Snakes: Versatile Predators of the Natural World

Editor's Introduction | Snakes live and hunt in a range of habitats, from under the ground to the tops of trees, and from the desert to the open sea. They eat everything from insects to medium-sized mammals. Garth Underwood, honorary research fellow at The Natural History Museum, London, explores the array of adaptations that explain the extraordinary success of snakes.

There are about 2,930 species of snake in the world today. They have evolved specialist adaptations for living in a variety of different environments, and range in size from species that reach a maximum length of 10 centimetres to those that can exceed 7 metres. Despite their diversity, one characteristic they share is that they swallow their prey whole. The snake diet consists of meals which are infrequent but large; they can swallow prey which are larger than their own heads. The unique shape and function of their skull bones allow them to do this. Even the worm snakes that eat ants and termites take a large number in one meal.

The Natural History Museum

Brown vine snake, *Oxybelis aeneus.*

The bones of a snake's skull may have as many as 17 flexible connections. The bones that suspend the lower jaws have flexible attachments to the skull. Unlike most vertebrates the two halves of the lower jaw are linked only by an elastic ligament. It's a very flexible skull and the left and right hand upper jaws can move independently of one another. The snout itself is movable on the rigid brain case. Humans, by comparison, have only one flexible connection in their skulls--between the lower jaw and the rest of the skull.

The snake's primary sense in the recognition of food is chemical. The first response, on being aroused, is to flick out the tongue. By dabbing the tongue on the ground the snake can follow a scent trail.

Many diurnal snakes have good eyesight and detect their prey's movement visually. Snakes' eyes contain light-receptive chemicals such that they *could* perceive colour, but there is no experimental demonstration that they do.

Tree snakes, unable to follow a scent trail from branch to branch through a tree, have particularly good eyesight. When they detect the movement of a prey, such as a lizard or frog, they creep up, folding their necks into an S-bend and whirring their tongues up and down very fast. This suggests that they pick up scent particles from the air. They appear to be able to judge their distance from the prey and, when within range, strike with deadly accuracy.

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Green vine snake *Oxybelis fulgidis*, from Belize.

The vine snakes are the most highly modified of all tree snakes. They have long, narrow snouts and horizontal pupils which extend the forwards field of view. Vine snakes are remarkable because they appear to have binocular vision. The eyes are placed laterally as in all other snakes, but because the snout is narrow, the forward view is extended. One of the vine snakes is the only species known to have a fovea in the retina--an area of greater sharpness of vision. It is located on the posterior side of the retina and so faces forwards.

Two groups of snake--pythons and pit vipers--have heat-detecting organs. Their heat receptor nerves are contained in special pits. Pythons' pits are situated around the snout and in the lower jaw, facing forwards. They are nocturnal and detect the heat of warm-blooded prey, small mammals and birds, in the dark.

Garth Underwood

Australian python.

The pit vipers' pits, situated between the eyes and the nostrils, also face forwards and contain many heat-sensitive nerve endings. In effect, the pit organs are extending the snake's vision into the infra-red. It has been shown experimentally that a pit viper can strike accurately at a warm object in what to humans is pitch darkness.

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Eyelash palm viper
Bothreichis schlegelii.

Snakes subdue their victims by a variety of methods. They do not swallow prey if it has the potential to struggle and injure them; for example, they would not consume a live rat which would be able to inflict severe injuries with its chisel-like incisor teeth.

Peter Stafford

A new born emerald tree boa
Corallus canina.

The pythons and boas constrict their prey. They creep up slowly and attack quickly, wrapping their bodies around the victim before it has time to react. The constriction kills the prey by suffocation, rather than by breaking its bones. Like all snakes, constrictors appear to be very skilled at judging what they can swallow. They have been recorded eating prey that are more than 50 percent of their own bodyweight.

Pythons and boas are known as 'primitive' snakes--they exhibit various features which are archaic in terms of snake evolution. For example, whereas the majority of snakes have a large right lung and either a small left lung or none at all, boas and pythons have left lungs that may measure 50 percent or more of the length of the right lung. They also have vestigial hind limbs and lack the eye muscles which in other snakes allow accommodation or focusing of vision.

Peter Stafford

Sumatran short-tailed python,
Python curtus.

Rear-fanged snakes have an enlarged tooth at the back end of the upper jaw. A groove runs down the tooth and conducts venom which is secreted from a special gland. Most rear-fanged snakes are not known to be dangerous to human beings but there are two tree-dwelling rear-fanged African species that produce a deadly venom.

Apart from some rear-fanged species, there are three dangerously venomous groups of snake. One group is the burrowing asps. They have a long tubular fang on the upper jaw bone that can be folded against the roof of the mouth. There are about 15 species that live in parts of Africa and the Middle East. Their bodies are uniformly cylindrical along the length, unlike most snakes in which the body narrows at the neck. It is thought that they hunt for rodents in their burrows. The burrowing asps have a special feature--they can erect a single fang on one side of the head without opening the mouth. There are a number of cases of people being bitten while grabbing one of these snakes 'safely' by the back of the neck. The snake is able to twist its head and jab a finger with an erect fang. It seems likely that the snake metes out similar treatment to rodents within the confines of their burrows.

Elazar Kochva

Artractaspis engaddensis with a single fang erected.

