AMPHIBIANS

INTRODUCTION

Life originated in water. The evolutionary transition from water to land occurred over millions of years. Early land vertebrates are believed to have evolved from fish; their fins developing into limbs. This invasion onto land required modifications of their internal organ systems as well as their skeletal structure. In transitioning to land, an animal had to withstand the effects of gravity, had to be able to breath air, had to minimize water loss and be able to regulate their temperature and also to adjust their senses so they are suited for air instead of water.

Amphibians are ectothermic animals that spend part of their time on land and part in the water. They have glandular skin and are able to breathe through this skin. Despite their adaptations to terrestrial life, they still require cool, moist environments for their eggs and their adult skin. This permeable skin makes amphibians particularly vulnerable to environmental disturbances, from chemical pollution to the thinning ozone layer and global climate change.

I WHAT IS AN AMPHIBIAN?

The word amphibian comes from the Greek *amphi* and *bios*, meaning double life, that is, they can live or function on land and in water.

Modern amphibians are divided into three groups:

- Order Gymnophiona, the caecilians. Caecilians look like large earthworms. They are long-bodied, limbless amphibians, with virtually no tails. There are 163 known species of caecilians.
- Order Urodela, the salamanders and newts. Salamanders are generally more terrestrial, and newts are more aquatic. There are about 360 species of newts and salamanders.
- Order Anura, the frogs and toads. Frogs tend to be more active than toads, are found in or near water, have smooth skin, long hind legs, and fully webbed feet. Toads tend to be less active, prefer to live on land, have dry, warty skin, short legs, and little or no webbing on their feet. There are approximately 3500 species of frogs and toads.

Certain characteristics distinguish amphibians from other vertebrates:

- Like reptiles and fish, amphibians are ectothermic or poikilothermic.
- Amphibians have a naked skin, lacking hair, feathers, and surface scales.
- Amphibians have four methods of breathing.

II PHYSICAL CHARACTERISTICS

A Skin

The skin of amphibians serves many purposes:

- It serves as a respiratory membrane.
- It protects against abrasions and parasites.
- It absorbs and releases water (unlike a reptile, their skin is not watertight).
- It has poisons in the skin that help protect against predators.
- Its colors and patterns in many species offer camouflage and warn away predators.

B Breathing

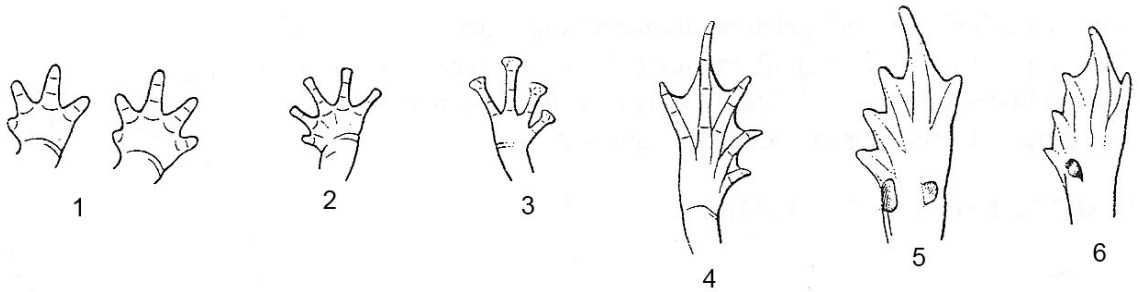
Amphibians are capable of breathing in four different ways.

- Larval amphibians breathe primarily with gills. The gills are usually lost when larvae become adults. Some amphibians, like the mudpuppy that remains aquatic throughout its life, will not lose its gills.
- Lungs serve dual purposes in most amphibians. They function in breathing and help in control of buoyancy. By changing the amount of air in their lungs, amphibians increase their ability to sink or to float.
- Amphibians can breathe through their skin. It was found that in the lungless dusky salamander, 85% of the time the breathing took place through the skin.
- The throat pulsation of amphibians is a type of breathing called buccopharyngeal respiration. Although this type of breathing is still being studied, it is believed that the amount to which this respiration is used may vary with temperature. In the spotted salamander, buccopharyngeal pulsation increased at higher temperatures.

