper eyesight than other arachnids. Bird-eating spiders (*right*), are the largest kind in the world. They can have a leg span as wide as a dinner plate! Bird-eating spiders chase their prey through the undergrowth of tropical forests, then rear up and strike with their huge, powerful fangs.

Silk is used by the spider for many other purposes besides forming webs. It can be a safety line when jumping, be woven into a sac by a female to hold her eggs, or used to wrap up prey before feeding.

All spiders have poisonous venom, which they use to paralyse or kill their prey. Some, such as the black widow spider (*below*), are so poisonous that they can kill humans.



Scorpions (*below*) hold their stings curved over their backs. Some kinds of scorpion have a sting that is deadly to humans.

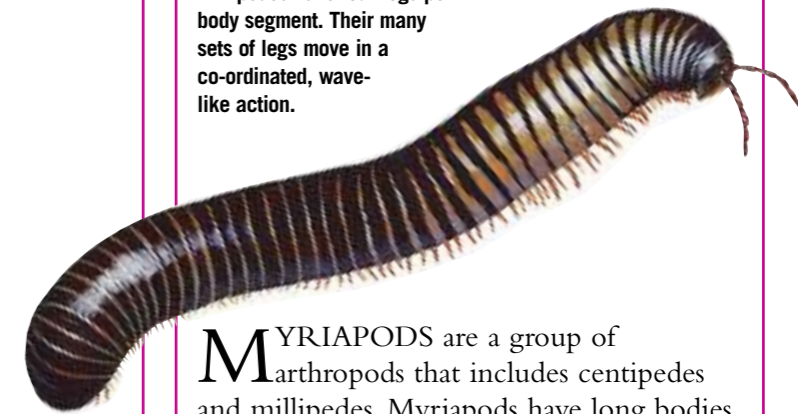


## SCORPIONS

Scorpions have a sharp sting on the end of their tail-like abdomen that injects poison into their prey. It is also used for defence. Like other arachnids, scorpions have an extra pair of "limbs" either side of their jaws. These form large pincers for the scorpion to grasp its prey. After hatching, young scorpions climb up their mother's pincers on to her back, where they are carried until they shed their skins for the first time and become independent.

## MYRIAPODS

Millipedes have four legs per body segment. Their many sets of legs move in a co-ordinated, wave-like action.



**M**YRIAPODS are a group of arthropods that includes centipedes and millipedes. Myriapods have long bodies made up of segments, and as many as 200 pairs of legs. They must live in dark, damp places because their bodies easily dry out.

**Millipedes** have short, strong legs for burrowing through soil or dead leaves. Most feed on plant material, chewing with their strong jaws. **Centipedes** are carnivorous predators. Most have longer legs than the millipedes, and can scuttle at great speed after their prey. They use the large "poison-claws" on their heads to capture and paralyse their prey before eating it.



Centipedes have two legs per body segment. They scuttle along on their long, outward-stretching legs. Their bodies wave from side to side as they move. Some kinds of centipedes have spiny rear legs for defence, while other, slower-moving kinds may be poisonous to eat. These kinds are often brightly-coloured as a warning to predators.



# FISH I

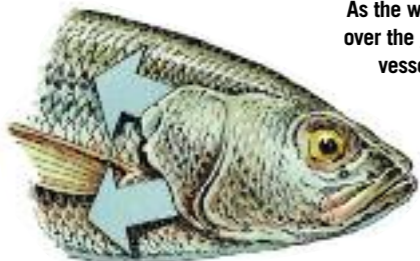
**F**ISH are vertebrates (animals with backbones). They live in water all the time. Most kinds cannot survive out of water, because they do not have lungs to breathe air. Instead, they take in oxygen from the water using gills in their heads.

Fish have hairless, streamlined bodies with fins and a tail. Many have a protective layer of overlapping scales. Fish are cold-blooded animals, so their body temperature depends on their surroundings. Some species have a special substance in their blood to stop them freezing in cold waters.

To breathe, fish open their mouths, and take in water that contains oxygen.



As the water passes out over the gills, tiny blood vessels filter out the oxygen.



Fish move by flexing the muscles along their bodies in a wave-like motion. The fins help to balance and steer the fish while the tail can be used for propulsion. The streamlined shape of most fish, as well as a coating of slimy mucus on their bodies, helps them to swim easily through the water.

Most fish lay vast numbers of eggs at once, which they leave to hatch out on their own. Newly-hatched fish are perfect, tiny replicas of their parents. A few kinds of fish, such as sharks, carry their eggs inside their bodies, and give birth to live young.

Fish were the first vertebrates to evolve, millions of years ago. One of the oldest types alive today is the coelacanth, fossils of which date back 90 million years.

There are two main groups of fish, the cartilaginous fish and the bony fish. Cartilaginous fish include sharks, rays and chimaeras. Most are found only in the seas and oceans. Cartilaginous fish have skeletons made of soft cartilage. Instead of flat, overlapping scales, they have tiny, pointed, tooth-like scales. Their gills can be opened and closed, but, unlike the bony fish, usually do not have protective flaps covering them. Cartilaginous fish must keep moving all the time, to stay afloat in the water.



Cookiecutter shark



Coelacanth

## SHARKS

Sharks are mostly predators, although the largest kinds of all, the whale shark and the basking shark, feed only on plankton, which they filter from the water using a part of their gills. Unlike bony fish, most of which have good vision, sharks rely on smell to hunt their prey. Sharks can detect a single drop of blood in a huge volume of water. They also have sensors on their bodies that can pick up tiny electrical signals produced by the movements of their prey.

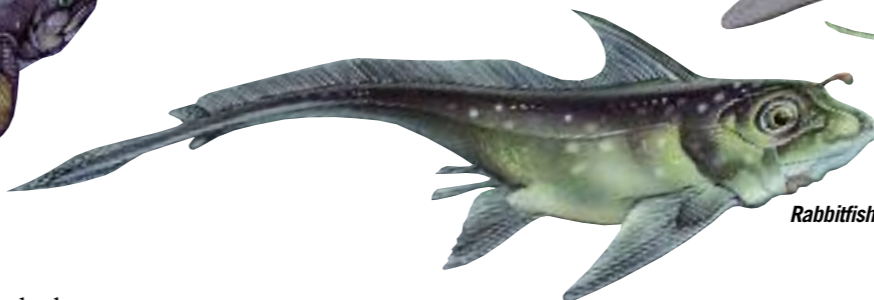
Sharks have large, razor-sharp teeth, which are set in rows. If the shark loses a tooth during feeding, a new one comes forward in the mouth to take its place. Most sharks feed on fish or squid, but the larger sharks, such as the great white, also eat turtles and large mammals such as seals. They slam into their prey, tearing out huge chunks of flesh. Despite their fearsome reputation, only the largest of the predatory sharks, such as the tiger shark or the great white shark, are dangerous to humans.



The sawshark (right) uses its long snout to dig up small creatures from the sea bed.



The great white shark lives in the surface waters of the open ocean. It can measure 6 m in length and its teeth can be 7 cm long.



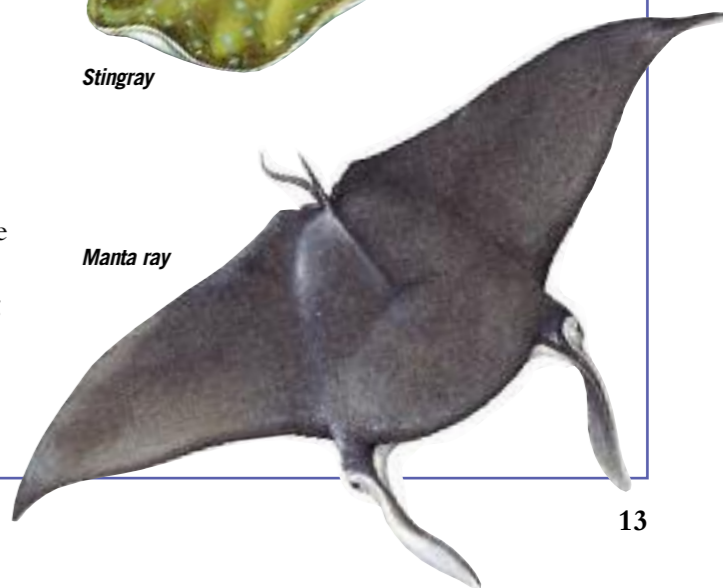
Rabbitfish

## RAY

Rays, and their relatives the skates, are cartilaginous fish with flat bodies and often long, narrow tails. Their gills and mouths are on their undersides. They have large, wing-like fins that they flap as they swim, making them look as if they are flying through the water. Rays feed on fish and shellfish near the sea bed. Sometimes they hide in the sand to ambush passing prey.



Stingray



Manta ray



# FISH II

FORMING a much larger group than the cartilaginous fish, bony fish have skeletons made of bone. Their bodies are usually covered with overlapping scales. They also have gas-filled swim bladders inside their bodies that allow them to stay afloat even when they are not moving.

Most bony fish have good eyesight, and can see in colour. Their eyes are on the sides of their heads, giving them a wide field of vision. Some kinds of bottom-dwelling fish have eyes that point upwards, to spot predators or prey above them. Fish such as salmon, which are preyed upon by many other animals, swim in large groups for protection in the same way as some animals, for example, cattle, herd together on land.

Seahorses rely on camouflage to keep themselves safe, while angelfish stay near clumps of seaweed or rocks. Some fish hide in the stinging tentacles of sea anemones.

Most fish have a familiar streamlined body shape, but several kinds look very different. Eels have long bodies with narrow dorsal fins that do not stick out from their bodies like those of other fish. Seahorses live in shallow waters and swim upright. They grasp on to seaweed with their tails to avoid being swept away by the current.

Many ocean-living fish are found close to the surface, where there is warmth and light and tiny plants, called plankton, to eat. Small plankton-eating fish may be prey for larger fish.

