Amphibians and reptiles in quarries and gravel pits

Wanderers between the elements

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Preface

Like the previous volumes in our series of books on biodiversity in quarries and gravel pits, the fourth volume focuses on species groups which may find ideal conditions in mineral extraction sites. The first group are the amphibians, i.e. frogs, toads, newts and salamanders. These animals spend parts of their life cycles in the water, and part on land. So they are wanderers between the elements. The reptiles, with snakes and lizards as well-known representatives, form the second group. They are well-adapted to dry habitats. As cold-blooded animals, they need sunny sites such as piles of sand and stone, dry walls, and rock faces.

These two groups share a requirement for a rich mosaic of habitats for feeding, breeding, thermoregulation (temperature control) and hibernation. Their often strict dependence on certain habitat structures makes them ideal indicator species. The presence of amphibians and reptiles allows scientists and conservationists to make conclusions about habitat status and quality.

Frogs, toads, newts, snakes, lizards, and friends… they may not be the favourite animals of some readers. Few animal groups – with the exception of spiders – are subject to so many prejudices and myths. An array of horrible features come to one's mind: frogs: slimy; toads: cold and warty; snakes: venomous and dangerous. No wonder that even the Frog King had to wait endlessly for the liberating kiss of the princess. The tree frog once had some popularity as a meteorologist… but only when the forecast was good! This book also deals with the unjustified bad image of these animals. Its purpose is to demonstrate that amphibians and reptiles are fascinating creatures that must be granted their own permanent place within our modern cultural landscapes. Their amazing adaptations to diverse habitats, their complex behaviour, and their global distribution, have added to the evolutionary success story of these animals.

Mineral extraction on the one hand, and the protection of amphibians and reptiles on the other hand, may seem to be in conflict. Mining activities destroy existing landscapes and animal habitats, and amphibian and reptile populations are often harmed or lost. Therefore, it is of the utmost importance that modern approval processes take into account the protection of nature by adequate avoidance, mitigation, and compensation measures. Amphibians and reptiles are usually part of ecological audits when assessing the environmental impacts of mineral extraction projects.

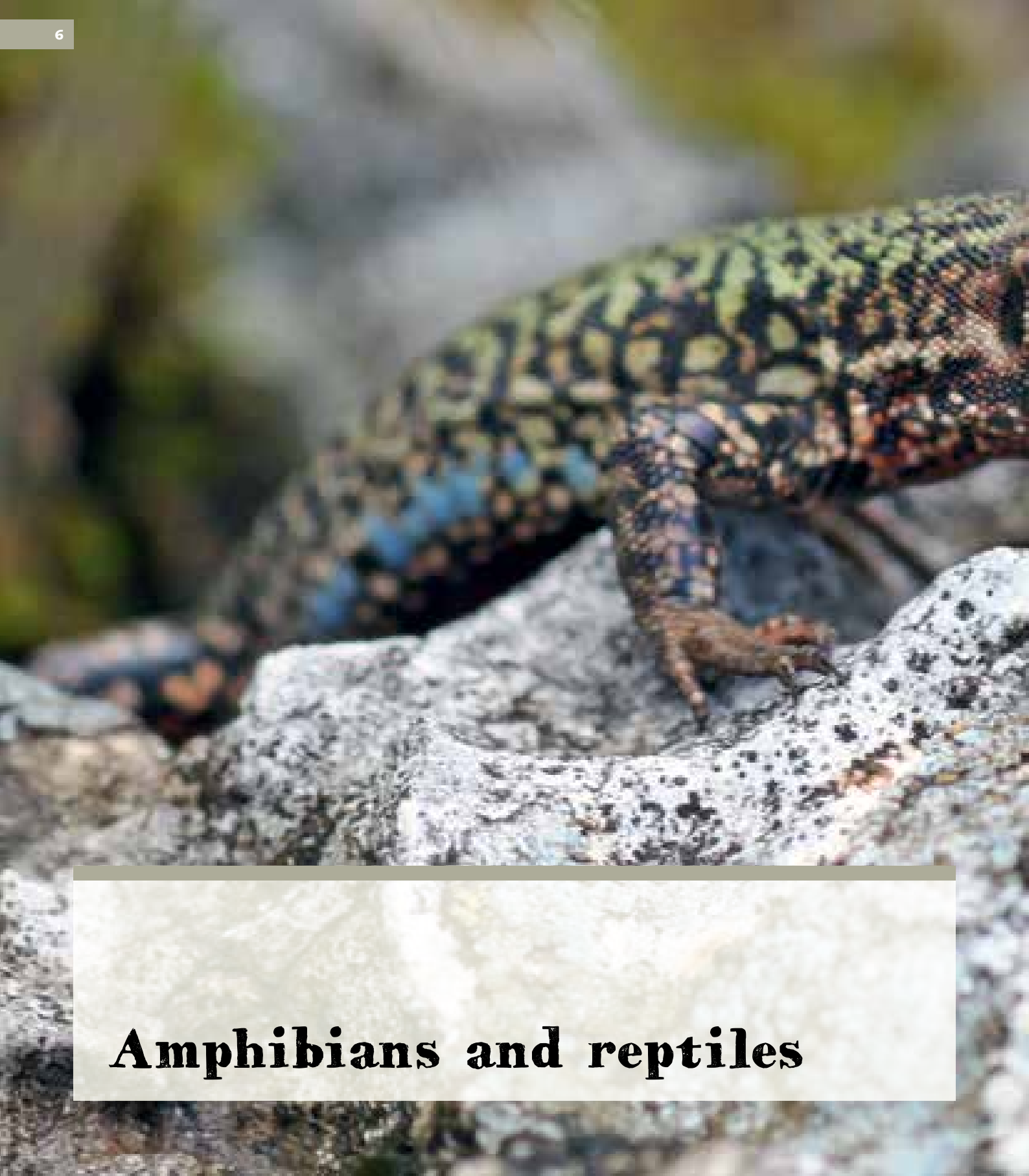
If their habitat requirements are met, both active and abandoned quarries and gravel pits can be of great importance for the protection of amphibians and reptiles. Many of the species that originally belonged to natural floodplains and sunny slopes find havens in our mineral extraction sites. Quarries and gravel pits have become important stepping-stone habitats in increasingly impoverished cultural landscapes. We highlight this aspect in our book because, as natural scientists, we are convinced that modern nature protection should cooperate closely with mining companies in order to guarantee the long-term survival of species such as yellow-bellied toad, natterjack toad, midwife toad, crested newt, sand and wall lizards.

The protection of many plant and animal species in quarries and gravel pits is strongly dependent on the right management. Mineral extraction companies and nature protection experts must communicate regularly, and on an equal footing. Nature protection projects for amphibians and reptiles in mineral extraction sites serve many other groups of organisms as well. They demonstrate that cooperation between conservationists and companies creates true gains for nature and science. The collaboration between HeidelbergCement and BirdLife International is now in its third year. Within this short period, 13 larger projects with BirdLife partner organisations have been started in six European countries. Many of these new projects foster amphibians and reptiles in our quarries and gravel pits. Suggestions for active protection measures for these animal groups form an important part of this book.

As in the first three volumes of our book series, we tend to combine biological facts with interesting stories and beautiful photographs.

Get into it!

Dr. Michael Rademacher
Director Biodiversity and Natural Resources
Programme Director BirdLife Cooperation



Amphibians and reptiles

Wanderers between the elements

What do amphibians and reptiles have in common? In fact quite a few things! Although they look very different, they do have many similarities. This explains why amphibians and reptiles have always been treated together by scientists. Their field of research is called herpetology. Both amphibians and reptiles are vertebrates. Amphibians, like fish, lay eggs embedded in a jelly, and at least during the first stages of their lives must live in water in the form of a larva (tadpole), which looks quite different to the adult frog or newt. Reptiles lay a more typical hard-shelled egg, like birds, which hatches into a perfect miniature of the adult. Both groups are cold-blooded and hibernate during the cold season.

01

Origin of the names

The term "amphibians" is derived from Greek. The prefix ***amphi*** means "both", and the second syllable comes from ***bios***, meaning "life". Together, they mean "both kinds of life" – a good description of the amphibious life style. The etymology of "reptiles" is easier – it is derived from the Latin word ***reptilis*** – creeping.

01 A basking marsh frog *(Pelophylax ridibundus).*

02 This sand lizard *(Lacerta agilis)* needs the sun's warming rays to get into gear.

Cold-blooded and warm-blooded animals

Amphibians and reptiles are cold-blooded **(poikilothermic)** animals. In contrast to warm-blooded **(homoeothermic)** animals, like birds and mammals, their body temperature is not constant, but depends on the temperature of their surroundings. This allows the animals to save significant amounts of energy during periods of bad weather. Their metabolism slows down in cool weather, and the animals can simply wait for more favourable conditions. They pass the winter in a state of hibernation.

Extended sun-baths in the following spring kick-start their metabolism. When it gets too hot, they retreat into the shade. The higher the air temperature and the hotter the sun, the faster and more agile the animals get. If you want to watch lizards during the summer, do it when the sky is overcast or during the cooler morning hours.

So, cold-bloodedness is a very sound biological mechanism, because the animals can save lots of energy and spend less time foraging.

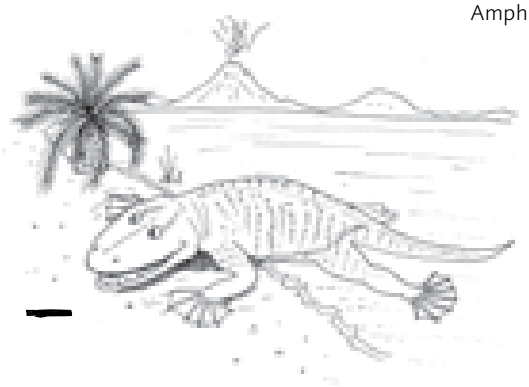
01

02

Amphibians and human beings

Once upon a time, frogs, toads, and newts were looked upon as disgusting, slimy and poisonous creatures. In his Natural History, Pliny the Elder, one of the most important chroniclers of ancient Rome, wrote that the salamander "spits forth a milky matter from its mouth; and whatever part of the human body is touched with this, all the hair falls off, and the part assumes the appearance of leprosy". Even in the famed fairy tale of the brothers Grimm, "The Frog King", the "cold frog" is described as nasty and ugly. In spite of this not very flattering image, huge amounts of frogs were and continue to be eaten. The French liking for frogs' legs is the stuff of joke and legend, but in 2010 the European Union as a whole imported more than 5,000 tonnes of frog legs from Indonesia, Vietnam, Turkey and Albania, equivalent to about 100 to 250 million frogs. More of these imports went to Belgium than to France! Even larger quantities are eaten in China and south-east Asia. Trade on this scale can pose threats to regional frog populations, and the global trade may be helping to spread the chytrid fungus, which is fatal to frogs.

