

grzimek's
Student Animal Life Resource

Amphibians

Volumes 1 - 3



grzimek's

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Amphibians
volume 1

New Zealand frogs to Australian toadlets

Leslie A. Mertz, PhD, and
Catherine Judge Allen, MA, ELS, authors

Madeline S. Harris, project editor
Neil Schlager and Jayne Weisblatt, editors

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Reader's Guide

Grzimek's Student Animal Life Resource: Amphibians offers readers comprehensive and easy-to-use information on Earth's amphibians. Order entries provide an overview of a group of families, and family entries provide an overview of a particular family. Entries are arranged by taxonomy, the science through which living things are classified into related groups. Each entry includes sections on physical characteristics; geographic range; habitat; diet; behavior and reproduction; animals and people; and conservation status. All entries are followed by one or more species accounts with the same information as well as a range map and photo or illustration for each species. Entries conclude with a list of books, periodicals, and Web sites that may be used for further research.

ADDITIONAL FEATURES

Each volume of *Grzimek's Student Animal Life Resource: Amphibians* includes a pronunciation guide for scientific names, a glossary, an overview of amphibians, a list of species in the set by biome, a list of species by geographic location, and an index. The set has 221 full-color maps, photos, and illustrations to enliven the text, and sidebars provide additional facts and related information.

NOTE

Grzimek's Student Animal Life Resource: Amphibians has standardized information in the Conservation Status section. The IUCN Red List provides the world's most comprehensive

inventory of the global conservation status of plants and animals. Using a set of criteria to evaluate extinction risk, the IUCN recognizes the following categories: Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Conservation Dependent, Near Threatened, Least Concern, and Data Deficient. These terms are defined where they are used in the text, but for a complete explanation of each category, visit the IUCN web page at http://www.iucn.org/themes/ssc/redlists/RLcats2001booklet.html.

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Pronunciation Guide for Scientific Names

Acanthixalus spinosus ay-kan-THICK-sal-us spy-NO-sus
Adelotus brevis ay-deh-LO-tus BREH-vis
Adenomus kandianus ay-deh-NO-mus kan-die-AY-nus
Albericus siegfriedi al-BEAR-ih-kus SIG-freed-eye
Alexteroon jynx ay-LEKS-tih-roh-on jinks
Allophryne ruthveni ah-lo-FRYN rooth-VEN-eye
Allophrynidae ah-lo-FRY-nih-dee
Alytes obstetricans ah-LYE-tes ob-STET-trih-kanz
Ambystoma tigrinum am-bih-STOH-ma tih-GRIH-num
Ambystomatidae am-bih-stoh-MA-tih-dee
Amphiuma tridactylum am-fee-U-ma try-DAK-tih-lum
Amphiumidae am-fee-U-mih-dee
Aneides lugubris ay-NEE-ih-deez lu-GU-bris
Ansonia longidigita an-SOH-nee-aye lon-jih-DIJ-ih-ta
Anura ann-UR-uh
Arenophryne rotunda ah-ree-no-FRYN roh-TUN-da
Arthroleptidae ar-throh-LEP-tih-dee
Arthroleptis stenodactylus ar-throh-LEP-tis sten-oh-DAK-tih-lus
Ascaphidae as-KAF-ih-dee
Ascaphus montanus as-KAF-us mon-TAN-us
Assa darlingtoni AY-suh dar-ling-TON-eye
Atelognathus patagonicus ay-teh-log-NAYTH-us pat-ah-GO-nih-kus
Atelopus varius ay-teh-LO-pus var-ee-us
Atelopus vogli ay-teh-LO-pus vohg-lye
Barbourula busuangensis bar-bo-RU-la bus-u-an-JEN-sis

Bolitoglossa pesrubra bo-LYE-toh-glos-sah pes-ROO-bra
Bombina bombina BOM-bin-ah BOM-bin-ah
Bombina orientalis BOM-bin-ah oh-ree-en-TAL-ihs
Bombina variegata BOM-bin-ah vay-ree-GA-ta
Bombinatoridae BOM-bin-ah-TOR-ih-dee
Brachycephalidae brak-ee-sef-FAL-ih-dee
Brachycephalus ephippium brak-ee-SEF-fal-us ee-FIP-ee-um
Brachycephalus nodoterga brak-ee SEF-fal-us no-DOE-tur-ga
Brachycephalus pernix brak-ee-SEF-fal-us PER-nicks
Brachycephalus vertebralis brak-ee-SEF-fal-us ver-teh-BRA-lis
Brachytarsophrys intermedia brak-ee-TAR-so-frys in-tur-ME-dee-uh
Bufo marinus BOO-foe MAYR-ih-nus
Bufo periglenes BOO-foe pair-ee-GLEH-nees
Bufonidae boo-FOH-nih-dee
Bymnophiona bim-no-fee-OH-nuh
Caecilian seh-SILL-ee-uhn
Caeciliidae seh-SILL-ee-eye-dee
Caudata kaw-DAY-tuh
Centrolene geckoideum SEN-troh-lean gek-oh-EYE-dee-um
Centrolenidae sen-troh-LEN-ih-dee
Ceratophrys cornuta seh-RAT-oh-fris kor-NEW-ta
Chioglossa lusitanica chee-oh-GLOSS-ah loo-sih-TAN-ih-ka
Cochranella ignota kok-ran-ELL-ah ihg-NO-ta
Cochranella saxiscandens kok-ran-ELL-ah saks-ee-SKAN-denz
Colostethus caeruleodactylus coh-loh-STETH-us see-RUE-lee-oh-DAK-til-us
Conraua goliath kon-RAH-u-ah go-LYE-eth
Cophixalus riparius co-FIX-ah-lus rih-PAIR-ee-us
Cryptobranchidae KRIP-toe-BRAN-kih-dee
Cryptobranchus alleganiensis krip-toe-BRAN-cus al-lee-GAY-nee-en-sis
Cyclorana platycephala sy-klo-RA-na plat-ee-SEF-fa-la
Cynops pyrrhogaster sy-NOPS pie-roh-GAS-ter
Dendrobatidae den-droh-BA-tih-dee
Dermophis mexicanus der-MO-fis meks-ih-KAN-us
Desmognathus fuscus dez-mog-NATH-us FUS-cus
Dicamptodon tenebrosus di-CAMP-toe-don ten-eh-BROH-sus
Dicamptodontidae di-CAMP-toe-DON-tih-dee
Discoglossidae dis-ko-GLOSS-ih-dee

Discoglossus pictus dis-ko-GLOSS-us PIK-tus
Edalorhina perezi ed-dah-LOR-heena PER-ez-eye
Epicrionops marmoratus eh-pee-KREE-oh-nops mar-moh-RA-tus
Epipedobates tricolor eh-pee-ped-oh-BA-tees tri-KUL-or
Eurycea bislineata u-REE-see-uh bis-LIN-ee-ah-ta
Eurycea rathbuni u-REE-see-uh rath-BUN-eye
Gastrophryne carolinensis GAS-troh-fryn kay-roh-LIN-en-sis
Gastrotheca riobambae gas-troh-THEH-ka ree-oh-BAM-bee
Gymnophiona jim-no-fee-OH-nuh
Heleophryne natalensis heh-lee-oh-FRYN nay-TAL-en-sis
Heleophrynidae heh-lee-oh-FRYN-ih-dee
Hemiphractus proboscideus heh-mee-FRAK-tus proh-BOSS-kid-day-us
Hemisotidae heh-mee-SAW-tih-dee
Hemisus barotseensis heh-MEE-sus bare-aht-SEEN-sis
Hemisus marmatorus heh-MEE-sus mar-mah-TOR-us
Hemisus sudanensis heh-MEE-sus soo-dan-EN-sis
Hyalinobatrachium valerioi high-ah-LIN-oh-bah-TRAK-ee-um vah-LAIR-ree-oh-eye
Hyla leucophyllata HIGH-lah loo-ko-fye-LAT-ta
Hylidae HIGH-lih-dee
Hynobiidae high-no-BEE-eye-dee
Hynobius retardatus high-NO-bee-us ree-tar-DAT-tus
Hyperoliidae high-per-OLE-lee-eye-dee
Hyperolius marginatus high-per-OLE-lee-us mar-jin-AT-tus
Hyperolius marmoratus high-per-OLE-lee-us mar-more-AT-tus
Hyperolius viridiflavus high-per-OLE-lee-us vir-rid-ih-FLA-vus
Ichthyophiidae ik-thee-oh-FYE-eye-dee
Ichthyophis glutinosus ik-thee-OH-fis gloo-tin-OH-sus
Kaloula pulchra kah-LOW-oo-la PULL-kra
Kassina senegalensis kah-see-na sen-ee-gall-EN-sis
Leiopelma hamiltoni lay-oh-PEL-ma ham-il-TO-nye
Leiopelma pakeka lay-oh-PEL-ma pa-KEY-ka
Leiopelmatidae lay-oh-pel-MAH-tih-dee
Lepidobatrachus laevis lep-ee-doh-bah-TRAK-us lay-EH-vis
Leptobrachium banae lep-toh-BRAK-ee-um BAN-nee
Leptodactylidae lep-toh-dak-TIL-ih-dee
Leptodactylus pentadactylus lep-toh-dak-TIL-us pen-ta-DAK-til-us

Limnodynastidae lim-no-dye-NAS-tih-dee
Lithodytes lineatus lih-thoh-DYE-teez lin-ee-AT-tus
Litoria caerulea lih-TOR-ree-uh seh-RU-lee-uh
Mantidactylus liber man-ti-DAK-til-us LEE-ber
Megophryidae me-go-FRY-ih-dee
Megophrys montana me-go-FRIS mon-TAN-ah
Micrixalus phyllophilus my-krik-SAL-us fye-LO-fil-us
Microbatrachella capensis my-kro-bah-trak-ELL-la cap-PEN-sis
Microhyla karunaratnei my-kro-HIGH-la kare-roo-nah-RAT-nee-eye
Microhylidae my-kro-HIGH-lih-dee
Myobatrachidae my-oh-bat-TRAK-ih-dee
Nasikabatrachidae nas-SIK-ka-bat-TRAK-ih-dee
Nasikabatrachus sahyadrensis nas-SIK-ka-bat-TRAK-us sa-HIGH-ah-dren-sis
Necturus maculosus nek-TOO-rus mak-u-LOH-sus
Neobatrachus pictus nee-oh-bat-TRAK-us PIK-tus
Notaden melanoscaphus NO-tah-den mel-an-oh-SKAF-us
Nyctixalus pictus nik-TIK-sal-us PIK-tus
Occidozyga lima ock-sih-DOZE-ih-gah LEE-ma
Onychodactylus japonicus on-ik-oh-DAK-til-us ja-PON-ih-kus
Oreolalax schmidti oh-ree-oh-LA-laks SCHMIDT-eye
Otophryne pyburni oh-toe-FRYN pie-BURN-eye
Parhoplophryne usambarica par-HOP low-fryn u-sam-BAR-ee-ka
Pelobatidae pel-low-BA-tih-dee
Pelodytes punctatus pel-low-DYE-teez punk-TAH-tus
Philautus papillosus fil-LAW-tus pa-pill-OH-sus
Philoria pughi fil-LOW-ree-uh PYU-eye
Phrynomantis bifasciatus fry-no-MAN-tis bi-FAS-see-at-tus
Phyllobates terribilis fye-low-BA-teez ter-rib-BIL-iss
Pipa pipa PIE-pa PIE-pa
Pipidae PIE-pih-dee
Plethodontidae pleth-oh-DON-tih-dee
Pleurodema bufonina PLOOR-oh-dee-ma boo-fo-NEE-na
Proteidae pro-TEE-ih-dee
Proteus anguinus PRO-tee-us AN-gwin-us
Pseudis paradoxa SOO-dis pair-ah-DOKS-sa
Pseudoeurycea bellii soo-doe-yur-EE-see-ah BELL-ee-eye
Rachophorus arboreus rak-OH-for-us ar-bor-EE-us
Rana catesbeiana RAH-nah kat-TEEZ-bee-eye-an-uh

Rana temporaria RAH-nah tem-po-RARE-ee-uh
Ranidae RAH-nee-dee
Ranodon sibiricus RAH-no-don sib-EAR-ee-kus
Rhacophoridae rak-oh-FOR-ih-dee
Rhinatrematidae rye-na-tree-MA-tih-dee
Rhinoderma darwinii rye-no-DER-ma dar-WIN-ee-eye
Rhinodermatidae rye-no-der-MA-tih-dee
Rhinophrynidae rye-no-FRY-nih-dee
Rhinophrynus dorsalis rye-no-FRY-nus DOR-suh-lis
Rhyacotriton cascadae rye-YA-koh-try-ton KAS-kah-dee
Rhyacotritonidae rye-ya-koh-try-TON-nih-dee
Salamandra salamandra sal-a-MAN-dra sal-a-MAN-dra
Salamandridae sal-a-MAN-drih-dee
Scaphiophryne calcarata skaf-FEE-oh-fryn kal-ka-RAT-ta
Scaphiophryne gottlebei skaf-FEE-oh-fryn got-LEB-ee-eye
Scaphiophrynidae skaf-fee-oh-FRYN-nih-dee
Scarthyla goinorum skar-THIGH-la go-in-OR-um
Scolecomorphidae skoh-lee-kom-MOR-fih-dee
Scolecomorphus kirkii skoh-lee-kom-MOR-fus KIRK-ee-eye
Silurana tropicalis sil-u-RA-na trop-ih-KAL-is
Siren intermedia SIGH-ren in-ter-ME-dee-uh
Sirenidae sigh-REN-nih-dee
Sooglossidae soo-GLOSS-sih-dee
Sooglossus sechellensis soo-GLOSS-sus say-shell-EN-sis
Stumpffia helenae STUM-fee-uh hell-LEN-ah-ee
Taudactylus eungellensis taw-DAK-til-us ee-u-jel-LEN-sis
Thoropa miliaris thor-OH-pa mil-ee-AIR-iss
Trichobatrachus robustus try-koh-ba-TRAK-us roh-BUS-tus
Triprion petasatus TRIP-pree-on pet-TAS-sah-tus
Triturus cristatus TRY-ter-us krih-STAT-us
Triturus vulgaris TRY-ter-us vul-GARE-iss
Tylototriton verrucosus tie-LOW-tow-try-tun ver-ruh-KOH-sus
Typhlonectes compressicauda tie-flo-NEK-teez kom-press-sih-KAW-duh
Uraeotyphlus oxyurus u-ray-ee-oh-TIE-flus oks-ee-YUR-us
Uraeotyphylidae u-ray-ee-oh-tie-FIE-lih-dee
Vibrissaphora ailaonica vie-brih-saf-FOR-uh ale-la-ON-nik-ah
Xenopus laevis zee-NA-pus lay-EH-vis



Words to Know

A

Adaptable organism An organism that can adjust to various living conditions.

Ambush A style of hunting in which a predator hides and waits for an unsuspecting prey animal to come to it.

Amphibian A vertebrate that has moist, smooth skin; is cold-blooded, meaning the body temperature is the same as the temperature of the surroundings; and, in most instances, has a two-stage life cycle.

Amplexus In frogs, a mating position in which the male clings to the female's back.

Amphipods Beach fleas, water lice, and other small water-living invertebrates.

Aposematic coloration Warning colors that advertise something about an animal, possibly its bad-tasting, poisonous skin.

Aquatic Living in the water.

Arboreal Living in trees.

Arthropods Insects, spiders, and other invertebrates that have jointed legs.

B

Balancers Structures on the sides of the head of some salamander larvae that support the head until the legs develop.

Barbels Little bits of flesh sometimes seen dangling from the mouth or chin of animals, such as some frogs and fishes.

Bask Sunbathe; often seen in reptiles and amphibians to help warm up their bodies.

Bioindicator species An organism that people can use to tell whether or not the environment is healthy.

Bromeliads Plants of warm, usually tropical, forests that often grow on other plants. Their leaves typically overlap into cup shapes that can hold water.

C

Cannibalistic Describing animals that eat other members of their own species.

Carnivorous Meat-eating.

Cartilage A flexible material in an animal's body that is often associated with bones.

Chorus In male frogs, a group that calls together.

Chromosomes The structures in a cell that hold the DNA.

Cloaca The chamber in some animals that holds waste from the kidneys and intestines, holds eggs or sperm about to be released to the outside, holds sperm entering a female's body, and is the passage through which young are born.

Coniferous forest Land covered with trees that bear their seeds inside cones.

Crepuscular Describing animals that are active only at dawn and at dusk.

Crustaceans Water-dwelling animals that have jointed legs and a hard shell but no backbone.

Cryptic coloration Colors and often patterns on an animal that help it blend into its environment.

Cutaneous respiration Breathing through the skin

D

Deciduous forest Land covered by trees that lose their leaves during cold or dry seasons.

Direct development Process by which frog eggs develop right into froglets and skip the tadpole stage.

Diurnal Active during the day.

DNA A chain of chemical molecules that is the instruction booklet for making a living thing; scientists can tell one species from another by comparing the DNA.

E

Ectothermic Describing animals whose body temperature changes when the outside air warms up or cools down.

Embryo A developing animal that has not yet hatched or been born.

Estivation As seen in some animals, a period of inactivity during dry spells.

Explosive breeders Members of a species that breed together in a large group, usually over a very short time.

F

Fertilization The joining of egg and sperm to start development.

Filter feeder An animal that strains water for bits of food.

Foraging Searching for food.

Fossorial Living underground.

Froglet The life stage of a frog right after the tadpole stage.

G

Gill An organ for obtaining oxygen from water.

Granular glands Poison glands, which in frogs are typically in noticeable bumps, often called "warts," on the back.

H

Herbivorous Plant-eating.

Herpetologist A person who studies amphibians and reptiles.

Hibernation A state of deep sleep that some animals enter in the winter to help them survive the cold weather.

Hybrid Describing the young produced by parents of two different species.

I

Indirect development Process by which frog eggs develop first into tadpoles and then into froglets.

Infertile eggs Eggs that will never develop into young.

Introduced species An animal, plant, or other species that is brought to a new location, usually by humans, either on purpose or by accident.

Invertebrate An animal, such as an insect, spider, or earthworm, without a backbone.

L

Larva (plural, larvae) An animal in an early stage that changes form before becoming an adult.

Lateral line system A row of tiny dot- or stitch-shaped organs, seen in fishes, tadpoles, and some other water-living organisms, that allow the animal to feel vibrations in the water.

M

Marsupium Found in some animals, a pouch in the adult where the young develop.

Metamorphosis The changes in form that some animals make to become adult, such as tadpole to frog.

Microorganisms Living things that are too small to see.

Mimic To copy.

Mollusk An animal with a soft, unsegmented body that may or may not have a shell.

N

Nocturnal Active mostly at night.

Nuptial pads Seen in some frogs, thick pads that form on the forelegs, on the front feet, on the toes of the front feet, and sometimes on the chest to help the male grip onto the female during mating.

O

Ocelli In frogs, small dots of color.

Opportunistic feeder An animal that will eat just about anything that it can capture and swallow.

Ovary The organ that makes eggs.

P

Palate The roof of the mouth.

Paratoid glands In some frogs, a pair of enlarged poison-containing sacs found at the back of the head.

Permanent body of water A body of water that is filled with water year-round.

S

Silt Dirt that is washed from land and collects in rivers and streams.

Sperm Microscopic cells from a male that trigger eggs from a female to start development.

Spicules Seen on the snout of a Mesoamerican burrowing toad, small, hard, sometimes pointy bumps.

Spine Backbone; also known as the vertebral column.

Spiracle In a tadpole, a tiny hole that lets water out.

Sternum A bone in the middle of the chest between the ribs; breastbone.

Symmetrical Describing a pattern that has two sides that are mirror images of one another.

T

Temporary body of water A body of water that is only filled with water for part of the year.

Terrestrial Living on land.

Toxin Poison.

Toxicity The level of poison.

Transparent See-through.

Tubercles Bumps.

Tympanum Eardrum, which in many frogs is visible as a round spot on the side of the head.

U

Utraviolet radiation A type of light that humans cannot see, but that scientists believe may be harming some frog species, especially those that live high in mountains where the radiation is strongest.

Unken reflex Seen in some frogs and salamanders, a stiff backbend pose that serves to warn predators that the animal is bad-tasting or poisonous.

Urostyle A long, rod-shaped bone in the hip area of a frog.

V

Vernal pool A body of water that forms in the spring but then dries up for the rest of the year.

Vertebrae The bones that make up the spinal column.

Vertebrates Animals, such as birds, frogs, snakes, and mammals, with backbones.

Vocal sac Extra flesh on the throat of most male frogs that expands like a balloon when they make their calls.

W

Wart In frogs, a wart is a lump in the skin that contains poison and helps protect the frog from predators. In humans, a wart results from a virus and sometimes requires medical care.



Getting to Know Amphibians

AMPHIBIANS

Three different types of amphibians (am-FIB-ee-uhns) live on Earth today:

- Frogs are the often-slimy creatures almost everyone has seen hopping into a pond or heard calling on a spring evening. The smallest species reach less than one-half an inch (1.3 centimeters) long, while the largest can grow to more than a foot (30.5 centimeters) in length. Frogs are in the order Anura (ann-UR-uh). Toads are included in this order, too. They are simply one kind of frog. Frogs are different from other amphibians because they do not have tails when they are adults. Some frogs, called the tailed frogs, have little taillike bits of tissue, but they are not really tails. Many frogs have long and strong hind legs for hopping, but a few have short hind legs and typically get around by walking or running.
- Salamanders are the four-legged, tailed animals that hikers or gardeners sometimes surprise when they turn over a rock or log. The smallest salamanders are less than 1.2 inches (3 centimeters) long, while the largest can grow to 4 feet 11 inches (150 centimeters) in length, or more. Salamanders have bodies in the shape of a pipe with a tail at the rear. Most have small legs that are all about the same size. They hold their legs out to the side of the body when they are scrambling around on the ground. A few species have only two legs. The name of the salamanders' order is Caudata (kaw-DAY-tuh).

- Caecilians (seh-SILL-ee-uhns) come in many sizes, ranging from just 4.5 inches long to more than 5 feet 3 inches (160 centimeters) in length, but most people have never seen them in the wild. Caecilians look rather like earthworms, even having similar rings around their bodies, but caecilians have many things that earthworms do not, including jaws and teeth. A caecilian's tail is actually quite short, but since it blends into the rest of the body, this can be difficult to see unless the animal is flipped over. The tail in a caecilian begins at the vent, a slitlike opening on its underside. The caecilians are in the order Gymnophiona (jim-no-fee-OH-nuh).

In all, the world holds at least 4,837 species of frogs and toads, 502 of salamanders, and 165 of caecilians. Scientists are still discovering new species, so those numbers grow larger and larger as the years pass.

WHAT MAKES AN AMPHIBIAN AN AMPHIBIAN?

Although frogs, salamanders, and caecilians are usually not mistaken for one another, they still share several features that make them all amphibians.

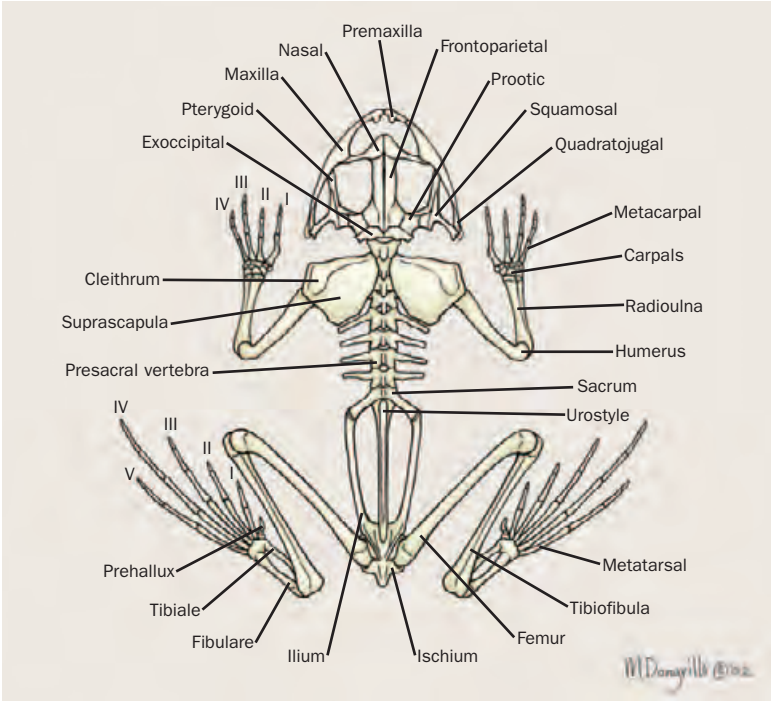


Illustration of a frog skeleton. (Illustration by Marguette Dongvillo. Reproduced by permission.)

Skin

Some people confuse salamanders with lizards, but lizards are reptiles. An easy way to tell an amphibian from a reptile is to check for scales on the skin. Reptiles have scales, but amphibians do not. The skin of an amphibian is at least a little bit moist, even among the rather-dry toads, and some amphibians are very slippery. Part of the slipperiness comes from the moist or wet places they live, and part of it comes from their mucus (MYOO-kus) glands. Mucus glands are little sacks that ooze a slimy substance.

Amphibians also have another type of glands in their skin that ooze poison instead of mucus. Depending on the species, the poison may be weak or very strong. The poison in some of the poison frogs of South America is even powerful enough to kill a person who gets some in his or her bloodstream. In other species, just a little taste of the poison can turn a person's lips numb or cause extreme sickness.

Body temperature

Like fishes and reptiles, amphibians have body temperatures that become colder when the outside temperature is cold and warmer when the outside temperature is hot. Animals with a changing body temperature like this are known as ectothermic (EK-toe-thur-mik) animals. Sometimes, people call ectothermic animals "cold-blooded," but they are really only cold when the weather is also cold. Many amphibians warm themselves by sunbathing, or basking. Frogs frequently sit on shore in damp but sunny spots to bask. They may also simply swim into the warmer, upper layer of water in a pond to heat themselves up a bit. When they get too hot, they typically move to a cooler place, sometimes even going underground. This not only keeps them cooler but also helps them stay moist, which is important for their breathing.

Breathing

Amphibians breathe in several different ways. Like reptiles, birds, and mammals, most amphibians breathe in air through their nostrils to fill up their lungs. Caecilians have two lungs, but the left one is much smaller than the right one. This arrangement works well for the caecilians, which would not have room for two large lungs in their long and thin bodies. Some salamanders have very small lungs, and a few, such as the red-backed

salamander that is common in North American forests, have no lungs at all.

Small or no lungs does not cause a problem for amphibians, however, because they do much of their breathing through their skin. When a person breathes in through the nose, the air travels into the lungs in the chest, where blood picks up the oxygen from the air and delivers it throughout the body. In amphibians, oxygen can pass right through their moist skin and into blood that is waiting in blood vessels just below the skin. The skin must be moist for this process to work: A dry amphibian is a dead amphibian. Using this through-the-skin breathing, which is called cutaneous respiration (kyoo-TAIN-ee-us res-per-AY-shun), amphibians can even breathe underwater. Oxygen that is dissolved in the water can also cross the skin and enter their blood.

Most amphibians go through a phase in their lives when they breathe underwater through gills, just as a fish does. Gill breathing is like cutaneous respiration, because dissolved oxygen in the water is picked up by blood in vessels that are in the gills. Gills are so full of blood vessels that they are typically bright red. Usually an amphibian breathes through gills only when it is young. Frogs, for instance, use gills when they are still tadpoles. A young salamander, which also has gills, is called a larva (LAR-vuh). The plural of larva is larvae (LAR-vee). Some amphibians, however, skip the gill-breathing phase and hatch right from the egg into a lung- and/or skin-breather. Others, however, keep their gills throughout their entire lives. Mudpuppies are examples of a salamander that has gills even as an adult. Since they live in the water, gills work well for them. In a few species, like the eastern newt, the animal goes through several phases: a gill-breathing larva, then a gill-less juvenile, and finally a gilled adult.

Hearing

Besides hearing sounds like humans do, frogs and salamanders can hear vibrations in the ground. When the ground vibrates, the movement travels up their front legs to the shoulder blade and then to a muscle that connects to the ear, so the amphibian can hear it. This type of hearing can be very sensitive. Not only can amphibians hear the footsteps of an approaching predator, like a raccoon, but they can also hear something as slight as an insect digging in the soil.

WHERE AMPHIBIANS LIVE

Amphibians live around the world. The only places where they do not live are in the extremely cold polar regions of the Earth, most of the islands in the ocean, and some desert areas. The three major groups of amphibians—the frogs, the caecilians, and the salamanders—each have their own favorite climates. Caecilians stay in warm, tropical climates and nowhere else. Although frogs live just about anywhere an amphibian can live, the greatest number of species make their homes in the tropics. Salamanders, on the other hand, tend toward cooler areas. Most salamanders live north of the Equator, and many exist in areas that have all four seasons, including a cold winter.

Because amphibians must keep their skin moist, they are always tied to water. That water may be a lake or river, a little puddle, a clammy spot under a log, or even a slightly damp burrow underground.

In the water

Most amphibians live at least part of their lives in the water. Many frogs and salamanders lay their eggs in the water. The frog eggs hatch into tadpoles, and the salamander eggs hatch into larvae. Both the tadpoles and the salamander larvae have gills that they use to breathe underwater. Eventually, the tadpoles turn into baby frogs, and the salamander larvae turn into young salamanders, and both can then leave the water to live on land. Scientists do not have all of the details about caecilians, but they think the typical caecilian lays its eggs on land; the eggs hatch into young that are also called larvae and have gills; and the larvae wriggle into water. The caecilian larvae grow in the water before losing their gills and moving onto land.

Those species that live on land for much of the year and only have their young in the water, often choose small pools that are only filled with water part of the year. Such pools are called temporary pools. Temporary pools, since they dry up later in the year, usually do not contain fish, which often eat amphibian eggs

THE RISE OF THE AMPHIBIANS

The oldest fossil amphibian is about 250 millions years old, but amphibians were around even before that. These animals lived when the Earth had only one large land mass that was surrounded by ocean. That land mass was called Pangaea (pan-JEE-uh). When Pangaea began to break up about 190 million years ago, the amphibians were split up, too. The land masses continued to move around the globe and split up into the continents as they are today. While these movements were taking place, the amphibians were changing and becoming new species. Some had features that made them well-suited to life in certain temperatures or certain areas. Today, the Earth holds thousands of different species.

and young. The only problem with laying eggs in a temporary pool is that the pools sometimes dry up too fast for the eggs to hatch into the tadpoles or larvae and for these to turn into land-living amphibians. When this happens, the young may die.

In each major group of amphibians, some species remain in the water for their entire lives. These are known as fully aquatic (uh-KWOT-ik) animals. The word *aquatic* means that an organism lives in the water, and the word *fully* means that it can always live there. Some caecilians from South America live in the water. Sirens and mudpuppies are types of salamanders that live in the water as eggs, larvae, and adults. As adults, both have bodies that are well-designed for swimming instead of walking on land. They have strong, flattened tails to move swiftly through the water but very tiny legs. The sirens only have two small front legs and have neither back legs nor hip bones.

Many frogs are fully aquatic. The clawed frogs and Surinam toads, for instance, live in just about any kind of freshwater, including swamps, slow streams, and ponds. They have very large and webbed hind feet, which make excellent paddles. One very unusual frog is the hairy frog. Adults of this species live on land most of the year, but the males will stay with the eggs underwater until they hatch. During this time, the male develops "hairs" all over the sides of its body. The hairs are actually thin fringes made of skin. This gives him more skin area and makes it easier for him to breathe. With his "hairs," he is able to stay underwater for days with his eggs without ever coming up for air.

Tadpoles, aquatic larvae, and some aquatic adult amphibians have lateral (LAT-eh-rul) line systems. Fishes have lateral line systems, too. The lateral line system looks like a row of stitch-like marks or dots that runs down each side of the body. Inside each mark or dot are tiny hairs that sway one way or the other with the movements of the water. When another animal swims past or enters the water nearby, the hairs lean and send a message to the amphibian's brain that it is not alone in the water. This helps amphibians to escape predators or, if they eat insects or other water-living prey, to find the next meal.

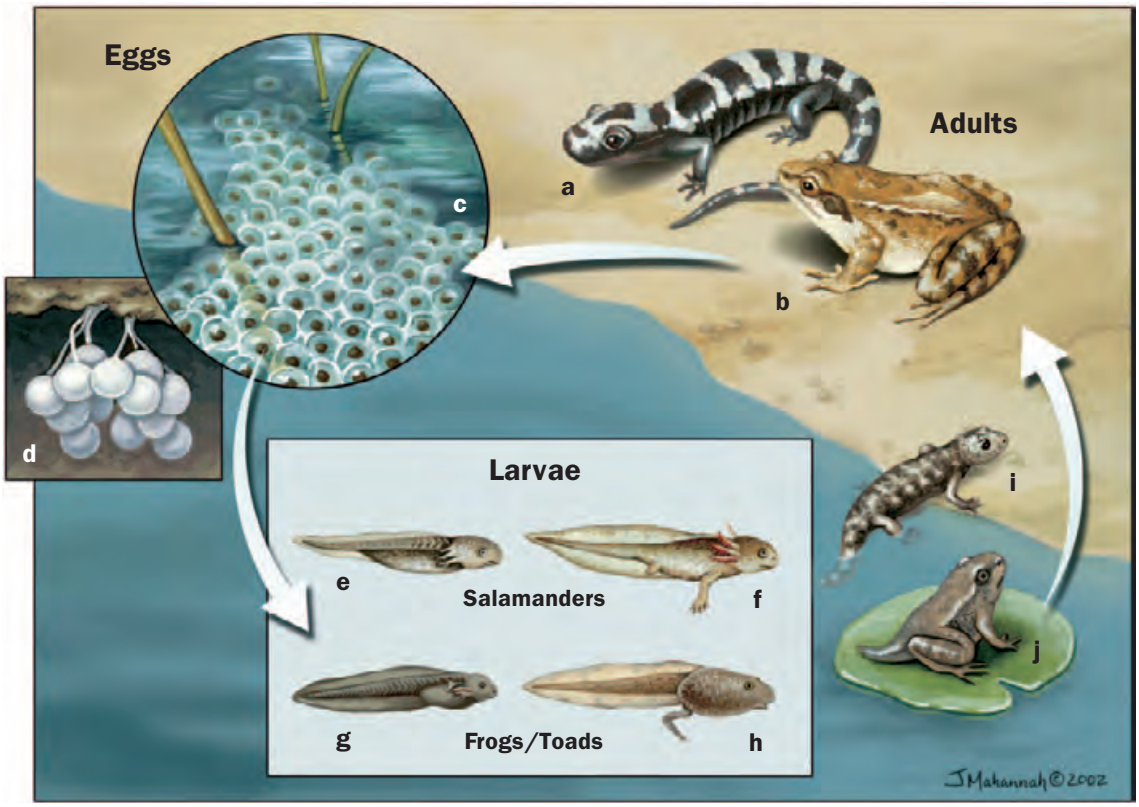
Along the ground

Many adult frogs and salamanders live on land and along the ground. Since they have to keep their skin moist, they often huddle under a rotting log, inside a crack in a rock, in piles of dead leaves, under the low-lying leaves of plants, or in some

other damp place. Once in a while, a caecilian is also found snuggled between a leaf and stem in a low plant. In many cases, amphibians only move about on the ground during or after a heavy rain. Some, like the American toads, can survive under a bit drier conditions than other amphibians and hop or walk around the forest floor even on warm and dry summer days.

Above the ground

Some frogs and salamanders will venture into the trees. Animals that spend part of their lives off the ground and in plants or trees are known as arboreal (ar-BOR-ee-ul) animals. Among the salamanders, only some lungless salamanders are arboreal. One, which is known as the arboreal salamander, may crawl under tree bark or climb into tree holes to escape hot and dry weather. Many more frogs than salamanders are arboreal. Hundreds of these are called treefrogs and have sticky, wide pads on the tips of their toes to help them scramble up plants and trees. Some of the arboreal frogs live in humid forests that are



Life cycle of a salamander (Ambystoma opacum) and frog (Rana temporaria); a. and b.—adults; c.—eggs laid in water; d.——terrestrial salamander eggs laid in a moist area on land; e, f, g, h—larval stage; i and j—juvenile stage. (Illustration by Jacqueline Mahannah. Reproduced by permission.)

moist enough for them to sit out on leaves most of the time. Others need more moisture and find it in bromeliads (broh-MEE-lee-ads), which are plants that often grow on the sides of trees and have tube-shaped leaves that catch rainwater. There, the frogs find tiny pools where they can dip their bodies or float.

Under the soil

Since amphibians need to keep their skin moist, many of them find dampness under the soil. Animals that live underground are called fossorial (faw-SOR-ee-ul) animals. Most of the caecilians remain underground, only coming up to the surface once in a while to feed. They typically have tiny eyes and are nearly blind, although they can tell light from dark. They make their own burrows, digging headfirst into moist soil. Among the salamanders, the best-known burrowers are the mole salamanders. These salamanders, which live through much of North America, usually do not make their own burrows, instead borrowing them from mice and other small rodents. They stay inside these underground hideaways until rains wet the ground. At that time, they climb out and look for food to eat. Many of the mole salamanders, such as the blue-spotted salamander, also may live under rotting logs. The larger spotted salamander sometimes hides under rocks or deep in a damp well.

Numerous frog species, including the spadefoot toads, live underground for much of their lives. They, like many other burrowing frogs, have a hard bump that looks like the edge of a shovel blade on each of their digging feet. Some burrowing frogs do not have hard bumps on their feet. They do, however, have powerful digging legs and usually wide feet to move away the soil as they burrow.

HOW DO AMPHIBIANS MOVE?

Since amphibians may have four legs, two legs, or no legs at all, and they may spend most of their time on the ground, in the water, or in trees, they move in many different ways. Some walk or run; some hop or leap; some swim; some burrow; and some even glide through the air.

Walking and running

The land-living, or terrestrial (te-REH-stree-uhl), salamanders travel from one place to another by walking or running. They do this with their bodies very close to the ground and their up-

per legs held out from the body in the same position that a person takes when starting to do a push-up. Lizards, which people often confuse with salamanders, typically hold their bodies higher off the ground. The arboreal salamanders use these same movements to climb trees. Some frogs, especially those frogs with short hind legs, also get around mainly by walking. The Roraima bush toad is an example. This little toad walks slowly over the rocks where it lives. If it needs to escape quickly, it tucks in its legs so it forms a little ball and rolls off the face of the stone.