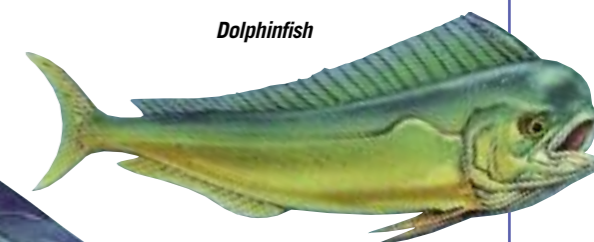
Flying fish (right) leap out of the water to escape from predators.



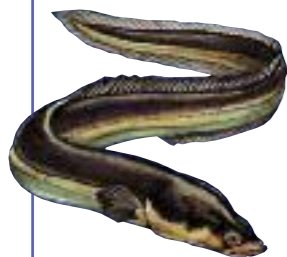
Pacific salmon



Barracuda



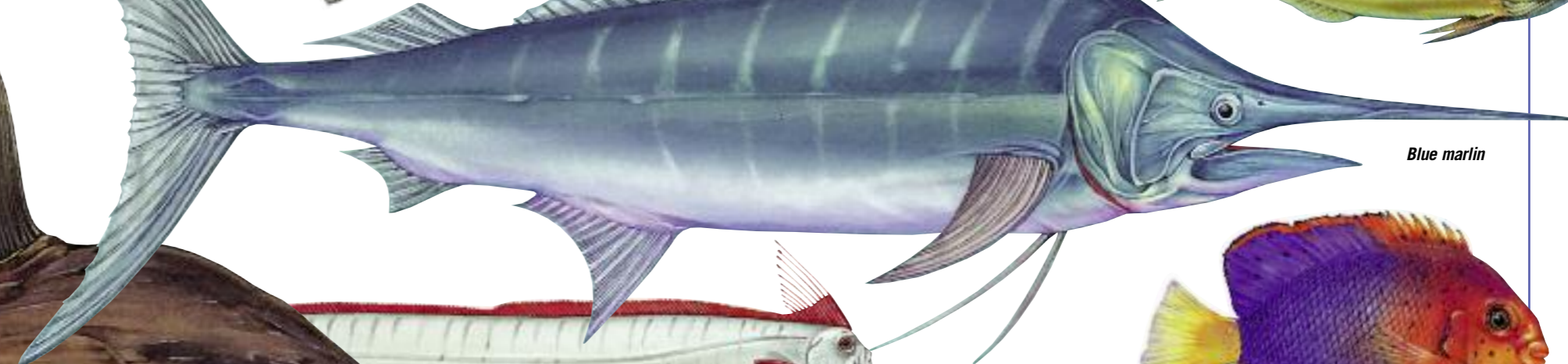
Dolphinfish



European eel



Stonefish



Blue marlin



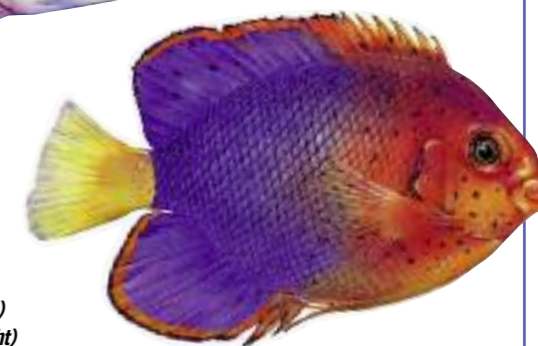
Lionfish



Ocean sunfish



Oarfish



The mandarinfish (left) and the angelfish (right) are both coral reef fish.



Thorny seahorse

Seahorses live among coral and sea grasses. They swim along in an upright position.

Several kinds of fish have protective armour made of fused scales, while others have sharp spines. Bright colours are often a warning signal to predators. The markings of the lionfish warn that its long, sharp spines are poisonous. Other fish inflate their bodies suddenly to startle an attacker.

Fewer fish live in the deeper, darker waters. The oarfish lives between 300 and 600 metres down. With its ribbon-like body and red "mane", it may be the sea monster described in old sea legends. Some deep-living fish travel up through the water to hunt, while others feed on scraps of food that drift down from the surface. Some deep-living fish are able to make their own small lights to attract prey towards their gaping mouths.

Some bony fish live in fresh water (rivers and lakes), while others live in the seas and oceans. Many feed on plant material, but some are carnivorous. Among the largest predators are the barracudas, which strike at great speed with their powerful jaws. Even larger is the blue marlin, which can be over four metres in length. Probably the most extraordinary of the large bony fish is the ocean sunfish, or mola mola. Its round body can be as large as a small car, and it "rows" itself through the water using its fins.



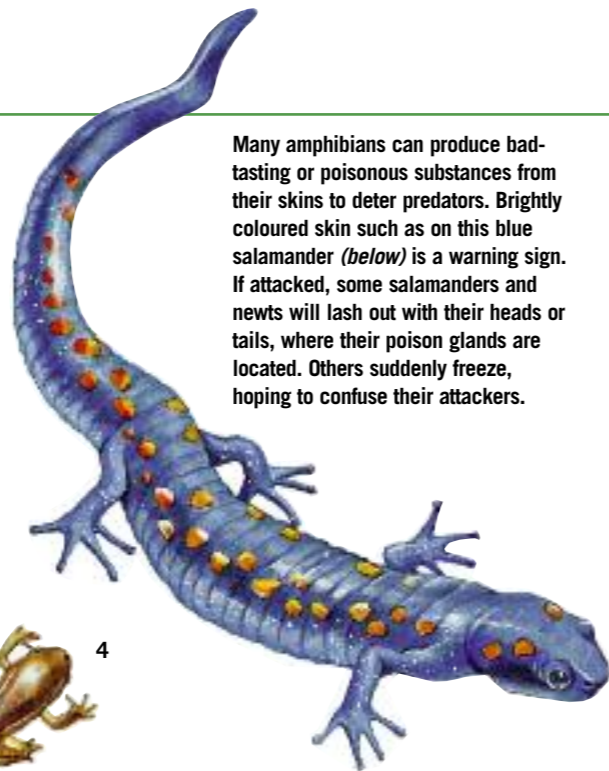
# AMPHIBIANS

**A**MPHIBIANS are a small group of cold-blooded, vertebrate animals. They include two main groups: the salamanders and newts, and the frogs and toads. The word “amphibian” means “double life”. Most amphibians spend the first part of their lives underwater, taking in oxygen from the water through gills, like fish. Their adult lives, however, are spent on land, breathing air through lungs. They return to the water to lay their eggs.



Frog tadpoles hatch from jelly-like eggs (1). At first, the tadpole breathes through gills and uses its tail to swim (2). Gradually its legs emerge and it develops lungs (3). Finally, it loses its tail (4).

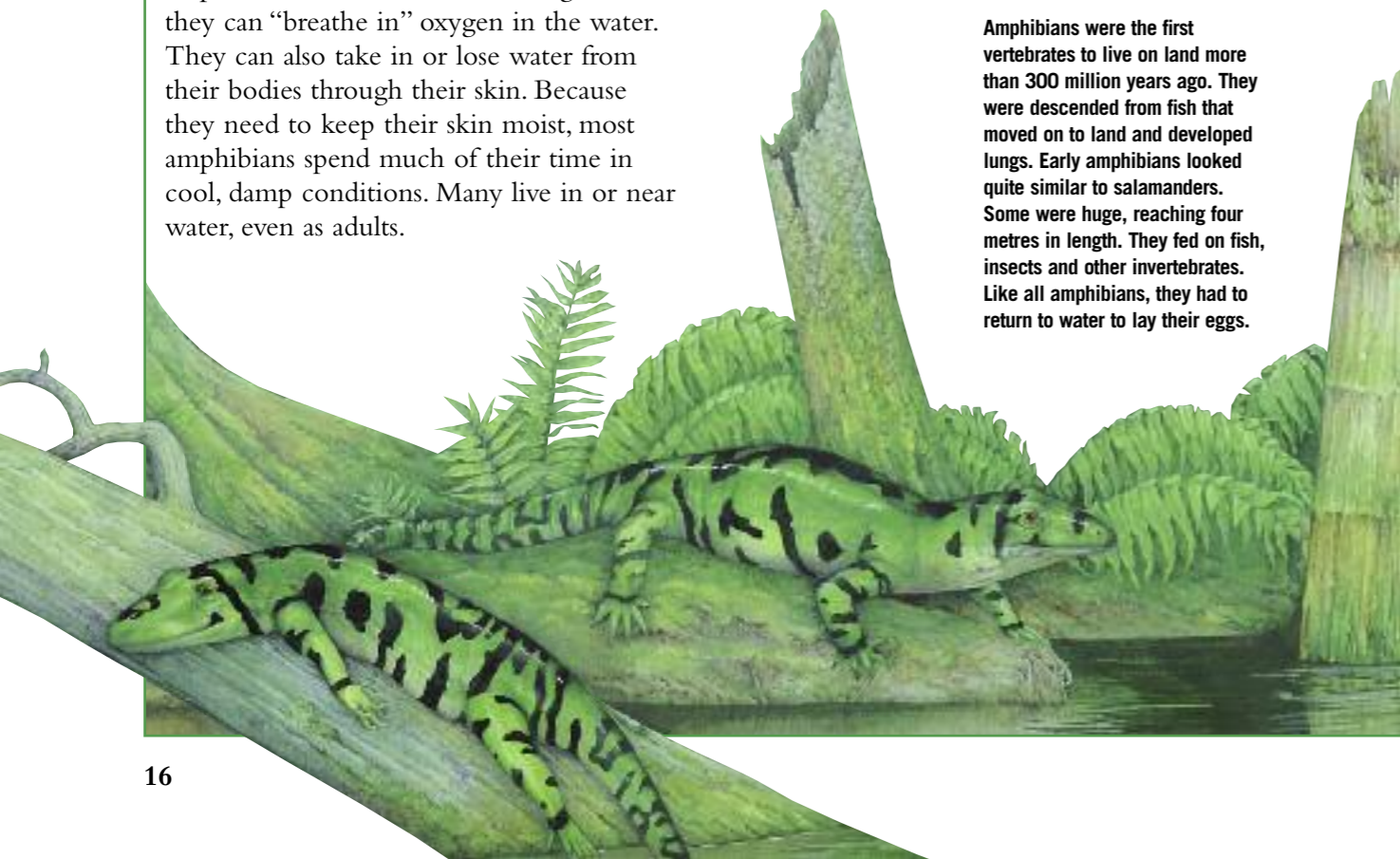
Most amphibians have four limbs. Only the salamanders and newts have tails. All amphibians have moist skin, through which they can “breathe in” oxygen in the water. They can also take in or lose water from their bodies through their skin. Because they need to keep their skin moist, most amphibians spend much of their time in cool, damp conditions. Many live in or near water, even as adults.