Fortunately, the standing of amphibians has improved a lot in Europe. Today, amphibians have an image as icons and indicators of a healthy environment. This is due to a growing ecological consciousness, and a better awareness of the world-wide decline in amphibian populations. The increasingly positive attitude towards amphibians is reflected in business: many companies have chosen a cute frog or showy salamander as their logo. "Kermit the frog" is a globally beloved character from the TV series "The Muppets". In medicine, the African clawed frog *(Xenopus laevis)* was long used for pregnancy tests, and the species is still important in medical research today. But amphibian populations are increasingly threatened by habitat destruction, climate change, and a fungal disease (sidebar p. 43), and many amphibian species and their habitats are in urgent need of protection.



Amphibians – ancient Frog Kings

All life originated in the water, and this is shown in an impressive way by the life-cyle of ambibians. With the exception of fish, no other vertebrate group is bound so tightly to the wet element. During breeding, ponds, lakes, river shores, and in some species even small puddles are the locations for impressive courtship activities. Amphibians are the oldest living terrestrial vertebrates. They have been around for about 360 million years. When they first occurred in the Devonian period, the time of the dinosaurs was yet to come.

01 A spawning pair of common frogs *(Rana temporaria)*.

02 Nomen est omen: Both the common and scientific name of the edible frog *(Pelophylax esculentus)* point towards its potential destiny in some countries. In this photo, however, the frog itself is eating.

03 The bizarre feathery outgrowths on this northern crested newt *(Triturus cristatus)* larva are its gills.

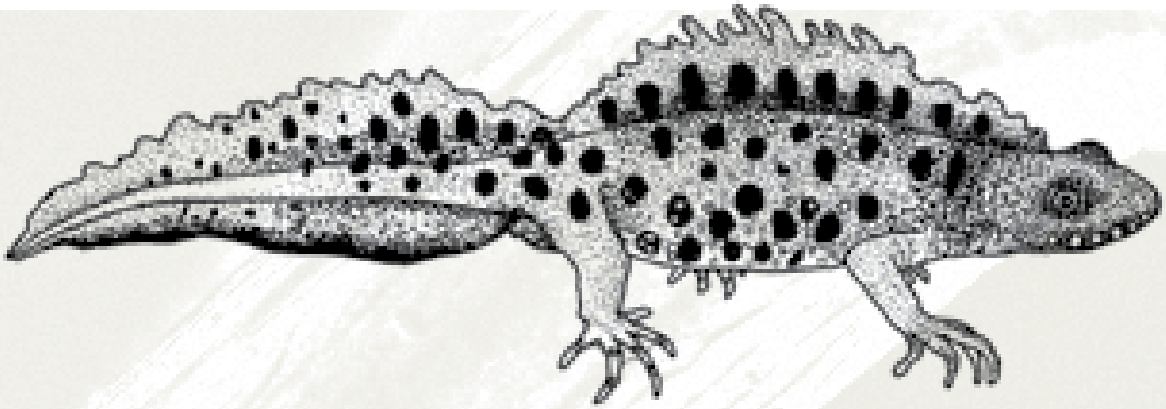
The anatomy of amphibians

Salamanders (Caudata) and frogs (Anura)

The amphibians that occur in Europe are divided into two groups (orders): **salamanders and newts** (about 600 species globally, around 35 in Europe) and **frogs and toads** (about 6,000 species, around 50 of them native to Europe). A third order, the earthworm-like caecilians, are found only in the tropics. **Salamanders and newts** look very much like the earliest animals to have emerged from the sea. They are in fact a much older order than the frogs and toads. They have long bodies, round or vertically-flattened tails, and short legs. The two pairs of legs are around the same length, and project from the sides of their bodies, so that their weight is suspended between them. Newts and salamanders walk, and cannot jump. Salamanders are mostly found in land habitats. Newts are more strongly tied to water, and unlike the salamanders, their hind feet are webbed. The hind legs of frogs and toads are generally longer than the front legs, and can be folded underneath them. The long legs and powerful thigh muscles of the common frog propel it in leaps that can be several times its own length. Frogs generally have smooth skins, and toads drier-seeming warty skins, but the difference is not a strictly scientific one.

Amphibians typically lay their eggs in water. The creatures which emerge from the eggs, popularly known as tadpoles, have tails but no legs, and feather-like external gills which enable them to breath under water. The lungs develop early, and the tadpoles begin to come to the surface to gulp air.

Over the course of a few weeks or months, the tadpoles develop legs (the front legs first in salamanders, and the hind legs first in frogs and toads). The tails of frog and toad tadpoles are absorbed into the body by the time they are ready to emerge from the water. Sometimes a stub of tail remains in newly emerged froglets, but soon disappears. Salamanders have tails throughout their lives. (The name of the salamander order, Caudata, comes from the Latin *cauda*, meaning tail.)



01 Tadpoles have a system of sense organs called the "lateral line", which enables them to sense the faintest movement or vibration in the surrounding water. The lateral line is apparent above the eye of this garlic toad tadpole *(Pelobates fuscus)*.

Spring fever! Courtship behaviour of amphibians

During the breeding season between late winter and early summer, there's high life in ponds and lakes! Male frogs and toads compete to attract and win over females, and have developed an array of strategies. When successful, the male embraces its female from behind – this looks just like riding piggyback. The female deposits the eggs in lumps (real frogs) or strings (toads), and the male fertilises them in the water. This is called external fertilisation.

01

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Some frogs and especially newts, have colourful courtship displays. Some newt species develop a wavy or jagged dorsal crest (see side bar page 65). Salamanders often show complex courtship behaviour. In some species, the males give off pheromones (chemical signals) to attract females. When a female has chosen a male, she follows him. The male then deposits a packet of sperm (a spermatophore) which the female takes up with her cloaca (the common opening for the intestinal, reproductive, and urinary tracts). This is called internal fertilisation, and all European salamanders and newts fertilise their eggs internally (see side bar page 12).

01 Males of "phylogenetically old" frogs and toads (species that evolved earlier), such as yellow-bellied toads *(Bombina variegata)*, clutch the female around the waist during mating.

02 In more modern frogs and toads, like these natterjack toads *(Bufo calamita)*, males embrace their females in the axillary region (the armpits). They are often seen being carried around piggyback by the females.

03 Three natterjack toad males cling to a single female, as each tries to get into position to fertilise her eggs. Prolonged struggles like this can drown the female.

04 Pool frogs *(Pelophylax lessonus)* form dense aggregations when mating, with ten or more frogs per square metre of water.

05 Courting palmate newts *(Lissotriton helveticus)*. The male (on the left) is using his tail to fan pheromones towards the female.

Ribitt! Ribitt! – Frogs' courtship calls

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01 The European tree frog *(Hyla arborea)* is barely 5 cm long, but its courtship calls can be heard over a kilometre away.

02 A calling male pool frog in his golden-green wedding suit. As in all green frogs, the vocal sacs are situated on either side of the mouth.

Frogs and toads have pouches in their throats called vocal sacs, which are used to amplify their courtship and "advertisement" calls. Calls which would only be audible for a metre or two can be heard for a kilometre or more because of the vocal sac.

03 The male natterjack toad's calls need to be loud to attract females to the right breeding pond.

04 Vibrations caused by the croaks of this male green toad *(Bufo viridis)* produce a pattern of ripples.

Wanderers between the elements – the fascinating reproduction of amphibians

Most amphibians spend their childhood days in waters. At this stage of their life cycle they are perfectly adapted to the wet element. After metamorphosis, they look for suitable land habitats. Most species return to their home waters only to breed. Depending on the species, it may take one to several years before they reach breeding age.

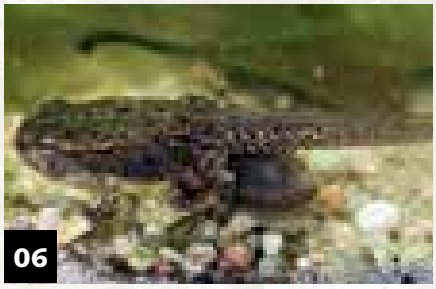
There are exceptions to the usual amphibian life cycle. Instead of laying eggs, several European salamanders give birth to larvae or even fully developed young salamanders. Fire salamanders mate on land and the female deposits the larvae in water after they have developed inside her. Alpine salamanders and salamanders of the genus *Lyciasalamandra* have cut out the aquatic phase altogether. They mate on land, and produce perfect miniature salamanders after a gestation of up to one year.

01

Developmental cycle of a green frog


07


02


06

01 Mating.

02 Spawn.

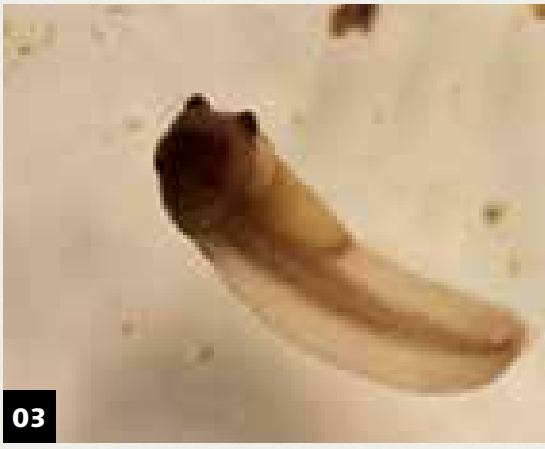
03 Freshly hatched tadpole.

04 Older tadpole.

05 Tadpole with developed hind legs.

06 Older tadpole with front and hind legs.

07 Almost ready for shore! The tail base is still present.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Developmental cycle of a smooth newt


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01 Male and female smooth newt team up.