C Limbs and Locomotion

As with other vertebrates, the length of the limbs of amphibians predicts the probable mode of locomotion. Species with long hindlimbs, like frogs, are generally jumpers or swimmers. Species with short hindlimbs, like toads, walk, run, or hop. Species that walk or burrow, like the salamanders and caecilians, are stout bodied and short limbed.

The feet of amphibians vary with size, skin, and webbing.



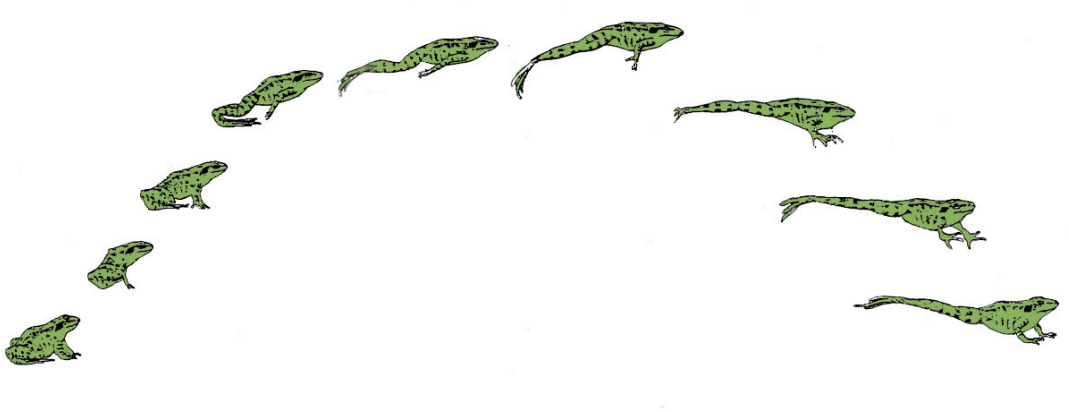
(1) The typical amphibian tow arrangement, four toes on the front feet and five on the hind feet. (2) The long toes with squarish tips of a climbing salamander. (3) Toe pads of a hylid frog, an adaptation for climbing and clinging. (4) Hind foot of a ranid frog showing extensive webbing. (5) Underside of the hind foot of a toad showing horny tubercles that reduces abrasion. (6) The sharp-edged black horny spade of spadefoot toads in burrowing.

Caecilians are legless and except for a few completely aquatic species, live in burrows. Aquatic caecilians swim like a fish, with side-to-side movements. Terrestrial caecilians move by an alternating fold -and-extension progression in which only the vertebral column bends, similar to the movement of earthworms.

Toads have shorter hindlimbs than frogs and tend to walk or hop to get from place to place.

Newts and salamanders usually move slowly. They walk or crawl on land, underground, in the trees, or on the bottom of ponds. Their legs move in an alternate and opposite pattern, which means salamanders lift and move the front foot of one side of their body forward at the same time as the hind foot of the other side of their body.

With their elongated hind legs, frogs swim with simultaneous thrusts of the legs. On land frogs leap with their powerful hind limbs and land on their forelimbs. Frogs that live in trees have sticky toe pads to help them with climbing.



D Senses

1 Smell

The olfactory sense is well developed in most amphibians, but it is best-developed in burrowing toads, newts, certain salamanders, and caecilians. Salamanders use their sense of smell for courtship, for finding and recognizing mates, in egg-clutch recognition, and in the detection of territorial boundaries. The females of Red-backed salamanders will smell a male's territory and his feces to determine if he would be a good mate. The male's feces have the odors of his consumed prey. Newts have an elaborate courtship behavior. Males release chemicals called pheromones from the cloacal gland at the base of their tail. The male will use their tail to waft these secretions toward the females who will pick up the male's scent.

2 Sight

The life cycle of many amphibians requires them to see underwater and on land. Amphibians focus their eyes by a change of position of the lens, rather than by a change in the shape of the lens in reptiles, birds, and mammals. Amphibians that

have gone through metamorphosis, larval salamanders, and a few tadpoles, rely on their sense of vision when finding prey. The movement of prey is necessary to trigger the feeding response. They have a nictitating membrane, which allows them to protect their eyes without obstructing their vision.