Many amphibians can produce bad-tasting or poisonous substances from their skins to deter predators. Brightly coloured skin such as on this blue salamander (*below*) is a warning sign. If attacked, some salamanders and newts will lash out with their heads or tails, where their poison glands are located. Others suddenly freeze, hoping to confuse their attackers.

Amphibians undergo **metamorphosis**, a change in the body from young to adult. The most obvious change in salamanders and newts is that they lose their feathery gills and develop lungs. Frogs and toads change from plant-eating tadpoles with gills, a tail and no legs, to carnivorous, tail-less adults with lungs and long legs.

Amphibians were the first vertebrates to live on land more than 300 million years ago. They were descended from fish that moved on to land and developed lungs. Early amphibians looked quite similar to salamanders. Some were huge, reaching four metres in length. They fed on fish, insects and other invertebrates. Like all amphibians, they had to return to water to lay their eggs.



# SALAMANDERS AND NEWTS

Salamanders and newts are long-bodied amphibians with long tails. They are often nocturnal, and are all carnivorous. They feed on insects, worms, slugs and snails, and the young also prey on frog tadpoles. Some salamanders live in water all the time, and several even keep their gills into adulthood. Others live on land but return to the water to lay their eggs. Newts will travel several kilometres to return to the breeding ponds where they grew up.



The bright colours of this fire-bellied toad (*left*) warn predators of its nasty taste. If threatened, the toad will twist itself so that its colourful belly can be seen from above.



Poison-arrow frog tadpoles hatch on land and are then carried to water on their parent's back (*left*). The poison from a poison-arrow frog's skin is used by rainforest peoples to coat the tips of arrows and darts for hunting. Just a tiny amount can be deadly to animals and even humans.

# FROGS AND TOADS

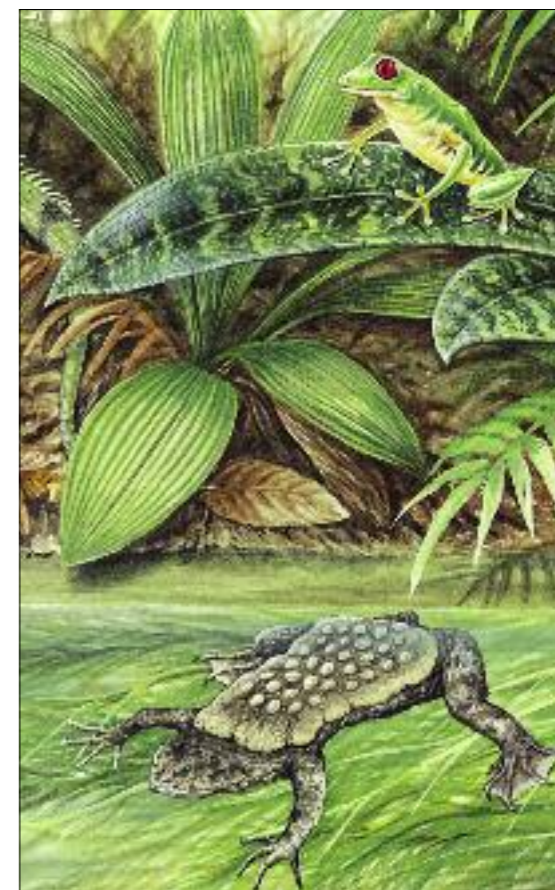
Frogs and toads have short, tail-less bodies and long hind legs. Frogs are usually smooth-skinned. They spend most of their time in water. Their very long legs and streamlined bodies mean that they can make huge leaps and swim quickly. Toads have shorter legs, fatter bodies and lumpier skin. They live mostly on land, in dark, damp places to keep their skins moist and cool. Toads crawl or hop rather than leap.

Tree frogs (*above right*) have pads on their toes that act like suckers, to cling on to shiny leaves. Some kinds of tree frog can even walk upside down. The Surinam toad (*right*) has a flat, square body. It carries its eggs on its back until they hatch.

Both frogs and toads usually lay their jelly-like eggs (spawn) in water, often returning to the same pond or lake year after year to breed. Some tree frogs lay their eggs inside a foam “nest” on an overhanging branch, so that when the tadpoles hatch, they will fall into the water. Many frogs and toads leave their eggs to hatch on their own. Others carry them on their backs to keep them safe. Mouth-brooding frogs hold their tadpoles in a throat sac, until they jump out as tiny frogs.

Frog and toad tadpoles mostly feed on water plants or filter algae from the water. As adults, however, they are carnivorous, feeding on insects, snails or worms. The larger frogs and toads will also eat fish, other frogs, and even small mammals.

In hot climates, toads and frogs burrow underground to avoid the heat of the day. Frogs that live in colder climates often spend winter in hibernation at the bottom of ponds, breathing through their skin.





# REPTILES

**R**EPTILES are cold-blooded, vertebrate animals that have a dry, scaly skin. The skin is made of one continuous sheet, rather than individual scales as in fish. Water cannot pass out through their skin, unlike that of amphibians. This means that reptiles do not need to keep their skin moist.

Reptiles moult regularly, shedding their skin when a new one has grown underneath.

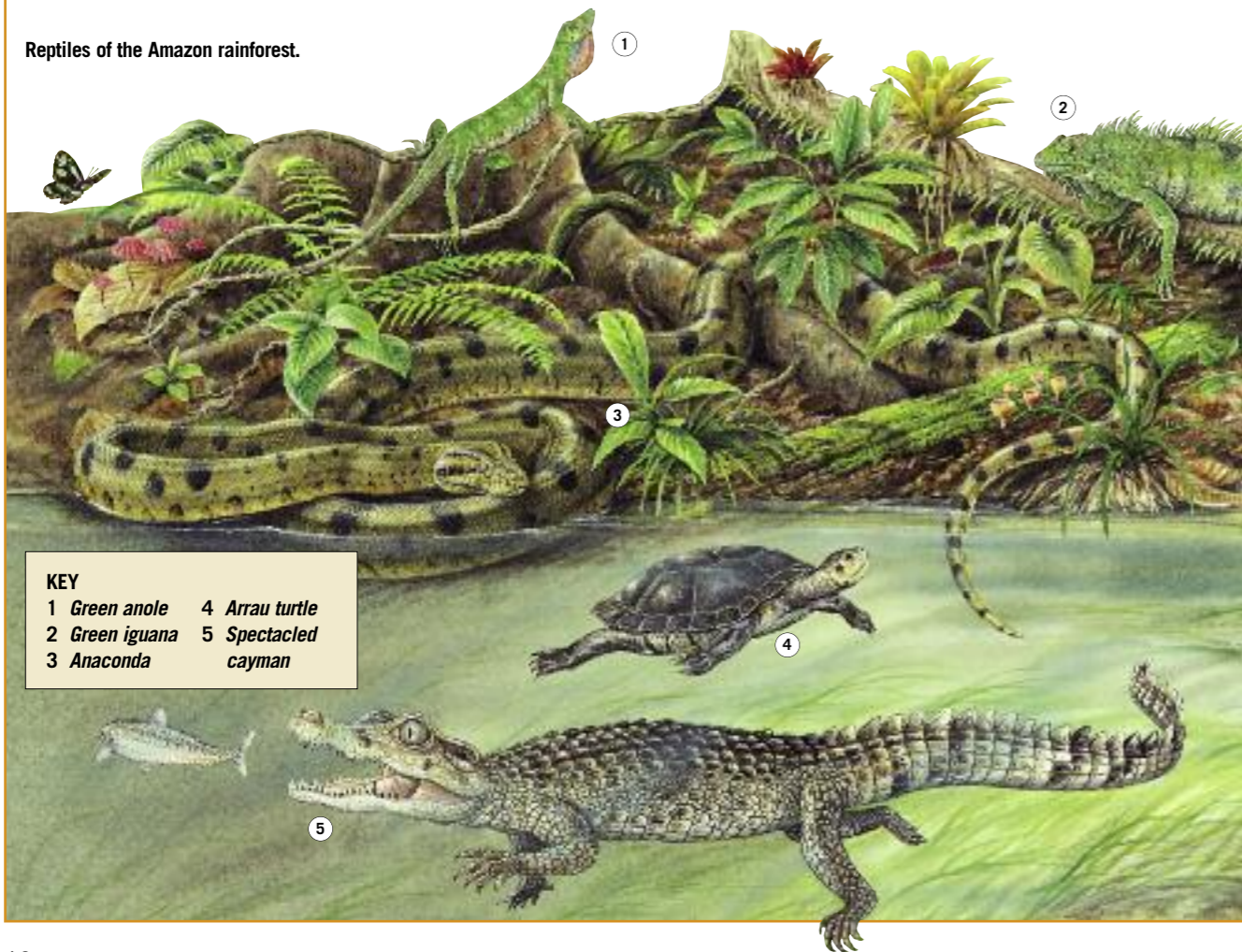
Because they are cold-blooded animals, reptiles need to bask in the sun to raise their body temperature before they are able to move about in search of food. However, they do not need to eat as much food as the warm-blooded birds and mammals, so are able to survive more easily in harsh desert environments. Most reptiles lay eggs, either soft and leathery, or hard-shelled. Some give birth to live young. Reptiles do not care for their young after hatching or birth.



*Eusthenopteron* was an ancestor of the amphibians and reptiles. It was a fish that had lungs and used its fins as legs.