Hopping

The frogs and toads are the hoppers and leapers among the amphibians. They have two especially long ankle bones in their hind legs, as well as a long rod of bone in the hip where the jumping muscles attach. These bones give the frog's leaps added boost. They also have a strong but springy chest that can catch the frog safely as it lands on its front feet. Not all frogs and toads hop, but most do. Some, like most of the frogs in the family called true toads, have short hind legs and can only hop a short distance. Others, like most of those in the family called true frogs, have long and powerful hind legs that help them leap several times their body length. Some people even hold frog-leaping contests and bet on the frog they think will jump the farthest.

Swimming

Adult frogs swim much as they leap, shoving off with both hind feet at the same time. The frogs that are the best swimmers typically have large hind feet with webbing stretched between the toes and to the toe tips or close to the tips. Tadpoles do not have any legs until they start to turn into froglets, but they can swim by swishing their tails. Salamander larvae and the aquatic adult salamanders may or may not have tiny legs, but they all use their tails to swim. The aquatic caecilians swim much as snakes do, waving their bodies back and forth in "s" patterns to slither-swim through the water.

Burrowing

Caecilians burrow head-first into the moist soil where they live. Frogs may burrow head-first or hind feet-first. The spadefoot toads are one of the groups of frogs that dig backwards into the soil, scraping through the soil with their back feet while wriggling backward. This buries the frog deeper and deeper into

the soil. The sandhill frog that lives in Australia is one of the frogs that digs head-first by paddling its front feet and making it look as if it is swimming down into the sand.

Gliding

A few of the frog species, including the flying frogs in the family known as the Asian treefrogs, can soar through the air. They do not flap their front legs or have feathers like a bird, but they do have long toes that are separated by webbing that reaches the toe tips. When they widen their toes, the feet look almost like fans. These treefrogs can leap off a tree branch high above the ground and glide safely to earth by using their fan-shaped feet to keep from falling too fast. They are also able to steer by moving their feet one way or the other.

WHAT DO AMPHIBIANS EAT?

Meat eaters

Many amphibians eat meat or are carnivorous (kar-NIH-vor-us). For most of them, their meals are insects, spiders, and other invertebrates (in-VER-teh-brehts), which are animals without backbones. Often, larger species will eat larger prey. Most caecilians eat earthworms, termites, and other invertebrates that live underground. Mexican caecilians, which may grow to 19.7 inches (500 centimeters) in length, sometimes eat other animals, such as small lizards and baby mice that crawl on top of the leaf-covered ground where the caecilians live. Most salamanders eat earthworms or small arthropods (AR-throe-pawds), which are insects and other invertebrates with jointed legs. Adult frogs also usually eat invertebrates, but if they are able to capture a larger prey and swallow it, many will. The bullfrog, which is common in much of North America, will eat anything and nearly everything from other frogs to small snakes, rodents, and even small birds.

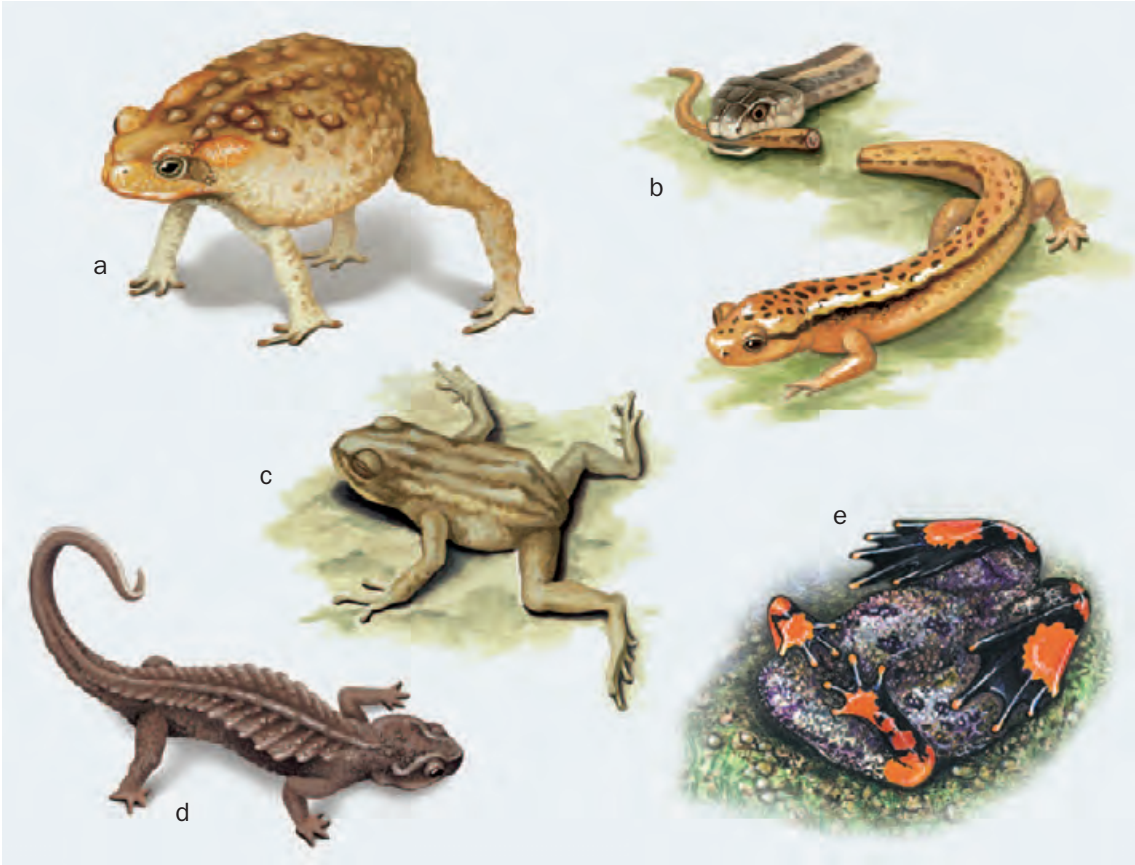
Many amphibians hunt by ambush, which means that they stay very still and wait for a prey animal to happen by. Some amphibians hunt by foraging (FOR-ij-ing), when they crawl, hop, or swim about looking for something to eat. Many amphibians simply snap their mouths around the prey and swallow it. Some flick their tongues out to nab it and then reel their tongues and the prey back into their mouths. Many salamanders have especially long tongues.

Plant eaters

Tadpoles are usually herbivorous (urh-BIH-vor-us), which means that they eat plants. Many have beaklike mouths that scrape algae (AL-jee) and other scum from rocks and underwater plants. Some, like the tadpoles of spadefoot toads, will eat invertebrates in addition to plants.

AMPHIBIANS AS PREY

A wide variety of animals attack and eat amphibians. Birds, snakes, raccoons and other mammals, fishes, and other amphibians are their predators. Even insects, like diving beetles, can kill a tadpole. For most amphibians, the best defense against their predators is to remain still and let their camouflage colors help them stay out of sight. Frogs, in particular, are often the same color as their surroundings. Some, like the horned frogs,



Amphibian behavioral and physiological defense mechanisms; a. Marine toad (Bufo marinus) inflates its lungs and enlarges; b. Two-lined salamander (Eurycea bislineata) displays tail autotomy (tail is able to detach); c. Eleutherodactylus curtipes feigns death; d. Echinotriton andersoni protrudes its ribs; e. Bombina frog displays unken reflex. (Illustration by Jacqueline Mahannah. Reproduced by permission.)

have large and pointy heads that look much like dead leaves. Other amphibians are very brightly colored. The juvenile eastern newt, for example, is bright orange red. This newt also is very poisonous, and its bright colors advertise to predators that they are dangerous to eat.

When numerous amphibians are attacked, they will stiffen their bodies, arch their backs, and hold out their feet. This position is called the unken (OONK-en) reflex. The fire-bellied frogs use this position, which shows off their bright red, yellow, or orange undersides and the similarly colored bottoms of their feet. The colors may remind predators that these frogs have a bad-tasting poison in their skin and convince them to leave the frogs alone.

Although it is not very common, some amphibians will fight back if attacked. Adult African bullfrogs will snap at large predators, even lions or people, who come too close to the frogs or their young. Among salamanders, the large hellbenders can give a painful bite.

REPRODUCTION

In all three groups of amphibians, mating involves both males and females. The females produce the eggs, and the males make a fluid that contains microscopic cells called sperm. An egg will only develop into a baby amphibian if it mixes with sperm. This mixing is called fertilization (FUR-tih-lih-ZAY-shun). In almost all frogs, the male climbs onto the back of the female, and as she lays her eggs, he releases his fluid so that the eggs are fertilized outside. In the caecilians, the male adds his fluid to the eggs while they are still inside the female's body. Salamanders fall in between these two types of fertilization. In most salamanders, the male puts drops of his fluid along the ground, and the female follows along behind to scoop up the droplets and put them inside her body with the eggs. All amphibians either lay their eggs in the water or in a moist place where the eggs will not dry out.

Most amphibian eggs hatch into tadpoles or larvae before becoming miniature versions of the adults. Often, these eggs, tadpoles, and larvae develop in the water. In some species, the adults lay the eggs on land but near water; the eggs hatch into tadpoles or larvae that squirm into the water or scramble onto the parent's back for a ride to the water. A number of species have young that never enter the water. In many of these amphibians,



These aglypto frogs are engaging in a behavior known as "explosive breeding." (Photograph by Harald Schüetz. Reproduced by permission.)

the eggs skip the tadpole or larvae stage and hatch right into miniature adults.

ACTIVITY PERIODS

Amphibians often have certain times of day or times of year when they are active. Some may even enter states of deep sleep for parts of the year when the weather is too cold or too dry.

Day and night

Most amphibians are nocturnal (nahk-TER-nuhl), which means they are active at night. Nocturnal animals hide someplace during the day. Sirens, which are the two-legged salamanders, spend their days buried in mud. Many frogs likewise stay out of sight during the day, sometimes hidden underground, in a rock crevice, or in some other hiding place, and come out at night to look for food or to mate. By being active at night instead of the daytime, these amphibians can avoid many predators that rely on their eyesight to find prey. Nights are also usually more humid than days, so the amphibians can keep their skin moist better if they are only active at night.

Some species are diurnal (die-UR-nuhl), which means that they are active during the day. In many cases, these species have especially poisonous or bad-tasting skin that protects them from daytime predators. Many of the poison frogs of South America, for example, are diurnal. On rainy days, some of the nocturnal amphibians will come out of hiding and wander about. With the wet weather, they can keep their skin moist.

During the seasons

Many species of amphibians are active only during some times of year. Those that live in climates with a cold winter often spend the winter underground or in another sheltered spot and enter a state of deep sleep, called hibernation (high-bur-NAY-shun). The bodies of some species, like the wood frog in the family of true frogs, actually freeze in the winter, but they are able to thaw out the following spring and continue living. Many other cold-climate species become active again when the spring arrives. Salamanders in the northern United States, for instance, start to move about on land even before the snow melts. Frequently, in these species, the spring also is the time for mating.

Besides the cold-weather species, some other amphibians enter a state of deep sleep when the weather becomes too dry. For species that live in deserts or dry grasslands, such as the water-holding frog of Australia, many burrow down into the ground and wait there until the next rainy season arrives. A period of deep sleep during a dry period is known as estivation (es-tih-VAY-shun). In these species, the rainy season marks the beginning of the mating period.

Amphibians that live in warm and wet tropical areas usually are active all year long, but they often mate only on rainy days.

AMPHIBIANS AND PEOPLE

Of all the amphibians, frogs are the most familiar to people. Nearly everyone has seen a frog or heard one calling during its mating season. Because neither salamanders nor caecilians have mating calls, and both usually stay out of sight during the day, many people have seen few, if any, of these two types of animals. Frogs are also much more common pets than salamanders or caecilians. In addition, many people eat frogs and some even eat tadpoles, but few people eat caecilians or salamanders.

Scientists are interested in amphibians for many reasons. In some species, their skin poisons or other chemical com-

pounds have been made into or studied as medicines. Scientists also use amphibians to learn how their bodies work and therefore learn more about how human bodies function. Perhaps most importantly, ecologists see amphibians as living alert systems. Since amphibians live on land and in the water, and often are very sensitive to changes in the environment, they are excellent alarms that can warn humans about problems, such as water or air pollution.

EXTRA LEGS?

In 1995, a group of students at the Minnesota New Country School were outside hiking when they found frogs with odd legs, including extra feet. In all, half of the frogs they saw had some type of deformity. After this discovery, many other people began reporting other deformed frogs. Scientists immediately started tests and experiments to learn why the frogs were deformed. Today, many believe the deformities were the result of disease, pollution, and/or some of the sun's rays, called UV radiation.

ENDANGERED AMPHIBIANS

Through the World Conservation Union, which goes by the initials IUCN, scientists keep track of how well amphibians, along with other organisms, are surviving on Earth. They separate the species into different categories based on the number of individuals in the species and anything that might make them lose or gain numbers in the future. One of the categories the IUCN uses is called Data Deficient. This category means that scientists do not have enough information to make a judgment about the threat of extinction. The number of amphibians listed as Data Deficient is quite large: 1,165 species of frogs, 62 species of salamanders, and 111 caecilians. Many of these species are rare and/or live underground or in some other hard-to-reach location where they are difficult to study.

Amphibians in danger

The IUCN lists 367 species of frogs and forty-seven species of salamanders as Critically Endangered and facing an extremely high risk of extinction in the wild; 623 frog species, 106 salamanders, and one caecilian are Endangered and facing a very high risk of extinction in the wild; 544 frogs, 86 salamander species, and three caecilians are Vulnerable and facing a high risk of extinction in the wild; and 302 frogs and fifty-nine salamanders are Near Threatened and at risk of becoming threatened with extinction in the future.

Many of these species are at risk because the places where they live or breed are disappearing or changing, perhaps as



Amphibian morphological defense mechanisms; a. Darwin's frog (Rhinoderma darwinii) uses camouflage and cryptic structure; b. Pseudotriton ruber and Notophthalmus viridescens display mimicry; c. Bufo americanus has poison parotid glands; d. Poison dart frog (Dendrobates pumilio) has warning coloration; e. Physalaemus nattereri has eye spots on its hind quarters. (Illustration by Jacqueline Mahannah. Reproduced by permission.)

people cut down trees for lumber or otherwise clear the land to put in farms, homes, or other buildings. Some of the other problems for amphibians come from air and water pollution, infection with a fungus that is killing amphibians around the world, and global warming. Global warming changes weather patterns, sometimes causing especially dry conditions in some places. Since frogs need to keep their skin moist, especially dry weather can be deadly to them.

Saving endangered amphibians

To help many of the at-risk amphibians, governments, scientific organizations, and other groups are protecting some of the areas where the animals live. These may be national parks, preserves, or other natural areas. Many local, state, and national governments have also designed laws to protect the amphibians from being hunted or collected. In a few cases, conserva-

tionists are trying to raise amphibians in captivity and then releasing them into the wild with the hopes that they will survive, breed, and increase the size of the natural populations.

Too late to save

The efforts to protect the Earth's amphibians are important, because many species have already become extinct in recent years. An extinct species is one that is no longer in existence.



Leopard frogs with missing, deformed or extra legs started appearing near St. Albans Bay of Lake Champlain in St. Albans, Vermont. Biologists are not sure if pollution, a parasite, disease, or something else is causing the frogs to develop abnormally. Photograph AP/World Wide Photos. Reproduced by permission.

This includes two species of salamanders and thirty-two species of frogs. In addition, the IUCN lists one frog as Extinct in the Wild, which means that it is no longer alive except in captivity or through the aid of humans.

FOR MORE INFORMATION

Books:

Behler, John. *Simon and Schuster's Guide to Reptiles and Amphibians of the World*. New York: Simon and Schuster, 1989, 1997.

Clarke, Barry. *Amphibian*. New York: Dorling Kindersley, 1993.

Florian, Douglas. *Discovering Frogs*. New York: Charles Scribner's Sons, 1986.

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians (Smithsonian Handbooks)*. New York: Facts On File, 1991.

Harding, J. H. *Amphibians and Reptiles of the Great Lakes Region*. Ann Arbor: The University of Michigan Press Institution Press, 1997.

Lamar, William. *The World's Most Spectacular Reptiles and Amphibians*. Tampa, FL: World Publications, 1997.

Maruska, Edward. *Amphibians: Creatures of the Land and Water*. New York: Franklin Watts, 1994.

Miller, Sara Swan. *Frogs and Toads: The Leggy Leapers*. New York: Franklin Watts, 2000.

O'Shea, Mark, and Tim Halliday. *Smithsonian Handbooks: Reptiles and Amphibians (Smithsonian Handbooks)*. New York: Dorling Kindersley Publishing, 2002.

Periodicals:

Hogan, Dan, and Michele Hogan. "Freaky Frogs: Worldwide Something Weird Is Happening to Frogs." *National Geographic Explorer* (March–April 2004): 10.

Masibay, Kim Y. "Rainforest Frogs: Vanishing Act? Frog Populations Around the World Are Dying Off Mysteriously. Can Scientists Save Them—Before It's Too Late?" *Science World* (March 11, 2002): 12.

Sunquist, Fiona. "The Weird World of Frogs." *National Geographic World* (March 2002): 14.

Walters, Mark Jerome. "Spotting the Smallest Frog: As Hopes Fade for One Species, a Tiny Frog Comes into View." *Animals* (May–June 1997): 8.

Web sites:

"North American Reporting Center for Amphibian Malformations." *National Biological Information Infrastructure*. http://frogweb.nbii.gov/narcam/index.html (accessed on May 15, 2005).

Stoddard, Tim. "Island hoppers: Sri Lankan tree frogs end game of hide-and-seek." *BU Bridge*. http://www.bu.edu/bridge/archive/2002/10-18/frogs.htm (accessed on February 12, 2005).

Trivedi, Bijal P. "Frog Fathers Provide Transport, Piggyback Style." *National Geographic Today*. http://news.nationalgeographic.com/news/2002/08/0807_020807_TVfrogs.html (accessed on February 12, 2005).

"Weird Frog Facts." *Frogland*. http://allaboutfrogs.org/weird/weird.html (accessed on February 12, 2005).

FROGS AND TOADS

Class: Amphibia
Order: Anura
Number of families: 28 families

order

CHAPTER

PHYSICAL CHARACTERISTICS

Like mammals, birds, bony fishes, reptiles, and other amphibians, frogs are vertebrates (VER-teh-brehts). A vertebrate is an animal with a spine, or backbone. Compared with all the other vertebrates, frogs are the only ones that have this combination of features:

- A wide head and large mouth
- Two big, bulging eyes
- A short body with only eight or nine bones in the spine
- Two extra bones in the ankle area that make their long legs even longer
- A long, rod-shaped bone, called a urostyle (YUR-oh-stile) in the hip area
- No tail

Most of the frogs are about 1.5 to 3.0 inches (3.5 to 7.5 centimeters) long from the tip of the snout to the end of the rump. Some are much smaller. The smallest species are the Brazilian two-toed toadlet and the Cuban Iberian rain frog, which only grow to about 0.4 inches (1 centimeter) long. These compare with the unusually large Goliath frog, which can grow to 12.6 inches (32 centimeters) long and weigh 7 pounds (3.25 kilograms).

Depending on the species, the skin on a frog may be smooth, somewhat bumpy, or covered with warts. Although many people think that all warty frogs can be called toads, only those in one family of frogs are true toads. The members of this family typically have chubby bodies, rather short hind legs, and

many warts. What sets them apart from other frogs—even those that are also chubby, warty, and short-legged—is something called a Bidder's organ. A Bidder's organ is a female body part that is found inside a male toad. This tiny organ does not appear to do anything in a healthy male toad, but it does help scientists tell a true toad from all other kinds of frogs.

A great number of frogs are green, brown, gray, and other colors that look much like the background in the place they live. They also have spots, stripes, and other patterns that help them blend into their surroundings. Many of the poison frogs, among others, are not camouflaged. They have bright colors that make them very noticeable.

Most species of frogs lay eggs that hatch into tadpoles. Tadpoles are sometimes described as a sack of guts with a mouth at one end and a tail at the other. Often, the mouth on a tadpole is hard like the beak of a bird and is able to scrape bits of plants off the sides of underwater rocks. Some tadpoles instead have a fleshy mouth. These tadpoles suck in water and strain little bits of food out of it. Including their tails, tadpoles are often as long as or longer than the adult frogs. As the tadpoles change into young frogs, however, the tail slowly becomes shorter and shorter until it is gone.

GEOGRAPHIC RANGE

Frogs live in North, Central, and South America, in Europe and Asia, in Africa, and in Australia. They do not live in extremely cold areas, such as the Arctic, or on many of the islands out in the ocean. The largest number of frog species is in hot and humid tropical areas, but some make their homes in places that have all four seasons, including a cold winter. Frogs usually stay out of very dry areas, but the water-holding frog and a few others are able to survive in dry grasslands and even deserts. The majority of frogs live in valleys, lowlands, or only partway up the sides of mountains. Some, however, survive quite well high above the ground. The Pakistani toad is perhaps the highest-living frog. It makes its mountain home at 16,971 feet (5,238 meters) above sea level in the Himalayas.

HABITAT

The majority of frogs start their lives in the water as eggs, then hatch into tadpoles, which remain in the water until they turn into froglets. At that point, frogs of some species may leave

the water and make their homes on land, while others may stay in the water. Some species are able to survive without ever having to even dip their feet in a puddle. Most of these frogs spend hours everyday underground or in some other moist place.

A number of frog species that live in dry areas, such as grasslands or deserts, stay underground and enter a state of deep sleep, called estivation (es-tih-VAY-shun) for much of the year. There, they wait for the rainy season and then climb back up to the ground to eat and to mate. Other frogs that live in colder places that have a frigid winter find shelter, sometimes also underground, and also enter a state of deep sleep, called hibernation (high-bur-NAY-shun). They remain in hibernation until warmer weather arrives in the spring.

DIET

Most frogs eat mainly plants when they are tadpoles and switch to a diet of mainly insects once they turn into froglets. Some tadpoles also eat little bits of dead animal matter that float down to the bottom of the water, and the tadpoles of a few species will even eat an insect or other invertebrate (in-VER-teh-breht), which is an animal without a backbone. Not all adult frogs will only eat insects. Many of the larger species will gulp down anything they can catch and swallow. Bullfrogs, which are common throughout much of North America, are one type of frog that will almost eat anything that comes within reach, including ducklings and other bullfrogs.

BEHAVIOR AND REPRODUCTION

Like other amphibians, frogs can breathe through their skin, but they can only do so if the skin is moist. Most frogs are active at night, which is when the air is more humid. Humid air helps them keep their skin moist. During the daytime, these frogs sit still in moist places, like under a rotting log, in a muddy place, underground, or in the crack of a rock. Even when frogs are active at night, they spend a good part of the time sitting still. This is how many species hunt. They remain in one place and wait for an insect or other prey animal to wander past, either grasp it with their mouths or flick out their tongues to snatch it, and swallow it whole. Most frogs have sticky tongues that attach in the front of the mouth and flip outward. Some frogs, including the poison frogs, take a more energetic approach to hunting, and hop about looking for their next meals.

FROGS IN DANGER

In the 1990s, scientists noticed that the number of frogs around the world was dropping. Some species were nearly gone, and others were already extinct. They began trying to figure out why and now believe that many things may be to blame, including air and water pollution, habitat destruction, and infection with a fungus, called chytrid (KIT-rid) fungus. They also believe that introduced species are a danger to frogs. People often add fish to streams or ponds without thinking about what will happen to the frogs that use the water, too. In many cases, fish eat frog eggs, tadpoles, and sometimes adult frogs. Just a few fish in a pond may be enough to gobble up every frog egg and tadpole for the whole season. Since most adults only live and breed for a few years, the fishes can quickly wipe out an entire frog population.

Frogs often mate based on the weather. Those that live in warm, humid places may mate any time of year but usually only do so during or after a rainstorm. Frogs that make their homes in colder climates commonly wait until the temperatures warm and the spring rains have come. For species in especially dry areas, the rainy season is the time for mating. The males of almost all frog species call during the mating season. They make the calls by sucking in and letting out air from the vocal sac, which is a piece of balloon-like skin in the throat area. Most frogs, like the spring peeper, have one vocal sac, but some species, including the wood frog, have two. The males of each species have their own calls. The calls not only attract females but sometimes tell other males to stay away and find their own mating places. In a few species, calls may not be enough, and two males may fight. Most fights are little more than wrestling matches, but in some species, like the gladiator frogs, males have sharp spines and often injure one another. In many frog species, the males call together in a group. This type of group calling is called a chorus (KOR-us). In some species, the males all call and mate over a very short time, often within a few days. Frogs that breed over such a short time are called explosive breeders.

To mate in most species, the male scrambles onto the back of a female in a piggyback position called amplexus (am-PLEK-sus) and hangs onto her. As she lays her eggs, he releases a fluid. The fluid contains microscopic cells called sperm that mix with the eggs. This mixing is called fertilization (FUR-tih-lih-ZAY-shun). Once fertilization happens, the eggs begin to develop. The tailed frogs do things a bit differently. The males have "tails," which are actually little bits of flesh they use to add their fluid to the eggs while the eggs are still inside the female's body.

Depending on the species, a frog may lay less than a dozen eggs at a time or more than a thousand. The typical female frog lays her eggs in the water, often in underwater plants, and she

and the male leave the eggs alone to develop on their own. In a few species, one of the parents stays behind to watch over the eggs and sometimes stays to cares for the tadpoles, too. The typical frog egg develops in the water into a tadpole. In some species, the egg develops instead in a moist spot, and in a few species that moist spot is inside a pouch or on the back of one of the parents. A number of the frogs that have their young on land lay eggs that skip the tadpole stage and hatch right into baby frogs. In most frogs, however, the eggs hatch into tadpoles that continue growing in the water. Most tadpoles begin to change into froglets within a month or two, but some remain tadpoles for a year or more. The change from a tadpole to a froglet is called metamorphosis (meh-tuh-MOR-foh-sis). In this amazing process, the tadpole's tail becomes shorter and shorter, tiny legs sprout, and the tadpole begins to take on the shape and color of the adults. Soon a tiny froglet, often still with a little bit of the tail left, takes its first hops.

FROGS AND PEOPLE

Many people greatly enjoy the sound of frogs calling on a spring or summer night. In some places, people even gather together to listen to frog choruses. Some people eat frogs, especially frog legs, and occasionally tadpoles. Frogs are also popular as pets. Perhaps more importantly, some frogs have chemicals in their skin that are helping to treat human medical conditions. In addition, scientists are watching frog populations very closely, because frogs can help them tell whether the environment is healthy. A population that suddenly disappears from a pond, for example, may be a warning sign that the water is polluted.

CONSERVATION STATUS

The World Conservation Union (IUCN) lists thirty-two species that are Extinct, which means that they are no longer in existence; one species that is Extinct in the Wild, which means that it is no longer alive except in captivity or through the aid of humans; 367 species that are Critically Endangered and facing an extremely high risk of extinction in the wild; 623 species that are Endangered and facing a very high risk of extinction in the wild; 544 that are Vulnerable and facing a high risk of extinction in the wild; 302 that are Near Threatened and at risk of becoming threatened with extinction in the future;

and 1,165 that are Data Deficient, which means that scientists do not have enough information to make a judgment about the threat of extinction.

FOR MORE INFORMATION

Books:

Behler, John. *Simon and Schuster's Guide to Reptiles and Amphibians of the World.* New York: Simon and Schuster, Inc., 1989, 1997.

Clarke, Barry. *Amphibian.* New York: Dorling Kindersley, 1993.

Florian, Douglas. *Discovering Frogs*. New York: Charles Scribner's Sons, 1986.

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians (Smithsonian Handbooks).* New York: Facts On File, 1991.

Harding, J. H. *Amphibians and Reptiles of the Great Lakes Region.* Ann Arbor: The University of Michigan Press Institution Press, 1997.

Lamar, William. *The World's Most Spectacular Reptiles and Amphibians.* Tampa, FL: World Publications, 1997.

Maruska, Edward. *Amphibians: Creatures of the Land and Water.* New York: Franklin Watts, 1994.

Miller, Sara Swan. *Frogs and Toads: The Leggy Leapers*. New York: Franklin Watts, 2000.

O'Shea, Mark, and Tim Halliday. *Smithsonian Handbooks: Reptiles and Amphibians (Smithsonian Handbooks).* New York: Dorling Kindersley Publishing, 2002.

Periodicals:

Hogan, Dan, and Michele Hogan. "Freaky Frogs: Worldwide Something Weird Is Happening to Frogs." *National Geographic Explorer* (March–April 2004: 10).

Masibay, Kim Y. "Rainforest Frogs: Vanishing Act?" *Science World* (March 11, 2002): 12.

Sunquist, Fiona. "The Weird World of Frogs." *National Geographic World* (March 2002): 14.

Walters, Mark Jerome. "Spotting the Smallest Frog: As hopes fade for one species, a tiny frog comes into view." *Animals* (May–June 1997): 8.

Web sites:

"Anura Species Database." *LivingUnderworld.org.* http://www.livingunderworld.org/anura/families/ (accessed on May 15, 2005).

Morell, Virginia. "The Fragile World of Frogs." *National Geographic.* http://www.nationalgeographic.com/ngm/0105/feature6/index.html (accessed on February 12, 2005).

"North American Reporting Center for Amphibian Malformations." *National Biological Information Infrastructure.* http://frogweb.nbii.gov/narcam/index.html (accessed on May 15, 2005).

Stoddard, Tim. "Island hoppers: Sri Lankan tree frogs end game of hide-and-seek." *BU Bridge.* http://www.bu.edu/bridge/archive/2002/10-18/frogs.htm (accessed on February 12, 2005).

Trivedi, Bijal P. "Frog Fathers Provide Transport, Piggyback Style." *National Geographic Today.* http://news.nationalgeographic.com/news/2002/08/0807_020807_TVfrogs.html (accessed on February 12, 2005).

NEW ZEALAND FROGS
Leiopelmatidae

Class: Amphibia
Order: Anura
Family: Leiopelmatidae
Number of species: 4 species

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

New Zealand frogs are rather small creatures that have wide heads with large eyes and round pupils, but no showing eardrums. They have little or no webbing between the toes on their front or hind feet. Their four feet also have smooth soles, a feature that sets them apart from similar species living in New Zealand, which have pads or suckers on their feet. New Zealand frogs are usually brown, but some are green or reddish brown. Most have dark brown to black patterns on their legs and backs. Lines of raised bumps on their backs and other small bulges on their bellies, legs, and/or feet hold poison. These bumps are called granular (GRAN-yoo-ler) glands. When a predator bites one of these frogs, the poison in the glands oozes out, which may cause the predator to spit out the frog, and possibly learn to leave the frogs alone in the future, too.

New Zealand frogs grow to 0.8 to 2 inches (2 to 5.1 centimeters) long from the tip of the head to the end of the rump.

GEOGRAPHIC RANGE

Although they share New Zealand with a few other species of frogs, the members of this family are the only frogs that are actually native to New Zealand. Humans introduced, or brought in, the others, which include two species of bell frogs and a brown tree frog. New Zealand frogs live on North, Maud, Great Barrier, and Stephens Islands. Conservationists in 1997 introduced one of the four species to Motuara Island, where it is surviving.

HABITAT

Most New Zealand frogs live in damp, forested areas, where they often hide during the day under rotting logs or loose stones. Some also survive among rocks and shrubs in a misty but almost treeless part of Stephens Island. Of the four species, Hochstetter's frog prefers the wettest environment, often living near streams or other bodies of water.

DIET

These small frogs eat insects and other invertebrates (in-VER-teh-britts), which are animals without backbones, that live in their habitat. Many species of frogs capture their prey by flinging out their long tongues and using them to grasp. New Zealand frogs, on the other hand, cannot stick out their tongues. Instead, a New Zealand frog must quickly lunge at a prey animal and grab it with its mouth.

THREE RECENT EXTINCTIONS

Fossils scattered throughout New Zealand show that it once was home to many frogs—all in the family Leiopelmatidae. These frogs, which have the fitting common name of New Zealand frogs, included three species that lived on the islands until 1,000 to 2,000 years ago, when they became extinct. Today, four species from this family still exist in New Zealand, but they live in very small areas compared to the land the family once called home.

BEHAVIOR AND REPRODUCTION

Most people, including the native people who have lived near them for thousands of years, are completely unaware of these quiet little frogs. New Zealand frogs make almost no noise. They may offer a soft squeak if they are roughly handled or some faint squealing sounds during the mating season. Otherwise, they remain silent and even stop moving if a person or some other possible predator comes close. These behaviors, combined with the frogs' camouflage colors and patterns, hide them from all but the most careful observers. In addition, these frogs are mostly nocturnal (nahk-TER-nuhl), which means that they are active at night. The darkness also helps to hide the frogs from sight.

Sometimes, however, predators are still able to find them. If the frogs have the chance to escape by jumping into the water, they will. They swim by kicking one leg at a time instead of kicking both hind legs together, as other frogs do. If they cannot escape a predator, three of the four species defend themselves by raising up on their four legs so they are as tall as possible and turning their bodies to face the predator. This puts

JURASSIC FROGS

Scientists are especially interested in New Zealand frogs because they have some very primitive features, including extra backbones and muscles that are designed to move tails. Since the frogs have no tails, scientists believe the tail-wagging muscles are left over from long-extinct ancestors of these species. The only other living frogs with these features are frogs of the family Ascaphidae. The extra backbones are also seen in fossils from the first frogs to live on Earth. The fossils date back to about 150 million years ago, which means the frogs shared the planet with dinosaurs.

forward their largest poison glands, those located in long bumps or ridges behind each eye, so that the attacker's first chomp is a mouthful of bad-tasting poison. Hochstetter's frog does not raise up its body as a line of defense, because its poison glands are on its belly not on its back.

During mating season, most species of frogs find one another by either making loud calls, in the case of the males, or responding to those calls, as the females do. Since New Zealand frogs do not call and even lack a real voice box, scientists think that they find each other by their smells instead. The female lays five to 20 eggs, depending on the species. The developing frog is visible inside the see-through egg capsule. Hochstetter's frog lays its eggs at streamside, and the animals go through a short tadpole stage before becoming frogs. The other three species—Archey's, Hamilton's, and Maud Island frogs—all lay their eggs on land, but under rotting logs or in other moist spots. These frogs go through their tadpole stage while still inside the eggs, so the eggs hatch right into tiny frogs. The male in all three of these species stays with the eggs until they hatch, often covering them with his body. He continues to protect newly hatched young by letting them climb onto his back and legs. Male Hochstetter's frogs do not care for their young.

NEW ZEALAND FROGS AND PEOPLE

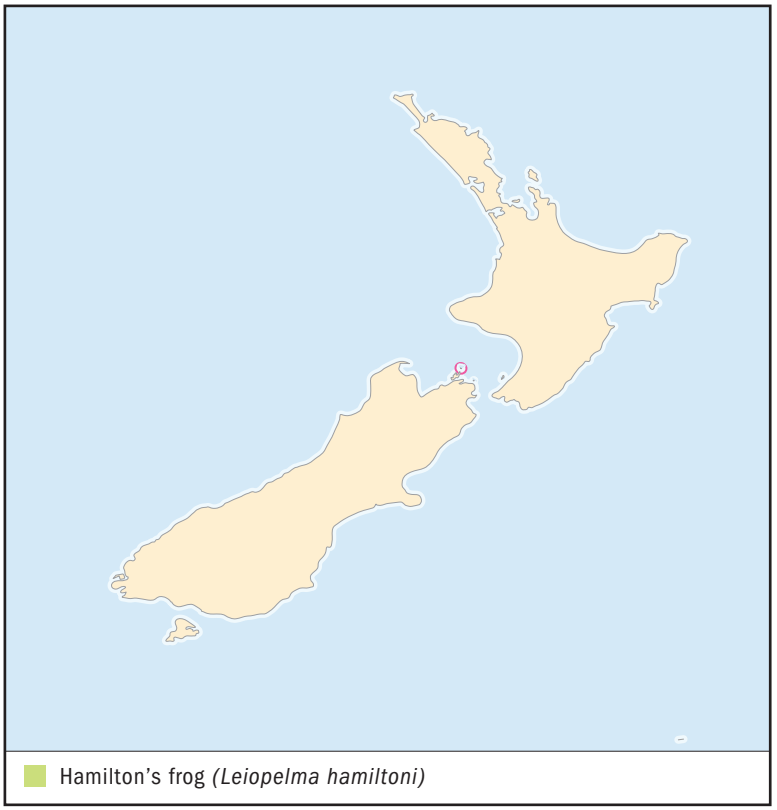
As people have developed the land in New Zealand, these frogs have had to survive in smaller and smaller areas. Strict laws are now in place to protect the frogs and the places they live.

CONSERVATION STATUS

According to the World Conservation Union (IUCN), all four species in this family are in danger. The most at-risk species is Archey's frog, listed as Critically Endangered, which means that it faces an extremely high risk of extinction in the wild. They were once much more common, but when scientists counted them in 1996 and again in 2002, they found that their numbers fell by 80 percent: four out of every five frogs had disap-

peared. In one population, the number of frogs went from 433 individuals to just 53. The cause of the drop was probably disease, possibly caused by a fungus. Scientists first became aware of the fungus, called chytrid (KIH-trid) fungus, in Australia and Central America in 1998 and have since blamed it for the declines of many frog species. They think an introduced species, called the Australian bell frog, brought the fungus to New Zealand and passed it on to Archey's frog in about 1998. The fungus is still a problem. When the fungus infects one of these frogs, it has trouble moving and soon becomes paralyzed.

The IUCN considers Hamilton's frog to be Endangered, which means that it faces a very high risk of extinction in the wild. The remaining two species, Maud Island and Hochstetter's frogs, are Vulnerable and face a high risk of extinction in the wild. The major threats to these species are introduced predators, including rats and ermines, which are in the weasel family, and the lizard-like tuataras. In some cases, conservationists are trying to build barriers around the frogs' habitats so the predators cannot reach them. In addition, scientists are keeping a watchful eye on these three species to see if the chytrid fungus eventually affects them, too.