02 The female glues the fertilised eggs onto water plants.

03 The female uses her hind legs to glue the eggs between folded water plant leaves.

04 The eggs are well protected in this plant pouch.

05 Larva ready to hatch from its egg.

06 Freshly hatched newt larva with yolk sac.

07 In newt larva, the front legs develop first.

08 Newt larva with front and hind legs and the typical feathery gills.

09 Newt larva shortly before metamorphosis.


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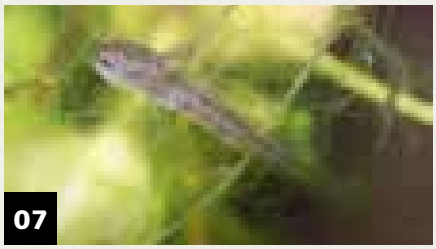
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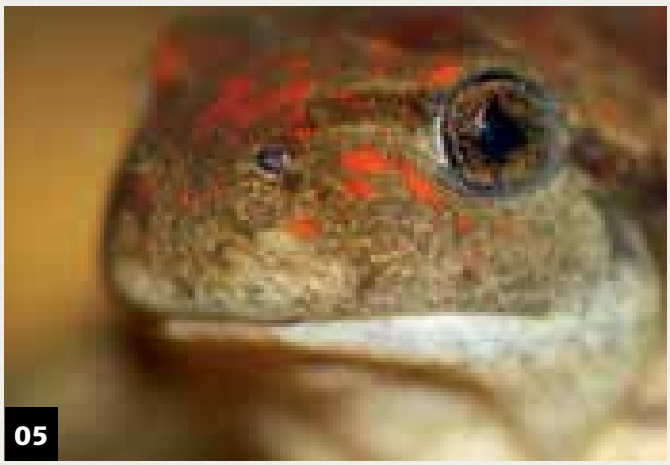
01 – **05** This sequence shows how the mouth of a garlic toad *(Pelobates fuscus)* changes during metamorphosis. The beak-like mouth of the newly emerged tadpole, which is used for rasping algae, gradually changes into the typical wide frog's mouth.



Metamorphosis

Amphibian larvae, (known as tadpoles in frogs and toads, and often also in newts), have a tail and gills after hatching. Their bodies undergo an incredible transformation over several weeks or months. During this process, called **metamorphosis**, they develop legs, and lungs, and frogs and toads absorb their tails. Their digestive organs are completely remodeled during metamorphosis. While tadpoles take up their mostly vegetarian food by rasping or filtration, the adult frogs gulp down their prey in one piece.

06 A palmate newt shedding its skin. The skin of amphibians is thin and delicate, to enable the exchange of oxygen and carbon dioxide during respiration.

The amphibian way of life

01 – **05** Garlic toads can dig themselves quickly into soft soil or sand when threatened, using a spade-like projection on their hind feet. They are also known as spadefoot toads.

Swimmers, climbers and diggers – the special adaptations of amphibians

Amphibians display multiple adaptations to their habitats. Some examples are the **webs** between the toes of many frogs, making them much better swimmers, and **suction cups** at the fingertips of the European tree frog which enable it to climb the smoothest surfaces.

The garlic toad, or common spadefoot, has flat spade-like protrusions on its hind feet that it can use to dig itself backwards into sand or earth when threatened.

The amphibian lung is much less efficient than lungs of higher vertebrates. Supplementary **cutaneous (skin) respiration** plays an important role in supplying the amphibian with oxygen. It is effective both in water and on land. Amphibian skin is very thin, to enable respiratory gases (oxygen and carbon dioxide) to be exchanged through it. However, to function effectively, the skin has to be kept moist at all times. Because of this, both larval and adult amphibians are confined to moist habitats. Cutaneous respiration also allows amphibians of the temperate zones to hibernate under water, and in the mud at the bottoms of ponds.

The lungs of some species are completely degenerated. The cave salamaders, for example, are also known as lungless salamanders, and breathe only through their skins and the linings of their mouths. The olm, which retains its larval form throughout its life, never leaves the water and keeps its gills. European newts, which spend most of their lives in water, however, have to come to the surface regularly to breathe. Cutaneous respiration is an ideal adaptation to an aquatic life but the thin skin makes amphibians very susceptible to toxic chemicals such as pesticides, detergents, and fertilisers.


02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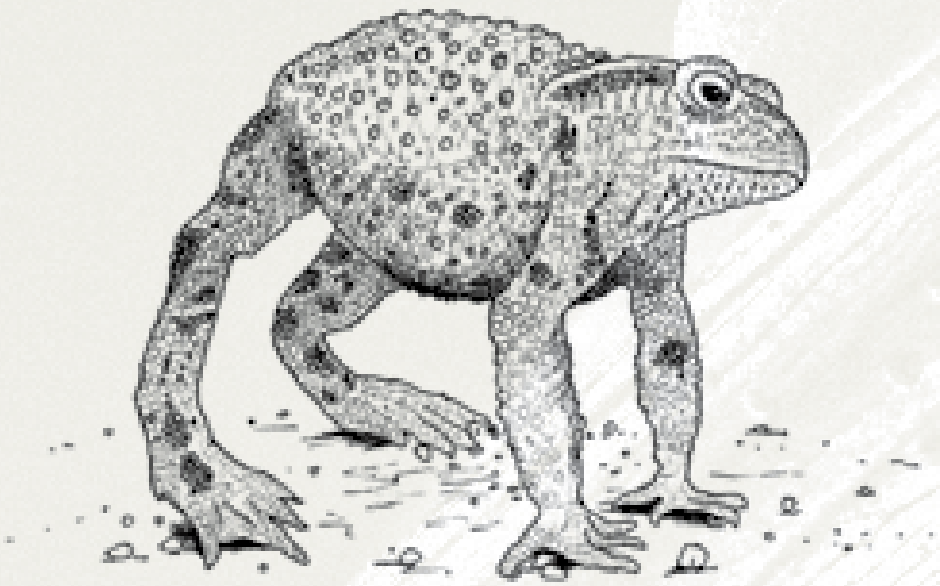
Survival strategies in amphibians – hide away or display

01

To avoid their predators, amphibians have developed three different strategies. The most widespread technique is the old disappearing trick used by most European frogs, which have a brown or green basic colouration with camouflage patterns. The capacity of melting into the environment is called mimesis. In addition, many species hide away in broad daylight.

The garlic (spadefoot) toad, for instance, can dig itself in backwards within a few minutes. If camouflage is not successful or a predator has got too close already, some amphibians try to scare it away with threatening gestures. The common toad, for instance, inflates itself and "stands up tall" in order to appear bigger and more dangerous when encountering a grass snake.

02



01 The most common protective strategy – making oneself invisible – is demonstrated by young garlic toads …

02 … and midwife toads *(Alytes obstetricans)*.

A different strategy, which in central European species is most strikingly displayed by the fire salamander, is a high-contrast warning colouration. It is just the opposite of camouflage, and signals: "Watch out, I taste horrible!" Other amphibians, especially toads, exude poisonous secretions when threatened. The yellow-bellied toad combines both strategies. Its upper side is perfectly mud-coloured and camouflaged, while its belly bears a black-and-yellow warning pattern which the toad displays when it is in danger. The poisons of European amphibians are not dangerous to human beings, but the skin toxins produced by some tropical amphibians to protect themselves against predators can kill humans, too. The batracho-toxins secreted by the poison dart frogs of Central and South America are among the strongest toxins known.

01 A yellow-bellied toad tries to deter predators by displaying its black and yellow underside.

02 The fire salamander *(Salamandra salamandra)* has a characteristic black-and-yellow colouration, to warn predators that it is poisonous.

A third strategy is called mimicry. Harmless species imitate the colours and patterns of their toxic cousins. As predators learn from experience to avoid vividly coloured poisonous species, the cheats profit – they do not get eaten, and yet save themselves the energy-consuming process of making toxins. Popular examples in Europe are the completely peaceable hoverflies (Syrphidae) with many black and yellow striped species imitating wasps.

Among amphibians, examples can be found within the group of South American poison dart frogs (Dendrobatidae). Only one third of these roughly 170 motley rain forest dwellers are really toxic; the rest just fake it.

03 Toads can produce poison from special skin glands when threatened.

Reptiles

Reptiles have been around for a long time (though not as long as amphibians). They appeared about 290 million years ago, and are closely related to dinosaurs. Like amphibians, and in contrast to birds and mammals, all recent species are cold-blooded (see side bar p. 9) and can control their body temperature only by switching between sunny and shady places. An incredible diversity of reptiles has evolved, and about 10,000 species are known so far. Some of them do look like small dinosaurs – or even dragons, like for example the frill-necked lizard, also known as frilled dragon, which occurs in Australia and New Guinea.

01

No such thing as a reptile?

The term reptile is usually applied to lizards and snakes (together Squamata), tortoises and turtles (Testudinata), tuataras (Rhynchocephalia), and crocodiles (Crocodylia) because of their common traits. Recent paleontological findings demonstrate, however, that crocodiles are more closely related to birds than to, for instance, snakes. So, to use the term "reptiles" as if describing a single class of organisms with a common ancestor is technically wrong.

Reptiles and human beings

As is the case with amphibians, human attitudes to reptiles have always been ambiguous and diverse. Especially in Asia, where reptiles are more abundant and species-rich, and therefore more present in everyday life, reptiles are pervasive in mythology and religion. In some Asian cultures, a tortoise carries the Earth as a disc on its back through the ocean (an idea that, minus a few elephants, will be familiar to the millions of fans of Terry Pratchett's Discworld novels). In Africa, tortoises are considered very wise and are characters in many fairy tales. In European fables, too, tortoises are recognised as clever and wise.

The opposite is true for snakes. In the Old Testament, the snake represents the Devil, and by tempting Eve to eat from the tree of the knowledge of good and evil, caused humankind to be expelled from Paradise. Today, snakes still symbolise malice and deceitfulness in many cultures – but also wisdom and enlightenment. In ancient Greece, the snake was considered holy and immortal, because of the recurrent shedding of its skin, after which it emerges bright and new, as if reborn. The snake became the emblem of Asclepius, the Greek god of healing, and hence of all physicians. The Rod of Asclepius – a staff with a single snake entwined around it – is still sometimes used as an emblem of medicine or health care. In India and south-east Asia, snake-like gods or nature sprits called "nagas" (often associated with the King Cobra), are still part of Hindu culture. For the Australian aborigines, the Rainbow Serpent is a great sprit which moulded the mountains and valleys, and now guards the waterholes. Similarly, the crocodile is an important spirit figure for Australian Aboriginals, as it is for some African peoples, and as it was for the ancient Egyptians, who worshipped it as the god Sobek.

Lizards and snakes have inspired people from all parts of the world to invent fantastic creatures. Dragons, for example, are found in both eastern and western mythologies. Reptiles also feature in our language, in proverbs and in figures of speech, though usually in ways which perpetuate negative stereotypes about them. Historically snakes (or serpents) might have been proverbial for their wisdom, but they mostly stood – and still stand – for treachery, deceit and lurking menace – as in the phrase "a snake in the grass". "Reptile" similarly implies someone not to be trusted, especially when applied to journalists.