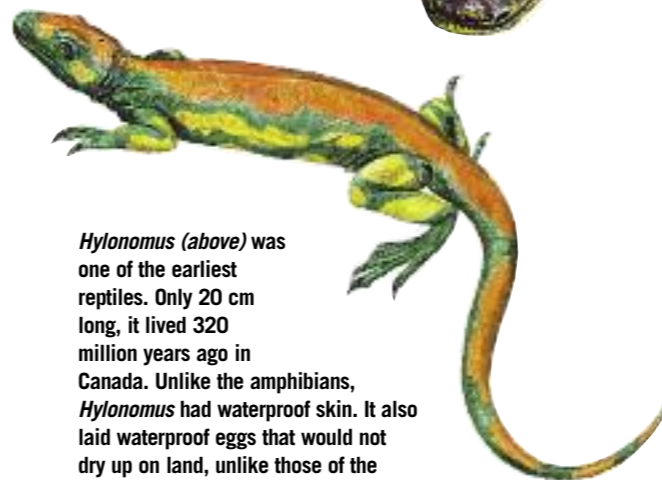
Reptiles are descended from the early amphibians (see page 16). The first reptiles were probably small, lizard-like creatures. Unlike the amphibians, they did not have to stay close to water to keep moist and lay their eggs. They were able to live more easily on land. The lizards, turtles and tortoises and the crocodilians (crocodiles and alligators), appeared during the Triassic Period, about 250 million years ago. Snakes evolved later, about 135 million years ago. Some modern-day reptiles have hardly changed since the time of the dinosaurs.

Reptiles of the Amazon rainforest.



- KEY**  
 1 Green anole    4 Arrau turtle  
 2 Green iguana    5 Spectacled cayman  
 3 Anaconda

Some air-breathing fish developed legs rather than fins, allowing them to move around on land more easily. They became the first four-legged animals, the amphibians. *Ichthyostega* (right) was an early amphibian. It crawled through the warm, swampy forests of Greenland about 360 million years ago.



*Hylonomus* (above) was one of the earliest reptiles. Only 20 cm long, it lived 320 million years ago in Canada. Unlike the amphibians, *Hylonomus* had waterproof skin. It also laid waterproof eggs that would not dry up on land, unlike those of the amphibians. This meant that it could breed wherever it wanted to on land.

# THE AGE OF DINOSAURS

The period from 250 million to 65 million years ago is known as the Mesozoic Era. During this time, a new group of reptiles, the dinosaurs, emerged. They held their legs straight beneath their bodies, rather than sprawling out to the sides like other reptiles.

For about 150 million years the dinosaurs were the only large land animals. They ranged in size from the chicken-sized *Compsognathus* to the 14-metre-tall *Brachiosaurus*. Some were slow, four-legged plant-eaters, while others ran swiftly on two legs. A few kinds were terrifying predators. Many of the plant-eaters lived in herds like modern-day cattle or horses, while the smaller predators hunted in packs, as hyenas and wild dogs do today.

The dinosaurs all died out quite suddenly, but no-one knows why. Perhaps a huge asteroid hit the Earth, and a dust cloud plunged the Earth into cold darkness.

In this scene from 150 million years ago, a herd of huge plant-eating dinosaurs is threatened by a pack of hungry predators. The adults try to protect their young by using their bulk and their whip-like tails.





## LIZARDS

**L**IZARDS are mostly quite small, quick-moving reptiles. They have a thick, scaly, and usually smooth skin. Most lizards have four legs and a tail, though some kinds are legless. They have long tongues that they flick in and out to “taste” the air or ground, to pick up information about their surroundings. Geckos also use their tongues to clean their permanently closed, transparent eyelids, while chameleons shoot theirs out to catch insects.

Lizards have a special receptor on their heads that is sensitive to light. This is connected to the brain, and may act as a “third eye”, giving the lizard information about the patterns of day and night.



The green iguana (above) is found in the forests of Central and South America. In spite of its size (up to 2 metres in length), it is an agile, tree-dwelling lizard. It also swims easily in the forest rivers. It has a crest of comblike spines running all the way down its body from head to tail.

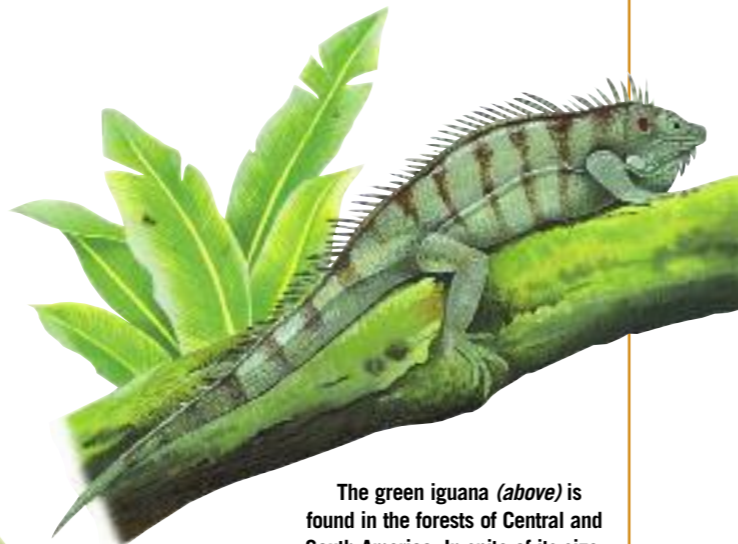
Chameleons (left) can change colour to blend in with their background. They sit motionless on a branch, until an insect approaches. In a split second, they flick out their long sticky tongues to catch their prey.

Lizards are mostly land-dwellers, living all over the world except in polar regions. Some are burrowing animals, while many live in trees. Chameleons and some iguanas have prehensile tails to help them climb. Geckos have tiny ridges on their toes and can even walk upside down. Some lizards, such as skinks, are good swimmers and will dive into water to escape from predators.



The Komodo dragon is found on several Indonesian islands.

Almost all lizards are meat-eaters, feeding on insects, birds, small mammals and other reptiles. The largest lizard, the Komodo dragon, can reach three metres in length. It is a powerful predator, and can kill large mammals such as cattle. It has even been known to attack and kill humans.



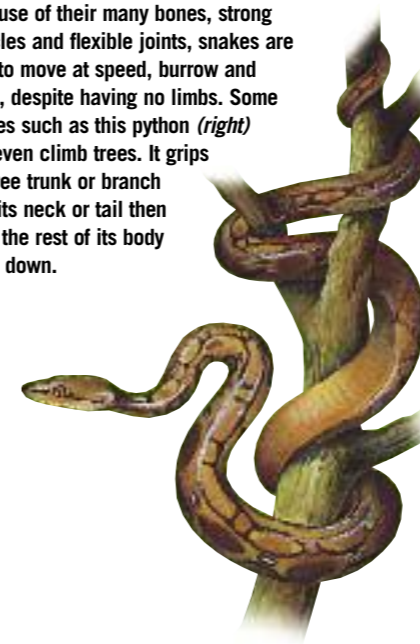
Lizards lay their eggs in warm, damp holes. Most female lizards take no interest in their eggs after laying them, but a few kinds guard the eggs until they hatch.

The smaller lizards have many predators. They defend themselves with camouflage, or by running away, climbing trees or even playing dead. Several species are able to break off their own tails, to confuse an attacker while they run away. The tail has a special “weak point” that can be snapped without harming the lizard. A new tail will grow in its place.

## SNAKES

**S**NAKES are a group of reptiles that have long, narrow bodies and tails, and no limbs. Their ancestors, however, were four-legged, lizard-like creatures. Some snakes have two tiny lumps on their bodies—the remains of the hind legs of these ancestors. Snakes have no eyelids. Instead, their eyes have a permanent, transparent covering.

Because of their many bones, strong muscles and flexible joints, snakes are able to move at speed, burrow and swim, despite having no limbs. Some snakes such as this python (right) can even climb trees. It grips the tree trunk or branch with its neck or tail then pulls the rest of its body up or down.

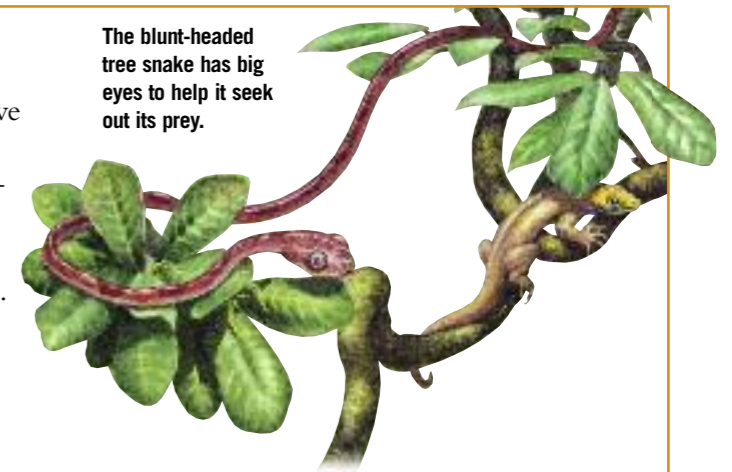


Snakes have many more bones in their spines than other animals. They move by flexing their belly muscles, which are attached to their many ribs. As they move, most snakes curve their bodies into a series of S-shapes, giving them greater speed.

Most snakes lay eggs, and a few kinds will guard them from predators until they hatch. There are some snakes, such as sea snakes (below), that give birth to live young. Young snakes are left to survive on their own.