3 Hearing

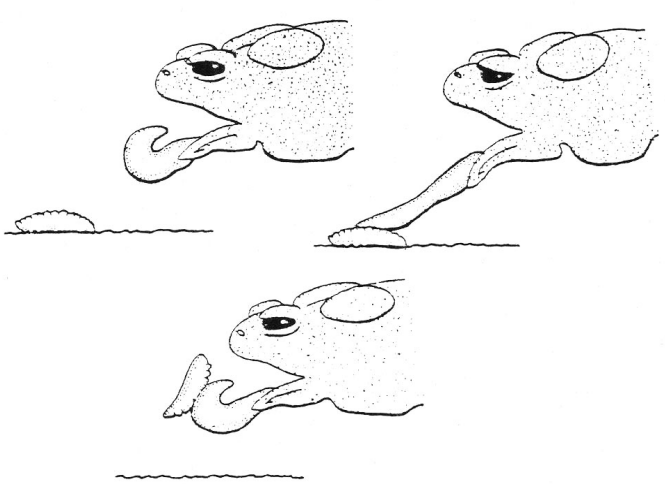
Toads and frogs are very vocal animals. They were the first animals to develop true vocal chords. Salamanders, caecilians, and amphibian larvae have no vocal abilities and therefore, are assumed not to hear very well. Toads and frogs have well developed ears, which are noticeable in many species. In toads and frogs, hearing is used to recognize different species vocal signals. These signals are used to establish territories and in attracting mates.

In Bullfrogs, the eardrum is much larger in males than in females

E Feeding Habits

Most amphibians will eat almost any live food that they can manage to swallow. Insects, spiders, snails, slugs and earthworms form the main part of the diet for most adult amphibians. Larger species, like the ornate horned frog, will take larger prey, e.g., a mouse. Some species are cannibals; e.g., a frog eats another frog. There are also specialist feeders, e.g., some smaller frogs and toads eat only ants and termites, and one species of Brazilian tree frog eats only berries. Aquatic amphibians like the African clawed toad, tend to hang out just below the water's surface waiting for tadpoles or small fish to swim by. All amphibians will gorge themselves if food is plentiful, to enable them to survive when food is scarce.

Frogs are more active feeders than toads and will not often sit and wait for their prey – “see-it-and-seize-it” is their strategy. Frogs tend to go after fast-moving insects, like flies, crickets, and grasshoppers. Toads tend to eat slow-moving insects, like wriggling mealworms or earthworms. Their sticky tongues are able to quickly pick up the prey.



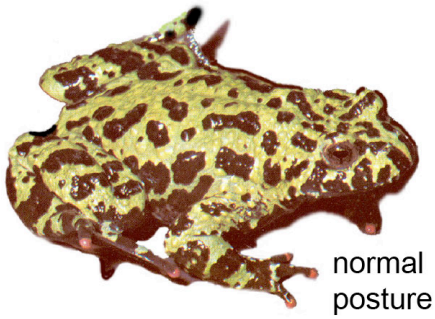
Newts, salamanders, and caecilians tend to eat slow-moving, soft-bodied animals, like earthworms. They approach their prey slowly, then make a quick, last minute grab, often turning their head to one side. They grip the food using teeth in their upper and lower jaw.

F Defense Mechanisms

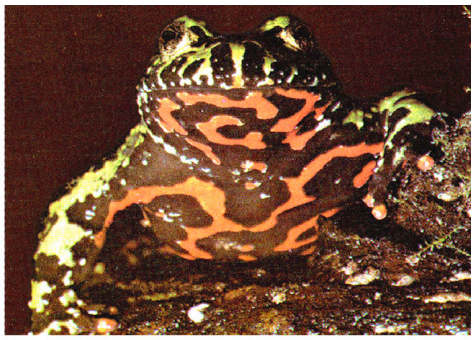
Each year predators eat millions of amphibians. An amphibian’s main defense mechanisms are camouflage and brightly colored skin they acts as a warning to predators, showing that the amphibians is poisonous. An amphibian’s poison defense is usually a last resort and will only work if a predator tries to eat it. Many newts and salamanders use mimicry to defend themselves.