Peter Stafford

Red spitting cobra, *Naja pallida*, from northeastern Africa.

Cobras, kraits, mambas, coral snakes and a number of other less-well-known snakes found in the warmer parts of all continents are front-fanged. Their fang is situated at the front end of the upper jaw bone; it is permanently erect and does not have much mobility. It is tubular, like a hypodermic syringe, with an oval opening at the end. Because the fang is permanently erect, it is limited in size for mechanical reasons. When these snakes strike they open their mouths wide and bite their victims, injecting venom.

Vipers, like burrowing asps, have proportionally long, tubular fangs which are hinged on the upper jaw. They are found at tropical and temperate latitudes in all continents except Australia. The fangs are folded back against the roof of the mouth when it is closed. When they strike, the fangs are erected and effectively stab the victim. They then release the prey as though confident that it will drop dead within a couple of minutes. After a short wait they pick up the prey's scent trail by flicking the tongue and, if it is dead, swallow it without any risk. Some vipers and other venomous snakes are kept in captivity and routinely 'milked' for their venom. They are squeezed at the back of the neck to force the venom out through the fangs which are jabbed through a plastic film. The venom is freeze-dried and sent to laboratories where it used to produce anti-venom.

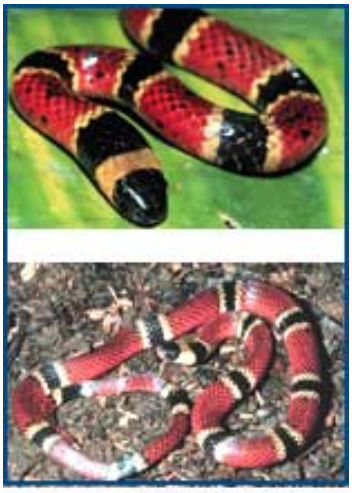
Weidenfeld & Nicolson

Extracting venom from Russell's viper.

Human wind pipes and food pipes cross over, which is why there is such a risk of choking when something goes down the wrong way. Snakes do not share this flaw in the anatomy of other air-breathing vertebrates. It might take a snake 15 minutes to swallow a large prey animal. Because the two halves of the lower jaw are not joined together it is able to push the windpipe forwards on the floor of the mouth, open it, take a breath and pull it back again.

The two sides of the snake's upper and lower jaws can move independently, and all the teeth point backwards, holding the prey. It alternately relaxes the jaws on one side of the head and pushes them forwards whilst holding on the other side. The jaws effectively 'walk' over the prey, left, right, left.

Venomous snakes have various features that warn off would-be predators. The coral snakes of the New World, whose venom is sufficiently powerful to harm a human being, are brightly coloured with bands of black, yellow and red. Some harmless snakes have developed similar body markings which send the same messages to their predators. In southern North America and tropical South America there are many species of snake that mimic the genuinely dangerous coral snakes.



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A variable coral snake, *Micurus diastema* (top) and a false coral snake, *Urotheca elapoides* (bottom).

Peter Stafford

A newly hatched red spitting cobra, *Naja pallida*.

Cobras deter predators by spreading their hoods and hissing loudly. Spitting cobras have fangs with round openings which direct the venom forwards. They use this fang to bite prey in the usual way but deter predators by squirting the venom out forcefully. They can spit accurately for more than a metre. If a person gets the venom in their eyes it can damage the cornea. Different species of spitting cobra are found in parts of Africa and Asia; the spitting habit has evolved independently two or three times.

Rattlesnakes warn off their predators by rattling. The rattle is situated on the end of the tail which has a series of overlapping horny rings. When the snake shakes its tail it makes a sound like a baby's rattle. Each time the snake sloughs its skin it adds a ring to the rattle. However, with the passage of time, rings at the end of the tail are lost through wear.

Snakes have no limbs but this does not cramp their lifestyles. There are hundreds of ground-dwelling species; some move on the surface, and some stay concealed by the leaf litter on forest floors. Some snakes burrow in the ground whilst others live in trees.

Some snakes, such as the North American garter snake and the European grass snake, are amphibious. They travel across the ground with side-to-side movements of the body and when they come to water are able to swim using the same bodily movements. Other snakes are more fully committed to life in fresh water.

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Common garter snake, *Thamnophis sirtalis coccinus*.

Sea snake. The Natural History Museum

There are about 50 species of snake that live in the sea. A few of them come ashore to lay eggs but the great majority spend their whole lives in water, produce live young in the water and are almost helpless if brought ashore. They have tails flattened sideways, like eels, that facilitate swimming.

The majority of sea-snake species are found around south-east Asia and the islands down to northern Australia. Most are about one metre long, although they can grow up to two metres in length. Sea snakes are front-fanged snakes, highly venomous but not particularly aggressive. Fishermen sometimes catch them in their nets and throw them back into the water; they usually get away with it but occasionally a fisherman does get bitten.

Tree snakes are highly adapted tree-climbers, despite having no limbs; they are long and slender and can bridge the gaps between branches. They are able to gain a purchase on rough bark by gripping with the scales on the belly which overlap one another providing sufficient friction. A few of these snakes can glide from tree to tree, but none can fly. Potential prey can avoid the snakes by taking to the air, but sooner or later they have to come down to earth. Given their lack of limbs, snakes really are extraordinarily versatile predators.

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