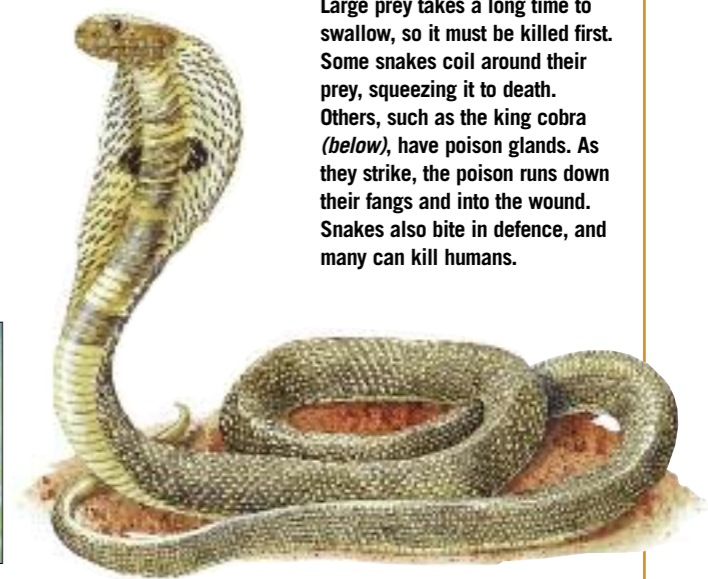
The blunt-headed tree snake has big eyes to help it seek out its prey.



All snakes are carnivores. Some kinds eat small animals such as snails or worms, but many feed on large prey such as frogs, birds and mammals. Snakes have special loosely hinged jaws that can open extremely wide to take large prey. Their skin can also stretch. They swallow their prey whole, using their sharp teeth to pull it into the throat, and their muscles to squeeze it into the stomach. A snake may need to hunt and feed only every few weeks or even months.

Some snakes have good vision, but most rely on special senses to hunt their prey. Like lizards, snakes are able to collect “tastes” from the air or ground by flicking out their forked tongues. Some kinds of snakes also have heat sensors on their heads that help them to locate live prey accurately, even at night.

Large prey takes a long time to swallow, so it must be killed first. Some snakes coil around their prey, squeezing it to death. Others, such as the king cobra (below), have poison glands. As they strike, the poison runs down their fangs and into the wound. Snakes also bite in defence, and many can kill humans.





## TURTLES AND TORTOISES

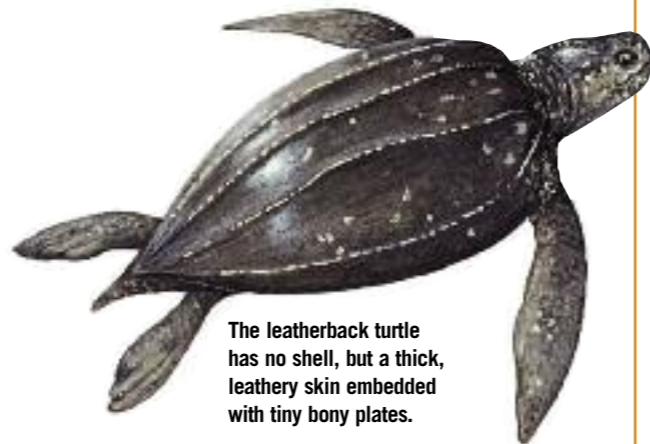
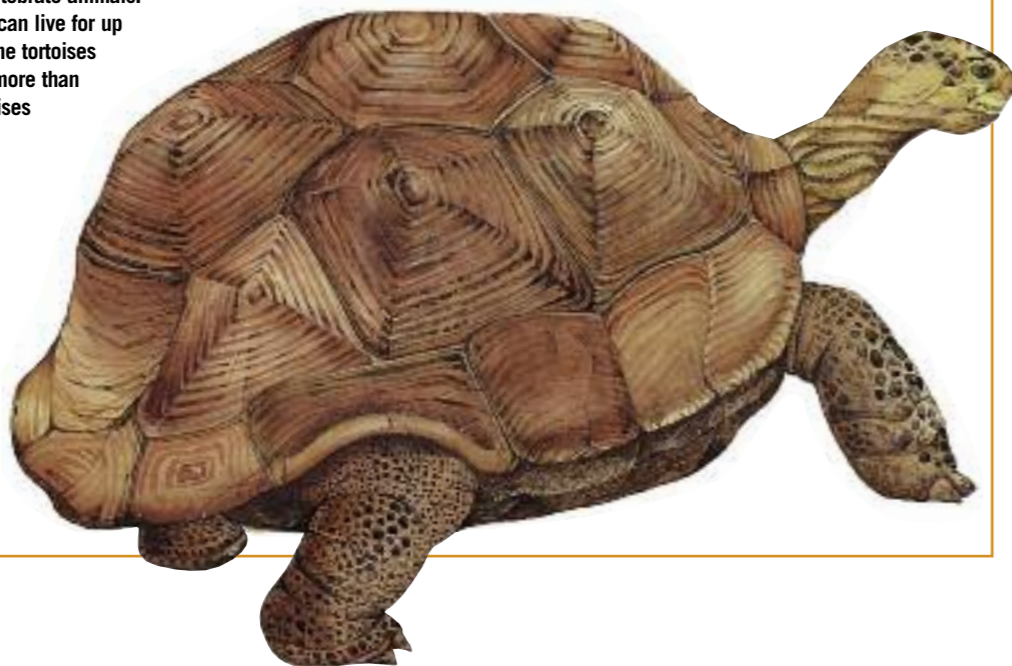
**T**HE MAIN characteristic that sets turtles and tortoises apart from other reptiles is their shell. It is made of bone fused to the skeleton, and covers both the back and belly. For extra protection, the shell is covered with thick, horny scales. If threatened, most turtles and tortoises are able to draw their heads and necks backwards into their shells.

Turtles and tortoises do not have teeth. Instead they have a sharp, horny, beak-like mouth. They are mostly plant-eaters, but some kinds also feed on insects, fish, snails and even small mammals and birds.



The red-eared slider turtle is found in quiet ponds and rivers in the United States.

Turtles and tortoises are some of the longest-lived of all vertebrate animals. Some kinds of turtles can live for up to 70 years, while some tortoises are known to live for more than 100 years. Giant tortoises (right) are among the longest-lived. Several kinds are found in the Galapagos islands off the coast of Ecuador. These huge creatures can measure up to 1.2 metres in length. Some kinds have a high, arched shell opening that allows them to stretch up to tall plants.



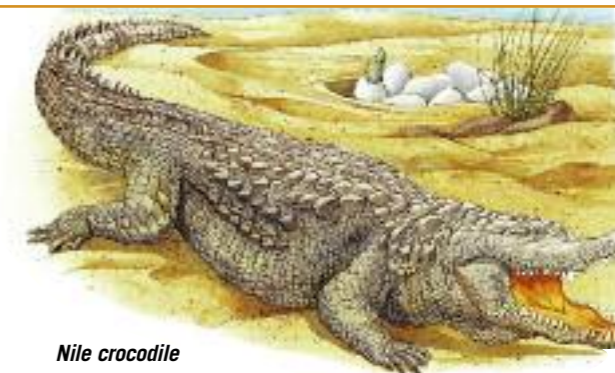
The leatherback turtle has no shell, but a thick, leathery skin embedded with tiny bony plates.

Tortoises are found on land. They have stumpy, scaly legs with short toes. Tortoises move slowly, relying on their high-domed, heavy shells to protect them from predators. Turtles live in the water, some in the oceans, others in freshwater rivers and ponds. Most have webbed feet, but some ocean turtles spend so much time in the water that they have developed paddle-like flippers that allow them to swim at speed.

All turtles and tortoises breed and lay eggs on land. Some large sea turtles can lay over 100 eggs at once, returning to the same beaches every year. They dig holes in the sand, lay their eggs and then cover them over. Then they return to the water. After hatching, the young must dig their way to the surface. Many newly-hatched turtles are killed by predators as they make their way from the beach to the sea.

## CROCODILIANS AND TUATARA

**C**ROCODILIANS are meat-eating reptiles that spend much of their time in water. They include crocodiles and alligators, and also the gharial, which has a long, narrow snout. Crocodilians use their long tails to swim, but can also run at speed on land. Most species live in freshwater rivers and lakes, especially tropical swamps. A few, such as the saltwater crocodile, live in sea estuaries.



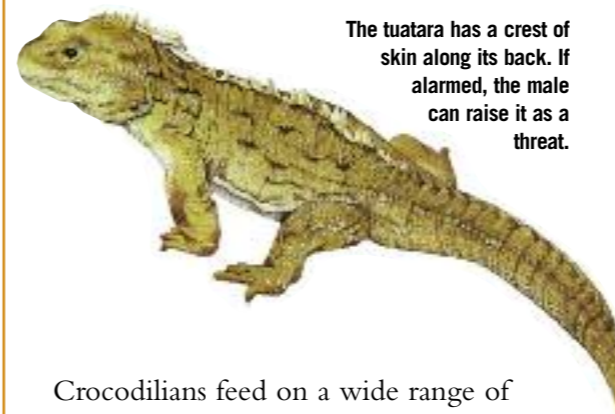
Nile crocodile

almost completely hidden underwater, because their eyes and nostrils are on top of their heads. They also have a transparent “third eyelid” which closes to protect their eyes when they submerge. They can close off part of their throat to avoid swallowing water while feeding.

Like all reptiles, crocodiles and alligators lay their eggs on land. Some kinds, such as the Nile crocodile, dig holes into which they lay their eggs, covering them over with soil to keep them warm. Others build nests of plant material. They will guard their eggs and defend their young.

The tuatara is the only member of an ancient group of reptiles that lived on Earth even before the dinosaurs. Lizard-like in shape, the tuatara lives in burrows on small islands off New Zealand. It basks in the sun during the day, and feeds at night, hunting insects, worms and small lizards.