SPECIES ACCOUNTS

HAMILTON'S FROG
Leiopelma hamiltoni

Physical characteristics: Hamilton's frog is usually light brown with a single dark stripe running along each side of the head and through the eye. It also has a noticeable ridge running from the head down each side of the body. Its feet have no webbing between the toes. The frog grows to 2.0 inches (5.1 centimeters) long from snout to rump. Females are usually a bit larger than males.

Geographic range: One of the rarest frogs in the world, it lives in a tiny area high atop Stephens Island in New Zealand.

Habitat: Although its preferred habitat is likely moist forest, this species now survives in a damp, rocky pile that is covered mostly by grasses and shrubs.



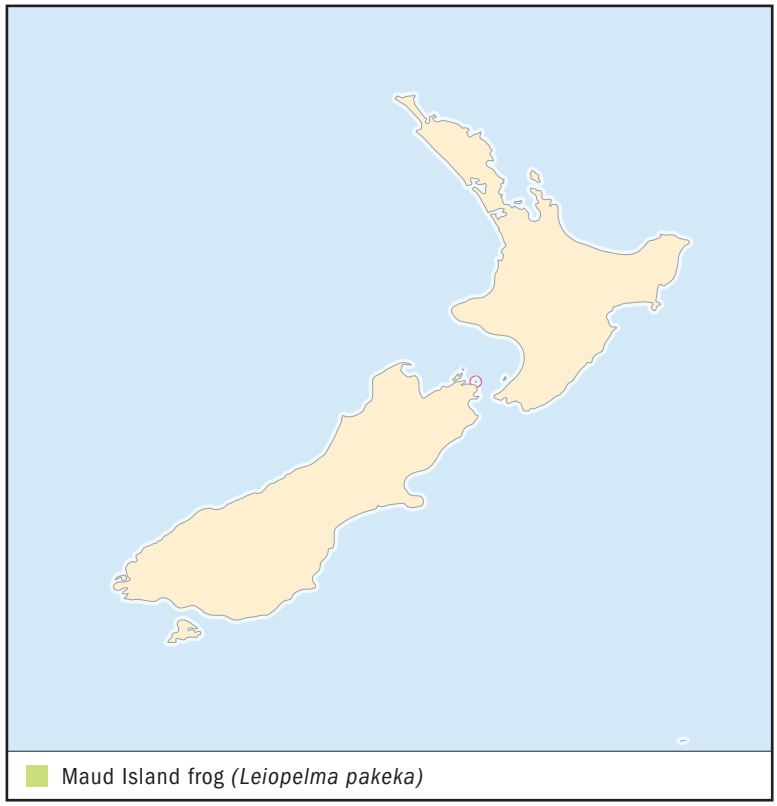
One of the rarest frogs in the world, Hamilton's frog lives in a tiny area high atop Stephens Island in New Zealand. (Illustration by Brian Cressman. Reproduced by permission.)

Diet: Hamilton's frog eats insects and other invertebrates.

Behavior and reproduction: This frog, for the most part, remains out of sight during the day. Like the other New Zealand frogs, it does not call. It can, however, squeak if mishandled. Females lay five to nine eggs at a time on land. Each egg hatches into a tiny frog. The males watch over the eggs and young.

Hamilton's frogs and people: Humans rarely notice this quiet frog.

Conservation status: The IUCN considers Hamilton's frog to be Endangered, which means that it faces a very high risk of extinction in the wild. Protection efforts are under way to protect its small home area and to help it survive into the future. ■



MAUD ISLAND FROG
Leiopelma pakeka

Physical characteristics: The Maud Island frog looks so much like Hamilton's frog that scientists thought they were the same species until 1998. At that time, they compared their DNA and found that the frogs were different enough to be separated into two species. DNA, which is inside the cells of all animals, is a chain of chemical molecules that carry the instructions for creating each species and each individual. When looking at the frogs from the outside, the biggest difference between the two species is their color: the Maud Island frog is paler, but only slightly. They both have unwebbed feet and ridges on the back, and each grows to 2.0 inches (5.1 centimeters) long from snout to rump. Females are a bit larger than males.



In 1997, conservationists gathered 300 Maud Island frogs and transplanted them to Motuara Island, where they seem to be surviving well. (Illustration by Brian Cressman. Reproduced by permission.)

Geographic range: It lives on a tiny scrap of land, measuring just 0.06 miles^2 (0.15 kilometers^2) on Maud Island in New Zealand. In 1997, conservationists gathered 300 individuals and transplanted them to Motuara Island, where the frogs seem to be surviving well.

Habitat: This frog makes its home in the forest that covers the east side of a hill on Maud Island. Although the forest reaches up the hill to about 980 feet (300 meters), the frog tends to live in the lower portion, where the slope is flatter and the climate is more moist. This species often hides among rocks and logs.

Diet: It eats insects it finds in its habitat.

Behavior and reproduction: The Maud Island frog stays out of sight during the day and comes out at night to hop slowly about and look for food. Female Maud Island frogs lay their eggs, which can number up to 20, in damp spots on the forest floor. Each male watches over his eggs until they hatch into tiny frogs. He allows the froglets to climb up his legs and onto his back.

Maud Island frogs and people: Humans rarely see this nighttime frog.

Conservation status: According to the World Conservation Union, the Maud Island frog is Vulnerable, which means that it faces a high risk of extinction in the wild. The current major threat to this species is introduced predators, including rats and ermines. Efforts are under way to keep the predators away from the frogs. Additional efforts proceed to protect and restore the frog's tiny habitat on Maud Island and to introduce the frog to a new area on Motuara Island. ■

FOR MORE INFORMATION

Books:

Grigg, G., R. Shine, and H. Ehmann, eds. *The Biology of Australasian Frogs and Reptiles.* Chipping Norton, Australia: Surrey Beatty and Sons, 1985.

Hutching, Gerard. *The Natural World of New Zealand: An Illustrated Encyclopaedia of New Zealand's Natural Heritage.* Auckland: Penguin, 1998.

Jones, Jenny. *Hamilton's Frog.* Auckland: Heinemann Education, 1994.

Robb, Joan. *New Zealand Amphibians and Reptiles in Color.* Auckland: Collins Publishers, 1980.

Web sites:

Barnett, Shaun. "The Trouble with Frogs." *Forest and Bird Magazines.* http://www.forestandbird.org.nz/magazines/00Feb/frogs.asp (accessed on January 20, 2005).

"Frogs." Christchurch City Libraries. http://library.christchurch.org.nz/Childrens/FactSheets/Animals/Frogs.asp (accessed on January 28, 2005).

Kingsley, Danny. "Ancient Frogs Threatened by Fungus." *ABC Science Online.* http://www.abc.net.au/science/news/enviro/EnviroRepublish_537533.htm (accessed on January 20, 2005).

Lehtenin, R. "Leiopelmatidae." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Leiopelmatidae.html (accessed on January 20, 2005).

"Native Frog Facility to Open at Auckland Zoo." *Scoop.* http://www.scoop.co.nz/mason/stories/AK0410/S00129.htm (accessed on January 20, 2005).

"New Zealand Ecology: Living Fossils." *TerraNature.* http://www.terranature.org/living_fossils.htm (accessed on January 20, 2005).

"Welcome to the New Zealand Frog Survey (NZFS)!" University of Otago. http://www.otago.ac.nz/Zoology/frogs/#nz%20species (accessed on January 20, 2005).

TAILED FROGS
Ascaphidae

Class: Amphibia
Order: Anura
Family: Ascaphidae
Number of species: 2 species

family CHAPTER

PHYSICAL CHARACTERISTICS

The tailed frogs get their name from their "tails," but only the males have them and they are not really tails at all. The tiny nub of a "tail" is really a fleshy structure that the adult male uses to mate with a female. Besides the "tails," the males and females look alike. Both have wide heads and large eyes with vertical, often diamond-shaped pupils. Unlike many other frogs, they have no round patch of an eardrum showing on the sides of the head. The skin of the tailed frog's back is covered with little warts, giving it a grainy look.

The frogs are usually shades of brown or gray, sometimes with a hint of green or red, and have darker markings, including blotches on the back and bands on all four legs. A lighter-colored patch, usually outlined with a thin, dark stripe, stretches between the eyes. Once in a while, a tailed frog may be almost completely black. The underside is pink, sometimes speckled with white. Tailed frogs have slender forelegs with no webbing on the toes and larger hind legs with well-webbed toes. Their toes, especially the outside toe on each foot, are quite wide.

Adult tailed frogs are small, growing only to 1.2 to 2.0 inches (3 to 5 centimeters) long from the tip of the snout to the end of the rump. The females are a bit bigger than the males. The tailed frog tadpole is dark gray and has a large, telltale sucker on the bottom of its broad head. Like other frogs, the tadpole has a long tail. When it begins to change into a frog, the tail shrinks until it disappears altogether. Often, people see an adult male tailed frog and believe that it is just a froglet that still has

some of its tadpole tail left. This is not correct. The fleshy nub on an adult male tailed frog is different from a tadpole tail and never disappears.

Two species of tailed frogs exist: the Rocky Mountain tailed frog and the coastal tailed frog. They look so much alike that scientists thought they were the same species until 2001 when they compared the frogs' DNA. DNA, which is inside the cells of all animals, is a chain of chemical molecules that carry the instructions for creating each species and each individual. In other words, DNA is a chemical instruction manual for "building" a frog. The DNA of the Rocky Mountain tailed frog and the coastal tailed frog were just different enough to separate them into two species.

Both of these frog species have very small lungs, compared to most other frogs, and have extra backbones. Only one other living group of frogs, the New Zealand frogs, has the same extra backbones. Scientists have found fossil frogs far in the past that had the extra bones. These date back to the dinosaur age 150 million years ago and are the oldest known frogs.

GEOGRAPHIC RANGE

Both species live in North America. The coastal tailed frog lives along the Pacific Ocean coastline from northern California in the United States into British Columbia in Canada, but not on Canada's Vancouver Island. The Rocky Mountain tailed frog makes its home in Idaho, western Montana, southeastern Washington, northeastern Oregon, and the most southeastern portion of British Columbia.

HABITAT

These frogs are found in or near clear, rocky, swift-moving streams that flow through forests. When they are in the fast current, they breathe mainly through their skin and do not have to rely on their lungs as much. Human beings get their oxygen by breathing air into the lungs. There, blood picks up the oxygen out of the air and delivers it through blood vessels to the rest of the body. Frogs can get their oxygen from the water. Water, also known as H_2O, is made up of two chemicals: hydrogen and oxygen. (The H_2 means two atoms of hydrogen are in every molecule of water, and the O means one atom of oxygen is in each molecule.) The water runs past the frog, and blood vessels near the surface of its skin take up the oxygen

from the flow. This arrangement allows the frog to survive even though it has very small lungs. On land, the frogs continue to breathe through the skin, which they must keep moist, but they are also able to take up some oxygen from the air through their lungs, as people do.

DIET

Adult tailed frogs eat insects, snails, and other invertebrates (in-VER-teh-brehts), which are animals without backbones, that they find either in the water or on land nearby. Tailed frogs do not have long tongues that flip far out of their mouths to nab prey. Rather, they have short tongues that are of little use for catching passing invertebrates. They are able to capture prey by remaining still and waiting for an insect or other prey animal to come just close enough that the frog can quickly jump out and grab the insect with its mouth. Tadpoles get their food another way. Tadpoles use the strong sucker around the mouth to cling to underwater rocks and avoid being swept away by the current. While they are hanging on, they scrape up and eat bits of algae (AL-jee) with their rows of tiny teeth. Algae are tiny plantlike organisms that live in water and lack true roots, leaves, and stems.

BEHAVIOR AND REPRODUCTION

During the day, adult tailed frogs stay hidden in damp to wet spots under rocks along the streamside. At night, especially during or after a rain, they hop about on land near the stream to look for food. They still must keep their skin moist while they are out of the water, because dry skin prevents them from taking up oxygen from the air. They move about on land by hopping and in the streams by sweeping their strong hind feet as they swim through the water. When in the water, they tend to stay in areas where overhanging trees cast shadows. Newly hatched tadpoles, which are almost see-through compared to the darker, older tadpoles, remain in slower water, often in small side pools where the current is calmer. The larger tadpoles, however, brave the strong current by using their large suckers to attach tightly to rocks.

These small frogs mate in the fall. They do so quietly because male tailed frogs do not call, as the males of most other frog species do. During the breeding season, the males grow black pads on their front feet and small black bumps on their

PIGGYBACK PADS

Many male frogs, including the tailed frogs, have rough pads on the soles of their front feet that they use during mating season. In the case of the tailed frogs, the pads are black, but they can be other colors, too. Called nuptial (NUHP-shul) pads, they help the males grab hold of the female's often slippery body during mating. This grip, in which the male looks as if he is taking a piggyback ride on the female's back, is called amplexus (am-PLEK-sus). Depending on the species, the male may hold onto the female up by her forelegs, a position that is called axial (ACK-see-uhl) amplexus, while the male of other species, including the tailed frog, may hang on in front of her hind legs in a position called inguinal (ING-gwuh-nuhl) amplexus.

forelegs and along their sides. These pads and bumps help the male grab and hang onto the back of a female during mating. As in other frogs, the male tailed frog must add a fluid to the female's eggs so they will develop into tadpoles and frogs. This process is called fertilization (FUR-tih-lih-ZAY-shun). The eggs are actually fertilized by microscopic cells called sperm that float inside the male's fluid. In most frogs, the male adds his sperm-filled fluid to the eggs as the female lays them, so the mixing of the eggs and sperm cells happens outside her body. A male tailed frog, however, fertilizes the eggs differently. He swings his "tail" around, squeezes it into the hole in the female's body that she will use to lay her eggs, and releases the fluid inside her body instead of outside. The female then saves the fluid within her body until she is ready to lay her eggs the next summer. When she does lay them, her eggs are already fertilized. The type of fertilization that happens inside the female's body is called internal (in-TER-nuhl) fertilization. The other type of fertilization, which happens outside the body and is used by most other species of frogs, is called external (eks-TER-nuhl) fertilization.

A female tailed frog can lay 35 to 100 eggs at a time. She lays her eggs underwater, sticking them under rocks and usually in an area of the stream where the current is slower, so the eggs are not swept away downstream. The eggs hatch about six weeks later into small, colorless tadpoles, which soon develop the mouth suction cups and grow into larger, dark-colored tadpoles. They may remain tadpoles for five to seven years before they finally turn into small froglets. They usually switch from tadpole to froglet in the spring or summer. The froglets may need another 3 to 8 years before they are adults themselves. This is unusual. Most other species of frogs go from egg to tadpole to froglet to adult frog in a shorter amount of time, often within a single year. The tailed frogs not only take a much longer time to develop, but they also stick around longer overall. They often live in the wild to the ripe old age of 15 or

20 years, making them some of the longest-living frogs in the world. Through their long lives, tailed frogs remain near the spot in the stream where they were born.

TAILED FROGS AND PEOPLE

People are often not aware of these quiet, little nighttime frogs, and believe they are very rare. However, they are actually quite plentiful in their habitat.

CONSERVATION STATUS

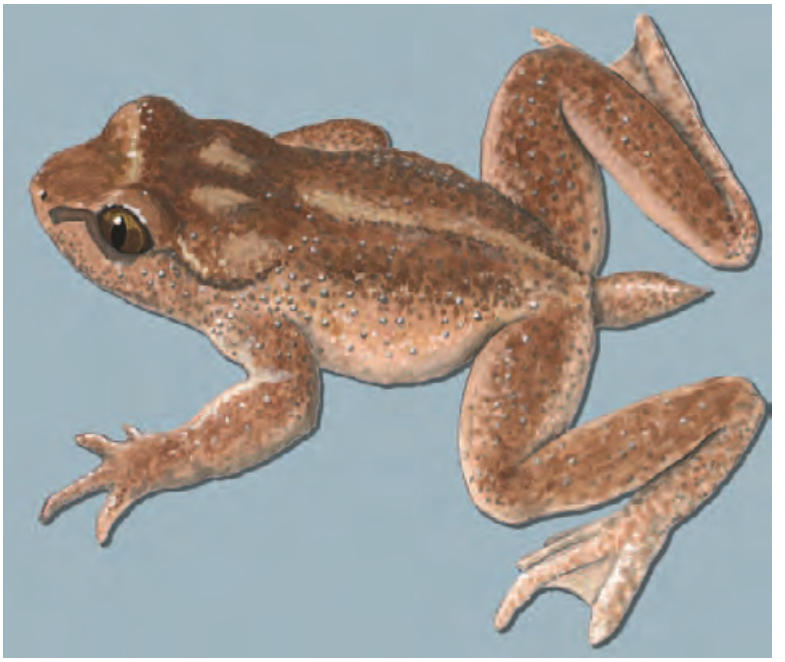
Neither species is considered to be at risk. Conservationists continue to keep watch over the frogs, however, because they must have clean and clear streams to survive. Human activity, such as logging or nearby housing development, can cause dirt and other things to wash into the frogs' streams, making the water too muddy or too polluted for the frogs to survive. Organizations in Canada, in particular, have begun protecting the habitat of this frog.



SPECIES ACCOUNT

ROCKY MOUNTAIN TAILED FROG
Ascaphus montanus

Physical characteristics: The Rocky Mountain tailed frog is a medium-sized brown to brownish black, sometimes gray, frog with tiny black specks. A lighter brown patch spreads between the large eyes, often dipping down toward the rounded snout. Its belly is pink. The male has a small nub of a "tail," which is actually not a real tail at all. It looks almost identical to the coastal tailed frog, except that the Rocky Mountain species has a bit more webbing between the toes of its hind feet and its tadpoles do not have the white-spotted tail tip that many of the coastal species' tadpoles do. Adults of both the Rocky Mountain tailed frog and the coastal species usually grow to 1.2 to 2.0 inches (30 to 50 millimeters) long from snout to rump.



In the wild, Rocky Mountain tailed frogs may live to be 15 to 20 years old. (Illustration by Dan Erickson. Reproduced by permission.)

Geographic range: This species is found in the northwestern United States, including Idaho, Montana, Oregon, and Washington and in British Columbia in Canada.

Habitat: Rocky Mountain tailed frogs live in mountain forests near and often in small, clear, rocky-bottomed streams with fast currents.

Diet: They eat insects and other invertebrates they catch in the water or on land nearby. They look for food at night. Tadpoles are vegetarians and use their small teeth to scrape algae (AL-jee), or microscopic plantlike organisms, off underwater rocks.

Behavior and reproduction: Active mainly at night, they spend their days hidden under rocks along the shoreline. They mate in the fall, and each female lays 45 to 75 eggs in the water the following summer. The eggs hatch into tadpoles, which may remain in that state for up to five years. Finally, the tadpoles turn into froglets, and another seven or eight years later, they are adults. In the wild, the frogs may live to be 15 to 20 years old.

Rocky Mountain tailed frogs and people: Scientists find both species of tailed frogs interesting because they have some features of the earliest known frogs that hopped the Earth at the time of the dinosaurs, and they mate differently from most other frogs alive today.

Conservation status: The Rocky Mountain tailed frog is not considered to be at risk. The Committee on the Status of Endangered Wildlife in Canada, however, lists it as Endangered, which means that it may soon disappear. Organizations in British Columbia have begun protecting the frog's habitat, including land in the Wycliffe Wildlife Corridor in the Kootenay region of British Columbia. ■

FOR MORE INFORMATION

Books:

Corkran, Charlotte. *Amphibians of Oregon, Washington, and British Columbia.* Auburn, WA: Lone Pine Publishing, 1996.

Nussbaum, R. A., E. D. Brodie, and R. M. Storm. *Amphibians and Reptiles of the Pacific Northwest.* Moscow: University of Idaho Press, 1983.

Stebbins, Robert C. *A Field Guide to Western Reptiles and Amphibians (Peterson Field Guide Series).* Boston: Houghton Mifflin, 2003.

Wright, A. H., and A. A. Wright. *Handbook of Frogs and Toads of the United States and Canada.* Ithaca, NY: Comstock, 1949.

Web sites:

"I Only Have Eyes for You." *All About Frogs.* http://allaboutfrogs.org/weird/general/eyes.html (accessed on February 7, 2005).

Mierzwa, Ken. "In Search of Tailed Frogs." *Ken Mierzwa.* http://kmier.net/ecology/tailed.html (accessed on January 31, 2005).

"Rocky Mountain Tailed Frog." *The Land Conservancy.* http://www.conservancy.bc.ca/sectioncontent.php?sectionid=55&pageid=380 (accessed on January 31, 2005).

"Tailed Frog." *Yahooligans Animals.* http://yahooligans.yahoo.com/content/animals/species/4281.html (accessed on January 31, 2005).

Thompson, Don. "Frogs Provide Clues to Calif. Environment." *Kansas City Star* (Monday, November 10, 2003). http://www.kansascity.com/mld/kansascity/news/nation/7227129.htmMon, Nov. 10, 2003 (accessed on February 7, 2005).

family CHAPTER

FIRE-BELLIED TOADS AND BARBOURULAS

Bombinatoridae

Class: Amphibia
Order: Anura
Family: Bombinatoridae
Number of species: 10 species

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

Fire-bellied toads are best known for the striking red, orange, or yellow colors that many species have on their throats, bellies, and even the undersides of the forelegs. They are named for these flame-like colors, which have black or gray spots, blotches, and patterns running through them. When seen from the top, the frogs show no hint of the bright colors underneath, and the brown, gray, and/or green of their backs and heads blend in with the environment. Some have patterns on their backs, but these also camouflage the frog rather than make it more noticeable. The barbourulas are also colored in muddy greens and browns, but they do not have the flashy undersides of the fire-bellied toads.

Members of this family have skin on their backs that is covered with warts and sometimes with pointy warts that look like tiny spikes. The belly skin, in contrast, is much smoother and in most cases has no warts at all. The head has a rounded snout and two large eyes with triangular pupils, and the sides of the head do not have the round eardrums, or tympanums (tim-PAN-umz) seen in many other frogs.

The frogs are small- to medium-sized. Adults grow from 1.6 to 3.9 inches (4 to 10 centimeters) long from the tip of the snout to the rump. Males and females look alike, except that the males have leathery pads on their front feet. The males use these pads to clutch onto the females during the mating season.

Even though the fire-bellied toads and barbourulas are often listed as being in their own family, some people prefer to group

them into another family that also contains the midwife toads and painted frogs. Other scientists like to split them into still different arrangements. Scientists are not sure which is best, but most lean toward the family as it is described here.

GEOGRAPHIC RANGE

Fire-bellied toads and barbourulas can be found in Europe and Asia, including parts of eastern and western Russia, Ukraine, Turkey, China, and Korea. Some species also live farther south in Vietnam, Borneo, and the Philippines.

HABITAT

The members of this family live mostly in the water. The fire-bellied toads prefer marshy areas, or small, often shallow ponds, where the water has little if any current. The barbourulas, on the other hand, like the faster-moving water of mountain streams and small pools of water that have plenty of rocks to provide hiding places.

DIET

Adults generally eat invertebrates (in-VER-teh-brehts), which are animals without backbones. These can include worms and snails, as well as beetles and other insects. The tadpoles of many species will eat insects, too, but usually fill their stomachs mostly with algae (AL-jee), plants, and fungi. Unlike many other types of frogs and toads, the members of this family do not have tongues they can flip out of their mouths to capture prey. Instead, they must lunge at prey and grab their meals with their mouths. This means that a fire-bellied toad, for example, must get close to its prey so it can leap and catch the insect before it can run or fly away. The camouflage pattern on the toad's back helps to hide it from prey and makes this type of hunting more successful.

BEHAVIOR AND REPRODUCTION

The fire-bellied toads are best known for the rather unusual way they defend themselves. The frogs have glands in the warts down their backs that can release a bad-tasting, white and foamy ooze that is also slightly poisonous. When the frog feels threatened, possibly by a predator that comes too close, it flips over, arches its back, stretches out its back legs, and reaches its forelegs up. Sometimes, the frog stays on its belly, but arches its back and spreads its legs. Both of these unusual displays

show off the frog's bright red, orange, or yellow underside to the predator. Scientists call this odd back bend an unken (OONK-en) reflex. The unken reflex and the colors it displays remind the predator that this frog does not make a good snack. Despite the frog's best efforts, the defense tactic is not always successful, and many of these frogs become meals for attackers. For example, a shorebird known as a night heron may get as much as one-quarter of its diet from fire-bellied toads.

The two main types of frogs in this family—the fire-bellied toads and the barbourulas—lead very different lives. The fire-bellied toads are very active during the day, often hopping about on land in open areas, like meadows. Compared to the fire-bellied toads, the barbourulas are very shy. These frogs stay out of sight, usually hiding among rocks in the water. When barbourulas do wander onto land, their gray and brown backs help them blend into the colors of this habitat, too. This camouflage, their secretive behavior, and the small numbers of this species that exist have made barbourulas difficult to study, and scientists still know little about them.

WARNING STRETCH

The fire-bellied toads warn predators to stay away by bending up their bodies to show off their brightly colored undersides. The bright colors are an advertisement to the predators that the frog has a nasty taste. Many other bad-flavored frogs and salamanders also bend in this way. Scientists call this type of strange stretch an unken reflex, because unken is the German word for fire-bellied toad. A reflex is an automatic action. People have reflexes, too, such as blinking or twitching at sudden noises.

The mating season for many of the fire-bellied toads starts in late spring and continues into the middle of summer, and some may breed two or three times a year. Unlike the males of other types of frogs, which call only during certain times of the day, male fire-bellied frogs sing at any time, even though they only mate with the females in the evening hours. Males mate with females by grabbing onto their back so they look as if they are riding them piggyback. This puts the male in the right position to fertilize (FUR-teh-lyze) her eggs as she releases them. During the mating season, a male will sometimes mistakenly grab onto a second male instead of a female. The second male frantically tries to squirm away, sometimes making a croaking squeal, known as a release call. People sometimes use this mating behavior as a quick way to tell the males from the females: During the mating season, those toads that climb onto the backs of others are likely to be males, and those who do not try to squirm away when another

PREDATOR LEARNING

The fire-bellied toads use their colors to advertise to predators that they taste bad. This can only work, however, if the predators learn what the colors mean. How does a predator learn? When a young predator finds one of these frogs for the first time, it only sees what it thinks is an easy meal. When it takes the frog into its mouth, however, the frog oozes an unpleasant-tasting poison from its skin, and the surprised predator quickly spits it out. Sometimes the frog dies from the attack, but often it survives. In either case, the predator has learned a lesson to stay away from these frogs and anything that looks like them. This is why many poisonous animals have bright colors, especially red. Scientists call such warning colors aposematic (ay-POE-sem-AT-ik) coloration.

grips them are likely females. Just because a toad tries to get away does not necessarily mean that it is a male, however, because females who are not ready to mate will also try to escape the clutch of a male toad.

Each female can lay up to 200 eggs a year, although many lay only a few to a couple of dozen at a time. She usually drops them in the water, either on underwater plants or down on the bottom. Some frogs lay their eggs in permanent bodies of water, like streams or ponds that never dry up, but others lay their eggs in temporary pools of water that disappear in dry summer months. In about a week, sometimes longer, the eggs hatch into tadpoles. In another six weeks or so, the tadpoles turn into baby frogs. The timing is very important to those that are born in temporary pools of water. If they cannot change into toadlets before the water disappears, they may dry up and die.

The female barbourula is a bit different than the fire-bellied toad. She lays her eggs—about 80 large eggs at a time—beneath underwater stones. Little more about this species's reproduction is known.

FIRE-BELLIED TOADS, BARBOURULAS, AND PEOPLE

People often buy and sell fire-bellied toads as pets, partly for their beautiful coloration, partly for their display of the unken reflex, and partly because they are quite easy to keep. Many of these frogs can live more than ten years in captivity. Sometimes pet owners find that the flashy colors on a pet fire-bellied toad's underside fades, but they can brighten up the belly again if they feed the toad the right types of foods. The species in this family also sometimes wind up in laboratories where scientists study how they develop from eggs to adults or learn how the animals' bodies work.

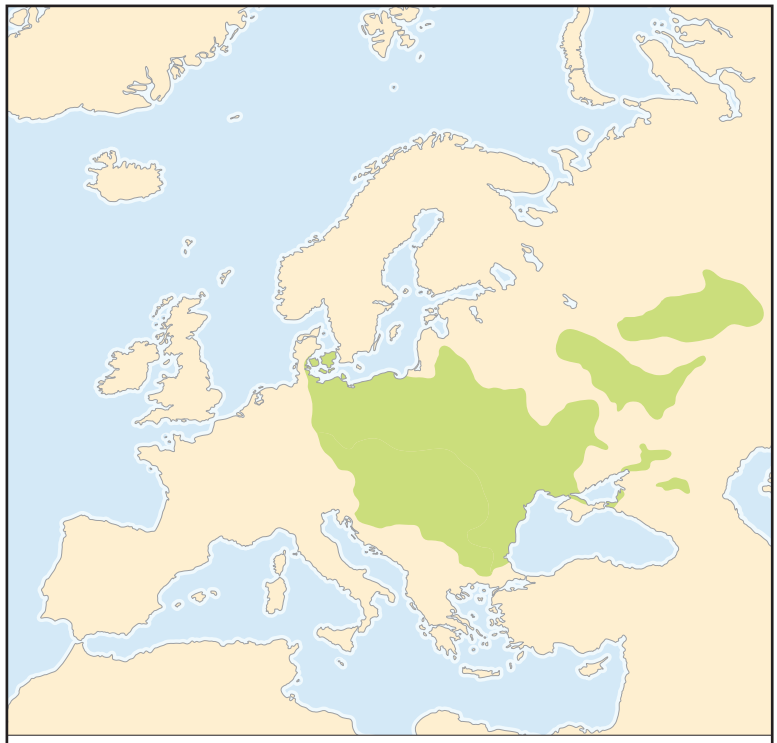
CONSERVATION STATUS

Half of the ten species in this family are at risk, according to the World Conservation Union (IUCN). Four are Vulnerable,

which means they face a high risk of extinction in the wild. These are the Philippine barbourula, the large-spined bell toad (also known as the Guangxi fire-bellied toad), the Lichuan bell toad, and the small-webbed bell toad (also known as the Hubei fire-bellied toad). The biggest threats to these frogs include pollution, habitat destruction, and collection for the pet trade. In addition, some are extremely rare. The large-spined bell toad, for example, is so uncommon that scientists have only found a few individuals and only in a small part of China. Fortunately, most of this area is protected inside a national nature reserve. Likewise, the Lichuan bell toad only appears to live in ten locations inside two Chinese provinces, and the habitat in many of these areas is being destroyed as new farms and homes move in. At least one of these populations, which makes its home inside a nature reserve, is protected.

The fifth of the five at-risk species is the Bornean flat-headed frog. This species is Endangered and faces a very high risk of extinction in the wild. The Bornean flat-headed frog lives in a single, tiny area that measures less than 300 miles by 300 miles (500 kilometers^2), and scientists know about it from just two individuals collected from forest rivers. Unfortunately, human activity near the rivers, including illegal gold mining, is making the rivers muddy and polluted, which may hurt the frogs that still live there.

Although the other five species in this family are not listed as being at risk, scientists are watching them closely because some groups of these frogs are disappearing. Human development in the habitat of the fire-bellied toad is wiping out entire populations of this animal.



SPECIES ACCOUNTS

FIRE-BELLIED TOAD
Bombina bombina

Physical characteristics: When seen from above, fire-bellied toads (also known as European fire-bellied toads) are usually dark gray or black with large black markings. When they live in places with green, leafy areas, they typically have dazzling lime-colored backs that are decorated with black spots. In both cases, their bellies are the same colors: red or orange with big black areas and small white dots. Sometimes, individuals have much more black on their bellies than red or orange. The fire-bellied toads have a rounded snout and eyes with a triangular pupil, but they do not have a flat, circular eardrum showing on each side of the head, as many other frogs do. The warts on their backs are rather tall with rounded tips. Their front feet do not have webs, but the hind feet do. Fire-bellied toads usually grow to about 1.6 inches (4 centimeters) long from snout to rump but occasionally can reach



Its bright belly colors have helped to make the fire-bellied toad very popular in the pet trade. (Photograph by Harald Schüetz. Reproduced by permission.)

2 inches (5 centimeters) long. Males and females look similar, except that the male has a slightly bigger head. In addition, the males develop pads on two of the toes on each front foot and on the inside of the forelegs throughout the breeding season. A male uses these pads to help him cling to the female during mating.

Geographic range: Fire-bellied toads live in central and eastern Europe, including Denmark, Austria, Germany, Poland, Greece, Turkey, and other nations. Sweden and the United Kingdom are home to some fire-bellied toads, but the toads did not get to these countries on their own. Rather, people probably brought them into the countries and released them. When a frog comes to a new place in this manner, it is said to be introduced. Sometimes, people introduce new species on purpose, perhaps thinking that they would be good additions to the area. Other times, people set free their old pets. In many cases,

these pets die, but sometimes they do quite well and begin breeding. Overall, however, conservationists warn people not to introduce new species, because they may hurt the other species that are already there, perhaps by eating their food or by bringing in new and dangerous diseases.

Habitat: Fire-bellied toads live in just about any watering hole they can find. Some populations, especially those in northern areas, prefer clean waters, but those in more southern areas can survive in somewhat polluted waters. These may include lakes and ponds, rivers and streams with slow currents, marshes, and small pools of water, sometimes located in forests and sometimes in more open habitats. The toads do not live high up in the mountains, as some other members of this family do. They spend most of their time either in the water or on land near the water's edge. Summer weather can dry up the small pools of water where some of the toads live, but they are able to survive by crawling into the wet, muddy gaps that remain.

Diet: Adult fire-bellied toads are mainly insect-eaters, often gobbling up mosquitoes. They will also eat many other land insects, like beetles, ants, and flies, as well as water-living insects and other invertebrates. The tadpoles eat a few insects they find in the water, but they are mostly vegetarian and eat algae and plants.

Behavior and reproduction: These frogs are active during the daytime and spend the warm, sunlit hours swimming or hopping about on shore looking for things to eat. They are more sluggish when the temperature drops below about 60°F (15°C) and often remain hidden until the weather warms up again. On warm, humid nights, they will wander farther away from their watering holes to find food. In the water, they can usually escape predators by taking a quick, deep dive. On land, these frogs have back colors that blend into the environment. When a predator does see one and comes too close, this toad will arch its back, displaying the unken reflex, to show off its bright belly-side colors.

Once the weather begins to cool off in the fall, usually September or October, but sometimes as late as November, the fire-bellied toads begin their hibernation (high-bur-NAY-shun), which is a state of deep sleep. To survive the cold of winter, the toads bury themselves in the mud either on land or underwater on the bottom of their watering holes. Hibernation usually lasts from about October to April. In May, after they wake up and become active again, the males start calling. Although they may call during the day, they begin to call even more as

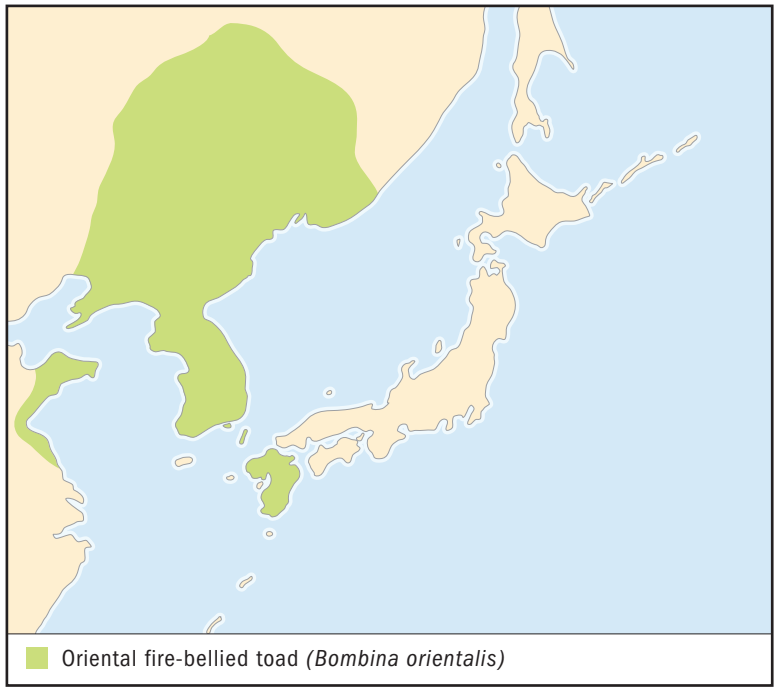
the sun sets. They flatten out their bodies and call from their watery homes, sometimes with their heads above the water's surface and sometimes from underwater. To make the call, the male blows up a single vocal sac that looks like a bubble under his chin when it is inflated. When the male is not calling, the vocal sac shrinks back down and is not noticeable. The call is somewhat like a chicken's cluck. During mating, the male climbs onto the female's back and grips her in front of her hind legs. His front foot pads help him to hang on.

Each year, females can lay 80 to 300 eggs, which they lay in small groups. The eggs hatch into tadpoles about one to two weeks later, and the tadpoles turn into toadlets between July and September, but always before the next hibernation. Although they now have legs, the toadlets stay in the water for this first year. When they reach about 2 to 4 years old, they are adults and ready to become parents themselves. In the wild, fire-bellied toads can live to be about 12 years old, but in captivity they sometimes reach as much as 30 years old.

Sometimes, this species of toad will mate with yellow-bellied toads and have young. These young are called hybrids (HIGH-brihdz). Scientists have compared these hybrids to young that have parents of the same species and found that the hybrid eggs and tadpoles are ten times more likely to die before they reach three weeks old.

Fire-bellied toads and people: Its bright belly colors have helped to make this toad very popular in the pet trade.

Conservation status: This species is not considered to be at risk. ■



ORIENTAL FIRE-BELLIED TOAD
Bombina orientalis

Physical characteristics: Also known as an Oriental bell toad, the Oriental fire-bellied toad has a bright red to orange underside that is marked with large, dark blotches. Its back is brownish to greenish gray or bright green, usually has black and shiny spots, and is covered with pointy warts. Each of the two large eyes on its head, which is colored like the back, has a triangular pupil. Some people think the pupil looks more like a heart than a triangle. The front and back toes look as if their tips were dipped in bright orange or yellow paint. The front toes have no webbing between them, but the back toes are webbed.