01 Snake deities known as Nagas are very abundant in Asian mythology and religions. In Thailand they are said to resemble snake-like dragons.

The anatomy of reptiles

01

In contrast to birds and mammals, the limbs of reptiles – those that have legs – have a horizontal upper joint, giving them a sprawling posture when standing or walking. In snakes, and in many species of lizard including the slow worm in Europe, there are no external limbs, though they may retain small leg bones hidden within their bodies.

01 A false map turtle *(Graptemys pseudogeographic)* from North America. Chelonians (turtles, tortoises and terrapins) are an older order of reptiles than lizards, snakes and crocodiles. They have changed little in more than 200 million years, and are often considered living fossils.

02 This grass snake *(Natrix natrix)* is about to shed its skin. When snakes moult, the scale covering the eye is shed too. Before moulting, the scale over the eye becomes milky blue, as seen here, and the snake's vision is poor, which can make it more aggressive than usual.

03 The shed skin of a sand lizard, like a tiny leopardskin coat.

No need to jump out of your skin – moulting of reptiles

All reptiles possess scales made of keratin, a protein from which human nails and hairs are also made. Reptiles have to shed (slough) their scaly skin periodically in order to grow, but also to get rid of parasites and to renew the old, worn skin. The discarded skin is quite tough and can be left behind in large pieces after sloughing.

01 This grass snake's flickering tongue is testing the air for the scent of prey.

02 Perfect camouflage and panoramic vision – the common chameleon *(Chamaeleo chamaeleon)*.

03 In contrast to snakes, lizards have moveable eyelids and can blink. Snakes also lack ear openings, like the one visible in this wall lizard *(Podarcis muralis)*.

Senses of reptiles

Snakes have an excellent sense of smell and can detect even the faintest vibrations. These sensory capacities are very important, because they can neither hear nor see well. Snakes smell with their forked tongue. By flicking or darting their tongue in the well-known way, they take odorous substances out of the air and transfer them to a special olfactory organ inside the mouth (the Jacobson's organ). Some lizard species, too, smell in this way.

Lizards and tortoises can see quite well, and some species have colour vision. Chameleons, such as the common chameleon, the only European species, have an almost 360 degree view around them, because of their independently moveable eyes.

Small but perfectly formed – the reproduction of reptiles

Reptiles do not depend on water for reproduction. Their hard-shelled eggs protect the embryos until they have grown to perfect miniature reptiles. In contrast to amphibians, there is no larval (tadpole) phase. Fertilisation of the eggs occurs exclusively within the body of the female. But before that, males have to go courting. Snakes, lizards, and tortoises all compete for females with ritualised fights in which the males pit their strength against each other, but do not generally hurt each other. Snakes wrestle, and tortoises try to capsize each other by barging.

Suitably warm and sheltered places to lay the eggs are important. In primeval landscapes some snakes, especially grass snakes, dice snakes, and Aesculapian snakes, used heaps of rotting plant material left behind after floods. Compost heaps make a good modern substitute. Other species, for instance sand lizards, common wall lizards, green lizards, and European pond turtles, use mostly sun-exposed, sandy sites, where the eggs can be easily dug in.

01 Two male slow-worms *(Anguis fragilis)* in a ritualised fight for a female.

02 A young Hermann's tortoise *(Testudo hermanni)* fights its way through the egg shell.

03 No snake charmer involved: two common European adders *(Vipera berus)* engaged in a ritualised fight.

Wherever I lay my eggs that's my home

Principally, reptiles lay eggs **(oviparity)**. But in some species the eggs develop and hatch inside the body of the mother, who gives birth to fully developed young **(ovoviviparity)**. Some snakes and saurians have gone one step beyond: the female possesses tissue structures resembling a placenta. These animals are called **viviparous**.

In about one-third of European reptiles, the eggs hatch inside the mother's body. They can regulate the breeding temperature much better than egg-laying species. The common or viviparous lizard and the common European adder, which are the European reptile species most often found in cool climates, belong in this group. (Perhaps the lizard should be renamed the ovoviviparous lizard ...)

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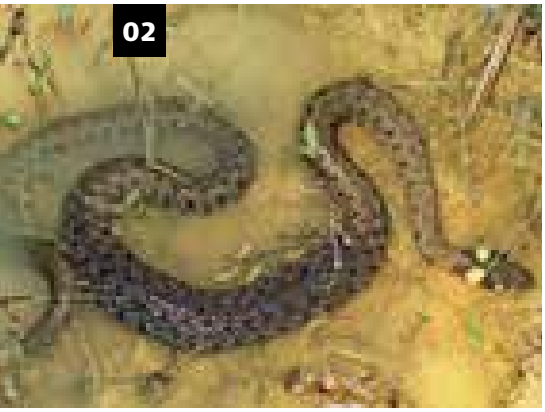
04 These empty grass snake eggs were dug up after they had hatched. The long slits in the leathery egg shells are made by the egg tooth, a small protuberance on the snout of the hatchling snake that is shed at the first moult.

Way of life



01 The smooth snake *(Coronella austriaca)* coils its body around its prey to suffocate or weaken it.

02 Snakes can unhook their jaws to swallow big prey. This grass snake has definitely gorged itself.

Diet of reptiles

Most reptile species are predators. Generally European species are small and prey on spiders, snails, and insects. Larger European species such as the grass snake live mainly on small vertebrates, such as frogs and toads, mice and voles, and nestling birds. Snakes can unhook their jaws to swallow prey bigger than their heads. Poisonous snakes such as adders bite their prey, and then follow it while the venom is acting. Finally, the dead prey is swallowed – the venom will have already started to act as a digestive juice. Constrictor snakes, such as the European smooth snake, squeeze and suffocate their prey.

In contrast, Europe's land tortoises are mostly vegetarian.

Reptiles eat infrequently, because they do not need energy to actively heat up their bodies. Therefore they can fast for long periods of time – sometimes for months.

03 Hermann's tortoises are vegetarian and feed mostly on leaves.

Reptile records

The biggest lizard on Earth is the Komodo dragon *(Varanus komodoensis)*. This inhabitant of a few Indonesian islands can grow up to three meters long. The largest and heaviest snake in the world is the green anaconda *(Eunectes murinus)*, a native of South American rainforests. Female specimens have allegedly surpassed lengths of nine metres and weights of 200 kilograms. The males, at a maximum of three metres, are mere dwarfs compared to their spouses. The Asian reticulated python *(Python reticulatus)* is sometimes cited as the longest snake worldwide; however, reliable sources state maximum lengths of "only" seven meters.

The most poisonous snake is the central Australian inland taipan *(Oxyuranus microlepidotus)*. The average amount of venom it injects could theoretically kill 230 adult human beings or 150,000 rats.

It is hard to determine the age of snakes, so statements about the maximum age in the wild are problematic. In captivity, a royal python *(Python regius)* reached an age of over 40 years.

The oldest tortoise is probably also the oldest animal on earth: the Galápagos giant tortoise Harriet, kept in captivity, reached an estimated age of more than 170 years.

Venom and bile – don't mess with snakes and lizards!

Predator avoidance in reptiles – passive and active defence

Reptiles have developed diverse **passive** and **active defence strategies** to avoid being eaten by predators. Snakes, in particular (but lizards as well) escape and hide as soon as they perceive vibrations. This is a passive defence strategy. So if you want to avoid encounters with snakes, tread heavily when hiking. Another passive strategy is when reptiles simply rely on their camouflage and do not move. Grass snakes are known for feigning death ("playing possum"). The snake rolls over on its back, opens its mouth and freezes until its opponent loses interest.

Another effective passive defence strategy is called self-amputation **(autotomy)**. Some lizard species shed part of their tail when a cat or crow grabs them. The discarded tail squirms vigorously and thus attracts the predator's attention, giving the lizard the chance to escape. The tail regrows, but it is usually shorter and darker than before.

Active defence strategies used by reptiles include making themselves look bigger, and threatening to bite. When a direct confrontation is inevitable, some snake species adopt an aggressive posture. Famous examples are cobras which raise the front part of their bodies off the ground and flatten their necks to appear larger to predators, and rattlesnakes which, when disturbed, threaten the aggressor by shaking the "rattle" at the end of their tail. Only when snakes are cornered – or trodden on – will they strike and bite. This is also true for European venomous snakes.

Another defence reaction of some reptiles is to squirt faeces, or foul-smelling secretions from their anal glands, or to throw up over themselves and their attackers.

Snake poisons

About 10% of the almost 2,800 snake species known worldwide are venomous. There are two types of poison, those paralyzing the central nervous system (neurotoxins), and those damaging blood or tissues (haemotoxins). The poison is usually injected with fangs located in the front (though sometimes the back) of the mouth. More rarely it is spat, such as in spitting cobras. Injected poison acts more rapidly and strongly. Neurotoxins usually paralyse the respiratory system and cause suffocation.

The common European adder is actually very shy, but defends itself with a bite when seriously threatened or trapped. Its venom, however, is relatively innocuous. An adult would have to be bitten by five adders in order to be in mortal danger; this is of course extremely unlikely.

01 Lizards can regrow their tails after shedding them to escape predators. Regrown parts of the tail are noticeably shorter, stubbier and less brightly coloured. If the tail is not completely broken off, a second tip can grow, producing "fork-tailed" lizards like this one.

Threats to amphibians and reptiles

Amphibians have thin and highly permeable skin which offers little protection against environmental stress. Although many amphibian species exude secretions to fend off predators, they are defenceless against environmental pollutants produced by human beings.

In addition to the direct harm inflicted by agricultural chemicals – such as infertility or even death – the ongoing intensification of agriculture leads to the loss of suitable habitats. This is the main reason for the worldwide decline of amphibians and reptiles. Wet meadows and bogs are drained, and small ponds are filled in to allow for the use of heavy agricultural machinery. Important corridors for animal migration, such as hedgerows and field margins, are removed.

Almost all reptile species depend on structured and diverse landscapes, and suffer from intensified land use and urban sprawl. In some cases, species occurring only in one small region can become seriously threatened by capture for the pet trade. One example is the turquoise dwarf gecko *(Lygodactylus williamsi)* from Tanzania, which has become very popular among terrarium owners. It occupies a patch of forest just 8 km² big and its population has been severely reduced by collectors.

Amphibians are additionally threatened by several other factors.

01 Excessive collection for the pet trade has made the turquoise dwarf gecko *(Lygodactylus williamsi)* one of the world's most threatened reptiles.

02 Amphibian fences can prevent the death of many frogs, toads, and newts as they make their way to their breeding waters.