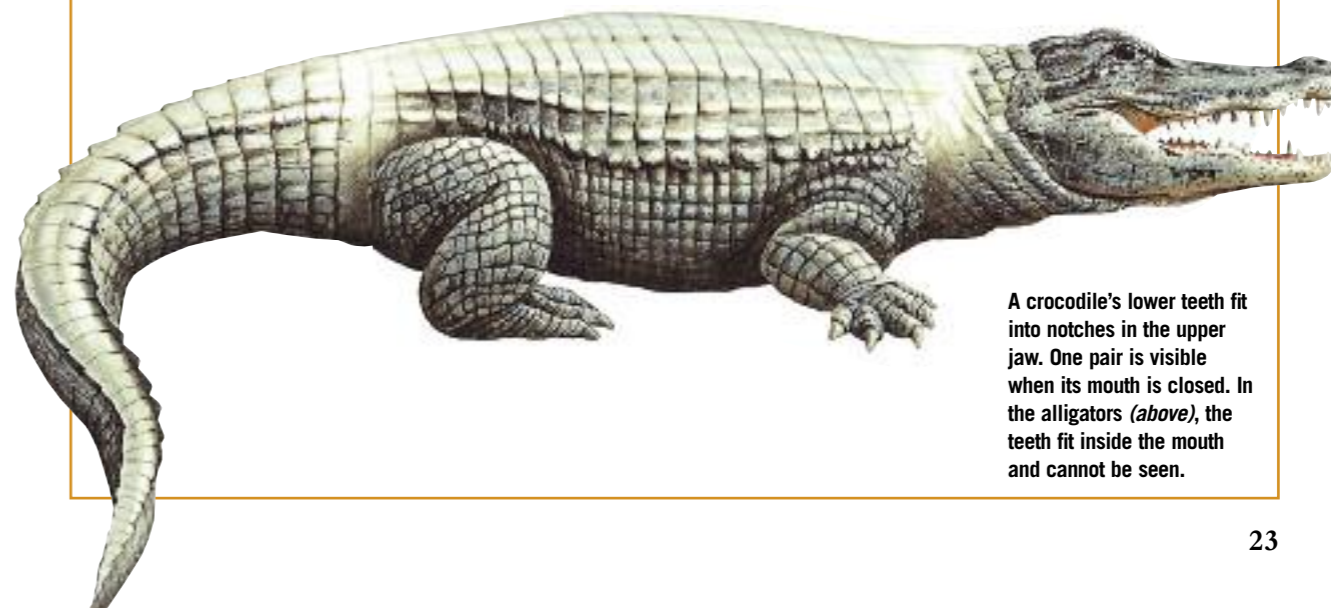
Like turtles and tortoises, the tuatara is very long-lived. It becomes an adult at 20 years old, and may live for over 120 years.



The tuatara has a crest of skin along its back. If alarmed, the male can raise it as a threat.

Crocodylians feed on a wide range of prey, including fish, turtles, birds, and mammals. The largest crocodiles, which can grow to more than seven metres long, will even kill deer and cattle. They lie in the water, waiting for their prey to come down to the water to drink. Then they lunge out with their powerful jaws, dragging their prey into the water to drown.

Crocodylians can lie with their bodies



A crocodile's lower teeth fit into notches in the upper jaw. One pair is visible when its mouth is closed. In the alligators (above), the teeth fit inside the mouth and cannot be seen.

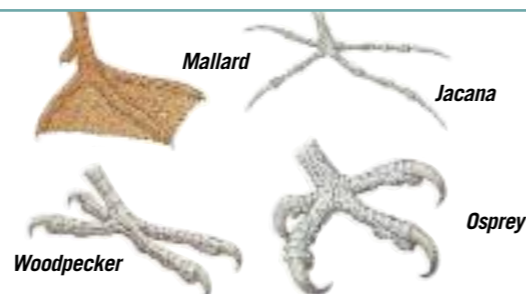


# BIRDS

THERE ARE almost 9000 species of birds in the world today. Birds are warm-blooded, vertebrate animals with four limbs, two of which are adapted into wings. They have a toothless beak and a covering of feathers over their bodies and heads (apart from the bald-headed vultures). The feathers close to the skin are soft and fluffy for warmth, while long, stiff outer feathers help birds to gain height, steer and control speed when flying. Birds have light, hollow bones to reduce their weight in the air.

Birds lay hard-shelled eggs, usually several at a time. After mating, the male and female often work together to build a nest ready to receive the eggs. Nests can be cup-like structures made of mud, grass and twigs, holes in trees, or even burrows underground. One parent usually sits on the eggs to keep them warm, while the other collects food. After hatching, most birds feed and protect their young until they are old enough to leave the nest.

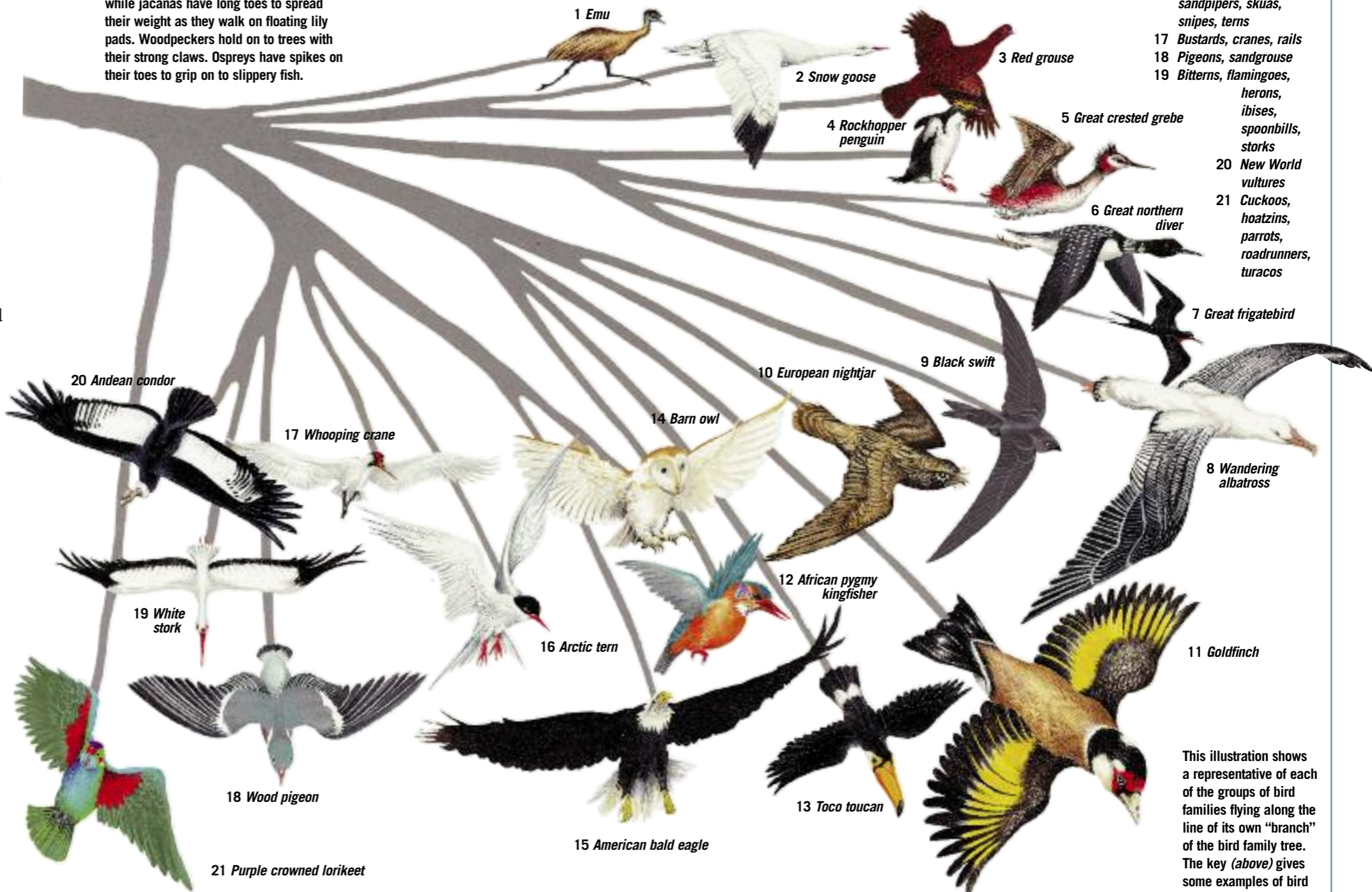
Because of their ability to fly at speed for long distances, some kinds of birds are able to migrate to warmer climates as winter approaches. They return to their breeding areas in spring, as food becomes plentiful.



Mallards have webbed feet for swimming, while jacanas have long toes to spread their weight as they walk on floating lily pads. Woodpeckers hold on to trees with their strong claws. Ospreys have spikes on their toes to grip on to slippery fish.

**KEY**

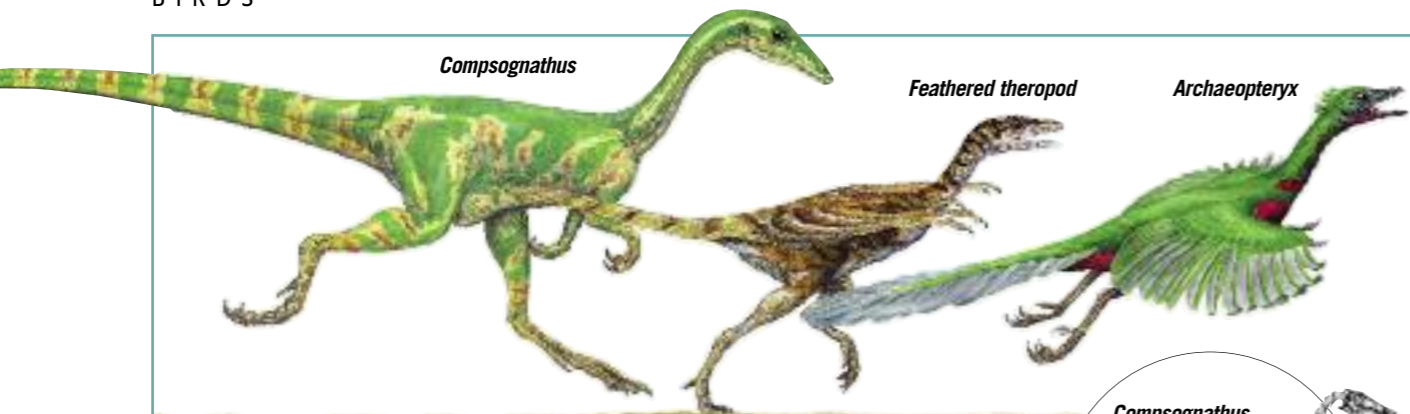
- 1 Cassowaries, emus, kiwis, ostriches, rheas
- 2 Ducks, geese, swans
- 3 Chickens, grouse, pheasants, quails, turkeys
- 4 Penguins
- 5 Grebes
- 6 Divers
- 7 Boobies, cormorants, frigatebirds, gannets, pelicans
- 8 Albatrosses, petrels, shearwaters
- 9 Hummingbirds, swifts
- 10 Frogmouths, nightjars, potoos
- 11 PERCHING BIRDS  
Antbirds, birds of paradise, buntings, crows, dippers, finches, larks, mockingbirds, orioles, pipits, sparrows, sunbirds, swallows, thrushes, tits, wagtails, warblers, wrens
- 12 Bee-eaters, hoopoes, hornbills, kingfishers
- 13 Honey-guides, jacamars, toucans, woodpeckers
- 14 Owls
- 15 Eagles, falcons, hawks, Old World vultures, ospreys, secretary birds
- 16 Auks, avocets, gulls, oystercatchers, plovers, sandpipers, skuas, snipes, terns
- 17 Bustards, cranes, rails
- 18 Pigeons, sandgrouse
- 19 Bitterns, flamingoes, herons, ibises, spoonbills, storks
- 20 New World vultures
- 21 Cuckoos, hoatzins, parrots, roadrunners, turacos