Oriental fire-bellied toads usually grow to about 1.5 to 2 inches (3.8 to 5 centimeters) long from the tip of their snout to the end of the rump. Males and females look alike, except that males have slightly thicker forelegs. In addition, during breeding season, the males develop black pads on their front legs and toes. The male uses these pads, which are called nuptial (NUHP-shul) pads, to grip onto the female during mating.



This Oriental fire-bellied toad adopts a defensive display, showing the warning colors on its belly. (Photograph by M.P.L. Fogden. Bruce Coleman Inc. Reproduced by permission.)

Geographic range: The Oriental fire-bellied toad lives in Korea, on two Japanese islands called Tsushima and Kyushu, in northeastern China, and in parts of nearby Russia.

Habitat: Oriental fire-bellied toads usually are found in or near ponds, lakes, swamps, and slow-moving streams. They may also be found in ditches and other temporary ponds, which typically dry up during the summer. These water bodies may be in forests or meadows.

Diet: Young tadpoles are vegetarians but begin to eat insects as they grow larger. Once they become toadlets, they switch to a diet of small invertebrates. The adults eat beetles, ants, flies, and other insects that they find on land or in the water. They also eat worms and snails.

Behavior and reproduction: Like many other members of this family, Oriental fire-bellied toads display their brightly colored underside as a way to scare off predators. Often, this toad will remain on its belly, lift its legs, and stretch its forelegs over its head to provide a good look at its throat and belly colors. Sometimes, it will flip over onto its back while holding out its forelegs, a display that shows

off its underside even more. It also releases a bad-tasting poison from its warts. The combination of poison and the display helps the toad avoid becoming a predator's next meal.

These toads are more active when temperatures are higher and the weather is not too dry. On these warm days, they will hop about in search of food. During especially dry spells in the summer, they sometimes take shelter under rocks or logs until a rain wets the land again. When the weather cools, usually in October, they find shelter either on the bottom of a stream or on land and hibernate for as long as seven or eight months. When they take their winter's sleep on land, they usually find a hiding spot under a pile of leaves or stones or inside a dead and rotting log or tree stump. Sometimes, up to six of these toads will spend the winter huddled together.

When the toads come out of hibernation in the spring, the males float on the surface of the water and start making their mating call. Depending on how close a person is to the calling toads, the mating call may sound like a duck quacking or more like a small bell. Males and females continue to mate throughout the summer. The female lays up to 250 large eggs a year, but only about six to 30 at a time, and places them beneath underwater rocks. Within one to two weeks, sometimes longer, the eggs hatch into tadpoles. The tadpoles change into toadlets in about two months and before hibernation. Overall, the Oriental fire-bellied toads can grow to a ripe old age. In the wild, they may live for as long as 20 years.

Oriental fire-bellied toads and people: Many people keep this toad as a pet.

Conservation status: This species is not considered to be at risk. ■

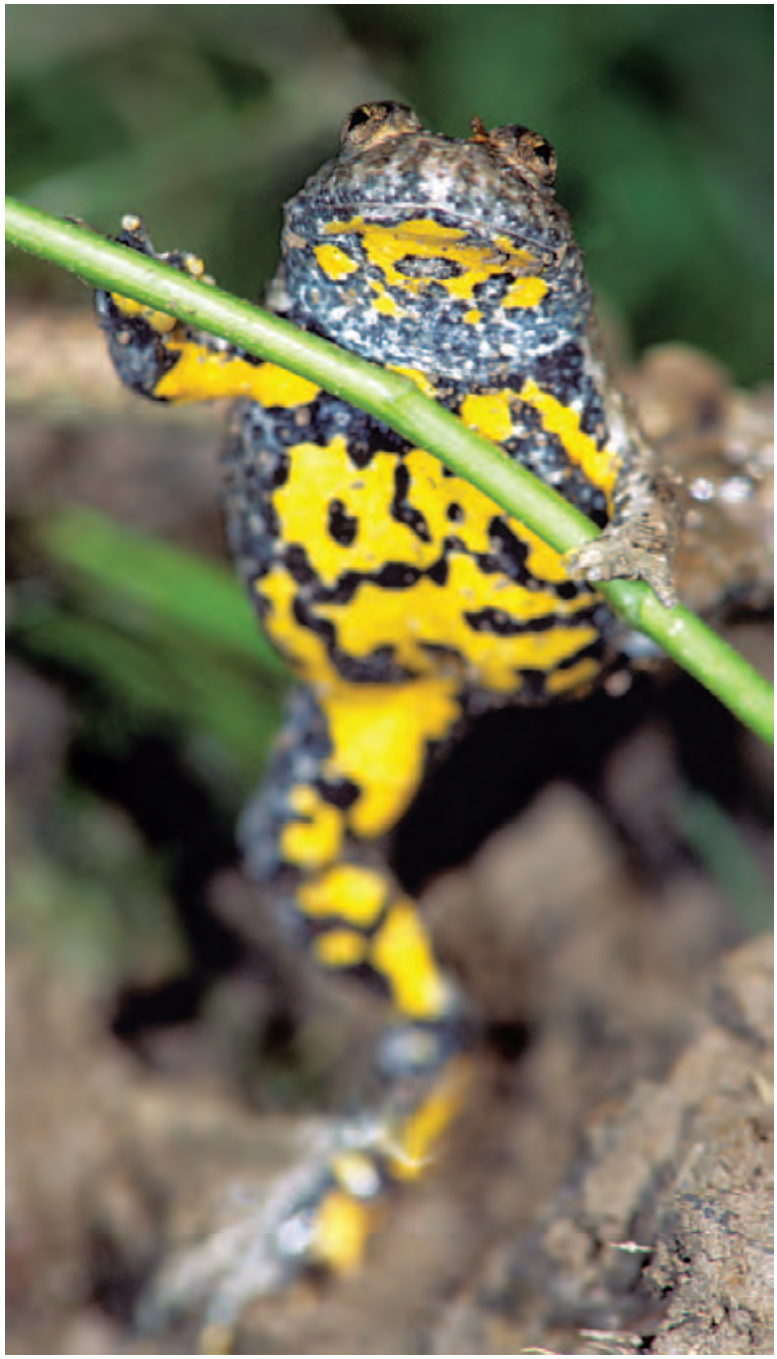


Yellow-bellied toad *(Bombina variegata)*

YELLOW-BELLIED TOAD
Bombina variegata

Physical characteristics: The yellow-bellied toad is most known for its bright yellow to yellow-orange underside, which is marked with black. The amount of black differs from individual to individual. Some may have an almost completely black belly, and others may be almost completely yellow. From a top view, however, this toad is olive-green with black speckles. These colors and the pattern on the head and back match the colors and pattern of the toad's habitat and help to hide it from predators. Compared to other members of this family, it has more warts, and its belly even has a few. This toad's warts are also different from other species because those on the back are very pointy and almost make the toad look as if it is covered with small spines. The tips of its front and back toes are yellow or yellow-orange like the belly. This species can grow to about 2 inches (5 centimeters) long

The yellow-bellied toad is most known for its bright yellow to yellow-orange underside, which is marked with black. The amount of black differs from individual to individual. Some may have an almost completely black belly, and others may be almost completely yellow. (Photograph by Harald Schüetz. Reproduced by permission.)



from snout to rump. The males and females look much alike, except that the males have pads on their front toes. During the breeding season, the males also develop pads on their forelegs. They use the pads to hold onto the female's back during mating.

Geographic range: Yellow-bellied toads live throughout much of central and southern Europe, including Austria, Greece, Hungary, Italy, Switzerland, the United Kingdom, and many other countries.

Habitat: These toads live in ponds, lakes, slow- and fast-moving streams and rivers, and pools of water in the hills and on mountainsides. They also do well near humans and can even survive in very polluted waters that would kill other types of frogs. They also spend much of their time on land in forests and/or meadows. In many places, this toad is quite common, and a person can see several toads within three feet (91 centimeters) of each other.

Diet: Unlike many other members of this family, the adult yellow-bellied toad finds almost all of its food on land. Its diet is made up of beetles, flies, ants, spiders, and other invertebrates.

Behavior and reproduction: This toad likes warmer weather and is most active during the daytime. Its schedule on a typical warm day includes time spent looking for food to eat and time resting in the water or sunbathing on land. Many cold-blooded animals, including frogs, warm themselves by such sunbathing, or basking. Like the other fire-bellied toads, the yellow-bellied toad will display the unken reflex when threatened. When the weather cools in October, it leaves the water and begins its hibernation in underground burrows or holes beneath rocks. When it awakens again the next spring, the males begin calling. Those higher in the mountains awaken last because the weather stays cold longer.

When the males and females come together, a male will climb onto a female's back and hang on just in front of her hind legs. Mating can continue off and on throughout the summer, even lasting until August. Often, a heavy rain will trigger many toads to mate at once. The female lays 45 to 100 eggs over the entire summer, but only about two dozen at a time. The eggs hatch 12 days later into tiny tadpoles. Some of the tadpoles turn into toadlets before the fall hibernation, but others wait until the following spring to make the change.

Yellow-bellied toads and people: Some people keep these toads as pets, although they are not as popular as some other species. The

poison from the toad's skin, although it is not especially strong, can cause some stinging to humans who handle them.

Conservation status: This species is not considered to be at risk, but it may still be in some danger. More than a dozen populations of this toad have disappeared from the Ukraine alone, and others may soon vanish as people continue to move into and destroy their habitat. ■



Philippine barbourula *(Barbourula busuangensis)*

PHILIPPINE BARBOURULA
Barbourula busuangensis

Physical characteristics: The Philippine barbourula is also known as the Busuanga jungle toad, the Philippine discoglossid frog, and the Philippine flat-headed frog. It is larger than any of the fire-bellied toads and typically can grow to about 3 inches (7.6 centimeters) long from its rounded snout to its rump. Like the other barbourula species, the Philippine barbourula has camouflage colors and patterns. Its back is drab brown or greenish brown with dark markings, a combination that hides the frog against the background of its water habitat. It has large eyes and a rounded snout. Both its front and back toes are webbed, which allows its feet to work like paddles as it swims through the water. Its hind legs, which are much larger and more powerful than its front legs, also give it swimming power.

Geographic range: Three western Philippine islands, called Busuanga, Culion, and Palawan, are home to this species.

Habitat: A fast-flowing, clean and clear, rocky or stony mountain stream or river is the best place to find one of these frogs. Within the



Philippine barbourulas spend much of their time floating at the top of the water, but people rarely see them because the frogs frighten easily and quickly dive out of sight to hide underneath stones or inside cracks in rocks, especially near the shoreline. (Photograph © Rafe M. Brown. Reproduced by permission.)

three Philippine islands where this species lives, it is split into small populations that are often separated quite a distance from one another.

Diet: Scientists suspect that these frogs mainly eat insects that they find in the water, although they may sometimes venture onto land to find a meal. More studies are needed to learn about their diet.

Behavior and reproduction: Philippine barbourulas spend much of their time floating at the top of the water, but people rarely see them because the frogs frighten easily and quickly dive out of sight to hide underneath stones or inside cracks in rocks, especially near the shoreline. The females even lay their large eggs beneath underwater stones. They may lay as many as 80 eggs, which possibly skip the tadpole stage and develop right into froglets. Additional studies are needed to provide more information about this secretive species.

Philippine barbourulas and people: People rarely see this species.

Conservation status: According to the World Conservation Union (IUCN), this species is Vulnerable, which means that it faces a high risk of extinction in the wild. Part of the reason the species are at risk is that people continue to damage the frogs' habitat by cutting down trees and/or by polluting the streams and rivers through such activities as mining and farming. Some people also collect these rare frogs to sell as pets. Many of the frogs on Palawan are safe from these dangers, because they live in rainforest that has been set aside as protected land. ■

FOR MORE INFORMATION

Books:

Arnold, E. Nicholas. *Reptiles and Amphibians of Europe (Princeton Field Guides)*. Princeton, NJ: Princeton University Press, 2003.

Arnold, E. N., J. A. Burton, and D. W. Ovenden. *Reptiles and Amphibians of Britain & Europe (Collins Field Guide).* London: HarperCollins Publishing Limited, 1999.

Duellman, William E., and Linda Trueb. *Biology of Amphibians.* Baltimore: Johns Hopkins University Press, 1994.

Garcia Paris, Mario. *Los Anfibios de España.* Madrid: Ministerio de Agricultura, Pesca y Alimentación, 1985.

Gasc, Jean-Pierre, A. Cabela, J. Crnobrnja-Isailovic, et al., eds. *Atlas of Amphibians and Reptiles in Europe.* Paris: Societas Europaea Herpetologica and Muséum National d'Histoire Naturelle, 1997.

Herrmann, Hans-Joachim. *Terrarien Atlas.* Vol. 1, *Kulturgeschichte, Biologie, und Terrarienhaltung von Amphibien, Schleichenlurche, Schwanzlurche, Froschlurche.* Melle, Germany: Mergus Verlag, 2001.

Miller, Sara Swan. "Fire-Bellied Toads." *Frogs and Toads: The Leggy Leapers.* New York: Franklin Watts, 2000.

Zug, George R., Laurie J. Vitt, and Janalee P. Caldwell. *Herpetology: An Introductory Biology of Amphibians and Reptiles.* 2nd edition. San Diego: Academic Press, 2001.

Web sites:

"Fire-Bellied Toad." *The Sacramento Zoological Society.* www.saczoo.com/1_about/_animals/fact_sheets/firebellied_toad2.pdf (accessed on February 6, 2005).

"The Oriental Fire-Bellied Toad." *Utah's Hogle Zoo.* http://hoglezoo.org/animals/view.php?id=201 (accessed on February 6, 2005).

"Frogs: A Chorus of Colors." *American Museum of Natural History.* http://www.amnh.org/exhibitions/frogs/featured/flashers.php (accessed on February 6, 2005).

MIDWIFE TOADS AND PAINTED FROGS

Discoglossidae

Class: Amphibia
Order: Anura
Family: Discoglossidae
Number of species: 10 species

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

Midwife toads and painted frogs are medium-sized frogs that reach about 1.6 to 3 inches (40 to 75 millimeters) long from the snout to the rump. From the outside, the four species of midwife toads look quite different compared to the six painted frog species. The midwife toads have the typical pudgy-looking, warty body and rounded snout of a toad. The painted frogs, on the other hand, look much like the average frog with a trimmer body and a snout that narrows down almost to a point. Sometimes, the painted frogs are quite warty, but even so, they look more like a frog that happens to have warts than like a toad.

The two groups in this family do share several characteristics. Their bodies sit low to the ground, which gives them a squat look. Most of the midwife toads and the painted frogs have warts that are small but noticeable. Some, such as the Iberian midwife toads, even have warts on their eyelids. Both have a thick, disk-shaped tongue that resembles a small, round saucer instead of the long, thin tongue of most other species of frogs. They have large eyes, which may have vertical pupils that look like top-to-bottom slits, or somewhat heart-shaped pupils that are wider at the top than at the bottom.

The skeletons of the midwife toads and painted frogs also have some similar features. For example, the adults have just three ribs. Frogs, including the members of this family, have small, spiky ribs that attach to the backbone but not to the breastbone. Humans, on the other hand, have a full rib cage that is attached to the breastbone in the front and the backbone, or

spine, in the back. Different species of frogs have different numbers of ribs, and they are attached to different places in the backbone. The midwife toads and painted frogs have three ribs attached to the second, third, and fourth bones in the spine (counted from the neck down).

The color of these frogs varies from species to species. Many have gray, brown, and black patterns that blend into the background. The midwife toads typically have reddish spots on the tops of their warts, which sometimes form noticeable rows down each side of the body. They are often a lighter color, sometimes white, on the underside. Many painted frogs have obvious dark bands on all four legs and spots and blotches on the back. The now-extinct Hula painted frog had an unusual dark belly that was speckled with white. Its scientific species name is *nigriventer*, which means a dark underside.

In some cases, members of the same species in this family look quite different. The Corsican painted frog is one such frog. In this species, some individuals are all mostly one color, usually a shade of brown or dark gray, but others are covered with obvious dark spots. In both the midwife toads and painted frogs, the males and females generally look much alike. In some species, such as the Iberian and Mallorcan midwife toads, the male is a bit smaller but otherwise looks very much like the female.

The family as it is listed here includes only the midwife toads and painted frogs. Some people, however, add fire-bellied toads and barbourulas to this family. This book lists them under their own family, called Bombinatoridae.

GEOGRAPHIC RANGE

These frogs are mainly European, living in both central and southern Europe. Some also live in northwestern Africa and Israel.

HABITAT

Besides looking different, midwife toads and painted frogs spend their time in different habitats. The painted frogs stay nearer—and often in—the water and are particularly fond of rocky-bottomed, swift-flowing streams, although some live very well in small ponds that may dry up during part of the year. Many will only go into freshwater areas, but some, such as the Tyrrhenian painted frogs, survive in somewhat salty water. When the painted frogs hop onto land, they stay along the

shoreline or in areas where the ground is at least somewhat moist. The midwife toads prefer drier areas, like forests and meadows, but they never stray too far from a stream or pond. Both the midwife toads and the painted frogs stay out of sight during the day by crawling under rocks and logs or hiding in burrows that they dig.

DIET

Their diets may include beetles, caterpillars, grasshoppers, flies, and other insects, as well as other types of invertebrates (in-VER-teh-brehts), which are animals without backbones. These invertebrates may include spiders, pillbugs, and snails. Although their tongues do not flick out of their mouths, as do the long tongues of many other species of frogs, they have no trouble snapping up prey right into their mouths.

BEHAVIOR AND REPRODUCTION

Midwife toads and painted frogs are mainly active at night, which is when they hunt for food. During the day, they remain hidden under logs and rocks or in burrows. Not all of the members of this family dig their own burrows, but those that do, like the species that is known simply as a painted frog, use their front legs and toes to scrape their way into sandy ground headfirst. They may pat firm the top of the burrow as they dig by butting the head up against it. Sometimes the frog digs only shallow burrows that go little farther than the length of its body, but at other times, the frog may dig a deeper, longer system with side tunnels. When the frogs leave their hiding spots at night, they tend to stay in fairly moist areas to look for food.

The males of all species call during the breeding season either from the water or from shoreline spots on land. In some species, the call sounds like chiming bells, and in others it sounds more like a series of high-pitched "poo" or "pie" noises. Unlike most other species of frogs, some females in this family also call. The Iberian midwife toad, for example, calls back when the male calls. Her call is similar, but quieter than his. Studies of the Iberian midwife toads show that females respond better to males who make faster but lower-pitched calls. Both male and female Mallorcan midwife toads also call. Some scientists believe that their calls do more than bring males and females together to mate. Their studies suggest that the toads, especially the youngest froglets—those that have just made the

change from tadpoles—may listen to the calls simply to find out where other toads are, so they can join them in a safe place.

When a male and female mate, the male climbs onto her back and hangs on just above her back legs. From this position, she releases her eggs, and he releases sperm, which unite to start development. Here again, the painted frogs do things differently from the midwife toads. The female painted frogs may mate many times a night, laying up to 1,000 eggs in a single 24-hour period, and she may have more than one mating day in a year. The Iberian painted frog, for example, may mate on six separate days a year and lay a total of 1,500 eggs in a year. Females drop their eggs into the water, where they either stay on the surface or sink to the bottom. The eggs hatch into tadpoles several days later. The exact timing of the hatch depends on the temperature of the water. In Iberian midwife toads, for example, eggs in warm water can hatch in just two days, but eggs in cold water may need six days before they are ready to hatch. The young then remain in the tadpole stage until the next spring or summer, when they change into froglets. When they reach 3 to 5 years old, the young are adults and old enough to mate themselves.

The midwife toads are very unusual in the way their eggs develop. The process starts when the female lays strings of eggs, one string at a time. After 10 minutes or so, the male collects the strings and wraps them around his ankles, one after the other. By the time he is done twirling them around his legs, the male is wearing what looks like a skirt of beads. A single male may mate with several females, and some, like the Iberian midwife toad, may carry up to 180 eggs from four different females. The eggs of the Mallorcan midwife toad are larger, but fewer in number. The Iberian midwife toad's eggs are about one-tenth of an inch (2.6 to 3.5 millimeters) in diameter, and the female may lay 40 to 50 eggs at a time. The female Mallorcan midwife toad typically lays only a dozen or fewer eggs, but her eggs are twice the size at about two-tenths of an inch (5.4 to 7 millimeters) in diameter.

Regardless of the size or number of eggs, the male continues to wear and protect them until they are ready to hatch. At that time, he hops over to the water to allow the newly hatched tadpoles to swim off on their own. This unusual behavior of the male gives the toads their name: midwife toads. A midwife is a person who helps a woman deliver her baby. Although the

HUMAN-CAUSED EXTINCTION

One of the Earth's frogs disappeared in the 1950s at the hands of humans. At that time, people in Israel were trying to fight a dangerous, fever-causing disease called malaria (muh-LAIR-ee-uh). The disease spreads through the bites of infected mosquitoes. One of the people's answers was to drain the swamps where the mosquitoes lived. Without water, the mosquitoes would die out, and the disease would vanish, too. The water disappeared, but the mosquitoes were not the only animals affected. The swamps were also home to other animals, including the Hula painted frog. Unlike the mosquitoes, which exist in Israel to this day, the Hula painted frog could not survive the destruction of its home and is now extinct.

male toad doesn't help the female bear her eggs, he does help make sure they hatch. Tadpoles of the midwife toads can grow quite quickly. Those of the Mallorcan midwife toad, for instance, can double their size and double it again in just a few weeks. Tadpoles make the change to toadlets, a process called metamorphosis (MEH-tuh-MORE-feh-sis), early the following spring and generally are old enough to mate when they reach their second year.

MIDWIFE TOADS, PAINTED FROGS, AND PEOPLE

People rarely see these toads and frogs in the wild. Scientists, however, are especially interested in the midwife toads for the unusual way the males care for the eggs. In most frogs, neither the male nor the female play any part in guarding the eggs or rearing the young.

CONSERVATION STATUS

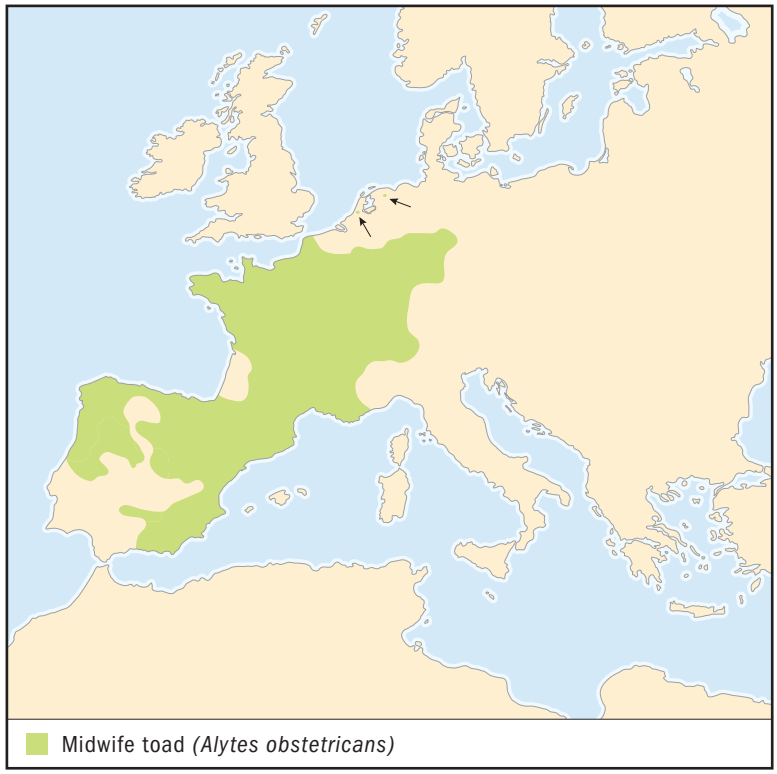
Of the 10 species in this family, the World Conservation Union (IUCN) considers one as already Extinct, or no longer living, and three others as Vulnerable, which means that they face a high risk of extinction in the wild. It also ranks two others as Near Threatened, which means that they are likely to qualify for a threatened category in the near future.

The Extinct species is the Hula painted frog, which once lived in Israel and possibly Syria. Scientists know about this species from just five specimens, the last of which was collected in 1955. Since then, no other specimens have been found. It probably disappeared as a result of damage to its habitat, especially when people drained the wetlands where it lived in an attempt to wipe out mosquitoes and to turn the swamp into farmland.

The Vulnerable species are the Betic midwife toad and the Mallorcan midwife toad of Spain and the Corsican midwife toad of France. Habitat loss and destruction have hurt the Betic and Corsican toads, while the Mallorcan midwife toad faces threats from new species that have come into its habitat. These new animals, known as introduced species, include a snake and a

frog. The snake, called a viperine snake, eats both adult Mallorcan midwife toads and their tadpoles. The new frog, known as the Iberian green frog or Iberian water frog, is taking away food and space from the Mallorcan midwife toad and causing the toad's numbers to drop. By the mid-1980s, conservationists had begun taking steps to protect the toad. In one effort, they have captured some toads so they could breed them in captivity and return the newborn toads to some areas where they had once lived but have since disappeared. This has been very successful, and soon three populations of these reintroduced toads had begun breeding in the wild. Conservationists are now trying to create new watering holes so they can raise and release additional toads in places that are free of animals that might eat them or compete with them for available food.

The toads are doing much better since these efforts began. In 1996, the IUCN considered the species to be Critically Endangered, which meant that it faced an extremely high risk of extinction in the wild. Just eight years later, in 2004, the IUCN saw such improvement in the toad's numbers that it took the species off the Critically Endangered list and now considers it to be Vulnerable, which means that it is at a lower risk of becoming extinct. The Mallorcan midwife toad is unusual for another reason. Until the late 1900s, scientists thought that it had become extinct 2,000 years ago, and all they would ever see were its fossils. They were stunned in 1980, when they learned of a living population that had turned up in a remote, mountainous area. Shortly after this discovery, however, the invading viperine snakes and Iberian green frogs were already taking their toll on the toads and lowering their numbers.



SPECIES ACCOUNTS

MIDWIFE TOAD
Alytes obstetricans

Physical characteristics: The midwife toad is a small, plump toad that sits low to the ground. Its tan to gray skin is spotted in black, brown, and greenish colors and is covered with tiny warts. These warts, which often sit in the middle of a dark spot, give the toad a rough look. In addition, a single row of red-tipped warts runs down each side of its back from behind the eardrum and over two larger warts to the hind leg. The two warts, each of which forms almost a ridge behind the eardrum, are called paratoid (pair-RAH-toyd) glands. These glands and the other warts on its back contain poison and help protect the toad from predators, which find that the poison tastes bad. The toad's large head has a rounded snout and big, copper-colored eyes with vertical slits for pupils. Its underside is off-white, often with gray speckles toward the front. The midwife toad has chubby legs and



The male midwife toad wraps long strings of eggs around his hind feet and protects them until they hatch. (Photograph by Nuridsany et Pérennou. Photo Researchers, Inc. Reproduced by permission.)

no webbing between its toes. Unlike many other frogs that have small, somewhat weak front legs, the midwife toad's forelegs are quite strong. The soles of its front feet have bumps, called tubercles (TOO-ber-kulz). It usually grows to 2.2 inches (5.5 centimeters) long from the tip of its snout to the end of its rump. The males are usually a bit smaller than the females.

Geographic range: The midwife toad is a European species, living in a small area in the Netherlands, in all but the coastal region of Belgium, and in much of Portugal and Spain, as well as France, Germany, Luxembourg, and Switzerland.

Habitat: The midwife toad lives in mountain ponds and slow-moving streams that are filled with water all year long and in nearby hiding places on land. Sometimes, they crawl into mostly bare, sandy soils; beneath small stones as well as large slabs of stone; and inside cracks in walls. All of these spots provide a moist, and at least somewhat warm, shelter for the toads.

Diet: The adults eat various invertebrates, including pillbugs, snails, and different insects.

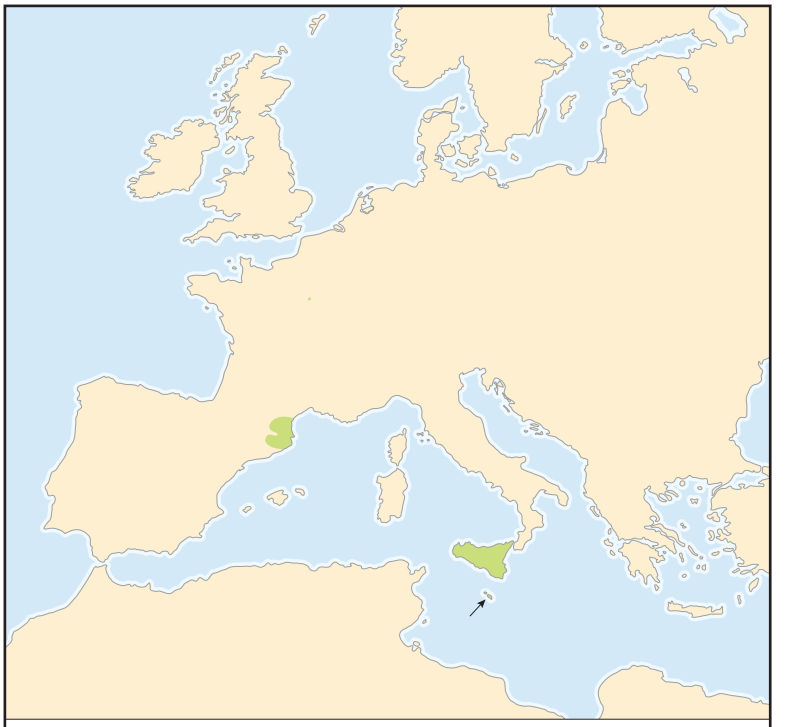
Behavior and reproduction: During the day, these toads remain out of sight under stones, inside the cracks in stone walls, and in other hideaways where they are shielded from the drying wind and temperature swings. They are also able to use their forelegs to dig head-first into loose gravel and make burrows that they use as shelter. They

become active as the sun sets and spend their nights looking for things to eat. They spend the winter in their hideaways, but come out in the early spring to begin mating. The mating season for these toads may begin as early as February in some areas, and it continues through the summer. At night, the male performs his mating call, which is a "poo" sound that he makes once every second or so. He may further prepare a female for mating by tickling her with his toes. They mate with the male on her back and clinging to her waist.

About 10 to 15 minutes after the female lays her strings of eggs, the male scoops them up and wraps them around his legs. He carries them there until they hatch. He may mate with more than one female and sometimes carries as many as 150 eggs at a time. As the eggs grow and become bigger, they look like large dark beads. The male stops now and then to soak the eggs in water. This keeps the eggs moist. When they are ready to hatch in about three to six weeks, the male again hops to the water. There, the tadpoles squirm out of the eggs and into the water. The tadpoles wait until the next spring when they are about 2 to 3.1 inches (5 to 8 centimeters) long to change into toadlets. Over the winter, they usually remain in the water. They are mature enough to mate when they are about 2 years old.

Midwife toads and people: Because of their secretive habits, people rarely see these toads in the wild. Scientists still find them to be fascinating creatures and are especially interested in the male's care of the young.

Conservation status: This species is not considered to be at risk. Conservationists are still watching it closely, however, because some populations of this toad have vanished or are losing numbers. The cause may be habitat destruction and possibly the introduction to the streams of fish that prey on the toads. ■



Painted frog *(Discoglossus pictus)*

PAINTED FROG
Discoglossus pictus

Physical characteristics: The painted frog is a rather wide, little frog with long hind limbs and shorter, but stocky forelegs. Its front feet have no webs between the toes, but the back toes are webbed. It is yellowish to greenish brown with long, dark, greenish brown markings. The markings may be bands or oval spots and are sometimes outlined in a lighter color. They usually have a brown band between the eyes. Often, just behind the barely noticeable eardrum, they have a thin paratoid gland that reaches back like a little ridge. The frog has a wide head with a rather pointy snout and big eyes centered with pupils that have shapes described as either hearts or upside down teardrops. Its back has scattered warts. The typical painted frog grows to 2.8 to 3.1 inches (7 to 8 centimeters) long.



The painted frog's call sounds somewhat like the hushed chuckle a person might make in a library. (Illustration by Patricia Ferrer. Reproduced by permission.)

Geographic range: Painted frogs live along the Mediterranean Sea in the northeastern African countries of Tunisia, Algeria, and Morocco; in Sicily, which is a southern island of Italy; and on the small Mediterranean islands of Malta and Gozo. Some have also been introduced to areas in France and Spain.

Habitat: Painted frogs live in freshwater and sometimes somewhat salty waters, usually preferring streams or small puddles. People often see them at night in the water filling tire ruts or the hoof prints of cattle. They frequently live near humans, making their homes in orchards or other farm fields, in wells and canals, or in campgrounds.

Diet: Their diet includes insects and other invertebrates.

Behavior and reproduction: Painted frogs use their strong front legs to dig burrows under stones, where they hide during the daytime. At night, they become active and begin looking for food. Their mating season runs almost all year—from January to early November. The males go to the water and give a call that sounds somewhat like the hushed chuckle a person might make in a library. To mate, a male climbs onto the female's back, grabbing her above her hind legs. Over the next half hour to two hours, she lays as many as 50 eggs while the male clings to her back. Afterward and on that same night, she may mate with many other males. The busiest of females may mate with about 20 different males and lay one thousand eggs in a single night. She drops her eggs one by one. They either clump

together on the water surface or sink. In about six days, the eggs hatch into tadpoles, which change into froglets one to three months later. The froglets continue to grow and are mature enough to mate the following year.

Painted frogs and people: Because the females can lay so many eggs over a very short time, scientists sometimes use them in laboratory experiments, which may study how eggs develop.

Conservation status: This species is not considered to be at risk. In some places, however, farmlands have disappeared, and the frogs have vanished with them. ■

FOR MORE INFORMATION

Books:

Arnold, E. Nicholas. *Reptiles and Amphibians of Europe (Princeton Field Guides).* Princeton, NJ: Princeton University Press, 2003.

Arnold, E. N., J. A. Burton, and D. W. Ovenden. *Reptiles and Amphibians of Britain & Europe (Collins Field Guide).* London: HarperCollins Publishing Limited, 1999.

Duellman, William E., and Linda Trueb. *Biology of Amphibians.* Baltimore: Johns Hopkins University Press, 1994.

Gasc, Jean-Pierre, et al., eds. *Atlas of Amphibians and Reptiles in Europe.* Paris: Societas Europea Herpetologica and Muséum National d'Histoire, 1997.

Miller, Sara Swan. *Frogs and Toads: The Leggy Leapers.* New York: Franklin Watts, 2000.

Zug, George R., Laurie J. Vitt, and Janalee P. Caldwell. *Herpetology.* 2nd edition. San Diego: Academic Press, 2001.

Web sites:

"Discoglossidae." *AmphibiaWeb.* http://elib.cs.berkeley.edu/aw/lists/Discoglossidae.shtml (accessed on February 7, 2005).

"*Discoglossus nigriventer.*" *Recently Extinct Animals.* http://home.hetnet.nl/harrie.maas/speciesinfo/palestinianpaintedfrog.htm (accessed on February 7, 2005).

"Mallorcan Midwife Toad Saved from Extinction." *Durrell Wildlife Conservation Trust.* http://www.durrellwildlife.org/index.cfm?p=295 (accessed on February 7, 2005).

"The Mallorcan Midwife Toad." *Durrell Wildlife Conservation Trust.* http://www.durrellwildlife.org/index.cfm?p=60 (accessed on February 7, 2005).

MESOAMERICAN BURROWING TOADS

Rhinophrynidae

Class: Amphibia

Order: Anura

Family: Rhinophrynidae

One species: Mesoamerican burrowing toad (*Rhinophrynus dorsalis*)

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

With its round and flat body and tiny, pointy-snouted head, the Mesoamerican burrowing toad is an odd-looking creature. It is so unusual, in fact, that some people might not even guess it is a type of frog until they see its hind legs and webbed feet sticking barely out from the saggy skin of its back. The skin droops along the sides of the body and up by the front legs, too. Its legs are short and pudgy, but very strong. The back legs are longer than the front legs, but the front legs are quite thick, as if the frog were a bodybuilder. The edges of the feet also have large, shovel-like bumps that help the frog dig. The toes of its front feet are much shorter than its very long back toes. It typically sits with its hind legs bent up against the body, so they almost disappear. In all, it looks like a dark, round blob with four feet poking out the sides. The head is little more than a cone-shaped lump on the front of the frog. It is small and has no obvious neck supporting it. The reason that the head looks so small is that the frog's shoulders are much closer to the head than they are in other types of frogs. The shoulder blades even wrap around the back of the head, which makes the frog look as if it is always shrugging up its shoulders.

The frog has two dark, small, round, beady eyes, two even smaller nostrils sitting just in front of the eyes on the top of the short snout, and thick lips. Most of the skin on this frog is smooth, but the skin on the snout is tough because it is covered with hard bumps, called spicules (SPIK-yuhlz), that can only be seen with a microscope. The spicules are rounded on the bottom of the

snout, but pointy on top. In many other frog species, two eardrums are easily seen on the sides of the head, but the tiny head peeking out from the shoulders in the Mesoamerican burrowing toad leaves no room for any eardrums to show.

Its tongue is different, too. The Mesoamerican burrowing toad does not have a long tongue to flip far out of its mouth as many other frogs do. Instead, it has a sticky, triangular-shaped tongue that it can stick straight out just a little way. Its mouth is toothless.

The frog also has an unusual pattern on its thick back skin that helps to tell it apart from other species. Its back is dark grayish brown, sometimes nearly black, with a single, thin, stripe of yellow, orange, or reddish orange running down the middle. This stripe may be broken here and there, but it is still obvious. It also has yellow and/or orange spots or blotches on either side of the stripe that continue down its sides. Its legs may have a few spots, but the limbs are mostly just grayish brown, and the webbing is typically a lighter gray or bluish color. Its head is also a little lighter in color than the back and may be light gray to light brown. Its underside is dark brown, gray, or bluish gray and has none of the speckles, spots, or stripes of the back.

The name "toad" in this species can be confusing, because it is not actually a toad at all. The only true toads are in the family Bufonidae. They have warty skin and short legs. The Mesoamerican burrowing toad has smooth skin and quite large hind legs. Even though its common name includes the word "toad," scientists consider it to be a frog and not a true toad. This is a small- to medium-sized frog, and the adults grow to 1.8 to 2.6 inches (4.5 to 6.5 centimeters) long from the tip of the snout to the end of the rump.