03 Taking a swab from a yellow-bellied toad to check for infection with the amphibian chytrid fungus.

Fragmentation and isolation

Amphibians and reptiles are strongly impacted by the increasing **fragmentation of landscapes** owing to the construction of roads and settlements. Amphibians, especially, fall victim to cars on their yearly migrations to their spawning waters. Losses at this time of year can be immense, and the deaths of so many before they have been able to breed contributes to population declines. Moreover, increasing fragmentation leads to the **isolation** of subpopulations. This can result in genetic depletion. When small populations are no longer connected, this may result in inbreeding and, in the long run, the extinction of populations.


02

Amphibian migrations and amphibian fences

Along roads that cross the migratory routes of amphibians, amphibian fences can help to reduce the numbers that fall victim to the traffic. Buckets dug in along the fences have to be checked and emptied each evening by volunteers, who carry the amphibians to their spawning water. In this way, tens of thousands of frogs, toads, and newts can be saved from being killed on the road. However, the success of such actions depends on the number and commitment of volunteers, because the migrations may last for several weeks. Newly-built or reconstructed roads through areas with large amphibian populations are increasingly furnished with built-in tunnels and fences, allowing the amphibians to cross safely.


03

Worldwide decline of amphibians

Amphibian populations are shrinking globally. The amphibian chytrid fungus *(Batrachochytrium dendrobatidis)* is considered an important factor. This pathogen stems from Africa, and is associated with the African clawed frog *(Xenopus laevis)*, which is immune to it. The clawed frog was used for pregnancy tests throughout the world, introducing the fungus to every continent. Chytrid fungus is held responsible for the extinction of about 200 frog species so far. The main reasons for the decline of amphibians, however, are habitat destruction, landscape fragmentation and isolation of populations. Global warming and increased UV radiation play an additional role.

Life in floodplains

The natural habitats of almost all European amphibian species and of many reptile species were situated in natural river floodplains, where floods created new ponds, shallow waters, and open gravel plains every year. Here, and within tranquil oxbows (former river meanders now cut off to form crescent-shaped lakes), frogs found ideal habitats.

The floodplains also contained richly-structured, sun-exposed habitats which were ideal for reptiles. Open sand and gravel plains were perfect for sunbathing and egg deposition. Heaps of decomposing plant material, piled up during the floods, served grass snakes as egg-laying sites.

As a consequence of changes such as river straightening and containment, and urbanisation, very few intact alluvial landscapes remain in Europe today. Many of their typical inhabitants have become rare and depend on secondary habitats. They often find these in quarries and gravel pits.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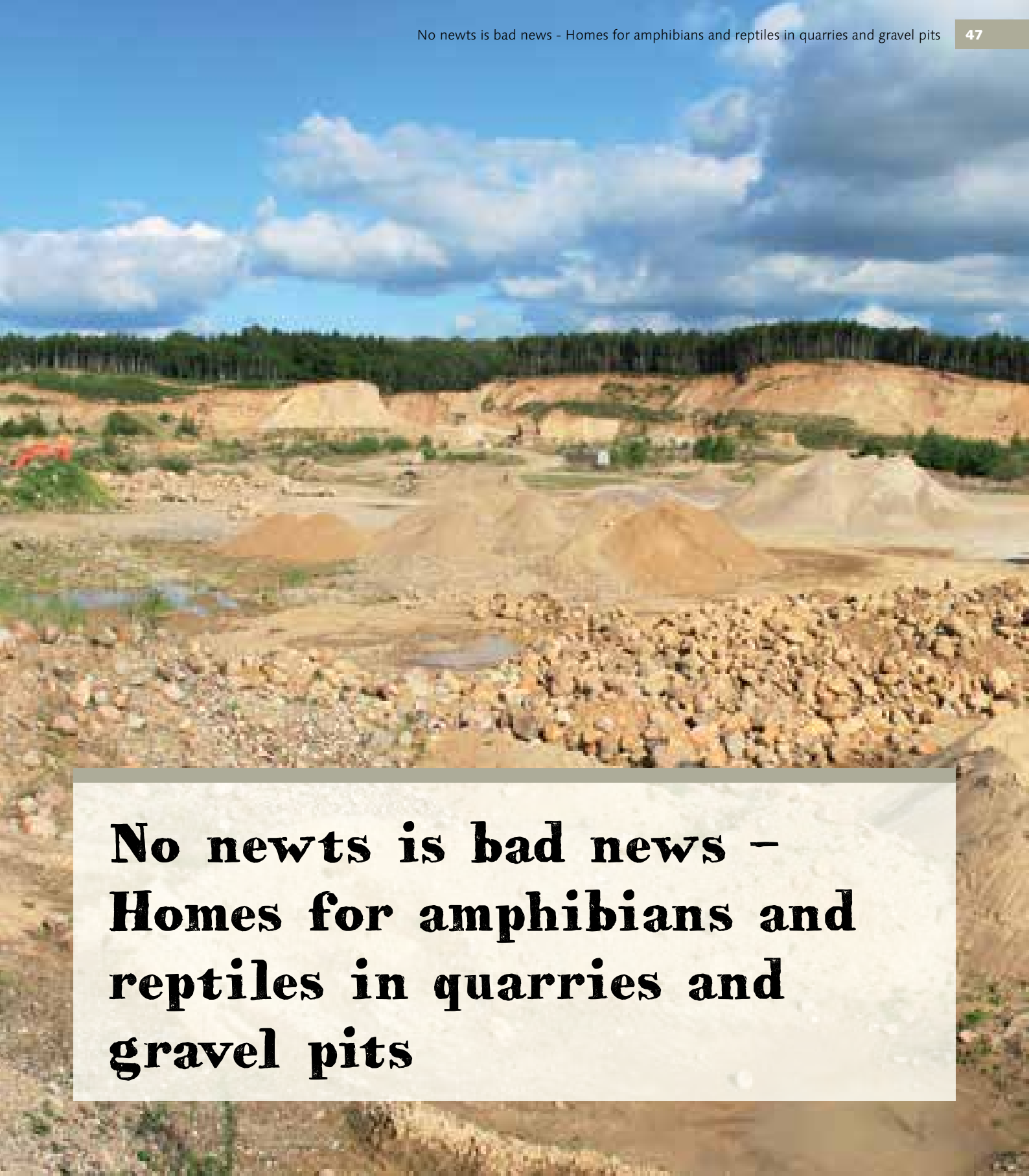
Though it may sound strange at first, natural floodplains and mineral extraction sites have much in common. Both are characterised by abundant dynamics. The power of flood waters in alluvial plains, and the forces of extraction activities in quarries and gravel pits, are continually remodelling the landscape, creating diverse habitat structures. In large mineral extraction sites, amphibians can roam freely between their spawning waters and winter habitats. As migrations occur mainly at night, they are not strongly affected by mining activities.

01 A natural flood plain in the Alps.

02 Like natural flood plains, mineral extraction sites can contain vast expanses of gravel.

03 Mineral extraction sites include large permanent bodies of water, as well as temporary pools. These can make up for some of the losses of water bodies in former natural foodplains.

03



No newts is bad news – Homes for amphibians and reptiles in quarries and gravel pits

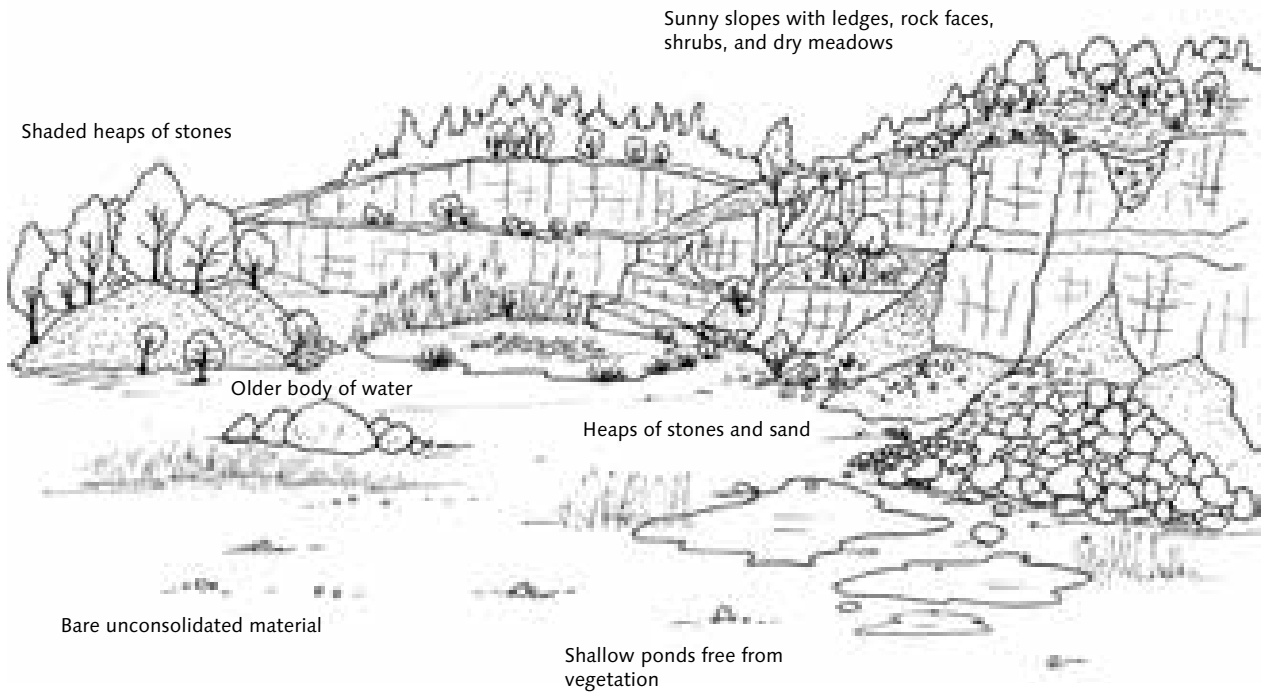
No newts is bad news – Homes for amphibians and reptiles in quarries and gravel pits

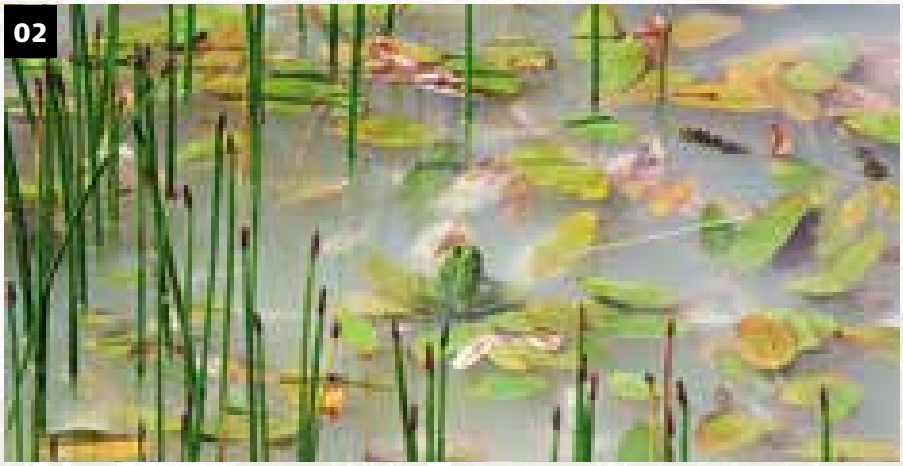
01

Most amphibian and reptile species need complex mosaics of habitats to cover all aspects of their lives. They need access to food for foraging, hideaways from predators, and safe sites for hibernation and breeding.