- The non-poisonous, Orange-brown yellow-eyed salamander is a mimic of the highly poisonous California newt. It resembles the newt in dorsal coloration and has the newt’s yellow eye color.

- The colorful Fire-bellied toads usually rely on their excellent camouflage to stay hidden from predators. If the toad is cornered and there is no chance to escape, the toad goes into a defensive posture - arching its back and showing the bright warning colors of its hands, feet, and belly.



normal posture



red markings

Bombina orientalis
Color images from
Encylopedia of Reptiles and Amphibians
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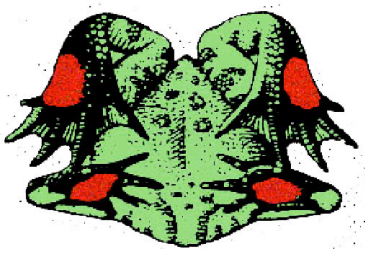


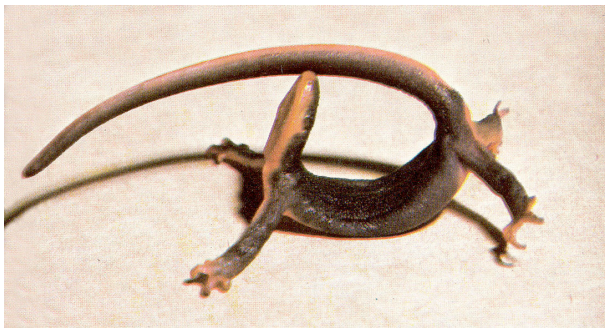
defense posture

- True toads, like marine toads, have an enlarged paratoid, or poison gland behind each eye. If a toad is threatened by a predator, a poisonous, milky secretion oozes from the gland's pores. If the predator gets the poison in its eyes or mouth, it suffers a burning sensation and muscle spasms, causing irregular heartbeats and breathing difficulties.

- The Chilean four-eyed frog has a pair of glandular eyespot markings above its hind legs, which are usually covered by the thighs when the frog is at rest. If the frog is threatened, it will suddenly expose the eyespots - enough to startle almost any predator. The "eyespot surprise" is backed up by a foul-tasting poison secreted from the glands.

- The Italian spectacled salamander uses two displays to avoid its enemies. It either plays dead or curls its tail forward to show the bright red underside of its tail. This display is usually followed by oozing of foul-tasting secretions from glands on the skin's surface.

The defense mechanism of the Italian spectacled salamander
(This is also the defense mechanism of the local California newt *Taricha torosa*
and the Red-bellied newt ***T. granulose)***
The Audubon Field Guide to North American Reptiles & Amphibians © 1979
by John L. Behler, plate 34



III REPRODUCTION

A Courtship in Newts, Salamanders, and Caecilians

In most newts and salamanders, courtship and mating involves a behavior display by the male for the female. The male has to find a mate of the same species and guide the female over a spermatophore (small sperm packet), which he deposits on the ground or in a pond. Fertilization is internal - the female picks up the sperm packet with her cloaca. In primitive salamanders, like the Hellbender *Cryptobranchus alleganiensis*, the female lays her eggs first and then the male deposits his sperm over them. Caecilians have a special kind of internal fertilization in which the male inserts the end of his cloaca into the female's cloaca.

The Audubon Field Guide to North American Reptiles & Amphibians
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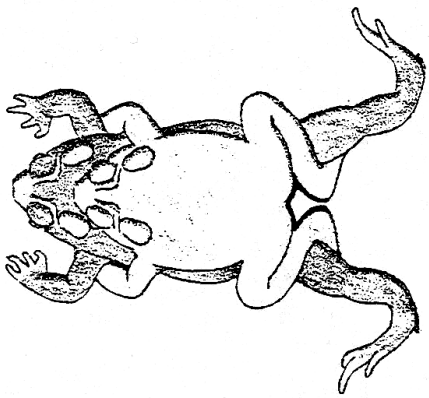
B Mating in Frogs and Toads

In most species of frogs and toads, the male has a distinctive mating call to attract the females of the same species. Sometimes the mating call must carry over a large distance, so they can be very loud. Once a suitable spawning ground has been found, then egg laying begins. Amplexus, the mating embrace, places the male in the correct position for fertilizing the female's eggs. Many male toads and frogs have nuptial pads, patches of rough skin on the thumbs to help hold onto the slippery female during mating. Fertilization usually happens as the eggs are laid.