The tadpole of the Mesoamerican burrowing toad also looks a bit different from the average tadpole. It has the typical head and long tail, but the head is wider and flatter than other tadpoles, and it has unusual, tiny, fleshy "whiskers" poking from the front of the mouth. These bits of flesh are called barbels

A HOLE IN ONE

Tadpoles breathe through their gills. Water rushes in; blood in the gills removes the oxygen from the water, and the water flows out through a tiny hole on the tadpole's side. This tiny hole is called a spiracle (SPIH-reh-kul). Tadpoles of the Mesoamerican burrowing toad, clawed frogs, and Surinam toads have two spiracles instead of one, and they are located on the bottom of the tadpole instead. Partly because they have the extra spiracle and because of the location of the two holes, scientists think that these three groups of frogs are very closely related.

(BAR-bulls). Unlike most other frog species, these tadpoles do not have horny beaks on their mouths. Other tadpoles use these beaks to scrape algae (AL-jee), or tiny plantlike organisms that live in water, off rocks or plants for their meals. The Mexican burrowing toad tadpole eats instead by sifting out little bits of floating algae from the water. The only other tadpoles that look like the burrowing toad tadpoles are those of the Pipidae family, which include the clawed frogs and Surinam toads that live mostly in South America and Africa. Like the Mesoamerican burrowing toad, the clawed frogs and Surinam toads also have a very unusual look that includes an oddly flat head. Scientists believe that these two families of frogs are very closely related because the tadpoles are so much alike and because of some details in their skeletons. Paleontologists (PAY-li-un-TA-luh-jists), or scientists who study fossils, at the Carnegie Museum of Natural History are also now studying a new fossil discovered at Dinosaur National Monument, which is located in Colorado and Utah. This fossil may be a newly discovered relative of the two families.

GEOGRAPHIC RANGE

This family has only one living species, which may be called a Mesoamerican burrowing toad, Mexican burrowing toad, or simply, a burrowing toad. It is found in North and Central America. In North America, it lives in the southernmost part of Texas and in Mexico. It also is found in the Central American countries of Honduras, Guatemala, Belize, El Salvador, Nicaragua, and Costa Rica. At one time, other burrowing toads lived on Earth as far north as Canada. Two now-extinct species lived in what is now Wyoming about 40 to 50 million years ago, and another lived in Saskatchewan, which is in western Canada, about 32 million years ago. Scientists learned about these three species from fossils collected from the two places.

HABITAT

The Mesoamerican burrowing toad mainly lives in underground burrows in lowland areas, which are nearer the Gulf of Mexico and Pacific Ocean and away from the hilly, mountainous regions farther inland. Some live in grassland areas, but others do well in forests that become very dry for part of the year. They can exist in tropical areas or in somewhat cooler subtropical grasslands and forests.

DIET



Even though the Mesoamerican burrowing toad's common name includes the word "toad," scientists consider it to be a frog, and not a true toad. (© Tom McHugh/Steinhart Aquarium/Photo Researchers, Inc.)

Although scientists know of no one who has actually seen them eating, they think that the Mesoamerican burrowing toad eats ants and termites that it finds in its underground burrows. They learned this by capturing some of these frogs and looking at what was in their stomachs. This is a somewhat common way for scientists to learn about the diet of animals that live most of their lives out of human sight. Based on the frog's short tongue, scientists believe that this frog digs through the soil until it pops just the tip of its snout into a termite or ant tunnel. From there, it can sit still to wait for one of the insects to crawl by and then quickly stick out its short, gummy tongue to pick up the insects one at a time and gobble them down. This type of sit-and-wait hunting is called ambush (AM-bush) hunting. Tadpoles, which live in pools of water, feed by sucking in water and picking out little bits of algae. This is called filter feeding.

BEHAVIOR AND REPRODUCTION

The frog uses its strong legs to dig backwards into the ground. As its legs work, the frog twists while blowing up its body with air and then letting the air out. When it is deep enough into the soil, the dirt falls in on top of the frog and eventually covers up the tunneling frog completely. It stays underground most of the time, coming up to the surface during the rainy season, which is when it mates. It may leave its burrows and move above ground at night to look for food, but its large body and short legs make it rather clumsy on land.

The breeding season begins when the heavy rains come. Sometimes, the males make a few calls from their burrows, but they do most of their calling once they find little pools of water. These can be puddles in a farm field, water-filled ditches along a road, or any other small watering hole that forms when the rains come. Males do not breed in ponds that have water in them all year long. From its pool of water, the male begins calling. In many species of frogs, one or two vocal sacs inflate when they call, and each sac looks like a balloon that blows up around its chin. The burrowing toad's sac stays on the inside of its body, so when it fills up with air, the frog's entire body blows up.



Every time the male makes his loud mooing call, the air rushes out of his body and pushes the frog backward in the water. Since the male may make its short "ooo" calls 15 to 20 times a minute, the frog continues to scoot around the water backward.

A female comes to a breeding pool, which may contain many males, and picks out a mate by bumping her snout into his chest and throat. He responds by climbing onto her back and grabs onto her with his forelegs just in front of her back legs. She lays a few eggs at a time, sometimes only one, and may mate with different males on several different days, especially if the area gets more than one drenching rain. By the end of the breeding season, each female may have produced thousands of eggs. After she lays the eggs, they sink to the bottom of the water, where they hatch into tadpoles a few days later. The tadpoles group closely together, forming living balls of tadpoles. The larger tadpole balls can reach 3.3 feet (1 meter) in diameter. The tadpoles change into froglets in one to three months. If the water is warmer, they make the change, called metamorphosis (MEH-tuh-MORE-feh-sis), sooner. In cooler water, metamorphosis occurs later.

MESOAMERICAN BURROWING TOADS AND PEOPLE

If enough frogs are calling at once, the noise sounds something like running machinery, and people sometimes hear this so-called chorus (KOR-us) of breeding calls from up to a mile away. Outside of the breeding season, however, people rarely see this frog. It is not popular in the pet trade. It did, however, draw at least a little attention in 2004 when a part-time stuntman rode his unicycle in Death Valley, California, to raise awareness of the Mesoamerican burrowing toad.

CONSERVATION STATUS

This species is not considered to be at risk. It is quite common in parts of Mexico and Central America, but it is rare in the United States and only lives in a few scattered areas in Texas. For this reason, Texas Parks and Wildlife lists it as threatened.

FOR MORE INFORMATION

Books:

Lee, Julian C. *The Amphibians and Reptiles of the Yucatán Peninsula.* Ithaca, NY: Comstock Publishing Associates, Cornell University Press, 1996.

Meyer, John R., and Carol F. Foster. *A Guide to the Frogs and Toads of Belize.* Malabar, FL: Krieger, 1996.

Web sites:

Beaudry, B. 1999. "*Rhinophrynus dorsalis.*" *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Rhinophrynus_dorsalis.html (accessed on February 10, 2005).

Cannatella, David. "Rhinophrynidae." *Texas Memorial Museum, University of Texas.* http://www.zo.utexas.edu/research/salientia/rhinophrynidae/rhinophrynidae.html (accessed on February 10, 2005).

"Family Rhinophrynidae (Burrowing Toad)." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Rhinophrynus_dorsalis.html (accessed on February 10, 2005).

"Mexican Burrowing Toad." *Amphibian Conservation Alliance.* http://www.frogs.org/amphibianet/species.asp?Genus=Rhinophrynus&Species=dorsalis (accessed on February 10, 2005).

"Mexican Burrowing Toad." *eNature, National Wildlife Federation.* http://www.enature.com/fieldguide/showSpeciesFT.asp?fotogID=1098&curPageNum=4&recnum=AR0712 (accessed on February 10, 2005).

CLAWED FROGS AND SURINAM TOADS

Pipidae

Class: Amphibia
Order: Anura
Family: Pipidae
Number of species: 30 species

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

With their flat bodies and their wide and fishlike heads, the clawed frogs and Surinam toads are an odd-looking bunch. The head is flat in some species and shaped like a wedge—taller in the back and tapering down toward the front—in others. They have tiny eyes on the top of the head, but they do not have tongues. Their eardrums do not show on the sides of their heads, as they do in many other frogs. Another unusual feature is the line of stitchlike marks that run down each side of the body from the head to the rump. The marks are not actually stitches but allow the frog to feel the movements made by other animals in the water. This line of marks is known as a lateral (LAT-eh-rul) line system. While such a system is common in tadpoles and in fishes, it is unusual in adult frogs. The lateral line, which senses vibrations in the water, is helpful in finding prey.

Clawed frogs and Surinam toads have long hind legs with large, fully webbed feet. The webbing may match their foot color, or it may be a different color, such as the orange-yellow of the Müller's plantanna. The forelegs of clawed frogs and Surinam toads are much smaller than their hind limbs, and the thin toes on the front feet in most species do not have any webbing between them. The only members of this family with front toe webbing are the dwarf clawed frogs, which fall into the groups known as *Hymenochirus* and *Pseudhymenochirus*. All except two species, including the Surinam toad, have three claws on each foot. The claws are the second, third, and fourth toes. The outside two toes on each hind foot are clawless. A typical species

in this family has a tan, greenish brown, or gray back, usually with dark spots or markings, and a lighter colored underside with dark markings. Depending on the species, they may either have bumpy or smooth skin. The adults of some species grow to 0.8 to 1.2 inches (2 to 3 centimeters) long from the tip of the snout to the end of the rump, but others can reach as much as 4.1 to 6.7 inches (10.4 to 17 centimeters) in length.

None of the 30 species in this family has vocal sacs. In most other species of frogs, the vocal sac looks like one or two bubbles located below the chin that blow up with air and deflate when the frog makes its call. The clawed frogs and Surinam toads do not even have vocal cords, which are the structures inside the throat that most animals, including humans and other mammals, use to make noises. Instead, these frogs have two disks in their throats that move back and forth to produce clicking sounds. Since these frogs do their clicking underwater, the sound travels through the water as a vibration, rather like an underwater ripple. Another frog can hear the clicks through a different disk that sits under its skin and on the side of its head. This disk picks up the vibration and passes it along to the inner ear, which is the part of the ear located inside the head, and the frog hears the click.

FROGS IN SPACE

Four female frogs soared into orbit in 1992 on board the Space Shuttle Endeavor. Their trip was part of an experiment to see whether their eggs could live and grow normally in a gravity-free environment. Scientists treated the females with a chemical that triggered them to lay their eggs. They then added a male frog's sperm to the eggs to begin development. Through experiments like this one, they hope to learn how difficult it may be for humans to live and reproduce in space.

GEOGRAPHIC RANGE

Clawed frogs and Surinam toads live in tropical parts of South America, but not in mountains, and in the central and southern region of Africa, which is known as sub-Saharan Africa. Humans have brought them to other places, including the United States, the United Kingdom, and other parts of Europe and South America.

HABITAT

Members of this family live in many different watering holes including mucky swamps, small pools of water that dry up during part of the year, large ponds that are filled all year long, and slow-flowing rivers and streams. They rarely leave the water. If

their pool dries up, they typically burrow into the still-wet muck at the bottom and wait for the rains to return.

DIET

Many of the tadpoles are filter feeders, which means that they suck in water and strain out bits of food that were floating in it. The tadpoles of the dwarf clawed frogs actively hunt down and eat insects and other invertebrates (in-VER-teh-brehts) or animals without backbones that they find in the water. Adult clawed frogs and Surinam toads eat insects, fishes, occasionally their own tadpoles, as well as mammals and birds that may fall into the water. Since they have no tongues, they must lunge at prey and grab it with their mouths. Some use their front feet to stuff their catch farther into their mouths and/or use the claws of their hind limbs to shred their catch before swallowing it down.

BEHAVIOR AND REPRODUCTION

Clawed frogs and Surinam toads spend much of their time floating in the water with their legs held out from the sides of their bodies. Their dark colors blend in with the water, which makes them difficult for predators to see. They are also quite skittish. The common plantanna, for example, will dive to the bottom of its watering hole as soon as it feels the least bit threatened. Clawed frogs and Surinam toads almost always stay in the water, but sometimes, on very rainy nights, these frogs may leave the water and move short distances from one pond to the next. If they happen to live in a pool of water that dries up during part of the year, clawed frogs and Surinam toads typically bury themselves in the muddy bottom and wait for drenching rain to wet the ground again. This underground waiting period is called estivation (es-tih-VAY-shun). During this time, they do not eat and instead live off fat and other stored energy in their bodies. They may estivate for several months at a time.

Although scientists have not studied these water-loving species very closely, they believe the frogs may mate at any time of year, as long as a heavy rain has soaked the land. Both males and females have the throat disks that allow them to make underwater clicking noises. Each species can make three to six different types of clicks, at least one of which is used to signal that mating time has started. Males climb onto the backs of the females to mate. If a male accidentally climbs onto the back of

another male, the second male will click differently to tell the other to get off. As the males and females mate, the females of most species drop their eggs in the water. The eggs hatch into tadpoles, some of which have tiny bits of flesh dangling from the edge of the mouth. These fleshy bits, called barbels (BAR-bulls), are feelers.

Female Surinam toads lay and raise their eggs in a more bizarre way. She flips over while she is laying her eggs, and the eggs settle onto her back, where they stick. Her flesh then swells up around the eggs, turning her back into a sponge-like cradle for them. Depending on the species, the eggs may hatch into tadpoles, or they may skip the swimming tadpole stage and hatch right into froglets. Scientists know this type of back cradle occurs in all but one of the Surinam toads. This is the Myers' Surinam toad, and scientists still are not sure how and where its eggs hatch.

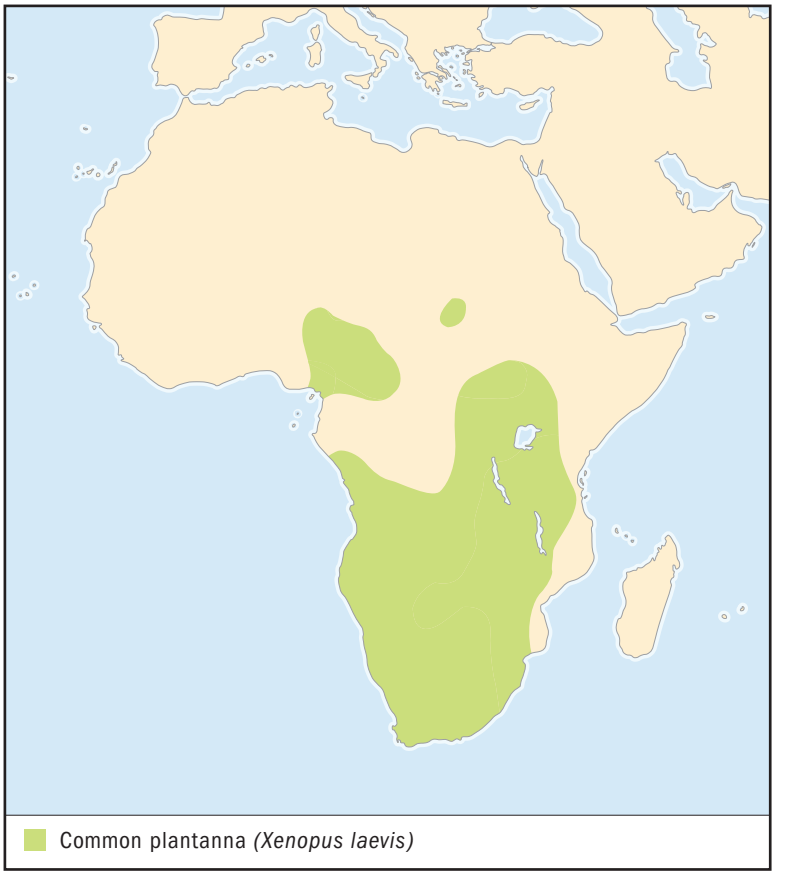
CLAWED FROGS, SURINAM TOADS, AND PEOPLE

People rarely see these frogs in the wild, but they are still very important creatures. Scientists have discovered some unusual chemicals in their skin that may be useful in treating illnesses or in preventing infections. One of these substances, first found in the skin of the common plantanna, is called magainin. Magainin is a piece of protein known as a peptide that fights both germs and fungi. Scientists have started to test this peptide and other compounds like it for use on such things as bandages to help cuts and other wounds heal faster. In addition, scientists use these frogs in the laboratory to study the development of their eggs. Common plantannas carry their see-through eggs on their backs, which provides a good view of the young as they grow and develop inside the egg.

CONSERVATION STATUS

Of the 30 species in this family, the World Conservation Union (IUCN) considers one to be Critically Endangered, which means that it faces an extremely high risk of extinction in the wild; two to be Endangered and facing a very high risk of extinction in the wild; and one to be Near Threatened, which places it at risk of becoming threatened with extinction in the future. It also views seven other species as Data Deficient, a category that means the IUCN does not have enough information to make a judgment about their threat of extinction.

The Critically Endangered species is the Lake Oku clawed frog, which lives in a single lake in western Cameroon. The lake currently has no fish in it to prey on the frogs, but conservationists fear that an introduced fish might find its way into the lake and possibly wipe out the entire frog species. The two Endangered species are the Myers' Surinam toad and Gill's plantanna (also known as the Cape clawed toad or Cape plantanna). Myers' Surinam toad lives in a small area in Panama, and Gill's plantanna lives in a tiny part of southwestern South Africa. Habitat loss is a threat to both species. In addition, water pollution appears to be hurting the Myers' Surinam toad.



Common plantanna *(Xenopus laevis)*

COMMON PLANTANNA (AFRICAN CLAWED FROG) *Xenopus laevis*

Physical characteristics: The common plantanna goes by several different common names, including African clawed frog and clawed toad. It has a flat head and body with long and strong hind legs. Its back and the top of its head are dark-colored, usually gray to olive-brown and sometimes are marked with dark, occasionally orangish, spots. Its underside is lighter colored and may be off-white, light gray, or grayish yellow, sometimes with faint, gray speckles. A thin row of what look like stitches run down each side of the otherwise smooth back from behind the eye to the rump. Each row holds 23 to 31 "stitches." The plantanna has two tiny eyes on top of its wide head and a tiny bit of flesh, called a tentacle, under each eye. It has no



The common plantanna is a water-loving species. It can live in all types of water from fast-moving rivers to calm ponds. (Photograph by E.R. Degginger. Bruce Coleman Inc. Reproduced by permission.)

tongue. True to its name, it has little black claws on three toes of each hind foot. The feet are quite large and have gray webbing between and to the tips of the long toes. Sometimes the webbing has a little yellow or orange color to it.

Males and females of this slippery-bodied frog look nearly alike, except that males are smaller. A male grows to about 1.8 to 3.8 inches (4.6 to 9.7 centimeters) long from the tip of the snout to the end of the rump, while females can reach 2.2 to 5.8 inches (5.6 to 14.7 centimeters) long.

Geographic range: The common plantanna is an African frog that lives as far south as South Africa and north to Kenya, Uganda, the Democratic Republic of Congo, and Cameroon. In addition, people have introduced them to many other nations, including England, Germany, Chile, and the United States.

Habitat: The common plantanna is a water-loving species. It can live in all types of water from fast-moving rivers to calm ponds. It can even survive in mucky pools and swamps and in somewhat salty water. Although its native African habitats do not cool much in the winter, it has held up well in places that have winters cold enough to freeze the tops of ponds.

Diet: Tadpoles eat by straining little pieces of algae (AL-jee) and other tidbits from the water. Algae are tiny plantlike organisms that live in water but have no true roots, stems, or leaves. Once the tadpoles change into froglets, their diet switches to insects and other invertebrates they find in the water. Adults also eat young, or larval

(LAR-vuhl), mosquitoes and other insects, sometimes leaping out of the water to nab a flying insect, and will eat larger things, such as fish or birds and mammals that fall into the water. Sometimes they even eat their own eggs and tadpoles.

Behavior and reproduction: Common plantannas stay in the water for almost their entire lives, only coming onto land now and then at night. People most often see them floating at the water's surface, with legs outstretched, and only the top of their heads out of the water. If their pond or swamp dries up, they will dig down into the mud, hind end first, and bury themselves until the rains return.

In addition to signaling the end of estivation for some frogs, the rains combine with warm weather to trigger the mating season for the entire species. Unlike most other types of frogs, both the males and the females call. Their call, which they make underwater, sounds like a buzzing tap. The females lay about one thousand tiny tan eggs, which stick to underwater plants and rocks.

Common plantannas and people: Though it seems strange now, until the 1940s, people turned to these frogs to learn whether a woman was pregnant. To do it, they used a hypodermic needle to suck up a little of the woman's urine and then inject it under the skin of the female frog. If the woman was pregnant, the hormones in her urine would spark the frog to start laying eggs. If the woman was not pregnant, the frogs laid no eggs. Medical professionals now find out if a woman is pregnant through other tests that do not involve frogs.

Nowadays, this species has another role in medicine. One chemical in its skin kills bacteria and may be a useful antibiotic, while another may be helpful in explaining how the human brain works. Besides its importance in medicine, people buy and sell the common plantanna as a pet. Some local people in Africa also once collected the frogs for food.

Conservation status: Because these frogs live in many areas and do well in a variety of different habitats, the species is not considered to be at risk. ■



TROPICAL CLAWED FROG
Silurana tropicalis

Physical characteristics: If a frog were made of milk chocolate and started to melt, it would look something like the tropical clawed frog. This frog has a light chocolate brown or slightly greenish brown, flat, round blob of a body. Tiny gray and black marks fleck its back, and a row of 18 to 20 "stitches" runs down each side of the body from the eye to the rump. Its underside is white or light gray with some black blotches. It has a small, flat, round head with two beady eyes on top, and a tiny tentacle hanging below each eye. Its hind legs are large and pudgy. When the frog is sitting, its back legs and its much smaller forelegs stick out from the side of the animal, rather than tucking against the body as is common in most other frog species. Three claws



If a frog were made of milk chocolate and started to melt, it would look something like the tropical clawed frog. (Illustration by Michelle Meneghini. Reproduced by permission.)

are visible on its feet. The females are slightly larger than the males and usually grow to 1.7 inches (4.3 centimeters) long from snout to rump. The males typically reach 1.4 inches (3.6 centimeters) long.

Geographic range: Tropical clawed frogs live in western Africa.

Habitat: The tropical clawed frog lives mainly in water within tropical forests, but sometimes it lives in the ponds of grassland areas that are alongside forests. It does not exist in mountain areas.

Diet: From what little is known about its diet, scientists believe the tropical clawed frog eats almost anything it can find, including various invertebrates and tadpoles. They are not sure if it eats its own tadpoles or those of other frogs.

Behavior and reproduction: This frog stays in the water most of the time, but it will move about on land from pond to pond on very rainy nights. They behave differently during the dry season, when water can be scarce. Those that live near rivers hide in holes or under stone and roots during the daytime and sit at night in small, rocky pools of water left standing along the river. Those that live in ponds that lose much of their water in the dry season will bury themselves in the muddy pond bottom.

The tropical clawed frog takes advantage of the year-round warmth of the climate where it lives and may mate whenever a heavy rain drenches the land. The males will make their rattling call at night from large forest ponds or small forest pools. When a male finds a female, he climbs onto her back and holds on above her hind legs to

mate with her. She lays her eggs in the water, and the eggs stick to underwater plants.

Tropical clawed frogs and people: People rarely see this frog in the wild, and it is not popular in the pet trade.

Conservation status: This species is not considered to be at risk. ■



Surinam toad *(Pipa pipa)*

SURINAM TOAD
Pipa pipa

Physical characteristics: The Surinam toad is nothing less than bizarre. Its body is so flat that it appears as if it has been run over. It has a triangular-shaped head that comes to a point at the end of the snout. Its fairly short hind legs have huge, webbed feet. Each of the toes on its short front legs is split at the end into four pieces that almost look like four more small toes, and each of these small "toes" is split again at the tip into two more. It also has tiny, spiny bits of skin poking out from the sides of its mouth. Two tiny eyes may peer out from the top of the head, but sometimes they are completely hidden



The female Surinam toad incubates eggs on her back, which remain there for three or four months. At that time, the eggs hatch right into froglets. (Photograph by Tom McHugh/Steinhart Aquarium. Photo Researchers, Inc. Reproduced by permission.)

underneath flesh. The Surinam toad also has two slits for nostrils on the top of its head. Its body is dark brown, grayish brown, or tan and often has a blotched pattern. Its underside has a T-shaped marking with the top of the T running across the chest. Females are usually a bit larger and can grow to 4 to 7 inches (10.5 to 17.1 centimeters) long from the snout to the rump. The males usually reach no more than 6 inches (15.4 centimeters) long.

Geographic range: The Surinam toad lives in the northern and central parts of South America, including Colombia, Venezuela, Guyana, French Guiana, and Surinam (also sometimes spelled Suriname) in the north, and south into Brazil, Ecuador, Peru, and Bolivia. It also lives on the West Indies island of Trinidad.

Habitat: The Surinam toad lives on the bottoms of mucky ponds and swamps, as well as in slow-flowing streams and rivers throughout the lowland rainforests. It does not live in the mountains.

Diet: This toothless, tongueless frog catches small fish and invertebrates underwater by lunging at the prey while opening wide its mouth and blowing up its body. This sucks in the water and the prey together. Using its front feet, it pushes the prey farther into its mouth.

Behavior and reproduction: This frog stays still and rests in the mucky water bottom much of the time, but it will move on land from pond to pond on very rainy nights. Because it usually stays out of sight, scientists know little else about its non-mating behavior. During the mating season, they call with a sharp clicking noise. The males grab onto the females in piggyback fashion, hanging on in front of her hind legs. The frog pair rolls over while floating in the water, and the female lays three to five eggs while she is in the upside down position. The eggs catch on the male's belly, then drop onto the female's back as the pair completes the roll. Instead of the eggs sticking to vegetation or floating off into the water as they do with most frogs, the eggs stay on the mother's back, where they become caught. Her skin swells up around the sides of each egg. In all, she may have about 50 eggs on her back, which remain there for the next three or four months. At that time, the eggs hatch right into froglets, which pop right out of her back.

Surinam toads and people: Some people eat these frogs.

Conservation status: This species is not considered to be at risk. ■

FOR MORE INFORMATION

Books:

Channing, Alan. *Amphibians of Central and Southern Africa.* Ithaca, NY: Comstock Publishing Associates, Cornell University Press, 2001.

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians (Smithsonian Handbooks).* New York: Facts on File, 1991.

Maruska, Edward J. *Amphibians: Creatures of the Land and Water.* New York: Franklin Watts, 1994.

Miller, Sara Swan. *Frogs and Toads: The Leggy Leapers.* New York: Franklin Watts, 2000.

Rödel, Mark-Oliver. *Herpetofauna of West Africa.* Vol. 1, *Amphibians of the West African Savanna.* Frankfurt: Edition Chimaira, 2000.

Tinsley, R. C., and H. R. Kobel, eds. *The Biology of Xenopus.* London: Clarendon Press, 1996.

Web sites:

"African Clawed Frog." *Smithsonian National Zoological Park.* http://nationalzoo.si.edu/Animals/ReptilesAmphibians/Facts/FactSheets/Africanclawedfrog.cfm (accessed on February 14, 2005).

"Frog Facts: About the African Clawed Frog." *Fluffy's Frog Pond.* http://fluffyfrog.com/FrogPondFactsF.html (accessed on February 14, 2005).

"Froggiecam." *Ferrell Lab, Stanford University.* http://www.stanford.edu/group/ferrelllab/frogtank.html (accessed on February 12, 2005).

"Frogs: A Chorus of Colors." *American Museum of Natural History.* http://www.amnh.org/exhibitions/frogs/featured/laboratory.php (accessed on February 14, 2005).

"*Xenopus laevis* African Clawed Frog." *Western Ecological Research Center, San Diego Field Station, U.S. Geological Survey.* http://www.werc.usgs.gov/fieldguide/xela.htm (accessed on February 12, 2005).

ASIAN TOADFROGS
Megophryidae

Class: Amphibia
Order: Anura
Family: Megophryidae
Number of species: 107 species

family CHAPTER

PHYSICAL CHARACTERISTICS

Most of the Asian toadfrogs have vertical, cat-like pupils, paddle-shaped tongues, and colors and patterns on their heads and backs that blend in with their environment. Some species have warty skin, but others have smooth skin. A few do not have the cat-eye pupils. These include species like the Asian mountain toad, which has a diamond-shaped pupil. The males and females look quite similar for most of the year. In the breeding season, the males of some species develop bright red-, yellow-, or orange-colored spots on their sides and upper legs or some colorful tints on their front toes or on their vocal sacs. The vocal sac is a balloon-like area under the chin that blows up and deflates when the male performs its call. Also during the mating season, the males of some species, including those known as alpine toads and cat-eyed frogs, develop rough patches on the chest and front toes. Male moustache toads are unusual in that they grow spiny "moustaches" when they are ready to mate.

Asian toadfrogs are split into two main groups. One group includes the leaf litter and dwarf litter frogs, the slender mud frogs, the lazy toads, and the moustache toads. All of these frogs have a bump that runs from the second toe onto the first, or big, toe. They usually have large or small "horns" on their eyebrow ridges. The horns are actually pieces of flesh that are pointed. In fact, the name of the family, Megophryidae, is from two Greek words that mean "large eyebrow." Some, like the Asian horned frog, have large, pointed eyebrows. The "horns" on other species are much smaller, and some do not have them

at all. This group of frogs has tadpoles with mouths that are pointed upward on their heads and look like funnels. The tadpoles also have a small, fingernail-like beak on the lower jaw.

The other main group of Asian toadfrogs include a variety of mostly large-eyed frogs that have a large bump at the bottom of the second front toe but not on the first toe. Species in this family are the horned frogs, broad-headed frogs, Asian mountain toads, Burmese spadefoot toads, and others. Their tadpoles have larger beaks on both the upper and lower jaws, and mouths that open on the bottom of the head.

The species in this family come in many sizes, too. The smallest only grow to 0.7 inches (1.8 centimeters) long from snout to rump, but the largest top 5.5 inches (14 centimeters) in length. The broad-headed toads can grow to 6.6 inches (16.8 centimeters) long. The females usually outgrow the males, but in the moustache toads, the males are slightly longer.

GEOGRAPHIC RANGE

Asian toadfrogs live in many areas of Southeast Asia and Indonesia.

HABITAT

Although Asian toadfrogs live in many different habitats, most tend to prefer old, thick forests that have ground covered by layers of leaves. Most of them move into clean and clear streams, usually those with slow currents, to breed.

DIET

Many Asian toadfrogs eat a wide variety of invertebrates (in-VER-teh-brehts), or animals without backbones. Some, like the Annam broad-headed toad, are opportunistic (ah-por-toon-ISS-tik) feeders. An opportunistic feeder is an animal that will eat almost anything it can catch, get into its mouth, and swallow. Many Asian toadfrogs hunt by sitting still and waiting for prey to wander by. This type of hunting is called ambush hunting.

BEHAVIOR AND REPRODUCTION

The typical Asian toadfrog spends its days resting under rocks, logs, or leaf piles on land and comes out at night to look for food. They are mostly slow-moving frogs that rarely climb and are not particularly good hoppers or swimmers. The leaf

litter frogs, for instance, do a slow, waddling walk on land. A few species, like the Asian mountain toad, do some climbing, especially during the mating season. They climb onto branches above the stream, where they mate. Despite the slow speed of most Asian toadfrogs, they are able to avoid the mouths of predators by blending into the background. Most of them have backs and heads in grays and browns that are similar in color to the leaf piles scattered on the forest floor. Many of them also have horn-like eyebrows that make the frog look like a dead leaf. At the slightest sound, these frogs hunker down and stay still and wait for the predator to pass by. The broad-headed toads have another defense tactic. If a predator comes too close, these frogs will spread open their big mouths and hold them wide. Sometimes the sight frightens off the attacker.

PUT YOUR HEAD ON MY SHOULDER

Some male frogs use other methods besides calling to convince females to mate with them. One of the Asian toadfrogs is the slender mud frog, also known as the mountain short-legged toad, which is a dark-speckled, orange to tan, somewhat warty frog. When a female comes close to a male, he lays his chin on her shoulder, then moves toward a rock in a shallow mountain stream. If she is interested, she follows him, they mate, and she lays her eggs underwater and beneath the rock.

For those that live in cool or dry areas, the mating season begins when rainy weather arrives. Those whose homes are in places that are mild and wet all year may mate over longer periods. During the mating season, the males usually move to stream shores and begin calling. Although a male may make a few half-hearted calls during the day, it mainly does its calling after sundown. Depending on the species, the male's call may sound like a honk, a loud clank, a low bark, a repeating whistle, or some other noise. During mating a male climbs onto the female's back. The males of some species then grasp her at her front legs, while other males hold on to her above her hind legs. The female lays her eggs so they attach, often in clumps, to the bottom of large rocks along the stream's bank. The adults leave, and the eggs soon hatch into tadpoles. The moustache toads mate a bit differently. In these species, several males may group together at a nesting site and, after mating with females, remain with the eggs until they hatch. Tadpoles of many Asian toadfrogs stay in slower parts of the stream, but a few, like the slender mud frog, prefer faster currents in stony streams. Some tadpoles do not change into frogs until they are two years old. A few species, like the Bana leaf litter frog, appear to lay their eggs on land.

ASIAN TOADFROGS AND PEOPLE

People who live near the larger species sometimes eat them, but for the most part, people rarely see any of the Asian toadfrogs. These frogs, however, may prove to be quite important to humans. Since the tadpoles must have clean streams to live and grow, they are good bioindicator (bie-oh-IN-dih-KAY-tor) species. A bioindicator species is an animal that people can use to tell whether the environment is healthy. For example, if a population of Asian toadfrogs were to disappear suddenly from an area, the change might mean that the water in the streams has become polluted.

CONSERVATION STATUS

Of the 107 species in this family, the World Conservation Union (IUCN) considers three species to be Critically Endangered, which means that they face an extremely high risk of extinction in the wild; 14 to be Endangered and facing a very high risk of extinction in the wild; and 26 to be Vulnerable and facing a high risk of extinction in the wild. In addition, 13 are Near Threatened and at risk of becoming threatened with extinction in the future; and 28 others are Data Deficient, which means that the IUCN has too little information to make a judgment about the threat of extinction.

The three Critically Endangered species are the web-footed dwarf litter frog, the Liangbei toothed toad, and the spotted lazy toad. The web-footed dwarf litter frog has a very small population that lives only in one place: near a small, clear, rocky stream in a forest reserve of Sabah, in Malaysian Borneo. Although the stream is inside a reserve, loggers are removing the surrounding forests. Since this species probably spends much of its life in those vanishing forests, it may soon become extinct. The Liangbei toothed toad also lives in a tiny area and breeds in just one small, mountain stream in southern Sichuan province, China. Scientists believe the entire species has fewer than 100 members. The stream is not in a protected area, and the surrounding forests are disappearing to logging. If its forest habitat disappears from logging or from a fire, this frog could easily become extinct. The last of the three Critically Endangered species is the spotted lazy toad, which is known from just a few individuals that were collected in the 1970s from mountains in China. Although scientists have made numerous searches since then, they have not been able to find any more of these frogs and fear they may already be extinct.

Many of the other Endangered, Vulnerable, and Near Threatened species in this family are in danger because their habitat is disappearing, mainly due to people cutting down forests for lumber or to make way for farming or houses. In some cases, the number of frogs is dropping because fertilizers and pollutants are draining into the streams where the frogs have their young. The tadpoles typically cannot survive in anything but clean, clear water. Changes in the habitat are especially dangerous for those species that live in very small areas. In fact, scientists believe that nearly one of every four Asian toadfrog species lives or breeds in only one place, such as a tiny part of a mountain forest or stream. For them, a few days of tree-cutting or a change to one stretch of a stream can wipe out their entire home.



SPECIES ACCOUNTS

BANA LEAF LITTER FROG
Leptobrachium banae

Physical characteristics: The Bana leaf litter frog has a body that looks too big for its skinny legs. It has a wide head with huge, bulging eyes. The eyes are black on the bottom, white on top, and circled with a thin, white circle. Its back is dark brown with tiny, red spots along the sides and also on its hind legs. Its front and back legs are brown with darker bands continuing down onto its toes. It has a white-spotted gray underside. Adult females can grow to 3.1 to 3.3 inches (8 to 8.4 centimeters) long from the snout to the rump, but adult males typically only reach 2.3 to 2.9 inches (5.7 to 7.3 centimeters) in length.

Geographic range: The Bana leaf litter frog lives in the Gia Lai province of south-central Vietnam and in the Annamite Mountains of Laos.



By day, the Bana leaf litter frog hides under the leaves that coat the forest ground. It comes out at night to wander about on land. Often, this species actually walks, rather than hops. (Illustration by Bruce Worden. Reproduced by permission.)

Habitat: The Bana leaf litter frog lives in thick, evergreen primary forests, which are forests that have never been cut down. These forests are located where the land is higher—between 2,620 and 5,240 feet (800 to 1,600 meters) above sea level.

Diet: The Bana leaf litter frog probably eats insects.

Behavior and reproduction: By day, this frog hides under the leaves that coat the forest ground. It comes out at night to wander about on land. Often, this species actually walks, rather than hops. Unlike many other frogs that mate and lay their eggs in the water, this frog does both on land. People have heard lone males calling from beneath logs and in burrows that are nowhere near a stream. More studies will provide additional information about this species.

Bana leaf litter frogs and people: People rarely see or hear this nighttime frog.

Conservation status: The World Conservation Union (IUCN) considers this species to be Vulnerable, which means that it faces a high risk of extinction in the wild. In Vietnam, its habitat is disappearing as people clear the land for farming or through logging. ■



Schmidt's lazy toad *(Oreolalax schmidti)*

SCHMIDT'S LAZY TOAD
Oreolalax schmidti

Physical characteristics: Sometimes called the webless toothed toad, the Schmidt's lazy toad is a grayish brown animal with warts dotting its body, thin forelegs, and rather short back legs. All of its legs have dark bands. Their undersides are pinkish tan and almost see-through. Adults grow to 1.7 to 2.0 inches (4.5 to 5.4 centimeters) long from snout to rump. Males are usually just a bit smaller than the females. The males also have many spines on the first toe of each front foot and two, large, rough spots on the chest. These rough spots, called nuptial (NUHP-shul) patches or nuptial pads, help the male hold onto the female's slippery back during mating.