Amphibians have very specific demands regarding both terrestrial habitats and spawning waters, and they need to be able to migrate back and forth without being harmed. Grass snakes, for instance, need open soil or piles of wood or stone for sunbathing. They hunt in ponds and shallow shore zones, and they prefer heaps of organic material for their eggs. Quarries and gravel pits can offer this diversity of habitats, and traffic and disturbance levels are relatively low. Frost-free sites for hibernation can usually be found there as well.

Structural diversity in mineral extraction sites





01 Shallow shores, reed zones, and gravel plains offer suitable habitats for many amphibian and reptile species.

02 A pool frog sitting on floating pondweed *(Potamogeton natans)*.

Small and very small temporary waters

Mining activities and heavy machine traffic create different types of small, often short-lived water habitats in many quarries and gravel pits: shallow inundated zones, depressions in the bedrock, or simply tyre tracks filled with rain water. Such temporary, usually sun-exposed waters are important spawning sites for specialised amphibian species. Typical European species of this type include natterjack toads, European green toads, and yellow-bellied toads. Because these small pools exist for such a short time, they harbour few or no predators to feed on amphibian spawn and larvae. On the other hand, there is a high risk that the tadpoles will die if the waters dry up too early.

01

01 A young natterjack toad.

02 Portrait of a midwife toad *(Alytes obstetricans)* with its characteristic vertical pupil.

02

The adaptations of these specialised amphibians include:

- Fast larval development. Natterjack toads hold the European record: three to twelve weeks is enough for the eggs to develop into young toads.

- A prolonged reproductive phase, with migrations between different spawning sites depending on the availability of small pools. Natterjack toads, green toads, yellow-bellied toads, and European tree frogs, spawn from April to August.

- In order to direct the females to the right spawning waters, the males have to emit extra loud courtship calls. Tree frogs and natterjack toads are the loudest.

- Some species have an amazingly long life expectancy. In this way, several dry years in a row may be bridged. Yellow-bellied toads can reach at least 15 years under wilderness conditions.

01 Water-filled shallow depressions made by heavy machines are used as spawning waters by several amphibian species.

02 The plump, short-legged natterjack toad does not jump, but runs in a mouse-like manner and at amazingly high speed. A light coloured dorsal stripe is characteristic.

Creating small temporary pools

To create shallow waters for natterjack toads, green toads and yellow-bellied toads, caterpillars or dredges can scrape out swales in low-lying areas where rain water will accumulate. The depth should be chosen carefully, so that the waters dry up completely at least once in years with average rainfall. This is important to keep fish (which might eat spawn and larvae) out of the waters. The water has to be kept free from shading vegetation by removing scrub periodically. Grazing by goats or sheep can be an effective and gentle method.

03 Egg strings of natterjack toads in very shallow water.

04 Sunny, shallow water with both open and vegetated shore zones.

01 The yellow-bellied toad is well camouflaged by its mud-coloured back. If detected, it displays the warning coloration of its belly to deter predators.

02 Like natterjack toads, yellow-bellied toads spawn in the temporary pools created by heavy machinery.


01


02

03 The waters of small pools like this warm up quickly, which speeds the development of toad eggs and tadpoles.

04 Water-filled wheel tracks.

05 The tails of yellow-bellied toad tadpoles bear a characteristic reticulated pattern.

01 The green toad *(Bufo viridis)* is a true pioneer species, able to colonise new habitats rapidly. It spawns in many different types of water, from puddles to flooded gravel pits.

02 Portrait of a green toad. Although similar in appearance to the natterjack, the male green toad has a very different mating call.

03 Breeding green toads need shallow, sunny water unshaded by plants.

Semi-permanent and permanent waters

In temperate climate zones, waters that never dry out, or do so only in very dry years, are the most species-rich amphibian spawning sites. However, the absence of fish and the presence of sunny shallow shore zones that warm up rapidly are mandatory. Permanent waters are quite different from temporary ones. On the one hand, spawning amphibians do not run the risk that their offspring will die from desiccation; on the other hand, many predators – water beetles and their larvae, dragonfly larvae, leeches – are just waiting to feast on their eggs and larvae. Newts, too, eat frogs' eggs.

Because of this abundance of predators, species that spawn early and in a synchronised way – common frogs, agile frogs, moor frogs, garlic toads, and common toads – are very prolific. On average, one egg string of common toad spawn contains 2,000 to 3,600 eggs, one clump of common frog spawn 600 to 3,000 eggs. Moreover, the early spawners aggregate in such large numbers over a short period of time that predators are overwhelmed. Under favourable conditions, myriads of freshly metamorphosed, tiny common frogs or common toads can cover the ground around their spawning waters. In German, this phenomenon is termed "frog rain".

In contrast to species that spawn later in the year, when the males have to signal where to go to their females, the early spawners have quiet courtship calls that cannot be heard over great distances. Many early-spawning amphibian species are very conservative with regard to their spawning sites, and always return to their home waters.

01

01 Female common toads *(Bufo bufo)* are much bigger than males, which is just as well, because they often have to carry their mates all the way from their overwintering sites to the spawning water.

02 In Europe, the common toad is the only amphibian that occurs regularly in larger waters with fish. Tadpoles form swarms to protect themselves from predators.

03 Common toads lay egg strings, which they loop around underwater vegetation.

01 Flooded quarry.

02 The very secretive garlic toad *(Pelobates fuscus)* has a stocky body with a big head and wide mouth. Because it does not possess vocal sacs, and croaks below the water surface, its courtship calls can only be heard at small distances. When not breeding, it lives in open landscapes with soft soil.

03 Garlic toad tadpoles are remarkably big and can reach more than 10 cm! Yet after metamorphosis, these toads are comparatively very small, with a body size of around 3 cm.

04 The eastern European fire-bellied toad *(Bombina bombina)* inhabits larger waters than its sister species, the yellow-bellied toad. Fire-bellied toads favour shallow, sunny spawning waters within meadows, pastures, and arable fields, and in contrast to the yellow-bellied toad, prefer a good growth of underwater vegetation. Typical land habitats are sunny forest edges.

05 Pond in sand pit.

01

01 Dice snake *(Natrix tessellata)*.

02 Viperine snake *(Natrix maura)*.

03 The common frog *(Rana temporaria)* has, in comparison with other brown frogs, a blunt snout and considerably shorter hindlegs. It is very adaptable and can occur in almost any moist and shady habitat.

Speciation by spatial separation

During the ice ages, the populations of many European species were separated into southwestern subpopulations in Mediterranean refuges, and eastern subpopulations in Siberian refuges. This geographic separation led to the development of new, closely related but separate species, as each part of the divided population adapted to the conditions in these ecologically different refuges. (The evolution of new species following the separation of populations by a geophysical barrier is known as **vicariance**). After the ice ages, these "sister species" (or species pairs) re-colonized parts of their former ranges, where they encounter each other today.

Examples are yellow-bellied and fire-bellied toads. The former occurs in parts of Western Europe and western Central Europe, and reaches Greece in the southeast. The range of the fire-bellied toad has its western limit in Central Europe, and extends eastwards to western Russia and the Black Sea. However, in the Czech Republic, Austria, and on the northern Balkan Peninsula, their ranges partly overlap. Here, the two sister species may hybridise. The hybrids share traits of both parents. A second European example involves two water-dwelling snakes: dice snake (east) and viperine snake (southwest).

02

04 The moor frog *(Rana arvalis)* has a short pointed snout. During the breeding season, the males change their colour to grey, blue, and violet. The species prefers completely unshaded waters with well-developed water vegetation and shallow shores. It occurs also in swampy areas.

05 The agile frog *(Rana dalmatina)* is the most "gracile" of the three central European brown frogs. It has very long hindlegs and a relatively pointed snout. When it comes to spawning sites, agile frogs are not very choosy, using woodland ponds, swampy pools, ditches and brooks. Preferred land habitats are deciduous forests with sunny floors.

01

Newts also develop in small permanent waters with aquatic vegetation. The adults spend only the reproductive period from early spring to summer in the water; the rest of the year they live on land.

02

01 The Northern crested newt *(Triturus cristatus)* is an impressively large beast, measuring 14 to 18 cm. During the mating season it is decorated with small white dots, and the male bears a conspicuous, jagged crest.

02 A pair of crested newts on land. The male is on the right. Out of the water its crest has collapsed, but can still be seen.

The double newt

All newts have two distinctly different appearances during the course of the year. During the breeding season, in the water, they are more colourful, especially the males, which develop a crest that runs along their back and tail. These differences in the colour and ornamentation of males and females are known as sexual dimorphism. **Sexual dimorphism** also applies to size, and in many amphibian and reptile species (including the northern crested newt), females are larger than males. However, male common newts tend to be slightly larger than females. On land, outside the mating season, both sexes are duller. The skin becomes water-repellent, and the crest disappears.

03 The alpine newt *(Ichthyosaura alpestris)* is the most colourful European newt. Its belly is bright orange. During the breeding season, the flanks and dorsal crests of the males acquire a leopardskin pattern, and their backs become blue.

04 The alpine newt female also has an orange belly, but is otherwise less spectacular than the male.

01 Female smooth newt *(Lissotriton vulgaris)*.

02 During the breeding season, the male smooth newt develops a serrated crest extending all the way from the head to the tip of the tail.

03 Palmate newts *(Lissotriton helveticus)* grow a thread-like extension at their blunt tail tips during the mating season. This is a male.