Birds have different shaped beaks according to the food they eat. The four birds pictured (left) all have very specialized beak shapes. The flamingo stands in shallow water with its head upside down, filtering out tiny plants and animals from the water. The scarlet ibis uses its long, narrow beak to stab at fish. Vultures have strong, hooked beaks for tearing meat. Their heads are bald to reduce the need for cleaning after they have been feeding on carrion. The macaw uses its powerful beak to crack open hard seeds.

This illustration shows a representative of each of the groups of bird families flying along the line of its own "branch" of the bird family tree. The key (above) gives some examples of bird species found in each group.



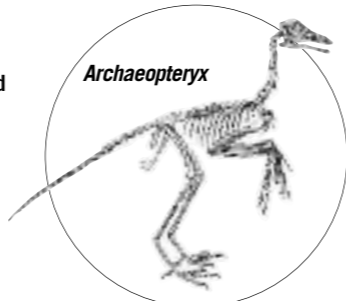
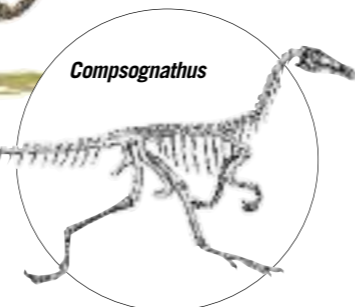


### THE RISE OF BIRDS

**T**HE ANCESTORS of birds were clearly reptiles—birds still have scaly legs, and they lay hard-shelled eggs. In fact, it is now known that birds are actually the living descendants of the dinosaurs.

Like the dinosaurs, early birds had teeth, fingers and a long, bony tail, but they also had small wings and a few feathers. They may have used their wings to glide from tree to tree, or to give them extra speed when escaping from predators on the ground. Gradually, their body structures developed so that they could lift themselves into the air and fly.

The chicken-sized *Archaeopteryx* is one of the earliest known animals that can be called a bird. *Archaeopteryx* was covered with feathers and was probably able to fly. However, its skeleton was discovered to be almost identical to that of the small theropod (meat-eating) dinosaur *Compsognathus*.

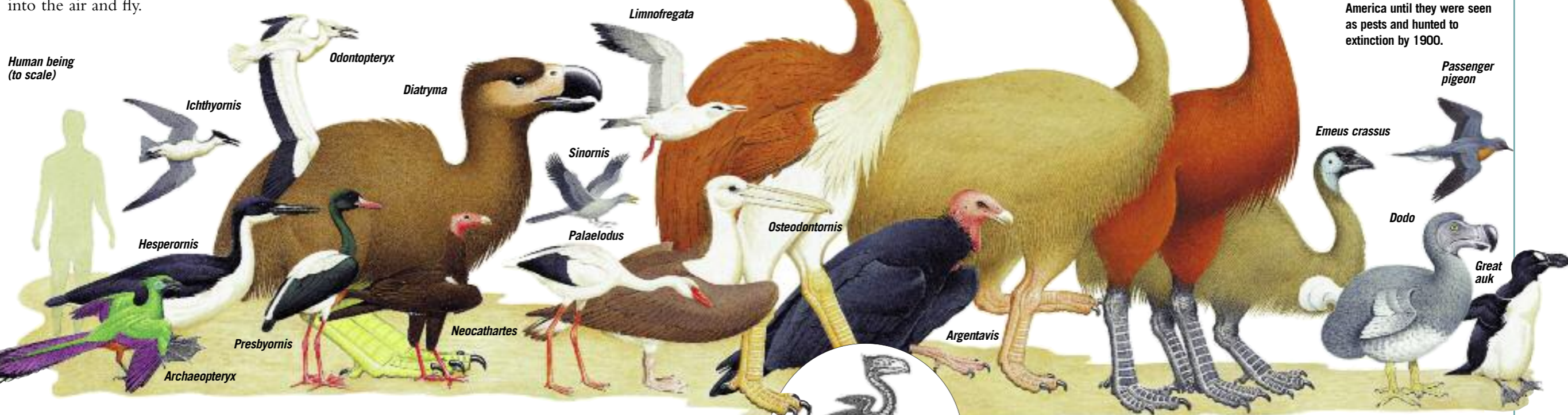


*Archaeopteryx* emerged in the late Jurassic Period, about 150 million years ago. Following *Archaeopteryx* came small flying birds such as *Sinornis*, which had shorter, more bird-like tails than *Archaeopteryx*. Up until the end of the Cretaceous Period, 65 million years ago, most birds still had teeth. These were useful for feeding on fish and insects, their main prey. *Ichthyornis* and *Hesperornis* were among the first marine birds and fed on fish, swooping over the waves like gulls or diving from rocks.

At the end of the Cretaceous Period, the dinosaurs, along with many other reptiles died out, but many birds and mammals survived. A wide variety of different kinds of birds appeared, and by Eocene times, 50 million years ago, all the bird groups we know today had emerged.

After the dinosaurs died out, some birds became large predators. Some kinds stood almost three metres tall. They were flightless, their small wings acting only to balance their heavy bodies. Ferocious meat-eaters, such as *Andalgalornis* and *Diatryma*, probably crushed mammals such as small, early horses in their powerful jaws. Other birds, such as *Argentavis*, a vulture with a seven-metre wingspan, were scavengers.

Some kinds of birds have become extinct quite recently, due to the arrival of humans into their habitats. They were hunted for food, or preyed upon by rats, cats and dogs which the humans brought with them. Two groups of large, flightless birds, the elephant birds of Madagascar and the moas of New Zealand, were completely wiped out within just a few hundred years.



Turkey-sized dodos once lived on the island of Mauritius. Slow-moving and flightless, they were easy to kill for food by 16th-century sailors. The last dodo was killed in 1681. Passenger pigeons were once the commonest birds in North America until they were seen as pests and hunted to extinction by 1900.

This scale illustration shows some species of early birds, (as well as more recent species), all of which are now extinct. Some have modern-day relatives that may look very different.

*Diatryma* is related to the long-legged cranes, while *Palaelodus* and *Osteodontornis* are relatives of modern-day wading birds, and gliding seabirds such as the albatross.

*Andalgalornis* (left) had tiny wings and bone-crushing jaws.

A flightless seabird, the great auk was hunted by sailors for its meat, eggs and oily fat. It finally became extinct in 1844.



## BIRD FAMILIES I

OVER MILLIONS of years, the ability to fly has enabled birds to escape from predators, and therefore to increase in number and variety. Every kind of bird has also adapted to survive in a particular habitat. In any one group of birds there may be several different families, all looking quite different from each other.

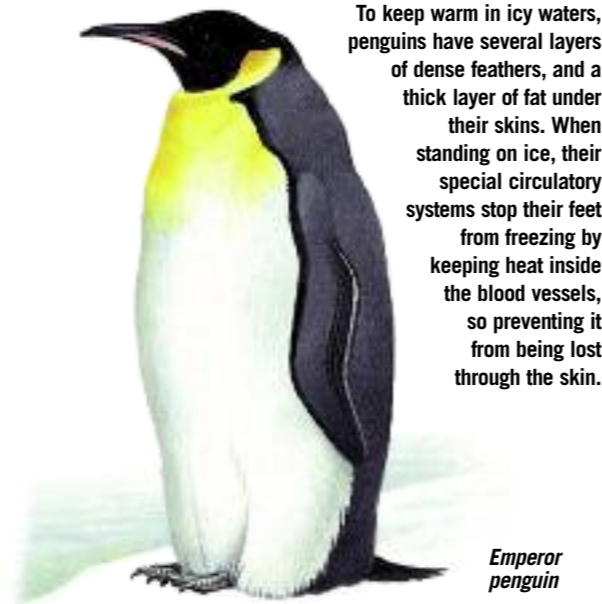
The **ratites** include the ostrich, rhea, emu, cassowary and kiwi. They are all birds that have lost the ability to fly, because of a lack of natural predators, or because they have developed another means of defence. Some ratites are tall, long-necked birds that live in wide open spaces. They use their good eyesight to spot predators, and their long strong legs to run away at top speed. Ostriches can reach 65 kilometres per hour.

Kiwis are much smaller birds, with hair-like feathers. They live in thick undergrowth, using their excellent senses of smell and hearing to detect predators, and their sharp claws for defence.



Cassowaries (*right*) search for fruit, berries and seeds in the dense rainforest of Australia and Southeast Asia. They use the horny ridge, or casque, on their head to break open a path before them.

**Penguins** are also flightless birds. Most live on cold, southern coastlines, such as Antarctica. Clumsy on land, in the water penguins are graceful and fast. Their stiff, flipper-like wings pull them through the water in pursuit of fish and squid. They breed in large colonies on land or on ice.



To keep warm in icy waters, penguins have several layers of dense feathers, and a thick layer of fat under their skins. When standing on ice, their special circulatory systems stop their feet from freezing by keeping heat inside the blood vessels, so preventing it from being lost through the skin.