Geographic range: The Hengduanshan Mountains of southern Szechwan and Yunnan, which are located in central to southern China, are home to this species.



Because the Schmidt's lazy toad lives in a very small area and its numbers are low, any changes to its habitat could be dangerous to this frog. (Illustration by Bruce Worden. Reproduced by permission.)

Habitat: Schmidt's lazy toad lives in marshes and streams within mountain forests and valleys.

Diet: No one knows what this toad eats.

Behavior and reproduction: Schmidt's lazy toad lives most of its life on land. During mating season, the males begin calling, often from underneath a rock. Unlike most other frogs, they will keep on calling even if a person walks up and flips over their rock, leaving the frog in plain sight. When the males spot a female, they will surround her and continue calling. Male and female pairs mate in the water, and the female lays a sticky ball of about 120 eggs onto the bottom of a stream rock. The eggs hatch into green- and gold-speckled tadpoles, which turn into froglets shortly after breeding season the following year.

Schmidt's lazy toads and people: People and these frogs rarely see one another.

Conservation status: The World Conservation Union (IUCN) considers this species to be Near Threatened, which means that it is at risk of becoming threatened with extinction in the future. Because it lives in a very small area and its numbers are low, any changes to its habitat could be dangerous to this frog. ■



Ailao moustache toad *(Vibrissaphora ailaonica)*

AILAO MOUSTACHE TOAD
Vibrissaphora ailaonica

Physical characteristics: The small spines that stick straight out of the male's upper lip give the Ailao moustache toad, also known as a Yunnan moustache toad, its common name. Its other common name, the Ailao spiny toad, also refers to its prickly lip. The females do not have spines and instead have tiny white spots on the upper lip. They have large eyes that are black on the bottom and bright green on the top and have vertical, cat-like pupils. Their bodies are reddish brown with faint, darker brown spots on the back and pale, dark brown bands on their front legs, unwebbed front toes, back legs, and webbed back toes. Their skin may be very rough and make them look as if they had been dipped in sand. Young frogs are tan instead of reddish brown and have more noticeable spots and bands on their bodies. Unlike many other species in this family, the males are a bit larger than



The small spines that stick straight out of the male's upper lip give the Ailao moustache toad, also known as a Yunnan moustache toad, its common name. (Illustration by Bruce Worden. Reproduced by permission.)

the females. Males typically reach 3.2 inches (8.2 centimeters) long from snout to rump, while females usually grow to 3.1 inches (7.8 centimeters) in length.

Geographic range: The moustache toad lives in the Ailao Shan and Wuliang Shan mountain ranges in central Yunnan, China, and possibly in northern Vietnam.

Habitat: The moustache toad spends most of the year on land in thick, shady forests high in the mountains, usually between 7,220 to 8,200 feet (2,200 to 2,500 meters) above sea level. During the mating season, it moves into slow-moving, clear streams.

Diet: It appears to eat various invertebrates, such as worms and snails, that it catches on the forest floor.

Behavior and reproduction: The Ailao moustache toad stays on land most of the year, but moves into a stream during the two- to six-week-long mating season in late winter. Several males share a nesting site under a large rock, and each male begins to sprout the 10 to 16 spines in his "moustache." At the same time, the male's front legs become thicker, and the skin on his back and sides starts to droop and become baggy. Females come to the nest, mate with the males, and lay their eggs in the nest. In most other species of frogs, both the male and female leave after the female lays her eggs, and the eggs hatch and

develop on their own. In the Ailao moustache toad, however, the females leave, but the males stay with the eggs. The males may continue to mate with other females, who also lay their eggs in the same nest. In about 40 days, the eggs hatch into tadpoles. The brown-colored tadpoles change into froglets in their second year.

Ailao moustache toads and people: Few people have ever seen this frog.

Conservation status: The World Conservation Union (IUCN) considers this species to be Near Threatened, which means that it is at risk of becoming threatened with extinction in the future. The Ailao moustache toad seems to be quite rare. However, most if not all of its habitat is inside nature reserves, where it is protected. ■



Asian horned toad *(Megophrys montana)*

ASIAN HORNED FROG
Megophrys montana

Physical characteristics: The Asian horned frog, which is sometimes called the Asian spadefoot toad, looks as if it has horns over its dark brown eyes. It is a big-bodied frog with a large head that sometimes has a fleshy lump on the end of its snout. Its back is tan to reddish brown and has several ridges that run from the head to the rump. Its hind legs usually show dark banding, but the bands may be faint. Other than a few small lumps on its back and sides, the frog has smooth skin. Males and females look alike, but the females are usually larger. Females can grow to 2.6 to 4.4 inches (6.7 to 11.1 centimeters) long from snout to rump, while the males usually only reach 1.7 to 3.6 inches (4.4 to 9.2 centimeters) in length.

Geographic range: Asian horned frogs are found in parts of Southeast Asia and Indonesia, including Thailand, Malaysia, the Philippines,



Asian horned toads look for food on the forest floor at night, eating larger invertebrates, such as cockroaches and land snails, as well as scorpions that may be as long as the frogs themselves. (© Suzanne L. Collins & Joseph T. Collins/Photo Researchers, Inc.)

Sumatra, Java, Borneo, and tiny Natuna Island northwest of Borneo.

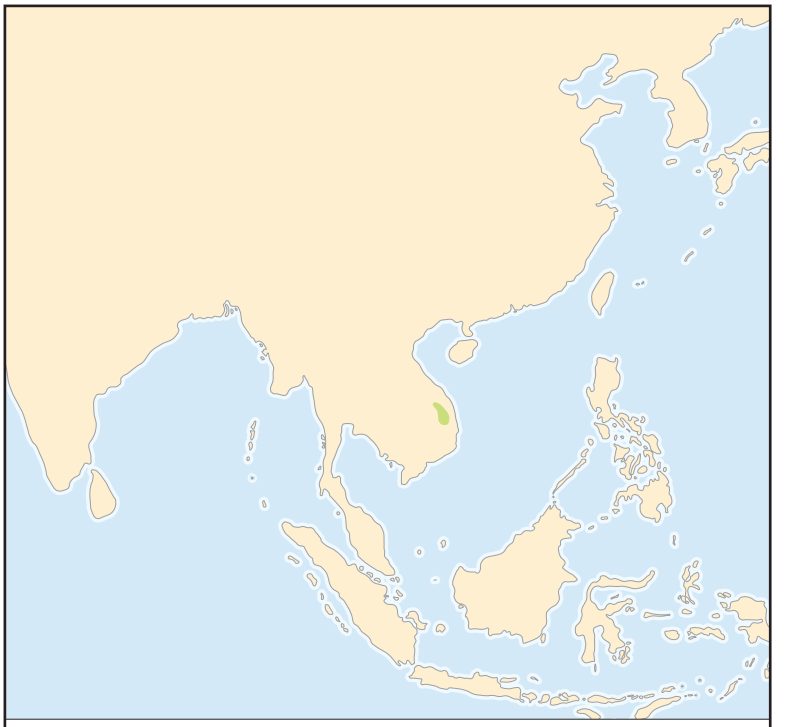
Habitat: Asian horned frogs live in thick, shady, humid, tropical forests, sometimes high in the mountains. They may also live in farm fields.

Diet: This frog looks for food on the forest floor at night, eating larger invertebrates, such as cockroaches and land snails, as well as scorpions that may be as long as the frog itself.

Behavior and reproduction: This frog takes advantage of its leaf-life body to hide from predators. When it crouches down and sits still, as it does whenever a possibly dangerous animal approaches, the frog looks like any other dead leaf lying on the ground. This ability to stay out of sight is important for this species, because it cannot move very fast on land or in the water, and it does not climb. The Asian horned frog is mainly active at night. During the day, it hides under leaves, logs, or rocks. It stays on land most of the year, but moves to small- and medium-sized streams during the mating season. The male's mating call is a loud, echoing honk or clang. The males appear to call more on nights with a full moon. Females lay their eggs in the water along the shore, and the see-through eggs hatch into brown-colored tadpoles that hide among underwater plants until they change into froglets, which probably happens when they are about two months old.

Asian horned frogs and people: People rarely see this well-camouflaged, nighttime frog in the wild.

Conservation status: This species is not considered threatened or endangered. In the areas where it lives, it is quite common. ■

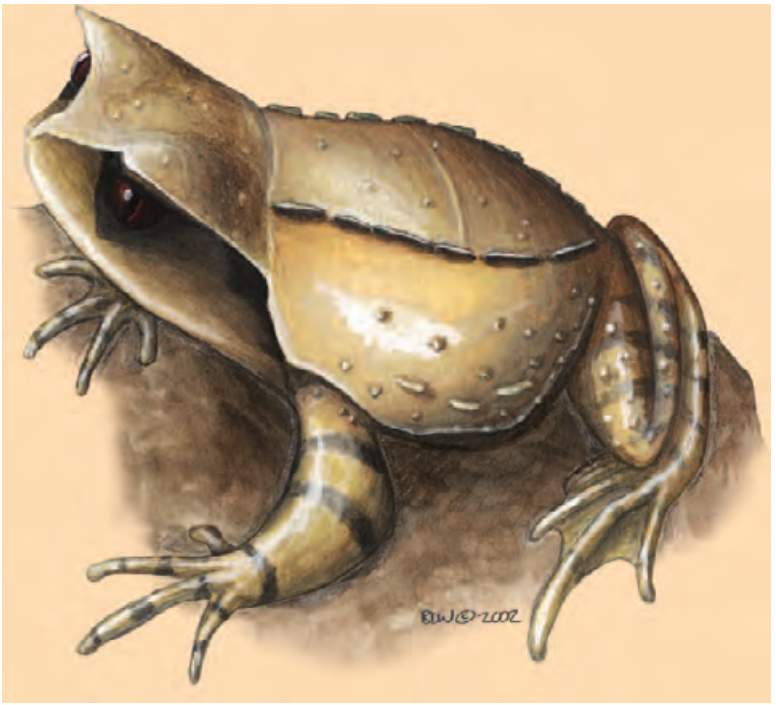


Annam broad-headed toad *(Brachytarsophrys intermedia)*

ANNAM BROAD-HEADED TOAD
Brachytarsophrys intermedia

Physical characteristics: Annam broad-headed toads, also known as Annam spadefoot toads, have so many ridges on their bodies that the head and back almost look as if they are covered with an armor shield. Two ridges begin at the back of the wide head, carry up over the eye to make a pointy eyebrow, then run forward to meet at the tip of the frog's pointed snout. Other, sometimes broken, ridges run from the rear of the head over the broad back or down its sides to the rump. Its head and back are usually light brown to reddish brown. Large for an Asian toadfrog, a female Annam broad-headed toad can grow to 5.5 inches (13.9 centimeters) long from snout to rump. The males are smaller and can reach 4.6 inches (11.8 centimeters) in length.

Geographic range: The Annam broad-headed toads are found in southern central Vietnam.



Annam broad-headed toads, also known as Annam spadefoot toads, have so many ridges on their bodies that the head and back almost look as if they are covered with an armor shield. (Illustration by Bruce Worden. Reproduced by permission.)

Habitat: Annam broad-headed toads live in mountainside forests that are between 2,460 to 3,940 feet (750 to 1,200 meters) above sea level. During mating season, they move into nearby streams.

Diet: This toad is an opportunistic feeder that will eat everything from insects and spiders to small frogs and rodents.

Behavior and reproduction: This frog sits still most of the time and blends into the background, which is useful for ambushing prey and for keeping out of sight of predators. If a predator does spot the frog and approach, the frog will open wide its mouth, which may scare away the predator. Unlike most frogs that mate in the spring, or in the spring and summer, this frog mates early in the spring and also late in the fall. The males move to streams and start calling from a sheltered spot under a large rock. Females come to the streams, mate with the males, and lay their eggs under the rocks.

Annam broad-headed toads and people: People rarely see this frog in the wild.

Conservation status: The World Conservation Union (IUCN) now considers the Annam broad-headed toad to be Vulnerable, which

means that it faces a high risk of extinction in the wild. Once a common species, its habitat has disappeared in the past 100 years, and the number of frogs has dropped. ■

FOR MORE INFORMATION

Books:

Cogger, Harold G., and Richard G. Zweifel. *Encyclopedia of Reptiles and Amphibians.* San Diego, CA: Academic Press, 1998.

Inger, Robert F. "Distribution of Amphibians in Southern Asia and Adjacent Islands." In *Patterns of Distribution of Amphibians: A Global Perspective,* edited by William Duellman. Baltimore: Johns Hopkins University Press, 1999.

Zhao, Er-Mi. "Distribution Patterns of Amphibians in Temperate Eastern Asia." In *Patterns of Distribution of Amphibians: A Global Perspective,* edited by William Duellman. Baltimore: Johns Hopkins University Press, 1999.

Web sites:

"Black-eyed Litter Frog." *Ecology Asia.* http://www.ecologyasia.com/verts/amphibians/black-eyed_litter_frog.htm (accessed on February 16, 2005).

"Draft Report Assessing the Impact of Importing Live Asian Horned Frog (*Megophrys montana*) into Australian Zoos." *Australian Government Department of the Environment and Heritage.* http://www.deh.gov.au/biodiversity/trade-use/publicnotices/archive/draft-report/m-montana.html#range (accessed on February 17, 2005).

"Frogs in Kerinci Seblat." *Kerinci Seblat National Park.* http://www.kerinci.org/about_frog.html (accessed on February 17, 2005).

"Malayan Horned Frog." *Ecology Asia.* http://www.ecologyasia.com/verts/amphibians/malayan_horned_frog.htm (accessed on February 16, 2005).

"Mountain Litter Frog." *Ecology Asia.* http://www.ecologyasia.com/verts/amphibians/mountain_litter_frog.htm (accessed on February 16, 2005).

"Spotted Litter Frog." *Ecology Asia.* http://www.ecologyasia.com/verts/amphibians/spotted_litter_frog.htm (accessed on February 16, 2005).

"Yunnan Moustache Toad." *Science Museums of China.* http://www.kepu.com.cn/english/animal/class/cls404.html (accessed on February 16, 2005).

SPADEFOOT TOADS
Pelobatidae

Class: Amphibia
Order: Anura
Family: Pelobatidae
Number of species: 11 species

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

The spadefoot toads are named for the small scoops, or spades, on the bottoms of their hind feet. They use their spades, which are made of the same material as fingernails, to move away the dirt as they burrow into the soil. The spadefoot toad is actually not a true toad. All true toads are grouped into the family called Bufonidae. Spadefoot toads do look a bit like true toads, because they have round, plump bodies, but they do not have very warty skin. Their skin is actually quite smooth and moist, although tiny lumps are sometimes noticeable on their backs. These small lumps may be tipped in red. In addition, spadefoot toads also have teeth on the upper jaw. True toads do not.

Many of the species in this family have brown to gray backs, sometimes with faint stripes or spots, and light-colored bellies. Their eyes have vertical, catlike pupils. Some, like the Great Basin spadefoot, have a large lump between the eyes. Depending on the species, adults may grow to 2 to 3.2 inches (5.1 to 8.1 centimeters) from the tip of the snout to the end of the rump.

Their eggs are tiny and typically dark brown. The tadpoles are usually tan to brown in color. Some have orange speckles and see-through tails.

GEOGRAPHIC RANGE

Four species live from Europe and western Asia to northwestern Africa. The remaining seven are North American species, found from southern Mexico through the United States and to southern Canada.

HABITAT

Spadefoot toads are burrowing frogs that live in areas with loose, often sandy soil and usually dry weather. Some, like the Plains spadefoot toad, can live in almost desert-like conditions. They come above ground, usually at night following a heavy rain or when the air is humid, to find food. Spring rains also bring the frogs onto land for mating. Those that live in the driest of places, however, may stay underground for all but two weeks of the year.

DIET

Unlike most other frog species, the tadpoles of spadefoot toads are not just vegetarians. They will suck in water and sift out bits of plants, as some other species of tadpoles do, but they will search the water to catch and eat insects and other invertebrates (in-VER-teh-brehts), which are animals without backbones. Once they become frogs, they switch to an all-meat diet and eat snails, spiders, earthworms, and various insects, including beetles, grasshoppers, and caterpillars.

BEHAVIOR AND REPRODUCTION

The spadefoot toads are burrowing frogs that spend their days and many of their nights underground where the ground is moist. They use the spades on their feet to dig rump-first into the ground. They shovel with one foot at a time and wiggle their bodies backwards into the burrow. During the rainy season, their burrows are only a couple of inches (5 centimeters) deep, but during long dry times, they may burrow down 3 feet (1 meter) or more. On rainy nights, or nights that are humid, they will come above ground to look for food. They need the moisture in the air because they can die if their skin dries out. When the soil becomes dry even deep below the surface, these frogs may snuggle inside layers of their own dead skin to keep themselves at least slightly moist and away from the dry soil, which might soak up what little moisture they have. They can survive inside these cocoons of dead skin for many weeks.

Because they stay underground much of the year, the spadefoot toads can avoid many of their predators. Even when they are above ground, the browns and grays of their skin can help to hide them from hungry eyes, especially if they stay perfectly still. If a predator does spot them, the frogs can defend

NO RELATIVE OF MINE

For many years, scientists had thought the Asian toadfrogs and spadefoot toads were so similar that they should both be placed in the same group, called a family. Closer studies revealed that the two were much more different than originally thought, and in 1985 scientists separated the toadfrogs into their own family.

themselves by sucking air into their lungs and blowing up their bodies to make them look bigger than they are. Their larger bodies might be enough to frighten away certain predators. Some species, like the eastern spadefoot toad, have skin that gives off bad-tasting and often smelly ooze that might discourage a predator. Despite all of these defense tactics, these frogs sometimes become lunch for their predators, including birds, such as owls and crows; mammals, like coyotes; and snakes.

Dangers aside, the spadefoot toads leave the protection of their underground burrows to mate on land. The sound of rain drumming on the ground overhead brings out hundreds of male spadefoot toads, which hop to puddles or shallow ponds and begin calling while floating in the water. Depending on the species, the calls may sound like crows cawing, sheep baaing, or a finger squeaking against a balloon. The calls can become quite loud, and people have reported hearing them from a mile (1.6 kilometers) away. In the water pools, the males set up territories and keep their distance from one another. The males call most at night, but may also call sometimes during the day. The females arrive and select mates. To mate, a male climbs onto a female's back and clings to her with his forelegs wrapped just in front of her hind legs. The eggs, which can number several hundred to more than a thousand per female, stream from her body and stick in clumps to underwater plants, stones, and other items. The eggs usually hatch into tadpoles within a week. If the weather is especially warm, they may hatch in just one to three days.

Dry weather is always a threat to a tadpole, which must turn into a froglet before its watering hole evaporates. Some species, like the Plains spadefoot toad, can change into a froglet in just a few days. Usually, however, tadpoles need about one month to become froglets. Sometimes, females lay so many eggs in a small pool of water that the growing tadpoles run out of space and food. At these times, some of the tadpoles begin to eat each other, although they can recognize their littermates and do not gulp them down, too.

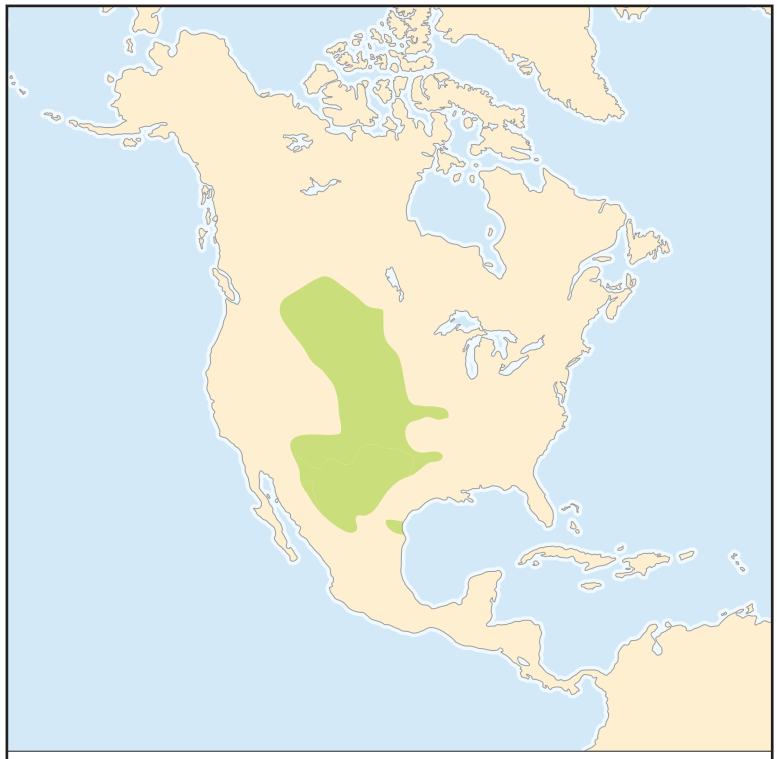
SPADEFOOT TOADS AND PEOPLE

People may hear these frogs occasionally during their mating season, but they rarely see the animals in the wild. Spadefoot toads are not especially popular in the pet trade, although some people do keep them in their homes. Nonetheless, at least one species has received attention. In 2003, the state government of New Mexico named the New Mexico Spadefoot Toad, a red and brown speckled species, as its official state amphibian.

CONSERVATION STATUS

The World Conservation Union (IUCN) considers one species to be Endangered, which means that it faces a very high risk of extinction in the wild. The U.S. Fish and Wildlife Services does not list any species as being at risk. The IUCN Endangered species is Varaldi's spadefoot toad, which lives in a few small areas in Morocco in northwestern Africa. Like many other spadefoot toads, it lives mainly underground in sandy soils, but comes on land to mate in puddles and pools of water. As humans farm in areas where the frog lives, the soil is beginning to pack down, which makes the frog's digging more difficult, and new pollutants are entering the watering holes. Both are likely hurting the frogs. In addition, some frogs are able to breed in larger ponds that are filled with water all year, but these ponds often are also home to fishes that eat the frogs.

Although no other species is considered to be at risk, some populations, including Couch's spadefoot toad, appear to be disappearing due to pollution and/or habitat destruction.



SPECIES ACCOUNT

PLAINS SPADEFOOT TOAD
Spea bombifrons

Physical characteristics: Plump and round-bodied, the Plains spadefoot toad has wrinkled skin. Its head has a short, rounded, and slightly upturned snout and two very large eyes with catlike, vertical pupils. Between its eyes and running down to the top of its snout is a blisterlike hump, also known as a boss. Its short forelegs end in feet with small toes that have no webbing between. It has webbed feet on its large back legs, and the bottom of each foot has a single, small, black scoop, or spade, below the toes. Its back is light tan, milk chocolate-colored, greenish brown, or gray, sometimes with four light-colored stripes running from head to rump, or with numerous faint, darker brown spots. The toads occasionally have red or yellow sand-like bumps on their backs, which may sit in small dark spots. The underside is white, although the males sometimes have a noticeable blue



Plains spadefoot toads are burrowing frogs that spend their days and many of their nights underground where the ground is moist. (Illustration by Emily Damstra. Reproduced by permission.)

or gray tint on the sides of the throat. Adults grow to about 1.5 to 2.5 inches (3.8 to 6.4 centimeters) from the tip of the snout to the end of the rump.

Geographic range: The Plains spadefoot toad is a North American species and lives from northern Mexico into the southern tip of Texas and in a wide area from northern Mexico through many central U.S. states and into southern Canada.

Habitat: It makes its home in the dry prairies and farm fields that are common in central North America.

Diet: Night hunters, adults eat insects and other invertebrates.

Behavior and reproduction: The Plains spadefoot toad is a fossorial (faw-SOR-ee-ul) animal, which means that it lives most of its life underground. The small spades on its feet help it dig hind-end-first into the loose, often sandy soil of its habitat. It leaves its burrows at night after a rain or when the air is humid to look for food. It also comes out of its underground burrow to mate. When the spring rains drench the land, hundreds of these frogs will all hop from their burrows at once to mate. Because so many frogs mate together over a short time, scientists call them explosive breeders. The males find small puddles and shallow ponds and begin making their squeaky calls to attract females. While mating, each female lays hundreds of eggs, which stick to underwater plants, rocks, and other objects. Within two days, the eggs hatch into tadpoles, and these change into

froglets in as little as two weeks. This quick egg-to-tadpole-to-froglet growth is important, because they live in a habitat where puddles and ponds can dry up in a very short time. A tadpole cannot survive without water. Males and females may mate again later in the year if another heavy rain soaks the ground.

Plains spadefoot toads and people: People only notice this toad when a group of males is calling together.

Conservation status: This species is not considered to be threatened. In some areas, however, its habitat is disappearing at an alarming rate. A few states and provinces have now begun taking measures to protect it. ■

FOR MORE INFORMATION

Books:

Duellman, William E., and Linda Trueb. *Biology of Amphibians.* Baltimore: Johns Hopkins University Press, 1994.

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians.* New York: Facts on File, 1991.

Stebbins, Robert C. *A Field Guide to Western Reptiles and Amphibians.* Boston: Houghton Mifflin, 1985.

Tyning, Thomas. *A Guide to Amphibians and Reptiles.* Boston: Little, Brown and Company, 1990.

Zug, George R., Laurie J. Vitt, and Janalee P. Caldwell. *Herpetology: An Introductory Biology of Amphibians and Reptiles.* 2nd ed. San Diego: Academic Press, 2001.

Periodicals:

Fellman, Bruce. "To eat or not to eat." *National Wildlife.* February-March 1995 (volume 33): page 42.

Freeman, Melanie. "The Spadefoot Toad." *Boy's Quest.* February-March 2002 (volume 7): page 2.

Web sites:

"Eastern Spadefoot Toad." *Connecticut Department of Environmental Protection.* http://dep.state.ct.us/burnatr/wildlife/factshts/esptoad.htm (accessed on February 14, 2005).

"Eastern Spadefoot Toad." *Savannah River Ecology Laboratory, University of Georgia.* http://www.uga.edu/srelherp/anurans/scahol.htm (accessed on February 14, 2005).

"Frogs and Toads Found in Texas." *Texas Parks and Wildlife.* http://www.tpwd.state.tx.us/nature/education/tracker/amphibians/species/ (accessed on February 14, 2005).

"Great Basin Spadefoot Toad." *B.C. Frogwatch Program, Ministry of Water, Land, and Air Protection, Government of British Columbia.* http://wlapwww.gov.bc.ca/wld/frogwatch/whoswho/factshts/spadeft.htm (accessed on February 14, 2005).

"Official State Amphibian: New Mexico Spadefoot Toad." *Netstate.com.* http://www.netstate.com/states/symb/amphibians/nm_spadefoot_toad.htm (accessed on February 14, 2005).

"Plains Spadefoot, *Spea bombifrons*." *Northern Prairie Wildlife Research Center, U.S. Geological Survey.* http://www.npwrc.usgs.gov/narcam/idguide/speab.htm (accessed on February 14, 2005).

"Plains Spadefoot Toad." *Lee Richardson Zoo.* http://www.garden-city.org/zoo/animalinfo/plains_spadefoot.htm (accessed on February 14, 2005).

PARSLEY FROGS
Pelodytidae

Class: Amphibia
Order: Anura
Family: Pelodytidae
Number of species: 3 species

family
CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

Parsley frogs have little dark green blotches on their backs that look somewhat like pieces of parsley. Many people are familiar with parsley as the small, ruffled leaf that often decorates a plate of food at a restaurant. The frogs are rather thin and somewhat flattened with short, slender forelegs and long back legs. Their backs are brown, light greenish brown, or gray and speckled with small rounded warts. The Caucasus parsley frog, also known as the Caucasian parsley frog or Caucasian mud-diver, may have some red dots on its back. The underside in all three species is whitish to gray. The toes on their front feet are long and thin and have no webbing between them. The even-longer toes on the back feet have only a small amount of webbing. These frogs have large eyes with vertical pupils, a rounded snout, and no obvious eardrum on the side of the head. They are rather small frogs, growing to 1.8 to 2.2 inches (4.5 to 5.5 centimeters) long from snout to rump.

Males and females may be quite similar. In the Caucasus parsley frog, however, the female has a reddish back and lower belly. During mating season, the male parsley frog may develop small, rough pads on the toes of its front feet, on its forelegs, and/or on its chest. The rough spots, called nuptial (NUHP-shul) pads, help the male hold onto the wet and slippery body of the female during mating.

Until the year 2000, scientists thought that two of the three species in this family—the common parsley frog and the Iberian parsley frog—were the same species. The Iberian parsley

frog, however, has some slight differences. Additional studies are now needed to find out whether populations that were thought to be common parsley frogs are actually Iberian parsley frogs and how the "new" species is surviving overall. In other research, scientists believe this family once had more than just three species. Based on fossils they have studied, they think the extinct species may actually outnumber the living ones.

Some people group the parsley frogs within the family spadefoot toads, but most scientists believe the parsley frogs should be separated into their own family as they are listed here.

GEOGRAPHIC RANGE

All three species of this family live in Europe and/or western Asia. The species known simply as the parsley frog or common parsley frog is found in southwestern Europe. The Caucasus parsley frog lives in Turkey and other areas near the Caspian Sea. The Iberian parsley frog lives in the southern parts of Portugal and Spain.

HABITAT

Parsley frogs live in various moist places, often near water. Some may live in forests near a stony stream, and others in a meadow near a pond. Tadpoles can survive in somewhat salty water.

DIET

Mostly night-feeders, the parsley frogs eat insects, worms, slugs, and other invertebrates (in-VER-teh-brehts), or animals without backbones.

BEHAVIOR AND REPRODUCTION

By day, parsley frogs take cover under rocks or in the bushes or grass that grow along walls. They leave their hiding places as the sun sets and begin hopping about looking for food. They usually stay fairly close to a body of water. If they feel threatened, they can either use their long, strong legs to leap out of sight on land or into the water, where they are good swimmers. The warts on their skin contain a bad-tasting poison, which is useful if a predator happens to catch and try to eat one.

When fall comes, some of the parsley frogs that live in colder areas prepare for hibernation (high-bur-NAY-shun), which is a state of deep sleep. They may start hibernating as early as

BIG BABIES

In some species, such as the parsley frogs, the tadpoles can be larger than the adults. How can this be? The answer is in the tail. As a tadpole changes into a froglet, it absorbs its tail. In other words, the tail disappears into the body. Often, new froglets still have small stumps of tail that have not yet vanished. In most frogs, tadpoles make the change into froglets when they are just a few months old. In parsley frogs and some other types of frogs, however, the tadpoles may not become froglets for one or two years. These especially old tadpoles can grow to be quite large—sometimes nearly twice as big as the adults.

September and not become active again until the following March. The Iberian parsley frog, which lives in the warmer climate of southern Spain and southern Portugal, remains active all year long and actually is the most lively in winter, when the cold-climate species are hibernating.

For cold-climate species, mating begins in the spring when warm rains soak the ground. In its much warmer climate, however, the Iberian parsley frog mates from fall to spring and becomes less active in the hot summer months. The males travel to ponds, puddles, and sometimes very slow-flowing streams and start calling. Scientists believe that they may call underwater. To mate, a male climbs onto female's back, and she lays her eggs. A female may lay several dozen eggs at a time and, depending on the species, may lay several hundred over the whole night. Sometimes, they may breed more than once a year, such as spring and fall. The eggs attach to sticks and leaves underwater and eventually hatch into tadpoles. Eggs of the Iberian parsley frog hatch quickly, needing just a week before the tadpoles wiggle out.

Depending on the species of parsley frog and the weather, the tadpoles may change into froglets about two to three months later, may hibernate as tadpoles and make the change the second year, or may hibernate yet again and change into froglets in their third year. Tadpoles hibernate by sinking into the mud at the bottom of their pond or pool of water and remaining there until the spring. Tadpoles that wait longer to change into froglets can grow quite large, sometimes even becoming bigger than the adults. Parsley frogs usually are old enough to have young of their own when they are two to three years old. Only frogs, and not tadpoles, can mate and have young.

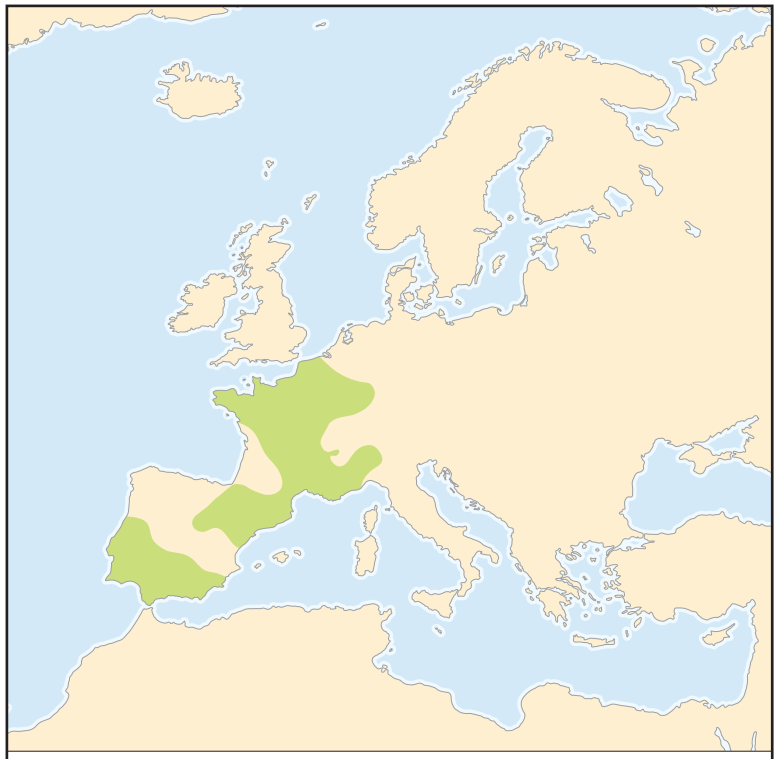
PARSLEY FROGS AND PEOPLE

People rarely keep these frogs as pets, do not eat them as food, and do not collect them for experiments or for making medicines. Since parsley frogs spend their days hidden away,

most people never see them. The frogs may still be helpful to humans, however, because they eat insects that some people consider pests.

CONSERVATION STATUS

None of these three species is generally considered to be at risk. However, several countries have listed them as Endangered or Vulnerable. An Endangered species faces a very high risk of extinction in the wild, and a Vulnerable species faces a high risk. In some populations, the number of frogs has dropped quite low. Often, the destruction of habitat is to blame. Sometimes, people drain water from a marsh or stream to turn it into farmland or to build homes or businesses. In addition, the habitat may become dangerous to frogs because of fertilizers and other pollutants that drain from human developments into streams and ponds.



Parsley frog *(Pelodytes punctatus)*

SPECIES ACCOUNT

PARSLEY FROG
Pelodytes punctatus

Physical characteristics: Also known as the common parsley frog or mud-diver, adults of this species are thin, somewhat flattened frogs. They have brown, light brownish green, or gray backs with dark green blotches and have numerous, small warts. The belly and the throat are whitish, and the underside of their legs is yellow-colored. They have a thin, black stripe on each side of the head from the snout, through the middle of the eye, and to the foreleg, as well as dark blotches on the upper lip. Their eyes are large and copper-colored and have vertical pupils. They do not have obvious eardrums showing on the sides of the head. Their forelegs are smaller and thinner than their hind legs, and all four limbs are brown with green blotches. The parsley frog has long toes. The toes on the front feet have no



The warts on the skin of parsley frogs contain a bad-tasting poison, which is useful if a predator happens to catch and try to eat one. (Illustration by Bruce Worden. Reproduced by permission.)

webbing between them, and the toes on the back feet have only a little webbing at the bottom. Adults grow to 1.4 to 1.8 inches (3.5 to 4.5 centimeters) from the tip of the snout to the end of the rump. The tadpole is greenish brown with noticeable dark eyes. It has an oval-shaped head and body and a long tail. Tadpoles can reach 1.6 to 2.6 inches (4 to 6.5 centimeters) long from head to tail before they change into froglets.

Geographic range: The common parsley frog lives in southwestern Europe, including Belgium, Luxembourg, France, Italy, Spain, and Portugal.

Habitat: The common parsley frog lives in many habitats, including forests, shrubby woods, and farmland, that either have very damp ground or are near a pond or stream. They mate in streams and small ponds.

Diet: It eats insects and other small invertebrates.

Behavior and reproduction: During the day, these frogs hide under stones or in small dips or holes in the ground, but they sometimes will venture out during or after a good rain. They become active from dusk to dawn. Animals that are active only at sunup and sundown are crepuscular (kreh-PUSS-kyoo-ler). Animals active at night

are called nocturnal (nahk-TER-nuhl). Using these terms, the parsley frog is both crepuscular and nocturnal. The parsley frogs that live in warmer areas are active almost all year long. Those that live in cooler areas may survive the winter by hibernating. Some hibernate from October to February or March.

When outside from dawn to dusk, the frogs protect themselves from predators in several ways. The colors of the back and head help blend them into the background and make them less noticeable to predators. If a predator does approach them on land, however, they are excellent jumpers and can often leap away. When they are near the water, they will jump in and swim. Although their hind feet do not have much webbing to help boost them through the water, they are still good swimmers. If a predator happens to catch a parsley frog, the warts in its skin ooze a mild poison that may taste bad enough to convince the predator to leave the frog alone.

Their mating season usually begins in the spring, but if the weather is right, they may mate almost any time of year, including the summer and fall. The male's call sounds a bit like a heavy, old door quietly creaking open. Females lay about 50 to 100 eggs at a time and may lay as many as 1,000 to 1,600 eggs a year in small strings or clumps. The eggs are tiny and brown and coated with a thick, see-through gel. The eggs stick to underwater plants and stems and hatch into tadpoles that may grow to be larger than the adult frogs.

Parsley frogs and people: Like most other frogs, this species eats insects that people may consider pests.

Conservation status: This species is not generally considered to be at risk, but Belgium, France, and other countries have listed it as Endangered or Vulnerable. In these areas, the numbers of parsley frogs have declined because of habitat destruction, especially the draining of water. ■

FOR MORE INFORMATION

Books:

Arnold, E. Nicholas. *Reptiles and Amphibians of Europe (Princeton Field Guides).* Princeton, NJ: Princeton University Press, 2003.

Arnold, E. N., J. A. Burton, and D. W. Ovenden. *Reptiles and Amphibians of Britain & Europe (Collins Field Guide).* London: HarperCollins, 1999.