04 The female palmate newt's thread-like tail extension is much shorter than the male's.

Some species of frog that breed in permanent waters have a long breeding season, and loud voices too. In Central Europe, the tree frog is the loudest caller in spite of his small stature.

01

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01 Newts and European tree frogs prefer ponds with well-developed shore and water vegetation.

02 The European tree frog is a real acrobat, and the only central European frog which climbs trees and shrubs. The disc-shaped adhesive pads which enable tree frogs to cling to smooth surfaces can be clearly seen here.

03 Small to medium-sized, open waters with shallow, reed or shrub-fringed shores are perfect breeding sites for tree frogs. Forest edges and hedgerows connected with wet meadows are important tree frog habitats.

01

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European green frogs inhabit mostly larger, permanent waters, and spawn throughout the spring and summer. In accordance with their body size, the smallest species, the pool frog, occurs in the smallest pools, and the largest species, the marsh frog, in the largest waters. The edible frog, a hybrid of the pool and marsh frog, is intermediate between its parent species.

Species developing in permanent waters, and with a long breeding period, can overwinter as tadpoles. This can be the case in European green frogs, and is frequent in midwife toads.

03

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Water frogs – the green frog complex

The group of Central European water frogs *(Pelophylax* spp.*)* encompasses two real species – the marsh frog *(P. ridibundus)* and the pool frog *(P. lessonae)* – and their hybrid, the edible frog *(P.* kl. *esculentus)*. Usually, hybrids between two species are either not viable, or are infertile. The edible frog, however, can reproduce successfully. Because of their mostly green colouration, water frogs are also called green frogs.

01 Breeding male pool frogs change their colour to a light yellow-green with a golden lustre, and have golden eyes.

02 An edible frog *(Pelophylax* kl. *esculentus)*. A hybrid between the pool and marsh frog, it is most similar to the pool frog but usually bigger.

03 The scientific name of marsh frogs is *Pelophylax ridibundus*. "Ridibundus" means "laughing" and refers to the staccato courtship calls of this species, which the Greek dramatist Aristophanes rendered "Brekekekex, koax, koax!" in his play, *The Frogs*.

04 Lake with water lilies *(Nymphaea alba)*.

Tender, tasty tadpoles …

Larvae of all amphibian species commonly fall prey to fish, predatory water insects, and leeches.

With the exception of common toads and green frogs, coexistence of tadpoles with fish is only possible when there is enough vegetation to offer hiding places. Tadpoles of common toads protect themselves against fish by giving off a bitter and poisonous glandular secretion (bufotoxin), by exuding a chemical alarm signal (schreckstoff), and by forming swarms. In Europe, the common toad is the only amphibian that occurs regularly in larger waters with fish. When creating waters for other amphibians, it is vital to keep them free of fish under all circumstances.

01 In rare cases male pool frogs become turquoise instead of yellow-green during the mating season.

02 A tree frog tadpole.

03 Standing water in a gravel pit.

European pond terrapins *(Emys orbicularis)* and striped-neck terrapins *(Mauremys caspica)*, are the two European reptile species which are dependent on water, where they hunt insects, tadpoles, small fish, and other prey. They need sun-exposed, sandy sites adjacent to the waters where they can lay and dig in their eggs.

01 Red-eared terrapins *(Trachemys scripta elegans)* are natives of the eastern USA, where they are known as red-eared sliders. These popular pets have been released or escaped into the wild in many parts of the world, and are a common sight in gravel pit lakes and other waters.

02 The European pond terrapin *(Emys orbicularis)* retreated from northern Europe as the climate cooled. Populations in Germany, Denmark and Britain were probably introduced.

03 Mature water body in a mineral extraction site with well-developed reed zone. Woody debris offers good basking opportunities.

Invasive species

Invasive alien species, also called exotics, have been introduced from other parts of the world either accidentally or deliberately. When they manage to establish themselves they can become a threat to native species. Examples in Europe are red-eared terrapins, the American bullfrog *(Lithobates catesbeianus)*, and the African clawed frog. The invasive species can put pressure on native species by eating their larvae and young, or by spreading fatal pathogens to which they are themselves immune (see sidebar page 43).

Owing to the seasonal climate with frequent cold winters, the problem is relatively small in Central Europe. In subtropical or tropical zones, however, invasive species can become real plagues. Examples among amphibians and reptiles include the cane toad *(Bufo marinus)* in Australia, and the Burmese python *(Python bivittatus)*, a giant snake, in Florida. As large predators, both species can massively threaten indigenous animal species. Cane toads were introduced into Australia from South America to reduce numbers of greyback cane beetles, a pest of sugar cane, while the Burmese pythons, natives of South Asia, are descendants of terrarium animals that escaped, or were released into the wilderness by their owners when they grew too large.

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Grass snakes, dice snakes, and viperine snakes are water snakes which hunt for prey mostly in and around ponds, swamps and rivers. Small snakes feed mostly on tadpoles and water insects, while the diet of full-grown specimens consists mainly of frogs and fish. Shallow, vegetated shore zones are important as hunting grounds for all three species. Heaps of decomposing vegetation are used to deposit their eggs.

02

Creation, design, and management of larger waters

Managers of mineral extraction sites can foster amphibians and reptiles by creating larger ponds or lakes. The minimum depth should be 1 to 1.5 meters, to allow for frost-free hibernation at the bottom of the water. The shores should be mostly shallow, and gradually sloping, so that the animals can climb out of the water easily. Ample shallow, seasonal inundation zones, where the water gets warmed up by the sun, are preferred spawning sites of amphibians. Along the shoreline, piles of sand, gravel, and woody debris should be established as hideaways, sunbathing sites, and also as egg-laying sites for reptiles. It is a good idea to make heaps of the reeds and other vegetation cut while doing management work to keep the waters open.

The waters should be sunny, and in most cases no woody plants should be planted. Every couple of years, work to push back the scrub from natural succession should be carried out. Also, as a rule of thumb, no water plants should be introduced; it is better to let nature take care of the spontaneous development of shore and water vegetation.

01 The grass snake is a large and powerful snake by European standards. Females may reach a length of 150 cm, and occasionally up to two metres. Males rarely grow beyond 90-100 cm. A yellow collar behind the head is characteristic and accounts for the alternative name, ringed snake. Grass snakes are widely distributed but need water to hunt in, and are thus most numerous in richly-structured wetlands.

02 Shallow waters like these can provide rich pickings for grass snakes, including tadpoles.

03 The dice snake *(Natrix tesselata)* is a slender snake with a narrow, pointed head. It is often found on stony river banks or in and around lakes with shore vegetation. Its range extends from central and southeast Europe all the way to Kazakhstan and China.

04 Standing waters used by amphibians need to be 1-1.5 metres deep for frost-free hibernation.

Dry semi-natural grasslands on unconsolidated materials

Dry semi-natural grasslands on unconsolidated materials, interspersed with stone and sand piles, are important land habitats for natterjack toads and European green toads. They also offer hideaways for midwife toads that need open areas with soft, sunny soil. Such richly-structured habitats exist in extensively used landscapes, as well as in many quarries and gravel pits. Depending on region and climate, mineral extraction sites are also the homes of sand lizards, common lizards, slow worms, and, more rarely, smooth snakes. In northeastern Europe, common European adders may occur, too, while green lizards may be encountered in more southern regions. Grass snakes and dice snakes use open areas for sunbathing. Apart from sand and stone piles, piles of woody debris should be created as hiding places.

01

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01 Tadpoles of midwife toads *(Alytes obstetricans)* can become very big, especially when they over-winter.

02 The midwife toad is the only central European amphibian which cares for its young. The female passes the fertilised egg strings to the male. He slips them over his hindlegs and carries them around until the tadpoles are ready to hatch, when he takes them to a suitable pool. Because of the long mating period, tadpoles at several different stages of development may be found together. The mating calls of the mid-wife are like the chiming of a little bell.

03 Tracks in the sand.

01 The coloration and patterns of sand lizards are extraordinarily variable. Most have a pattern of leopard-like spots, but some are almost unmarked. Some males are almost entirely green, while in others green is restricted to the flanks. The sexes differ markedly, especially during the mating season, when the green flanks of the male become very vivid.


01


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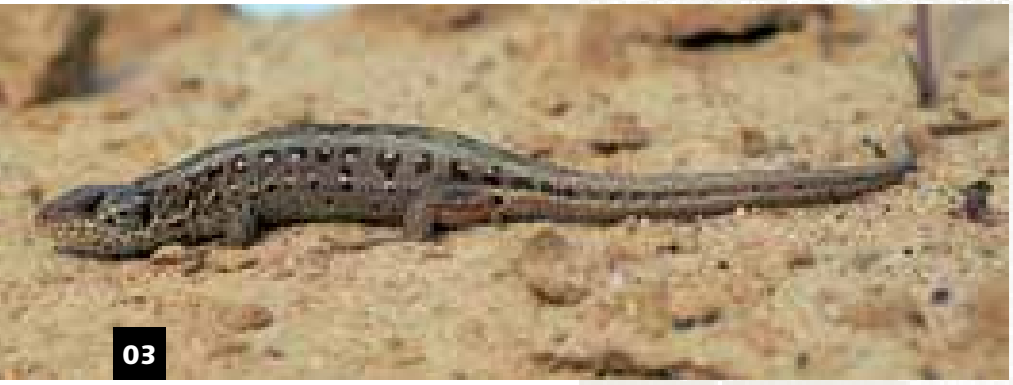

03

02 Sparsely vegetated plains of gravel and unconsolidated materials can be valuable habitats for amphibians and reptiles.