Emperor penguin

**Waterfowl** (ducks, geese and swans) also feed in the water, as do grebes and divers, though these are mostly freshwater birds. They swim along the surface with their feet, which are often webbed. Their feathers are coated with a waterproof substance that traps air and keeps the birds afloat. Ducks tip upside down to feed, while grebes and divers plunge completely underwater. These birds feed on fish, invertebrates and plants.

Ducks and geese are among the fastest birds in level flight. Species such as the red-breasted merganser (*below*), a sea duck, can fly at speeds of 100 km/h. To conserve energy on long journeys, such as during migration, geese and swans often fly in a "V" formation. The air movement created by the wingbeats of each bird gives extra lift to its neighbours.



**Birds of prey** include eagles, falcons, hawks and vultures. They are all meat-eating birds, with sharp, hooked beaks and strong talons. They swoop down through the air, often at very high speeds, on to their prey—small mammals, birds, reptiles, insects or fish. Most birds of prey, especially the vultures, also eat carrion. Birds of prey have excellent long-distance vision, and can spot potential prey from several kilometres away.



In a vertical dive, or stoop, peregrine falcons (*left*) can reach speeds of over 200 km/h.



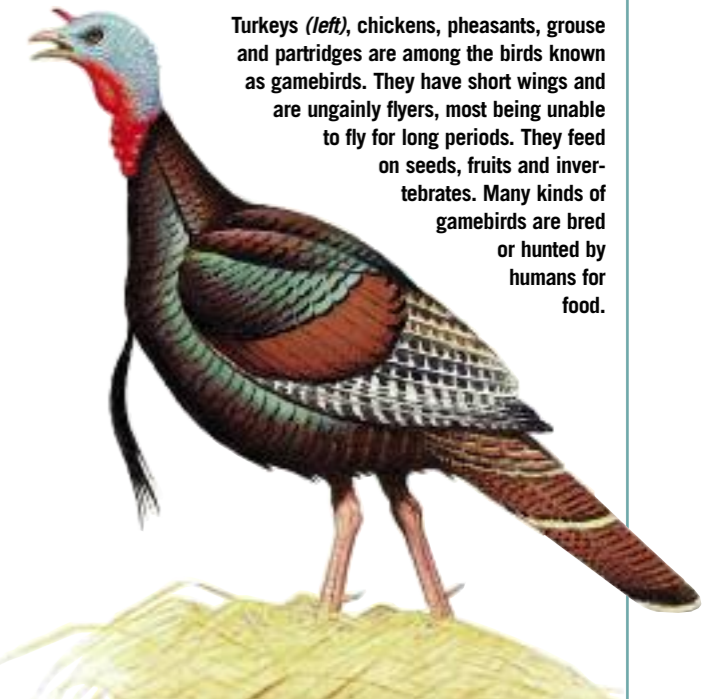
Like all owls, the eagle owl (*left*) has large eyes which are fixed in its head, and cannot be moved in their sockets. In order to get a good field of vision, owls must twist their very flexible necks. They can turn their heads all the way round in order to look backwards.

Though they are also hunting birds with strong beaks and talons, **owls** are a completely separate group to the birds of prey. Owls have flat faces with forward-facing eyes. Many kinds hunt in dim light or darkness. Their disc-like faces "collect" sound and direct it towards the ears, giving them exceptional hearing to locate their prey. Their feathers are soft, allowing them to fly almost completely silently, taking their prey by surprise.



The red-tailed tropicbird feeds in tropical ocean waters, plunging down into the water to grab its prey.

**Seabirds** spend much of their time in or near the water, feeding on fish or squid. Some kinds, such as cormorants or gannets, dive into the water from the air, or from high rocks. Albatrosses skim over the surface, scooping up food. Many seabirds gather together in colonies on cliffs to lay their eggs. Albatrosses and petrels only come on to land to breed. The rest of their lives are spent gliding on currents of air.



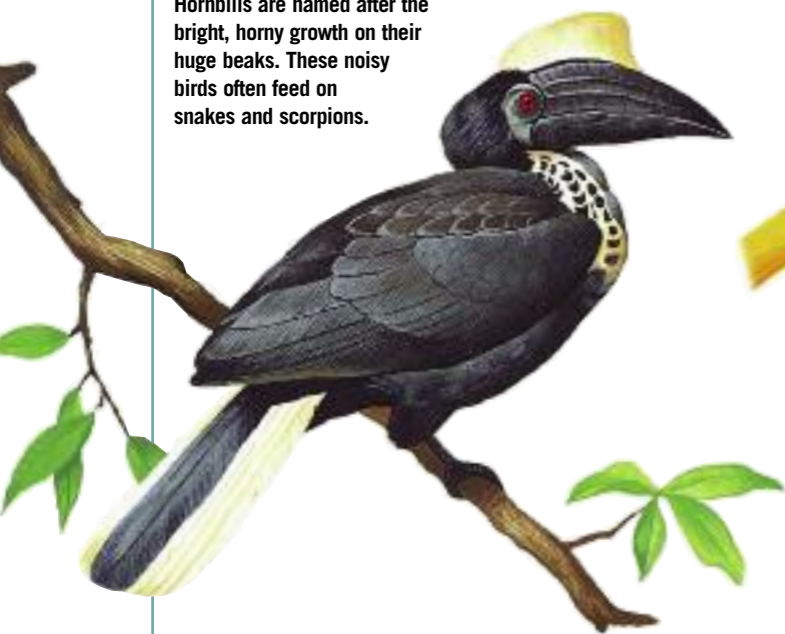
Turkeys (*left*), chickens, pheasants, grouse and partridges are among the birds known as gamebirds. They have short wings and are ungainly flyers, most being unable to fly for long periods. They feed on seeds, fruits and invertebrates. Many kinds of gamebirds are bred or hunted by humans for food.



## BIRD FAMILIES II

**M**ANY BIRDS have beautiful colours or feather displays. In many species, it is the males that are brightly coloured, to attract females. Females are duller in colour, for camouflage while nesting. Camouflage is also used by both sexes of some birds to avoid predators, or to hunt more effectively.

**Hornbills** are named after the bright, horny growth on their huge beaks. These noisy birds often feed on snakes and scorpions.



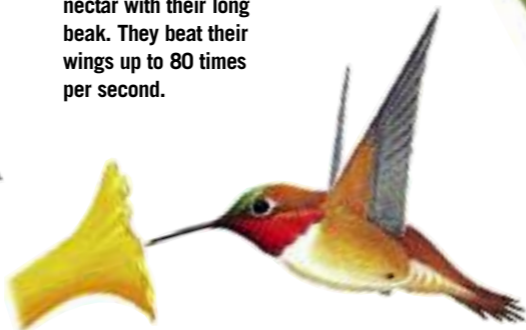
**Bee-eaters** and **kingfishers** are small birds, often with jewel-like colours. As their name suggests, bee-eaters feed on bees, wasps and other insects. Before swallowing their prey, they crush the sting by smashing it on a branch. Kingfishers sit on branches over stretches of water, diving in to catch small fish in their beaks.

The long-legged **storks** and **herons** also feed on fish, though some large storks are carrion-eaters. Most storks and herons are wading birds, standing in the shallows and snapping up fish in their long beaks. Their relatives, the flamingos, get their pink colour from the tiny plant and animal material in the water on which they feed.

**Hummingbirds** and **swifts** are excellent flyers. They are small birds with long, pointed wings. Swifts can mate, feed on flying insects, and even sleep on the wing.

**Woodpeckers** (*right*) cling to tree trunks, hammering into the bark with their long beak to extract insects. They also use this method to dig out nest holes. Two of their toes point forwards and two backwards, giving them a good grip on vertical surfaces.

The smallest hummingbirds (*below*) are only 5.4 cm long. Hummingbirds hover in front of flowers, drinking nectar with their long beak. They beat their wings up to 80 times per second.



Many members of the **cuckoo** family lay their eggs in the nest of a different species. After hatching, young cuckoos often kill their "true" nestmates. The hoatzin is probably related to the cuckoos. It nests over rainforest rivers. If attacked, the young drop into the water, then climb back up to the nest using sharp claws on their wings.

The parrot family includes parrots, macaws, cockatoos and budgerigars. They feed on fruits, nuts and seeds, picking them up with their nimble toes. Parrots can crack even the hardest nuts in their powerful jaws. Many kinds are also able to imitate human voices.



Scarlet macaw

## PERCHING BIRDS

With over 5000 species, the perching birds are the largest group of birds. They range in size from the tiny blue tit or wren to the large raven. They are land-living birds, with four unwebbed toes, three pointing forward and one backward. Most feed on seeds or insects, but some eat fruit or nectar. Many small perching birds fly in a bounding motion to save energy, flapping and closing their wings alternately.

**Snow buntings** breed in the icy Arctic, then move south in winter. They build their nests among rocks. Males are almost completely white in summer.



Bird of paradise



European swallow



Although lyrebirds (*right*) are not classed as songbirds, they are able to mimic perfectly the calls of other birds.



Most perching birds also belong to a subgroup called the **songbirds**. Though other birds can make short, simple calls, songbirds have extra muscles in their voiceboxes, allowing them to produce complex patterns of notes. Songs are used by males to establish territories and warn off intruders, as well as to attract females. Each species may have a large number of song variations, with birds from different areas having their own "accents". Young songbirds learn songs from their parents and other adults.



Willow warblers may travel from Siberia down to Africa during their long migration.

Most perching birds construct nests in trees or hedges, where their young will be safe from predators. The young are born naked, blind and helpless. They need to be kept warm and fed by their parents until they are old enough to fledge (leave the nest). Other birds such as ducks, gulls or gamebirds, that lay their eggs in more exposed places, hatch out as fully-feathered young that can feed themselves almost straight away.

Many songbirds, like other groups of birds, migrate to warmer places in the winter when food becomes scarce. They feed heavily before migration, laying down stores of fat for fuel on their long journeys. They return in the spring to breed, when there is a plentiful supply of food for themselves and their young.



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