Duellman, William E., and Linda Trueb. *Biology of Amphibians.* Baltimore: Johns Hopkins University Press, 1994.

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians.* New York: Facts on File, 1991.

Zug, George R., Laurie J. Vitt, and Janalee P. Caldwell. *Herpetology.* 2nd edition. San Diego: Academic Press, 2001.

Web sites:

"Dramatic Declines for European Amphibians." IUCN press release. http://www.countdown2010.net/documents/european%20frog%20and%20toad-2.pdf (accessed on February 14, 2005).

Heying, H. "Pelodytidae" *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Pelodytidae.html (accessed on February 14, 2005).

"Iberian Parsley Frog." *Amphibians and Reptiles of Europe.* http://www.herp.it/indexjs.htm?SpeciesPages/PelodIberi.htm (accessed on February 14, 2005).

"Parsley Frog, Common Parsley Frog, Mud-diver." *Amphibians and Reptiles of Europe.* http://www.herp.it/indexjs.htm?SpeciesPages/PelodPunct.htm (accessed on February 14, 2005).

GHOST FROGS
Heleophrynidae

Class: Amphibia
Order: Anura
Family: Heleophrynidae
Number of species: 6 species

family
CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

With colors and patterns that almost perfectly match the forest floor where they live, the ghost frogs live up to their name and, when they are very still, seem to vanish into the background. The Cape ghost frog, also known as Purcell's ghost frog, has a brown back and head that are covered with black blotches—almost as if someone had shaken out a wet paintbrush and splattered black paint on the frog. When in its habitat where the green mosses and plants and dark clumps of dirt and pebbles form a patterned blanket on the ground, the frog blends in well enough almost to disappear. People and predators can walk within a few feet of this frog and never notice it.

The other five species of ghost frog also have such camouflage, or cryptic (CRIP-tik) coloration. The frogs may be tan, brown, purplish brown, gray, or green, usually have darker blotches on the back and head, and may have dark bands around the front and back legs. The blotches may be purple, brown, or nearly black. The Natal ghost frog has the opposite coloration with a brown to black head and back and yellowish to green markings. The ghost frogs' undersides are typically lighter colored and almost see-through, giving them another ghost-like quality. Sometimes they have dark markings on the throat.

All ghost frogs have front and back toes that end in large, triangle-shaped pads. They have long, thin hind legs and shorter front legs on bodies that are slightly flattened. Their back toes are webbed, sometimes all the way to the tips. Their large,

bulging eyes have catlike, vertical pupils, and their snouts are rounded in front and somewhat flattened overall. In their mouths, the tongue is disk-shaped, and small teeth line only the upper jaw.

Ghost frogs are small- to medium-sized frogs, reaching 1.4 to at least 2.6 inches (3.5 to 6.5 centimeters) long from the tip of the snout to the rump. Males and females look mostly alike, but the females usually are larger. Females of the largest species sometimes reach lengths a bit longer than 2.6 inches (6.5 centimeters). Males of the species called Rose's ghost frog also have small black spines on their lower front and rear legs, back, and thighs, and male Natal ghost frogs develop pads on the lower front legs and little spines on the toes of their front feet during breeding season.

The ghost frogs were once grouped in another family that includes the Surinam horned frog and other leptodactylid frogs, but they now have their own family. Although scientists believe that the ghost frogs are a very ancient group, they have not yet found any fossils of species in this family.

GEOGRAPHIC RANGE

Ghost frogs live in and around South Africa's Drakensberg Mountains, where some of the world's highest waterfalls are found.

HABITAT

The ghost frogs may make their homes among the forests and sometimes grasslands of the Drakensberg mountain range, which are the highest mountains in South Africa. They can be found from sea level up the mountains' steep slopes to 9,843 feet (3,000 meters), but usually in an area with a swift, rocky river or stream, which is where they mate and have their young.

DIET

The adult diet includes various insects, snails, and other invertebrates (in-VER-teh-brehts), or animals with no backbone, as well as smaller frogs. They apparently are not cannibalistic (can-ih-bull-ISS-tik), which means that they do not eat members of their own species. The tadpoles are vegetarians and eat algae (AL-jee) that they scrape off underwater rocks. Algae are plantlike growths that live in water but have no true roots, leaves, or stems.

YEAR-ROUND WATER

Often, a tadpole's life depends on the water where it lives. Because tadpoles do most of their breathing through their gills, they have to remain in the water until they change into froglets, which can then breathe through their skin or with their lungs on land. In many species, the tadpoles are born into small watering holes and even puddles that dry up quickly. To survive, they must make the change into froglets while they are still only weeks or months old. In some species, like the ghost frogs, however, the tadpoles do not turn into froglets for 12 to 24 months. The adults must lay their eggs in lakes, ponds, rivers, streams, and/or wetlands that stay filled with water all year. Ghost frogs usually have their young in rivers and streams. Such waterways are called "permanent" because they are always, or permanently, filled with water. Those that dry up for part of the year are known as "temporary" watering holes, because they are only filled for a while, or temporarily.

BEHAVIOR AND REPRODUCTION

During the day, they hide from sight under or between rocks, or in cracks within rocks. Their flattened bodies help them to squeeze into even small openings. At night, they hop out to look for food. Their sticky, wide front and back toe tips help them to climb easily up even the wet and slippery sides of streamside rocks. Predators often do not see these camouflaged frogs, but even when they do, they often leave them alone, because the frog's skin contains a mild poison that many predators learn to avoid.

In the breeding season, the skin on these frogs becomes baggy. They usually breed from spring to mid-summer after the heavy storms of the rainy season. Male ghost frogs group together at waterfalls or at a river or stream with a fast current and begin calling from a hiding place under a rock or in a rock crack or from a spot that is sprinkled with water from a waterfall. Some species call both day and night, but others call mostly at night. Depending on the species, the call may be quite loud or so quiet that it can only be heard from about 10 feet (3 meters) away. Some calls, like those of the Cape ghost frogs and Natal ghost frogs, are repeating ringing sounds. Male and female ghost frogs are excellent swimmers and spend much of the breeding season in the water.

The females lay their 50 to 200 eggs one at a time either in a slow part of the stream or river or in a puddle or other wet area alongside the river or stream. Some species attach their large and gel-covered eggs to the bottom of an underwater rock. After the eggs are deposited, the female and male leave, and the eggs and tadpoles develop on their own. Usually within a week, the eggs hatch into tadpoles, which may stay in the quiet water or move into faster flowing water. They use their suction-cup-shaped mouths to grab onto rocks, while they scrape algae from them with tiny teeth. The tadpoles typically change into froglets when they are 1 to 2 years old.

GHOST FROGS AND PEOPLE

People rarely see these frogs.

CONSERVATION STATUS

According to the World Conservation Union (IUCN), two of the six species are Critically Endangered, which means that they face an extremely high risk of extinction in the wild. One is Hewitt's ghost frog, which lives in and around four streams about 1,310 to 1,805 feet (400 to 550 meters) above sea level in the Elandsberg mountains of South Africa's Eastern Cape Province. The frog breeds in the streams, but spends the rest of the year in the surrounding areas that have scattered trees and shrubs. Fires and human activity, like the logging of the few trees and the building of roads are destroying the frog's nonbreeding habitat and also allowing more dirt to drain into the streams where the frog has its young. In addition, new fish species that eat the frogs have been added to the streams, and in some places, the streams have dried up.

The other Critically Endangered species is Rose's ghost frog, which is also known as the Table Mountain ghost frog or thumbed ghost frog. This species makes its home in mountain forests, shrubby areas, and even inside caves on the sides of Table Mountain between 785 and 3,480 feet (240 to 1,060 meters) above sea level. The entire area where it lives is inside the Cape Peninsula National Park. New plants in the park, numerous park visitors, and a high number of fires are changing the frog's habitat and making it difficult for this species to survive. In addition, people have built holding areas for some of the mountain water, which is taking some away from the streams where the frogs' eggs and tadpoles develop. Since the tadpoles need more than a year before they turn into frogs and can leave the streams, they may die if too much water is sidetracked for the holding areas.

To learn more about the frogs of South Africa and how well they are surviving, scientists are now collecting information about them through the Southern African Frog Atlas Project (SAFAP).



Natal ghost frog *(Heleophryne natalensis)*

SPECIES ACCOUNT

NATAL GHOST FROG
Heleophryne natalensis

Physical characteristics: The Natal ghost frog has a brown to black head and back with yellowish to green blotches, and a lighter colored underside with markings on its throat. Like other ghost frogs, its body is flattened a bit, and it has small triangular-shaped pads on the tips of its front and back toes. Its large, bulging eyes have vertical, cat-like pupils.

Geographic range: It lives in the Drakensberg and Maluti mountains of South Africa, Lesotho, and Swaziland from 1,900 to 8,776 feet (580 to 2,675 meters) above sea level.



Natal ghost frogs' sticky, wide front and back toe tips help them to climb easily up even the wet and slippery sides of streamside rocks. (Illustration by Patricia Ferrer. Reproduced by permission.)

Habitat: The forests and sometimes the grasslands of the eastern mountains of southern Africa are home to these frogs. As the breeding season draws near, they travel 0.6 miles (1 kilometer) or more to reach a fast-moving stream where they mate and have their young.

Diet: Tadpoles are vegetarian and scrape algae from rocks with their small teeth. As adults, Natal ghost frogs eat spiders, small insects, and other invertebrates.

Behavior and reproduction: These frogs usually hide in holes along stream banks and cliffs during the daytime, but sometimes venture out to waterfalls, where they sit in water-splashed areas and look for things to eat. They are most active at night, however, and do the bulk of their hunting then. Their breeding season begins after the heavy spring rains. During this time, the males begin calling from hideaways under rocks, or in plants near a stream, or in the splashing water from a nearby waterfall. Their call sounds like the repeated ringing of a small, quiet bell. The females arrive, mate with the males, and lay their eggs beneath underwater rocks. In about four or five days, the eggs hatch into tadpoles. The tadpoles turn into froglets when they are 2 years old.

Natal ghost frogs and people: People rarely see this frog.

Conservation status: While the World Conservation Union (IUCN) does not list this rather common frog as being at risk, it does note that

the frog's numbers are slowly dropping. It believes several things are to blame. First, loggers and/or farmers are cutting down the forests that are home to this species. The removal of the trees can also muddy up the streams and rivers and make it difficult for the frogs to breed there. This muddying happens because plants, including trees, help keep rain from quickly washing down hills and slopes and taking the soil with it into the water. In addition, people are draining away water from under the ground. People are also putting barriers, or dams, in the rivers. Both activities can cause the levels of the rivers and streams to fall. If too much water disappears, the tadpoles, which need water to survive, could die. Another threat comes from fish, such as trout, that people put in the rivers. People may add trout to a waterway for sport fishing or for food. The problem is that the trout eat many other animals, including tadpoles and frogs. ■

FOR MORE INFORMATION

Books:

Channing, A. *Amphibians of Central and Southern Africa.* Ithaca, NY: Cornell University Press, 2001.

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians (Smithsonian Handbooks).* New York: Facts on File, 1991.

Miller, Sara Swan. *Frogs and Toads: The Leggy Leapers.* New York: Franklin Watts, 2000.

Web sites:

"Cape Ghost Frog." *Cape Nature Conservation.* http://www.capenature.org.za/cederbergproject/html/capeghost.html (accessed on February 17, 2005).

"The Ghost Family: Six Amphibians Exclusive to Southern Africa." *The World Conservation Union (IUCN).* http://www.iucnrosa.org.zw/news/ghost_frogs.html (accessed on February 17, 2005).

Heying, H. "Heleophrynidae." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Heleophrynidae.html (accessed on February 17, 2005).

"Table Mountain Ghost Frog." *University of the Western Cape.* http://www.botany.uwc.ac.za/envfacts/fynbos/ghost_frog.htm (accessed on February 17, 2005).

"UCT (University of Cape Town) scientists join project." *Amphibian Conservation Alliance.* http://www.frogs.org/news/article.asp?CategoryID=46&InfoResourceID=939 (accessed on February 17, 2005).

SEYCHELLES FROGS
Sooglossidae

Class: Amphibia
Order: Anura
Family: Sooglossidae
Number of species: 4 species

family CHAPTER

PHYSICAL CHARACTERISTICS

A small family, the Seychelles frogs include only four species. They are Gardiner's frog, which is one of the tiniest frogs in the world; a species known simply as Seychelles frog; Thomasset's frog; and the family's newest member, Seychelles palm frog, which scientists named in 2002. The frogs have a typical frog appearance with hind legs that are longer than the front legs, long toes on the hind feet and shorter ones on the front feet, and large, bulging eyes on the head. They also have a somewhat pointy snout and horizontal pupils in their eyes.

The four species come in different colors. The upper body of the Seychelles frog is usually yellowish brown with black spots and blotches. The Gardiner's frog may be reddish brown or tan with or without spots or stripes and sometimes with noticeable, small warts. The newly named Seychelles palm frog is light brown with a dark, diamond-shaped pattern in the middle of its back and faded dark patterns on its hind legs. Finally, Thomasset's frog is dark brown to reddish brown with a thin, light stripe running from its snout down the middle of its slightly warty back to its rump. The back also sometimes has small light-colored specks on either side of the line. Whatever their color or pattern, however, the four species blend in quite well with their habitat. Males and females look alike.

Depending on the species, the adults may be very small or medium-sized. The Gardiner's frog, which is tiny enough to completely fit on a U.S. dime, only reaches about 0.4 to 0.5 inch (1.0 to 1.3 centimeters) long from the tip of its slightly

pointy snout to the end of its rump. The largest member of the family is Thomasset's frog. This species usually grows to 1.8 inches (4.5 centimeters) in length. As in many other types of frogs, the females of each species are a bit larger than the males. For example, a female Gardiner's frog usually grows to 0.47 inch (1.19 centimeters) long and sometimes reaches 0.5 inch (1.3 centimeters) long, while the male typically grows to 0.4 inch (1 centimeter) long with a maximum length of 0.43 inch (1.1 centimeters).

In 2003, scientists announced the discovery of a new species of frog, known only by its scientific name—*Nasikabatrachus sahyadrensis*. They placed this species in its own family, but have since decided that its nearest relatives are the Seychelles frogs. In other words, the new species and the Seychelles frogs have the same ancestors. *Nasikabatrachus sahyadrensis* is a very odd-looking purple frog that apparently stays underground for all but two weeks a year, when it comes out to mate. The World Conservation Union (IUCN) considers it to be Endangered, or facing a very high risk of extinction in the wild, because it lives in a small area of mountain forests, and its habitat is disappearing as the forest is turned into farmland. As of 2004, scientists had only found 135 individuals, and only three of those were females.

GEOGRAPHIC RANGE

Seychelles frogs live only in the country called Seychelles, which is a group of islands in the western Indian Ocean about 580 miles (930 kilometers) northeast of Madagascar. Scientists believe that these islands may have been part of India far in the past, but about 55 to 65 million years ago, India began to slowly move away to its current location, about 1,800 miles (2,900 kilometers) north and now part of Asia. Like many other islands, the Seychelles islands are actually the tops of mountains that are mostly underwater. Scientists believe that the common ancestor of the Seychelles frogs and the new species of *Nasikabatrachus sahyadrensis*, lived more than 130 million years ago when Seychelles and India were still connected. As of yet, they have found no fossils of any of the four Seychelles frogs or of the new purple species.

HABITAT

Within Seychelles, these frogs live only on Mahé and Silhouette islands, and usually more than 656 feet (200 meters) above sea level, although a single Thomasset's frog was found

lower on the mountain, at about 312 feet (95 meters) above sea level. Rainforests are home for all four species. The Seychelles palm frog only lives in those areas that have plenty of palms, and Thomasset's frog likes to remain in forests near rocky streams.

DIET

They will eat mosquitoes, fruit flies, and other small insects, as well as mites and other invertebrates (in-VER-teh-brehts), which are animals without backbones, that they find in the forest. Thomasset's frog also hunts for insects alongside streams.

BEHAVIOR AND REPRODUCTION

The four Seychelles frogs usually stay out of sight under piles of leaves lying on the rainforest floor, inside cracks in rocks, and even within hollow plant stems or on the base of a leaf where it attaches to a stem. The Seychelles palm frog, for example, hunkers down in the leaves of palm and sometimes banana trees. Usually, only rains will bring the Seychelles frogs out of their hiding places. During these wet periods, the frogs will hop about day or night looking for food. Thomasset's frog often settles on a streamside rock after sunset and waits for flying insects to zip by closely enough for it to capture and eat them.

The mating season occurs during the rainy season. Males may call during the day or at night from under leaves or from one of their other hiding spots. Unlike the males of many other types of frogs, males in the Seychelles frog family do their calling alone and from their own personal, on-land location. In other frogs, the males often group together in one place—usually in the water—and all call at the same time.

From the "wrracck toc toc toc toc" of the Thomasset's frog to the high "peep" of the Gardiner's frog, each species has its own call. To mate, the male climbs onto the female's back and uses his front legs to hang just in front of her hind legs. Although scientists do not know how some of these frogs lay their

NEW PURPLE FROG!

In 2003, scientists announced the discovery of a new, red-eyed, purple frog that is so unusual, they even created a separate family for it. The frog, which is only known by its scientific name—*Nasikabatrachus sahyadrensis*—was described in *National Geographic News* as "a bloated doughnut with stubby legs and a pointy snout." Villagers in a small village in western India found the odd frog while digging a well and turned the purple creature over to scientists. After studying it, the scientists agreed that it was not only a new species, but was so different that it needed its own family, which is now known as Nasikabatrachidae. Of all the other frogs in the world, they think it is most closely related to the Seychelles frogs, which live 1,900 miles (3,000 kilometers) away on an island country in the Indian Ocean.

eggs or how those eggs develop into frogs, they do have details about Gardiner's frog and the Seychelles frog species. The female Gardiner's frog lays her eight to 15 eggs in a hiding place on the ground and stays with them. Instead of hatching into tadpoles, these eggs hatch in three to four weeks right into tiny froglets, each one about 0.12 inch (3 millimeters) long—no bigger than a grain of rice. As the froglets hop away, the female's job is done and she leaves. In the Seychelles frog species, the female lays her eggs on land and stays with them just as the Gardiner's frog does, but her eggs hatch in two to three weeks into tadpoles. Without water to swim in, the tadpoles instead wiggle up and cling to the mother's back. They stay there until a short while after they turn into froglets, and finally hop off to live on their own.

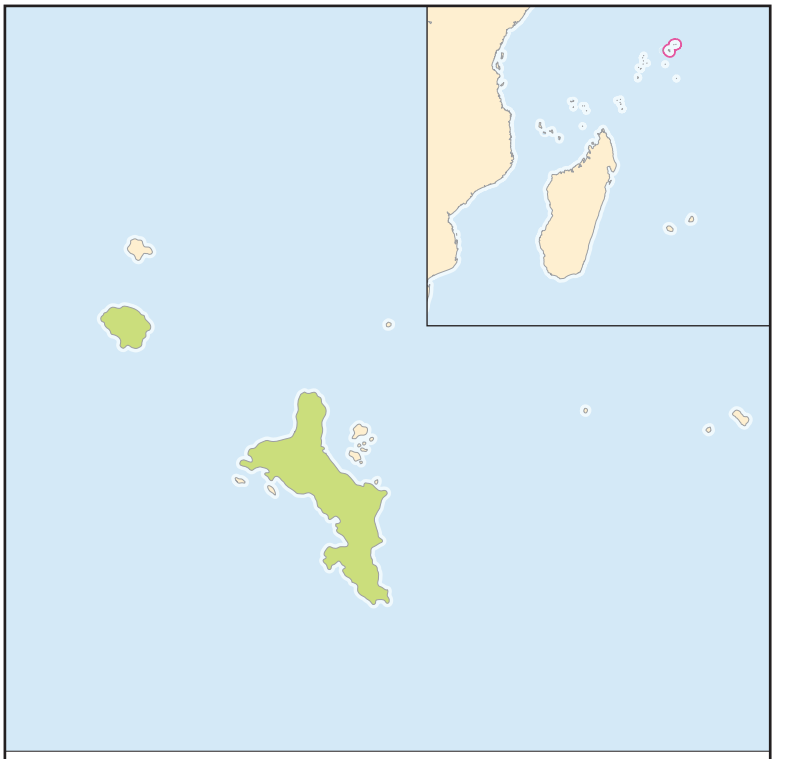
As yet, scientists are not sure how Thomasset's frogs or the Seychelles palm frogs mate, where the females lay their eggs, whether their eggs develop into tadpoles or right into froglets, and if the adult female or adult male watch over their young. They do know, however, that the female Thomasset's frog lays large eggs, and they think this may mean that her eggs skip the tadpole stage and hatch right into froglets. All frog species with eggs that hatch into tadpoles go through what is known as indirect development. Those whose eggs skip the tadpole phase and develop directly into froglets go through direct development.

SEYCHELLES FROGS AND PEOPLE

People rarely see these secretive frogs.

CONSERVATION STATUS

According to the World Conservation Union (IUCN), all four species are Vulnerable, which means that they face a high risk of extinction in the wild. Because all these frogs live in small areas, and some have small populations, changes to their habitat could possibly be dangerous to them. Fortunately, many live in Morne Seychellois National Park or inside the boundaries of a conservation project on Silhouette Island, and some seem to be able to survive in newly growing forests that were once cut down.



Seychelles frog *(Sooglossus sechellensis)*

SEYCHELLES FROG
Sooglossus sechellensis

SPECIES ACCOUNT

Physical characteristics: The Seychelles frog is yellowish-brown with black spots and blotches on its head, legs, and back. The blotches on its back legs may look like bands. It usually has a triangular-shaped, dark spot that runs from one of its rather large eyes across its forehead to the other eye. Its snout is somewhat pointed. The toes on its long hind legs and shorter, thinner front legs have no webbing between them. The females usually grow to about 0.8 inch (2 centimeters) long from the tip of the snout to the end of the rump, while the typical size of the males is about 0.6 inch (1.5 centimeters).

Geographic range: Seychelles frogs live on Mahé and Silhouette Islands in Seychelles, a country in the Indian Ocean.



Seychelles frogs live on Mahé and Silhouette Islands in Seychelles, a country in the Indian Ocean. (Illustration by Bruce Worden. Reproduced by permission.)

Habitat: They make their homes in the rainforests of the island mountains at least 660 feet (200 meters) above sea level. They usually hide in leaf piles on the ground, often in areas where cinnamon grows.

Diet: Seychelles frogs' diet includes small insects and other invertebrates that the frogs find on the forest floor.

Behavior and reproduction: They usually remain hidden, except on wet days and nights. During these rainy periods, they hop out of their hiding spots to search for food. To mate, the males begin calling from under the leaves at any hour of the day or night. A male climbs onto the back of a female and mates with her while hanging onto her body just above her hind limbs. She lays her eggs on land, and her six to 15 eggs hatch into tadpoles, which scramble onto her back. The tadpoles stay on her back and soon turn into froglets. The froglets leave her back to grow up on their own. At one time, scientists thought that the tadpoles rode on the back of an adult male. A closer look,

however, showed that it was the female who was the caretaker of her young.

Seychelles frogs and people: People rarely see these frogs.

Conservation status: According to the World Conservation Union (IUCN), this species is Vulnerable, which means that it faces a high risk of extinction in the wild. The frog lives in a small area on only two islands, but it is quite common there. Some of the frogs live in Morne Seychellois National Park and others within the boundaries of a conservation project on Silhouette Island. While it is doing quite well, a change to its habitat could possibly hurt some populations or the entire species. As people move closer to its habitat, conservationists are keeping a watchful eye on this species. ■

FOR MORE INFORMATION

Books:

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians (Smithsonian Handbooks).* New York: Facts on File, 1991.

Noble, Gladwyn K. *The Biology of the Amphibia.* New York: McGraw-Hill, 1931.

Nussbaum, R. A. "Amphibians of the Seychelles." In *Biogeography and Ecology of the Seychelles Islands,* edited by D. R. Stoddart. Hague: Dr. W. Junk, 1984.

Periodicals:

"'Weird stuff' found in India." *Current Science* January 16, 2004 (89): 12.

Web sites:

"Amphibians." *Silhouette Island.* http://www.silhouette-island.com/public/amphibians.htm (accessed on February 22, 2005).

"The Animal Life." *Virtual Seychelles, Republic of Seychelles.* http://www.virtualseychelles.sc/envi/envi_nathis_frm.htm?nathis_body=envi_nathis_amph.htm (accessed on February 22, 2005).

"Pictures of Seychellfrogs (Sooglossidae)." *Swiss Herp.* http://www.swissherp.org/Amphibians/Sooglossidae/Sooglossidae.html (accessed on February 22, 2005).

AUSTRALIAN GROUND FROGS
Limnodynastidae

Class: Amphibia
Order: Anura
Family: Limnodynastidae
Number of species: 48 species

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

Although some scientists still believe that the Australian frogs should be divided up differently, this book follows the most common arrangement with two families: the 48 species of Australian ground frogs in the family Limnodynastidae and the 121 species of Australian toadlets and water frogs in the family Myobatrachidae. This entry deals with the Australian ground frogs.

Many of the Australian ground frogs have earth-tone colors, like brown, greenish brown, tan, and gray, often with spots, blotches, or other patterns that camouflage them against the dirt and plants of the ground. They commonly have lighter colored bellies, sometimes with faint patterns on the throat. Some species, however, are quite brightly colored. The northern banjo frog, which is also known as the scarlet-sided pobblebonk, has bright yellow sides with red and orange splashes of color under its legs, and the crucifix (or Catholic) toad has a warty, yellow back centered with a thick, dark brown, cross.

Some of the Australian ground frogs, like Fletcher's frog and the giant barred frog, have a typical frog shape with long, jumping hind legs and a large head. Others, like Spencer's burrowing frog and the sand frog, have shorter hind limbs and a blunter face more associated with toads. Most of the Australian ground frogs have little or no webbing on their front or rear toes.

The different species come in a variety of sizes. The smallest grow only to 0.9 inches (2.2 centimeters) long from the tip of the snout to the end of the rump, while others can reach as

much as 4.3 inches (10.8 centimeters) long. Males and females usually look much alike, but in some species, the males develop very noticeable pads on their front toes and front legs during the breeding season. Called nuptial (NUHP-shul) pads, they help the male grab hold of the female during mating.

GEOGRAPHIC RANGE

Australian ground frogs are found in Australia and much of New Guinea.

HABITAT

Many of the species in this family are burrowers and live part of their lives underground. The giant burrowing frog is an example. During the daytime, and also during long, dry periods, this species uses its powerful hind legs to dig backward into the soil and bury itself. This behavior hides the frog from would-be predators and also helps to keep its skin moist. Other species in this family, like the woodworker frog and striped marsh frog, do not burrow. Instead, the woodworker frog hides in the cracks of rocks or in caves, and the striped marsh frog slips among the tall plants of the marshes, grasslands, and forests where it lives. The typical Australian ground frog mates in a stream or pond—sometimes one that dries up later in the year.

DIET

Australian ground frogs eat various types of invertebrates (in-VER-teh-brehts), which are animals without backbones, by either grasping them with a flick of the tongue or by biting at them. Australian ground frogs wait to hunt until night, and some do their hunting only after heavy rains soak the ground. In many species, such as the Baw Baw frog, the tadpoles do not need to search for food. Instead, they live on a sack of nutritious yolk that is left over from the egg and is still a part of their bodies.

BEHAVIOR AND REPRODUCTION

The species in this family are either nocturnal (nahk-TER-nuhl), which means that they are active mostly at night, or crepuscular (creh-PUS-kyuh-lur), which means that they come out only at dawn and dusk. As with the majority of other nocturnal or crepuscular frogs, the Australian ground frogs do not

KICKSTARTING LIFE

Giant barred frogs have an odd start to their lives. The female lays her eggs in the water with her back pointing toward the shore. As the eggs drop, she gives them a swift kick with her hind foot, flinging the gel-covered eggs in a splash of water onto shore where the eggs stick to the bank and shore-side rocks. When the tadpoles hatch from the eggs, they plop down into the water and swim off.

like air that is too dry, as it often is during the day. Instead, they come out when the air starts to become moister, which typically happens at night when the sun is down and the temperature starts to cool off. In addition, many Australian ground frogs will not even venture out at night during especially dry periods. For some of them, such dry periods, called droughts (drowts), happen at least once a year and may last several months. During this time, some of the Australian ground frogs burrow underground to keep from drying out.

Frogs must keep their skin moist to breathe. Like humans and other mammals, frogs can breathe through the nose and lungs. However, frogs also get a great deal of their oxygen right through the skin. If the skin dries out, they can no longer breathe through the skin, and they can suffocate. Many of the burrowing frogs in this family dig into the ground by swishing their powerful hind limbs one at a time and backing into the soil as their body wiggles back and forth. Other species, like Spencer's burrowing frog, dig backward into the soil, but turn their bodies in circles while they are doing it. These frogs look as if they are screwing themselves into the ground. Several species can stay underground for a number of months. They enter a sleep-like state, called estivation (es-tih-VAY-shun), and only wake up and become active again when the heavy spring rains drench the land. The tusked frog is an example. This animal, as well as numerous other members of this family, lives underground inside a cocoon of shed skin for several months each year.

Spring rains begin the mating season for most of the burrowing Australian ground frogs. In some of these species, all mating for the year is done within a few weeks' time. Some types of Australian ground frogs breed during certain seasons of the year, and others, like the spotted marsh frog, can mate and lay eggs all year long if the weather is right. Whenever their mating season begins, the males start calling at dusk or at night, usually from ponds, streams, or marshes, but sometimes from on land. Their calls attract females and also keep other males from invading their space. Different species have different calls.

The spotted marsh frog, for instance, calls with a repeated clicking noise of "tik-tik-tik"; the giant burrowing frog sometimes goes by the name of eastern owl frog, because its call of "oo-oo-oo-oo-oo" sounds like an owl hooting; and the common spadefoot frog has a knocking trill for its call.

Some of the females in this family lay their jelly-coated eggs in the water, often in a foamy nest. The female typically makes the foam by flailing her feet and whipping up her eggs and the mucus surrounding them. This adds air to the mixture and creates the foam. The eggs hatch into tadpoles, which then swim out into the water, or in some cases, stay in the foam until they turn into froglets. Other females lay their eggs in a foam nest, but make it inside a burrow or among plant leaves and branches on shore. When heavy rains flood the nest, the eggs hatch into tadpoles, which then live in the water.

AUSTRALIAN GROUND FROGS AND PEOPLE

Because many of these species burrow or otherwise stay out of sight during the day, people rarely see them. For some people who live in the deserts of Australia, however, a few of the burrowing species can be a good source of water. They dig up the frogs, whose bodies are plump with stored water, and suck the liquid from the frogs. Besides this unusual use, scientists are also now studying the slime of some species perhaps to make medicines.

CONSERVATION STATUS

According to the World Conservation Union (IUCN), one species is Critically Endangered, which means that it faces an extremely high risk of extinction in the wild, and seven others are Endangered, which means that they face a very high risk of extinction in the wild. In addition, IUCN lists two species as being Vulnerable and facing a high risk of extinction in the wild, one species as Near Threatened and at risk of becoming threatened with extinction in the future, and two species as Data Deficient, which means not enough information is available to make a judgment about the threat of extinction.

The Critically Endangered species is the Baw Baw frog, a dark-brown, warty creature that grows to about 2 inches long. It lives in tunnels in wetlands or under cover alongside streams in a small location on the Baw Baw Plateau, which lies in an area east of Melbourne. Although part of its habitat is inside the Baw

Baw National Park, the frog's numbers have dropped from more than 10,000 individuals in 1985 to fewer than 250 adults in 2004. Scientists are unsure exactly what is causing the Baw Baw frogs to disappear, but they think that dangers may come from a warming climate, infection with a type of fungus, pollution, or an increase in ultraviolet radiation. The sun gives off light in different forms, such as the light humans can see and other types they cannot, like ultraviolet, or UV, radiation. UV radiation is especially strong high in the mountains, which is where the Baw Baw frog lives. Through various experiments, scientists have learned that UV radiation causes death in the tadpoles of other mountain-living frogs and think the same thing may be happening to the Paw Paw frogs. Scientists are continuing to study this species to find out why it is vanishing.

The Endangered species are Fleay's barred frog, the giant barred frog, the red and yellow mountain frog, Loveridge's frog, the mountain frog, the sphagnum frog, and one known only by its scientific name of *Philoria pughi*. They all live in small areas, and often their habitat is being destroyed or changed by such activities as logging, movements of cattle that can trample the frogs' foam nests, and the building of homes, businesses, and roads. At least some Fleay's barred frogs have also died as a result of infection with a fungus. On the bright side, most of these frogs now live inside reserves or other protected areas, which should limit some of the dangers they face.



Tusked frog *(Adelotus brevis)*

TUSKED FROG
Adelotus brevis

Physical characteristics: The tusked frog gets its name from the male's two, unusually large, lower teeth, or tusks. The tusks only show if the frog's mouth is open. Otherwise, they are hidden inside. The female either has very small tusks or none at all. From above, the frog is tan with olive, brown, or black blotches on its back and markings that form broken band patterns on its legs. A reddish brown, somewhat triangular-shaped patch covers most of its snout. It has large eyes with horizontal pupils, and its front and hind feet have just a bit of webbing. Once the frog is flipped over, its color changes. The underside is mottled with black and white, and its legs are trimmed in dark orange or red. Unlike most other frogs, in which the males and females are the same size or the females are larger, male tusked frogs are usually the bigger of the two. Males typically grow to 1.3 to 1.7 inches (3.4 to 4.4 centimeters) from snout to rump, but females only reach 1.1 to 1.5 inches (2.9 to 3.8 centimeters) long. In addition, the male's head is larger than that of the female.



The tusked frog gets its name from the male's two, unusually large, lower teeth, or tusks. The tusks only show if the frog's mouth is open. Otherwise, they are hidden inside. The female either has very small tusks or none at all. (Illustration by John Megahan. Reproduced by permission.)

Geographic range: Tusked frogs live in the far eastern part of Australia from Queensland to New South Wales.

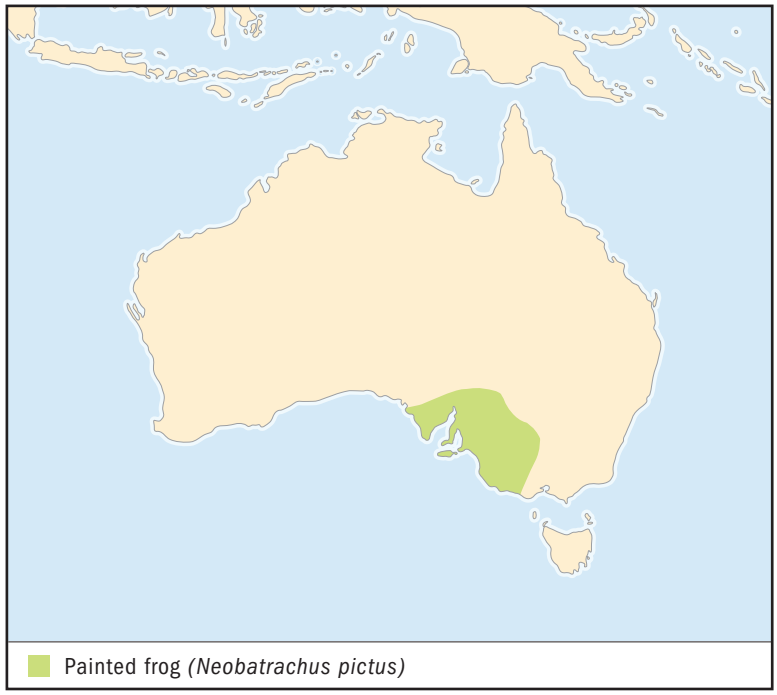
Habitat: Tusked frogs live in forests and sometimes in grasslands. The males usually stay near water, which may be a stream or just a puddle, but the females prefer drier places.

Diet: Their diet includes snails, insects, and other invertebrates. The males, which tend to live closer to the water, eat more snails, while the forest-living females eat invertebrates they find in their drier habitat.

Behavior and reproduction: Adults tend to stay under leaves and pieces of bark lying on the ground or huddled in some other hiding spot. During the breeding season, the males set up territories and defend them by biting other males with their long tusks. The bites can be severe and may leave scars. Each male calls from his territory with a voice that is a slow, soft "cluck - cluck - cluck." The female lays her eggs on the surface of the water in a foamy nest. The male stays with the nest, which is usually hidden from view under plants or other cover. The eggs, which measure less than 0.08 inches (2 millimeters) in diameter, hatch into tadpoles before changing into froglets.

Tusked frogs and people: People rarely see this frog in the wild or in the pet trade.

Conservation status: According to the World Conservation Union (IUCN), this species is Near Threatened, which means that it is at risk of becoming threatened with extinction in the future. Its numbers have dropped in many areas because of habitat loss, mainly as humans have turned the frogs' home into farmland or housing developments, and also because of infection with a fungus that is harming many species of frogs worldwide. ■



PAINTED FROG
Neobatrachus pictus

Physical characteristics: Also known as the painted burrowing frog, the painted frog is tan, yellow, orange brown, or gray with dark brown or black spots and blotches on its head, back, and legs. The upper body is almost completely covered with small, rounded warts. The frog has short but not thin front legs and longer hind legs. On the toes of each back foot, it has a black bump that it uses as a shovel, or spade, for digging. This bump, which is called a tubercle (TOO-ber-kul), gives the frog another common name, the mallee spadefoot. (A mallee is a shrubby area where a type of eucalyptus grows.) The painted frog has a short head with a rounded snout and two large eyes with vertical pupils. Males and females look similar except during the breeding season, when the males develop tiny spines on top of their warts, giving them a prickly look. Adults grow to 1.8 to 2.3 inches (4.6 to 5.8 centimeters) long from snout to rump.

Geographic range: Painted frogs live in south-central Australia, including South Australia, and likely Victoria and New South Wales.



The painted frog lives in an area that typically has a very dry season and a rainy season. During the dry season, it stays underground in open forests or shrubby areas. In the wet, breeding season, it is found in grassy marshes, small ponds, and various pools of water. (Photograph by Harald Schüetz. Reproduced by permission.)

Habitat: The painted frog lives in an area that typically has a very dry season and a rainy season. During the dry season, it stays underground in open forests or shrubby areas. In the wet, breeding season, it is found in grassy marshes, small ponds, and various pools of water.