03 Female sand lizards are mostly brown with creamy undersides.

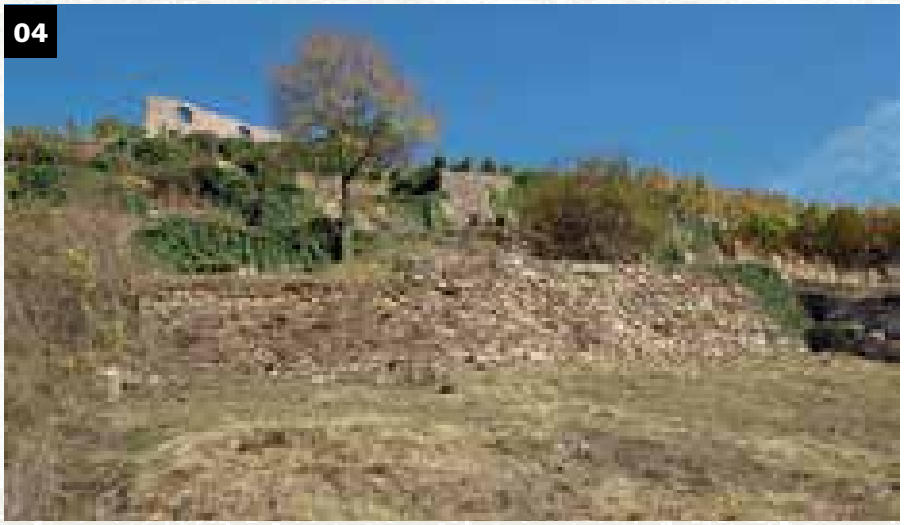
Creation of dry semi-natural grasslands, stone and sand heaps for amphibians and reptiles

Dry semi-natural grasslands are a special type of low-growing meadows which develop exclusively over very nutrient-poor, usually calcareous soils. Where no nutrient-poor unconsolidated soils are present, they can be produced by removing the topsoil. The excavated soil can be used to create a hilly relief. Dry grasslands can be established using the regional, species-rich seed mixes available from specialist suppliers. Less expensive alternatives include covering the surface with hay including seed-heads from nearby nutrient-poor meadows, or allowing spontaneous succession.

Piles of gravel and sand are created permanently during the process of mineral extraction. It is ecologically worthwhile to put them in sunny, remote places close to water or unconsolidated materials. Below-ground layers of stones at least one metre deep are important as frost-free overwintering sites for both amphibians and reptiles.

04 Extensive vineyards with dry stone walls are typical habitats of wall lizards. These days such walls are rarely built, or replaced when they collapse.

05 This mosaic of open and lightly-covered ground at the edge of a gravel pit lake is typical lizard habitat.



01 This chunky male green lizard *(Lacerta bilineata)* is keeping a close watch on its female. The throats of mature males have a blue coloration which in parts of the range extends to the head.

02 Wall lizards are more dependent on stony structures than other central European lizard species. They can find a variety of suitable dry, warm, stony or rocky habitats in mineral extraction sites.

03 The wall lizard is a mostly Mediterranean species which reaches the northernmost edge of its range in Germany. Typical features include the slender, flattened body for navigating cracks and crevices in rocks and walls, and the very long tail.

04 Green lizards are very thermophilic (warmth-loving), and are found on dry, sunny slopes and vineyards with mosaics of dry grassland and taller vegetation.

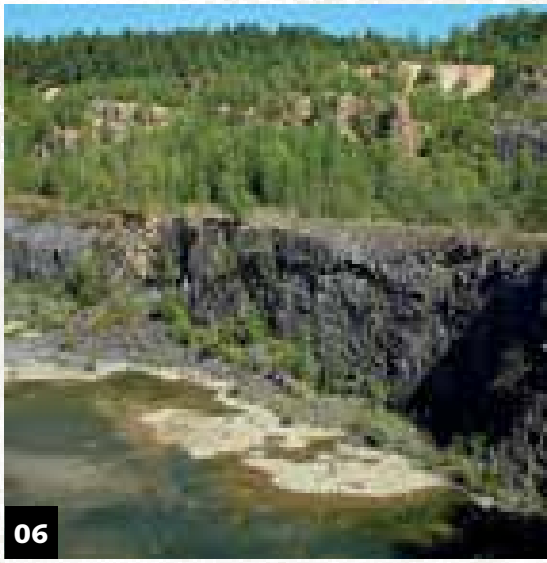
Succession, and how to stop it

Open areas in mineral extraction sites are important for a variety of amphibians and reptiles. However, without human interference, they will become covered with scrub and eventually woodland during the natural process of **succession**. The light-demanding species may linger on for a while, but when woody plant encroachment has reached a critical level, they disappear. In order to stop, or at least slow this process, semi-natural dry grasslands have to be cut or grazed regularly. Unconsolidated materials should be stripped at regular intervals. Piles of sand and stones also lose their function as places for sunbathing when they are shaded by shrubs and trees, and should be kept free of vegetation using chainsaws and brushcutters, or by grazing. Goats are very effective at pushing back scrub.

01 Despite appearances, the slow-worm is no snake, but a limbless lizard. Although it is the most abundant European reptile, relatively little is known about its behaviour, because slowworms lead a largely hidden life. They favour wet meadows, copses and gardens where dense vegetation is close to open basking places.

04

05



06

02 Soils that are poor in nutrients and organic matter develop a specialised vegetation, which can also be found on the asphalt of abandoned roads and parking places.

03 Portrait of a slowworm.

04 The viviparous or common lizard *(Zootoca vivipara)* is both the smallest central European lizard, and the one with the widest range. It extends from northern Spain, France and the British Isles across the whole of Eurasia, all the way to eastern Siberia.

05 The common European adder is a vigorous, compact snake. It lives in heaths, bogs, and forest edges, where hot days can be followed by very cold nights. It can be encountered, though rarely, in mineral extraction sites in the cool mountainous regions of western and northern Europe, and northern and central Asia.

06 Richly-structured quarry habitat, with water, gravel shores, screes, ledges, and forest.

Steep sunny slopes, rock faces and shrubs

Bare or sparsely vegetated steep slopes, rock faces and sunny ledges can provide hunting areas and habitats for common wall lizards, green lizards, smooth snakes, and Aesculapian snakes.


01


02

01 The smooth snake is a slender, rather delicate snake with a maximum length of 60 to 75 cm. Dark brown stripes at the sides of the head, and a dark, heart- or horseshoe-shaped dot on top of its head (hence the generic name *Coronella*, meaning "crowned") are characteristic. It prefers dry, warm, richly-structured habitats.

Creation, maintenance, and design of richly-structured steep slopes

During the process of mineral excavation in quarries, structural richness can be enhanced systematically by creating ledges, swales, and projections. After abandonment, pioneer vegetation and reptiles will colonise these sites.

03

02 Even in active mineral extraction sites, rock walls can be made reptile-friendly by providing horizontal ledges.

03 Unlike the rather uniform adults, young Aesculapian snakes *(Elaphe longissima)* have a high-contrast colouration.

04 The Aesculapian snake is a Mediterranean species, with small relict occurrences at the northern edge of its range in Germany, Austria, and Switzerland.

04

Species protection in quarries and gravel pits

Gravel pits and quarries often offer valuable habitats for a variety of amphibian and reptile species, and may be of high value for the preservation of biodiversity in intensively-used agricultural landscapes.


01

Habitat destruction and environmental pollutants (see sidebar page 43) have led to population declines in many amphibian and reptile species, and too many now feature on national and international Red Lists of threatened species. In Europe, some species are covered by the Habitats Directive of the European Union, and there is a ban on killing them or damaging their habitats. With careful preparation, mineral extraction need not add to the pressures on protected species in the long term. In spite of the loss of individuals during mining activities, the populations of amphibians and reptiles in mineral extraction sites can be stable over long periods of time. Stepwise exploitation of sites continually creates suitable habitats for pioneer species such as the natterjack toad. In areas where strictly protected species occur, CEF (continuous ecological functionality) measures have to be planned and carried out. This means that before their existing habitats are mined or quarried, new habitats of similar size and condition have to be created, which for example can be colonised by amphibians when their old spawning waters are lost. In the case of lizards, the relocation of whole populations may be necessary in order to avoid a violation of the ban on killing. Timing is important. The old habitat area must only be destroyed during times when neither eggs nor young, nor hibernating and immobile animals, are present. In Europe, this usually means the autumn.


02

Natura 2000

The Natura 2000 protected area network was established by the European Union to conserve the most seriously threatened habitats and species across Europe. It consists of **Special Areas of Conservation (SACs)** for specific habitats and species, and **Special Protection Areas (SPAs)** for birds. Many of the amphibian and reptile species treated in this book are listed in Annex II or Annex IV of the Habitats Directive, meaning that core areas of their habitats must be protected, or in the case of Annex IV species, strict protection must apply throughout their natural ranges, both inside and outside Natura 2000 sites.

01 Quarries and gravel pits can host diverse habitats, and an abundance of threatened animals associated with them.

02 Pale madwort *(Alyssum alyssoides)*, a pioneer plant of stony ground including quarries.

03 Sand lizards spend the winter in crevices and holes in the ground. Mining activities should be avoided during that time.

03

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Scientific species name	English species name	FFH-Kategorie	Amberg	Babenhausen	Burglengenfeld	
Amphibians						
Alytes obstetricans	midwife toad	IV				
Bombina bombina	fire-bellied toad	I, IV				
Bombina variegata	yellow-bellied toad	II, IV			x	
Bufo bufo	common toad			x	x	
Bufo calamita	natterjack toad	IV	x	x		
Bufo viridis	European green toad	IV			x	
Hyla arborea	European tree frog	IV	x	x	x	
Pelobates fuscus	garlic toad	IV				
Pelophylax kl. esculentus	edible frog	IV	x	x	x	
Rana arvalis	moor frog	IV				
Rana dalmatina	agile frog	IV			x	
Pelophylax lessonus	pool frog	IV				
Pelophylax ridibundus	marsh frog	V	x		x	
Rana temporaria	common frog	V	x		(x)	
Ichthyosaura alpestris	alpine newt				(x)	
Triturus cristatus	Northern crested newt	II, IV	x			
Lissotriton helveticus	palmate newt					
Lissotriton vulgaris	smooth newt		x	x	x	
Reptiles						
Anguis fragilis	slow-worm				(x)	
Coronella austriaca	smooth snake	IV			(x)	
Lacerta agilis	sand lizard	IV	x	x	x	
Natrix natrix	grass snake		x		x	
Pseudemys scripta elegans	red-eared terrapin			x		
Zootoca vivipara	viviparous lizard				(x)	

European Red List status: none of the species are listed.
(http://ec.europa.eu/environment/nature/conservation/species/redlist/#)

	Durmers-heim	Geseke	Lind-werder	Lang-hagen	Neu-kloster	Rhein-stetten	Schelklingen			
							Sotzen-hausen	Vohen-bronnen	Ger-hausen	Altheim
		x								
				x						
									x	
	x	x	x	x		x	x	(x)		
	x	x	x	x		x		x	x	x
	x				x					
	x		x	x			x	x	x	
	x		x							
	x		x	x	x	x	x	x	x	
			x	x	x					
	x					x				
								x		
	x					x				
	(x)							x		
	x	x					x	x	x	
		x		x				x		
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	x	x	x	x	x		x	x	x	
	x			x	x				x	
	x									
	x		x	x	x	x		x	x	x
	x		x	x	x	x	x		x	
						x				
							x			

x = current sighting, (x) = sighting prior to 2010

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