- Eurasian common toads often begin their amplexus out of water. The larger female then caries the smaller male to the breeding pond. Egg laying and fertilization are delayed until they are in the water.



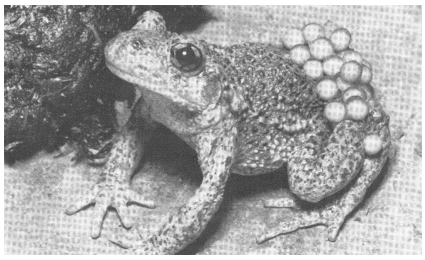
C Egg Laying and Parental Care

Not all amphibians lay large numbers of eggs in water and then leave them to hatch as free-swimming tadpoles. Many amphibians are attentive parents. The amount of parental care an amphibian gives is related to number and size of eggs produced. Fewer, larger eggs receive more care; many small eggs receive less care. The kind of care ranges from choosing a sheltered egg-laying site to enclosing the eggs in protective foam, to actually guarding the eggs. Some amphibians carry their eggs or tadpoles on their backs in shin pockets; others take their eggs inside the body, into a vocal sac or even into the stomach. Two species of caecilians give birth to live young (viviparous).

i. The male Darwin's Frog from Chile watches over its developing clutch of eggs, and when the newly hatched tadpoles start to squirm, takes them into his vocal sac. The tadpoles remain there, receiving some form of nourishment, until they are ejected as tiny froglets.

ii. The male European midwife toad *Alytes obstetricans* from Western Europe carries his string of 35-50 eggs wrapped around his hind legs. After the eggs are laid and fertilized, he keeps hold of the female and moving legs alternately back and forth through the eggs, fastens them securely around his legs. After about three weeks he takes his egg load into the water where the eggs hatch into tadpoles and then complete their development.

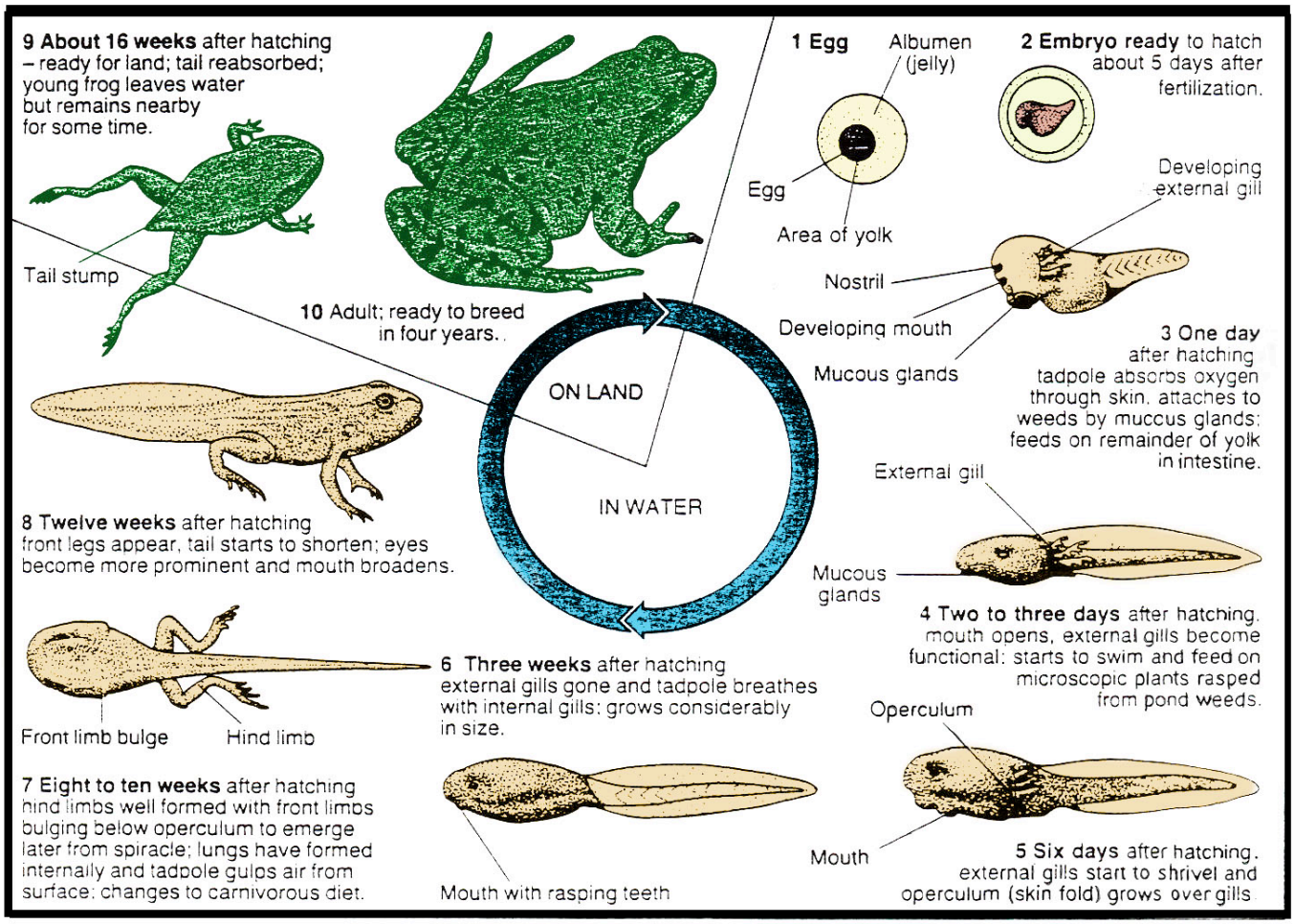
Encyclopedia of Reptiles and Amphibians
© 1974 by John F Breen page 455.
Photos by W. Lierath



iii. The lungless salamanders, found in Costa Rica and Panama, will guard their egg clutch for four to five months. The guarding parents, either the male or female, lies curled around the eggs to protect them from predators. They occasionally turn the eggs to prevent fungal infections.

D Metamorphosis

Metamorphosis means “change of body form and appearance.” Amphibians are the only four-limbed or land vertebrate that go through a change in the larval, or tadpole, state into adult. Amphibian means “to lead a double life.” This change is easier to see in frogs and toads than in other amphibians, since frog and toad larvae look completely different from their parents. The most notable difference is that a tadpole has an all-in-one head and body, a long tail and no legs. A tadpole must live in water to survive. The change from newly hatched tadpole to fully formed adult takes about 12-16 weeks. However, this time span is greatly affected by water temperature and food supply.



Life cycle of the European common frog

IV. Evolution

Amphibians first appeared in the fossil record about 380 million years ago. They most likely evolved from lobe-finned fish; the limbs of these tetrapods (four-legged) evolved from fins. They crawled out of the shallow seas and swallowed gulps of air with primitive lungs, found less competition for food on land and were able to avoid large predatory fish. The disadvantages for coming on land were that the amphibians have gas-permeable skin, which aids their inefficient lungs. This skin must be kept moist. Water is also needed to reproduce. Amphibian jelly-like eggs cannot survive out of water.

Amphibians were the only vertebrate life forms on earth for about 60 million years. They became rare and diminutive as better-adapted reptiles began to take over the land. Previous to this time the insects invaded this land over 400 million years ago and provided a food source for vertebrates to exploit as they moved onto dry land.

V. **Conservation**:

Globally there are more than 1,900 species of frogs, toads and salamanders. 30 percent of these are at risk of dying out, according to International Union for Conservation of Nature's Red List.

There have been dramatic declines in the populations of various amphibians all over the world in the past 10-20 years. It is thought that amphibians serve as a good indicator of the over all environmental health of the planet or the environmental health of individual habitats. Chytridiomycosis is an infectious disease (a fungus) that has been linked to the dramatic population declines or even extinctions of amphibian species.