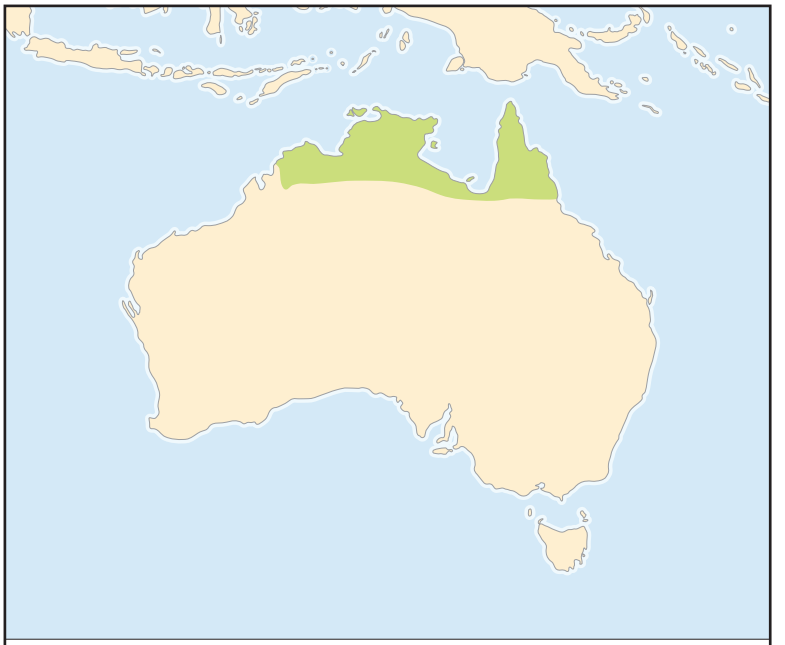
Diet: The painted frog probably eats insects and other invertebrates, but scientists have not studied them closely enough to say for sure.

Behavior and reproduction: At the beginning of the dry season, this frog digs down into the soil. Once in a suitable underground spot, the outer layer of its skin peels up from its body, but stays in one piece and attached to the frog's body to form a coat, or cocoon. Snuggled inside its cocoon with only its nose poking out, the frog enters a state of deep sleep, called estivation, which lasts until the rainy season begins in fall or winter. Once the ground becomes wet, the cocoon splits open, and the frog digs itself out of the ground. The frog apparently does all of its feeding during the rainy season. It also breeds at this time.

Males of this species, which some people call trilling frogs, float in the water and begin calling. The call is a two- or three-second purring or trilling sound. Males and females meet at marshes or other shallow pools, and the females lay clumps of up to 1,000 small eggs in plants at the edge of the water. The eggs hatch into tadpoles, which may grow to be as much as 3.5 inches (9 centimeters) long from snout to tail tip before they change into froglets.

Painted frogs and people: People rarely see this burrowing frog. Those who handle these frogs must wash their hands, because the frog's warts can ooze a gooey slime that is believed to make people sick if they get it in their mouths and swallow it.

Conservation status: The World Conservation Union (IUCN) does not consider this species to be at risk. Although it is not common, its numbers appear to be staying about the same. Some of the frogs live in protected areas, but others live in places that may be developed into farmland, which could hurt the frogs in the future. ■

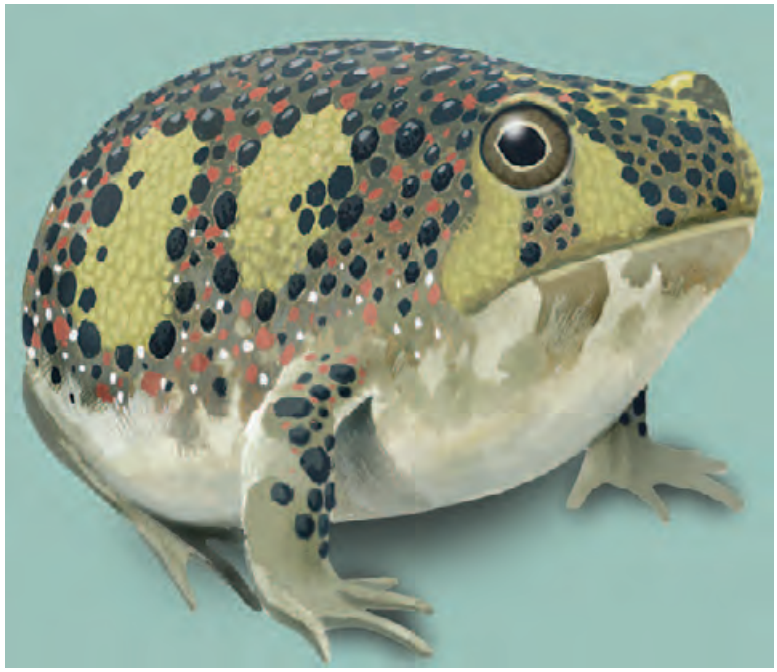


Northern spadefoot toad *(Notaden melanoscaphus)*

NORTHERN SPADEFOOT TOAD
Notaden melanoscaphus

Physical characteristics: Sitting as it often does with its short legs tucked against its body, the northern spadefoot toad has a shape like a golf ball. Some people even call this species a golfball frog. A small head with large eyes and a very short snout barely pokes out of its body. Its head, back, legs, and throat are brown to greenish brown or gray with black markings and are covered with warts. The warts may be tipped in white. Its belly is white. This frog has long, pointed toes and tubercles on its feet, similar to those of the painted frog, which give it the spadefoot name. Females usually grow to 1.8 to 1.9 inches (4.5 to 4.9 centimeters) long from snout to rump. The males sometimes are a bit smaller, usually reaching 1.3 to 1.9 inches (3.4 to 4.8 centimeters) in length.

Geographic range: The northern spadefoot toad lives in northern Australia, including parts of Kimberley, Western Australia, and Queensland.



When threatened, the northern spadefoot toad's warts ooze a gluey goop. A predator that unwisely bites at one of these frogs gets a mouth full that quickly hardens, turns bright orange, and becomes difficult to clean off. (Illustration by John Megahan. Reproduced by permission.)

Habitat: The northern spadefoot toad spends much of its life underground, but comes to the surface after heavy rains. It breeds in marshes, swamps, and small pools of water.

Diet: With the flip of a tongue out of the small mouth, the northern spadefoot frog snatches up small insects and other invertebrates to eat. The tadpoles appear to eat by straining tiny organisms out of the water.

Behavior and reproduction: This species uses the spades on its feet to burrow into the soil. In rainy weather, the northern spadefoot toad digs out of its underground home to look for insects, and in the breeding season, to mate. With its short legs and pudgy-looking body, this frog walks rather than hops and is not able to outrun most predators. It does, however, have a way of defending itself. When threatened, its warts ooze a gluey goop. A predator that unwisely bites at one of these frogs gets a mouth full of goop that quickly hardens, turns bright orange, and becomes difficult to clean off.

In the rainy, breeding season, males move to marshes, swamps, and newly filled pools of water and call from shallow spots. Their call is a loud, repeated "whoop." When the male calls, his body fills with air like a balloon. If he feels threatened, he will let the air out and

sink out of sight. Males mate with females by climbing onto their backs and hanging on in front of the females' hind legs. Each female lays 500 to 1,400 eggs on the water's surface, and the eggs later sink and tangle in underwater plants as they hatch into tadpoles. The tadpoles turn into froglets when they are about two months old. The young froglets look much like the adults, but are often speckled with bright yellow, red, and black spots.

Northern spadefoot toads and people: People rarely see this frog.

Conservation status: The World Conservation Union (IUCN) does not consider this common species to be at risk. Some of its populations live in protected areas. ■

FOR MORE INFORMATION

Books:

Anstis, M. *Tadpoles of South-eastern Australia: A Guide with Keys.* Sydney: Reed New Holland, 2002.

Barker, John, Gordon C. Grigg, and Michael J. Tyler. *A Field Guide to Australian Frogs.* Chipping Norton, Australia: Surrey Beatty, 1995.

Campbell, A., ed. *Declines and Disappearances of Australian Frogs.* Canberra, Australia: Environment Australia, 1999.

Cogger, H. G. *Reptiles and Amphibians of Australia.* 6th edition. Sydney: Reed New Holland, 2001.

Cogger, H. G., E. E. Cameron, and H. M. Cogger. *Zoological Catalogue of Australia.* Vol. 1, *Amphibia and Reptilia.* Canberra, Australia: Australian Government Publishing Service, 1983.

Cronin, Leonard. *Key Guide to the Reptiles and Amphibians of Australia.* Sydney: Envirobooks, 2001.

Littlejohn, M. J., M. Davies, J. D. Roberts, and G. F. Watson. "Family Myobatrachidae." In *Fauna of Australia.* Vol. 2A, *Amphibia and Reptilia,* edited by C. J. Glasby, G. J. B. Ross, and P. Beesley. Canberra, Australia: AGPS, 1993.

Malone, B. S. "Mortality during the Early Life History Stages of the Baw Baw Frog, *Philoria frosti* (Anura: Myobatrachidae)." In *Biology of Australasian Frogs and Reptiles,* edited by G. Grigg, R. Shine, and H. Ehmann. Chipping Norton, Australia: Surrey Beatty and Sons, 1985.

Robinson, Martyn. *Field Guide to the Frogs of Australia.* Sydney: Reed New Holland, 1993.

Swan, Gerry. *Green Guide to Frogs of Australia.* Sydney: New Holland, 2001.

Web sites:

"Frogs—Amphibia." *Wildlife of Sydney.* http://faunanet.gov.au/wos/group.cfm?Group_ID=36 (accessed on February 24, 2005).

"Frogs of Australia." *Amphibian Research Centre.* http://frogs.org.au/frogs/index.html (accessed on February 24, 2005).

"Frogs of North Queensland." *James Cook University School of Tropical Biology.* http://www.jcu.edu.au/school/tbiol/zoology/herp/NthQldHerps/NthQLDHerps-frogs.shtml (accessed on February 24, 2005).

"The Frogs of NSW Wetlands - Other Frogs." *NSW Department of Land and Water Conservation.* http://www.dlwc.nsw.gov.au/care/wetlands/facts/paa/frogs/other_frogs.html (accessed on February 24, 2005).

"Information on Protecting Australian Frogs." *ASX Frog Focus.* http://www.asxfrogfocus.com/ (accessed on March 1, 2005).

"Useful Links and Frog Resources." *NSW National Parks and Wildlife Service.* http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Useful+links+and+frog+resources (accessed on February 24, 2005).

family CHAPTER

AUSTRALIAN TOADLETS AND WATER FROGS

Myobatrachidae

Class: Amphibia
Order: Anura
Family: Myobatrachidae
Number of species: 121 species

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

Most of the Australian toadlets and water frogs are either small, slender creatures with long hind legs or tiny toads with short hind legs. Those members of the family that burrow head first, like the turtle frog, usually have powerful front legs and snouts that are tough, like the callous on a person's hand, while those that burrow hind end first, such as the northern toadlet, typically have hard bumps, called tubercles (TOO-ber-kulz), on their back feet to help them dig.

Overall, the Australian toadlets and water frogs range from 0.6 to 3.1 inches (1.6 to 7.9 centimeters) long from snout to rump, but the majority are on the smaller side. Typically, the frogs in this family are gray or brown, but often have brighter colored patches of skin that appear when they lift their front or back legs. Some, however, have bold colors all over their bodies. The Corroboree frog, for instance, is black and vivid yellow or green, while the sunset frog is covered in orange, red, and blue.

GEOGRAPHIC RANGE

Most of the species in this family live only in Australia, but at least two also are found in southern New Guinea.

HABITAT

Depending on the species, a frog in this family may live in a rainforest stream, a mountain meadow, a forest, a grassland that is dry much of the year, or in desert-like sand dunes near oceans. Many of them burrow into the soil or disappear under

moss, leaf piles, or logs during the daytime. Even the tadpoles live in many habitats. Eggs and tadpoles may develop in a stream that flows all year, in a pond that will dry up later in the year, in a nest on land, or under the ground. In a few species, the eggs and/or tadpoles actually develop into frogs inside pockets on their fathers' hips, or inside their mothers' stomachs.

DIET

The Australian toadlets and water frogs eat arthropods (AR-thro-pawds), which are insects, spiders, and other invertebrates that have jointed legs. An invertebrate (in-VER-teh-breht) is an animal that does not have a backbone. Some species eat mainly one type of arthropod. The sandhill frog, for instance, eats mostly ants, even sometimes poking its head inside ant hills. In many cases, however, scientists do not know exactly which types of arthropods these species eat because they have not yet done thorough studies of the frogs.

BEHAVIOR AND REPRODUCTION

Most of the frogs in this family hide themselves away during the day. Some stay under damp leaves, moss, logs, or rocks on the ground, and others burrow. Burrowers may use their front legs to dig head first, or they may use their hind legs to scramble into the ground back end first. The turtle frog, which has a body with the shape of a turtle but without the shell, is a head-first burrower. It uses its short, but thick and strong front legs to scrape aside the sand and pushes its hard snout forward. A few species, such as Eungella torrent frog, may be active day or night. Some species that stay above ground for much of the year will burrow during the dry season and only return to the surface after the rainy weather returns.

In the breeding season, the males of some species set up and defend territories. For instance, male stonemason toadlets will get into wrestling matches over a good calling place. In other species, such as the quacking froglet, the males do not set up territories and instead chase after females. As many as five males may try to mate with a single female at the same time.

Most of the frogs in this family mate only at certain times of the year. For those that live in areas with dry and rainy seasons, the mating period usually happens in the rainy time of year. Usually, the males call only or mainly during the breeding season, although the males of some species call almost year-round.

Different species have different calls. For instance, the smooth toadlet makes a buzzy, creaking sound, the eastern sign-bearing froglet gives a loud "eeek," and the Victorian smooth froglet has a repeating call that starts with a short quacking noise and follows with a repeated "tik-tik-tik-tik-tik-tik-tik." Most males call only at night, but those species that are active during the day also call sometimes in broad daylight. The moss frog, for example, makes its knocking call in the daytime from a hiding spot among plants on the floor of its mountain rainforests. Depending on the species, the males may call from underground, from a stream, pond or other watering hole, or from a hiding place on land, as the moss frog does.

Usually, the males and females pair and mate at the calling site. To mate, the male must climb onto the female's back as she lays her eggs. In a few species, however, the male calls not from the watering hole where he will mate, but from land a distance away. When a female approaches him, he climbs onto her back and she carries him to the water. The floodplain toadlet does things a little differently. Instead of the male climbing onto the female's back, she squirms underneath him while he is calling. Once she is fully beneath him, he stops calling, holds onto her, and they move to the water to mate.

The females of some of the species in this family, like the tinkling frog, mate in the water and lay their eggs there. Their eggs hatch into tadpoles that swim off in the water and eventually turn into froglets. Others, such as the red-backed toadlet, lay their eggs on land. When rains drench the land, the eggs hatch into tadpoles that float in the rainwater or squirm on the wet soil to get to a pond or other watering hole, where they eventually change into froglets. Moss frogs also lay their eggs on land, but their tadpoles survive without a pond or even a puddle. Moss frog eggs are large and coated with jelly. When the tadpoles are born, they live in

THAT'S A MOUTHFUL!

The female gastric brooding frog of Australia takes very good care of her young. After she lays up to two dozen eggs, she puts them in an especially safe place where they can develop and grow, and that place is inside her stomach. Normally, the stomach acids digest things that animals eat, but the acid in these frogs' bellies turns off so the eggs can safely turn into tadpoles and then froglets inside the female's stomach. When the froglets are finally born, they leave her body the same way they came in: through her mouth. Scientists had just begun studying these unusual animals for use in controlling stomach acid in humans when the frogs disappeared. One of the two gastric brooding frog species vanished in 1983, and the second species, which was just discovered in 1983, disappeared in 1985. The IUCN now considers both to be Extinct. The same method that the frog used to turn off its stomach acid is now used in medicines to help people who have stomach ulcers. An ulcer is a sore on the wall of the stomach.

TANGLED FAMILY LINES

Organizing the species of gastric brooding frogs, Australian toadlets and water frogs, and Australian ground frogs has been a confusing chore. Some people lump them all together into one family, while others separate them into three families. Scientists have been studying bones, fossils, and other characteristics to sort it out. For now, however, this book takes the middle ground with two families: the Limnodynastidae for the Australian ground frogs and the Myobatrachidae for the Australian toadlets and water frogs as well as the two recently extinct species of gastric brooding frogs.

the leftover jelly for more than a year, even surviving under a layer of winter snow. After about 13 months, they finally turn into froglets. Female sandhill frogs and a few other species lay their gel-covered eggs underground. These eggs hatch into froglets, skipping the tadpole stage.

Perhaps oddest of all are the hip pocket frogs and the gastric brooding frogs. Female hip pocket frogs lay their eggs in and/or under damp leaves on the ground. The female stays with her eggs until they are ready to hatch. The male then takes over. He rests the front part of his body on the hatching eggs, and up to a dozen newborn tadpoles squirm up the sides of his body and into his two pouches, one of which is on each hip. In about two months, froglets crawl out of the pockets to face the world. In the gastric brooding frogs, on the other hand, the female takes charge. After she lays her eggs, she swallows them. The eggs turn into tadpoles and then froglets in her stomach and leave her body through her mouth. While the eggs are in her stomach, she stops eating.

AUSTRALIAN TOADLETS, WATER FROGS, AND PEOPLE

For the most part, people do not see these mostly night-active frogs in the wild. They are also uncommon in the pet trade. Scientists are interested in the skin of many of these frogs, because it oozes a gooey fluid that may one day be useful in making medicines.

CONSERVATION STATUS

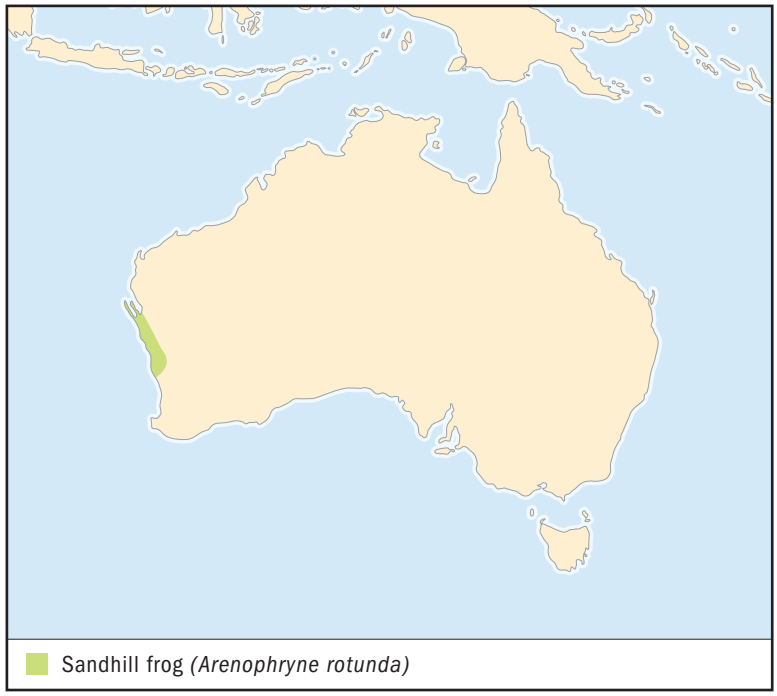
According to the World Conservation Union (IUCN), three species are Extinct and are no longer in existence, and six are Critically Endangered, which means that they face an extremely high risk of extinction in the wild. In addition, two are Endangered and face a very high risk of extinction in the wild; four are Vulnerable and face a high risk of extinction in the wild; and three are Near Threatened and at risk of becoming threatened with extinction in the future. The IUCN also lists

six as Data Deficient, which means that there is not enough information to make a judgment about their threat of extinction.

The three extinct species are the northern gastric brooding frog, which is sometimes known as the Eungella gastric brooding frog; the southern gastric brooding frog, also called the Conondale or platypus gastric brooding frog; and the Mount Glorious day frog, which also goes by the names Mount Glorious torrent frog or southern day frog. The northern and southern gastric brooding frogs vanished in 1983–1985, and although the Mount Glorious day frog was quite common in the early 1970s, it disappeared in 1979. Scientists do not know what caused the three species to die out, but they suspect that changes to their habitats, including the loss of trees and native plants, and infection with a fungus may be at least partly to blame.

Scientists are also unsure why the numbers of many other at-risk species are dropping. The Corroboree frog, which is Critically Endangered, is an example. This small species lives in mountain grasslands and forests. It is a beautiful, shiny black frog, with bright yellow or green stripes. In just 10 years, the number of adults living in the wild dropped from about 2,000 to fewer than 250 in 2004. Some scientists believe that differences in the weather, fungus infections, or habitat changes may be playing a role in the disappearance of the frogs, but they do not know for sure.

Studies of other at-risk frogs, however, have revealed why they are vanishing. The white-bellied frog, which is Critically Endangered, has become less and less common. As of 2004, it only lived in a few areas of the southwestern edge of Western Australia. Scientists believe that this burrowing frog has suffered because of habitat loss. According to the IUCN, about 70 percent of the habitat where this frog might live and breed has been logged or otherwise cleared since humans arrived in this part of Australia. The frogs now live in small groups here and there where the habitat is still in good shape.



SPECIES ACCOUNTS

SANDHILL FROG
Arenophryne rotunda

Physical characteristics: The sandhill frog, which also goes by the name of round frog, is a chubby little creature with toad-like features. It has a round, somewhat flat body with small hind legs and short, but strong front legs. The first toe on each of the unusually wide front feet is very small. The tiny head has a short, rounded snout with a hard, callous-like tip. Sandhill frogs are usually very light gray with darker gray and sometimes rust-colored speckles on the warty head, back, and legs. They also have a narrow, light-colored, sometimes hard-to-see, stripe down the middle of the back. Males and females look alike. Females grow to 1.1 to 1.3 inches (2.8 to 3.3 centimeters) long from snout to rump, and males usually reach 1 to 1.3 inches (2.6 to 3.3 centimeters) in length.

Geographic range: Sandhill frogs live along the ocean in far western Australia from Kalbarri to Shark Bay and Dirk Hartog Island.

Habitat: Sandhill frogs live in desert-like sand dunes along the ocean's coast and stay underground during the day. At night, when the air is more humid, they look for food on land. Unlike most other frogs, this unusual species does not need any ponds, streams, or even puddles of water to survive. Instead, it gets most of its moisture from the damp sand underground.

Diet: Their diet includes ants, beetles, spiders, and other arthropods.

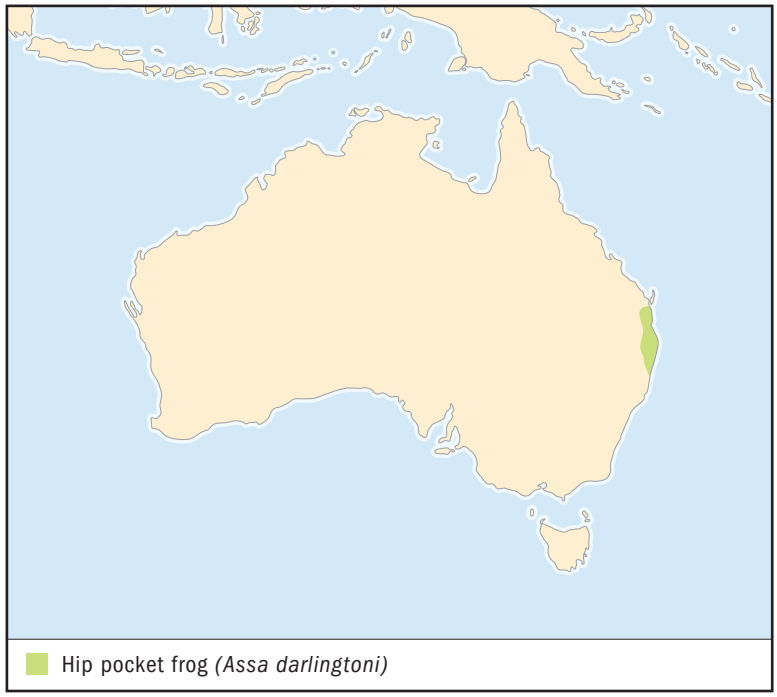


Unlike most other frogs, this unusual species does not need any ponds, streams, or even puddles of water to survive. Instead, it gets most of its moisture from the damp sand underground. (Kelvin Aitken/Peter Arnold, Inc.)

Behavior and reproduction: A sandhill frog digs head first into the sand, making good use of its hard snout and strong front legs. It stays underground during the day, digging deep enough to reach damp sand. At night, it crawls out of the sand and starts looking for food. It does not hop, instead walking across the dunes and leaving tiny, wide-spaced footprints behind. The males call from April to July, which is late fall in Australia, but do it underground. The males and females pair up, sometimes with several pairs in the same place, and the females lay their eggs from September to December, also underground and usually about 31.5 inches (80 centimeters) deep. The young skip the tadpole stage, and froglets hatch out of the eggs.

Sandhill frogs and people: Most people only see this animal's footprints, rarely the frog.

Conservation status: This frog is quite common in the sand dunes where it lives and is not considered to be at risk. ■



HIP POCKET FROG
Assa darlingtoni

Physical characteristics: Also called a pouched frog or marsupial frog, the hip pocket frog is best known for the pouch above each hind leg of the male. Each of his pouches is large enough to hold several eggs, but unless they are filled, the pockets are difficult to see and only visible as small slits. Hip pocket frogs have a rather wide body, which may be brown, pinkish brown, gray, or red. They commonly have a dark brown stripe that starts behind the eye, carries over the shoulder and onto the side of the frog behind its front leg. Their legs may have dark or faded brown bands, and all four feet end in pad-tipped toes. The underside of the frog is white. Females usually grow to 0.7 to 0.8 inches (18 to 21 centimeters) long, and males are usually about 0.1 inches shorter.

Geographic range: Hip pocket frogs live in mountains along the border of New South Wales and Queensland and in northeastern Australia.

Habitat: Hip pocket frogs make their home in the mountain rainforests that are thick with trees and plants. They usually stay out of



Hip pocket frogs make their home in the mountain rainforests that are thick with trees and plants. (Illustration by Barbara Duperron. Reproduced by permission.)

view in deep piles of leaves, under rocks, or in other hiding places on the forest floor.

Diet: They eat various arthropods.

Behavior and reproduction: Scientists know little about their behavior outside of breeding and reproduction. The breeding season begins when the males start to make their calls, which are fast, repeated, buzzy sounds. The females follow the calls to the male's hiding spot under a log or in the leaves on the ground. When a female gets closer, the male calls even more. The male climbs onto her back and mates with her as she lays her eggs, which fall onto the damp dirt and rotting leaves. The female stays with her eggs for several days until they are ready to hatch. The male then moves in and covers the hatching eggs with the front part of his body. Tadpoles wiggle out of the eggs, up his sides, and into his hip pouches. A single male can have as many as six tadpoles in each of his two pockets. The tadpoles stay inside. Each has yolk left over from its egg that it can eat and so does not need to find any other food. In 48 to 69 days, the tadpoles change into froglets and crawl out of the male's pockets to live life on their own.

Hip pocket frogs and people: People rarely see this small frog.

Conservation status: The hip pocket frog is not considered endangered or threatened. ■



Eungella torrent frog *(Taudactylus eungellensis)*

EUNGELLA TORRENT FROG
Taudactylus eungellensis

Physical characteristics: Also known as the Eungella day frog, the Eungella torrent frog is a light brown or gray frog with dark brown markings on its head, back, and legs. The markings on its head include one wide blotch that stretches between its two large eyes. The markings on its hind legs may look like bands. Its body is rather long and thin, and it also has slender front and hind legs. The toes on each of its four feet widen out at the end into pads, and the bones inside the tips of the toes are T-shaped. The hind legs are much longer that the front pair. Its throat and belly are creamy white with a touch of yellow on the thighs and lower belly. Some have smooth backs, but others have scattered, small bumps. Males and females look similar, but the males are usually a bit smaller. Males grow to 1 to 1.1 inches (2.5 to 2.8 centimeters) long from the tip of the snout to the end of the rump, while females normally reach 1.1 to 1.4 inches (2.8 to 3.6 centimeters) in length.



This was a common species until 1985, when scientists began noticing that the torrent frogs were quickly disappearing. In the late 1980s, they feared the frogs might be extinct, but the frogs turned up again in 1992. (Illustration by Barbara Duperron. Reproduced by permission.)

Geographic range: Eungella torrent frogs live in a small mountainous area of mid-eastern Queensland, Australia.

Habitat: The frogs spend their days in small or large, swift mountain streams located at 490 to 3,280 feet (150 to 1,000 meters) above sea level or in the thick plants of the surrounding rainforest.

Diet: Scientists are unsure, but they think Eungella torrent frogs eat different types of arthropods.

Behavior and reproduction: Eungella torrent frogs may be active day and night, often sitting on or under rocks along the river or near waterfalls where they can feel the splash of the crashing water. They often bob their heads or wave their hind legs, apparently a way to communicate. The males may call year-round, although they tend to do more calling and mating from January to May, which is the summer and fall in Australia. The call is a soft rattle. The females lay 30 to 50 eggs at a time, and these hatch into tadpoles. The tadpoles, which have suction cups around their mouths, usually move about at the bottom of the stream until they change into froglets in November, December, and January.

Eungella torrent frogs and people: Very few people have seen this rare frog.

Conservation status: According to the World Conservation Union (IUCN), this species is Critically Endangered, which means that it faces an extremely high risk of extinction in the wild. This was a common species until 1985, when scientists began noticing that the torrent frogs were quickly disappearing. In the late 1980s, they feared the frogs might be extinct, but the frogs turned up again in 1992. They now live in nine spots inside Eungella National Park, and their numbers seem to be climbing very slowly. Scientists do not know what caused the frogs to decline in the 1980s and are watching this species closely. ■

FOR MORE INFORMATION

Books:

Anstis, M. *Tadpoles of South-eastern Australia: A Guide with Keys.* Sydney: Reed New Holland, 2002.

Barker, John, Gordon C. Grigg, and Michael J. Tyler. *A Field Guide to Australian Frogs.* Chipping Norton, Australia: Surrey Beatty, 1995.

Campbell, A., ed. *Declines and Disappearances of Australian Frogs.* Canberra, Australia: Environment Australia, 1999.

Cogger, H. G. *Reptiles and Amphibians of Australia.* 6th edition. Sydney: Reed New Holland, 2001.

Cogger, Harold G., and Richard G. Zweifel. *Encyclopedia of Reptiles and Amphibians.* San Diego, CA: Academic Press, 1998.

Cogger, H. G., E. E. Cameron, and H. M. Cogger. *Zoological Catalogue of Australia.* Vol. 1, *Amphibia and Reptilia.* Canberra, Australia: Australian Government Publishing Service, 1983.

Cronin, Leonard. *Key Guide to the Reptiles and Amphibians of Australia.* Sydney: Envirobooks, 2001.

Ehmann, H., and G. Swan. "Reproduction and Development in the Marsupial Frog *Assa darlingtoni* (Leptodactylidae: Anura)." In *Biology of Australasian Frogs and Reptiles,* edited by G. Grigg, R. Shine, and H. Ehmann. Chipping Norton, Australia: Surrey Beatty and Sons, 1985.

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians (Smithsonian Handbooks).* New York: Facts on File, 1991.

Littlejohn, M. J., M. Davies, J. D. Roberts, and G. F. Watson. "Family Myobatrachidae." In *Fauna of Australia.* Vol. 2A, *Amphibia and Reptilia,* edited by C. J. Glasby, G. J. B. Ross, and P. Beesley. Canberra, Australia: AGPS, 1993.

Miller, Sara Swan. *Frogs and Toads: The Leggy Leapers.* New York: Franklin Watts, 2000.

Roberts, J. D. "The Biology of *Arenophryne rotunda* (Anura: Myobatrachidae): A Burrowing Frog from Shark Bay, Western Australia."

In *Research in Shark Bay, Report of the France-Australe Bicentennary Expedition Committee,* edited by P. F. Berry, S. D. Bradshaw, and B. R. Wilson. Perth, Australia: West Australian Museum, 1990.

Robinson, Martyn. *Field Guide to the Frogs of Australia.* Sydney: Reed New Holland, 1993.

Swan, Gerry. *Green Guide to Frogs of Australia.* Sydney: New Holland, 2001.

Tyler, Michael J. *Australian Frogs: A Natural History.* Ithaca, NY: Cornell University Press, 1994.

Tyler, M. J., ed. *The Gastric Brooding Frog.* London and Canberra: Croom Helm, 1983.

Periodicals:

Sunquist, Fiona. "Really Weird, Really Wild!" *National Geographic World* (February 1999): 3.

Web sites:

"Corroboree Frog." *Kidcyber.* http://www.kidcyber.com.au/topics/frog_corrob.htm (accessed on March 1, 2005).

"Frogs — Amphibia." *Wildlife of Sydney.* http://faunanet.gov.au/wos/group.cfm?Group_ID=36 (accessed on February 24, 2005).

"Frogs of Australia." *Amphibian Research Centre.* http://frogs.org.au/frogs/index.html (accessed on February 24, 2005).

"The Frogs of NSW Wetlands - Other Frogs." *NSW Department of Land and Water Conservation.* http://www.dlwc.nsw.gov.au/care/wetlands/facts/paa/frogs/other_frogs.html (accessed on February 24, 2005).

"Information on Protecting Australian Frogs." *ASX Frog Focus.* http://www.asxfrogfocus.com/ (accessed on March 1, 2005).

Jamal, Rina Abdul. "Marsupial (Pouched) Frog." *AnimalFact.com.* http://www.animalfact.com/article1020.htm (accessed on March 2, 2005).

"Useful Links and Frog Resources." *NSW National Parks and Wildlife Service.* http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Useful+links+and+frog+resources (accessed on February 24, 2005).

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Amphibians
volume 2

Leptodactylid frogs to Shovel-nosed frogs

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family CHAPTER

LEPTODACTYLID FROGS
Leptodactylidae

Class: Amphibia
Order: Anura
Family: Leptodactylidae
Number of species: 1,124 species

PHYSICAL CHARACTERISTICS

With more than 1,100 species of leptodactylid frogs, this is a huge family that has many different-looking species. The smallest species grow only to 0.4 inches (1 centimeter) long from the tip of the snout to the back of the rump, while female helmeted water toads can reach as much as 12.8 inches (32 centimeters) long. Many species in this family have toadlike features, including short legs and warty backs, while others have the look of a typical frog with long, jumping hind legs and smooth skin on their backs. Some have chunky bodies, some are slender, and a few are quite flat. Some of the more unusual members of this family have very baggy skin that hangs in folds from their sides and the upper part of each hind leg, and others have fleshy points, or "horns," on the eyelids.

Although they may look different on the outside, they do share some common features. For example, most of the leptodactylid frogs have teeth on the upper jaw, as well as horizontal pupils in their eyes. A few have vertical pupils. The bones at the tips of the toes of all species in this family either are T-shaped or have knobs. In some species, small pads cover the tips and help the frog to climb up slippery rocks or tall trees. Most species in this family are gray, green, or brown and blend into the background.

A few, however, have bright patterns. The gold-striped frog, for instance, is black with bright yellow stripes. Scientists think that these bright colors trick predators into thinking the gold-striped frog is actually a species of poison dart frog that is also

black with yellow stripes. Predators will not eat the poison dart frog, because it oozes a poison from its skin, and may also avoid the look-alike species, even though it is harmless. In addition to its copycat color, the gold-striped frog has red "flash colors" at the tops of its legs. When threatened, this frog and some other species in the family that have similar bright patches move their legs so these spots show. This sudden burst of color may surprise a predator and give the frog time to escape. The gray four-eyed frog has another feature on its back that can scare off attackers. When threatened, it rounds its lower back to show off two large, dark-colored glands. This display gives the impression that a larger animal with two big eyes has suddenly appeared.

Males and females usually look alike. In some species, however, the males develop spines on the front toes and/or chest during the breeding season. These spines help the male ride piggyback and hold onto the female during mating. The males of many species in this family grab the female around her front legs, but some hold her near her back legs while she lays her eggs.

GEOGRAPHIC RANGE

These frogs live in North, Central, and South America, as well as the West Indies. In North America, they can be found in Mexico and southernmost parts of the United States. One species, the gray four-eyed frog, lives farther south than any other species in the world: the Straits of Magellan at the southern tip of South America.

HABITAT

These frogs may live almost anywhere from hot and humid valleys and lowland forests to cooler, drier land high up in the mountains. Depending on the species, they may spend much of their time hiding under rocks or other places on land, hopping through grass or forests, climbing in trees, or swimming under water. Some even live in burrows inside ant hills. Mating in the typical leptodactylid frog happens in the water. This may be a lake, small pond, a pool that is only filled with water during part of the year, or some other body of water.

DIET

Most of the species in this family get their food by finding a promising spot and waiting there for a meal to come to them. This kind of sit-and-wait method is called ambush hunting.

Many of the species in this family have colors and patterns that make them almost disappear from view if they remain very still. Many leptodactylid frogs eat arthropods (AR-thro-pawds), which are spiders, insects, and other invertebrates with jointed legs. An invertebrate (in-VER-teh-breht) is an animal without a backbone. Some of the larger species, like the Surinam horned frog and South American bullfrog, will eat almost anything that they can capture and swallow, including other frogs, snakes, and even small birds and mammals.

BEHAVIOR AND REPRODUCTION

Although some species in this family are active during the daytime, most of them usually stay out of sight while the sun is shining and move about after dark. During the day, they typically hide under rocks or logs, inside dark cracks and burrows, or tucked into the leaves of plants. Some of the species, like the Surinam horned frog, have camouflage colors and eyebrow "horns" that help the frog to look like a leaf when it is nestled in a pile of dead leaves on the ground. Most leptodactylid frogs do their hunting at night.

To protect themselves against predators, the majority of the frogs in this family simply try to hop away. Others will stay still and hope their camouflage is good enough to keep them hidden. If an attacker comes too close, some species will use other defensive methods. For example, the helmeted water toad takes a big gulp of air to blow up its body, stands up as tall as possible on all four legs, opens wide its mouth, and snaps at the attacker. Since males of this species can reach 4.8 inches (12 centimeters) long, and females can grow to a whopping 12.8 inches (32 centimeters), they can convince many predators to back off.

Some leptodactylid frogs that live in areas with particularly dry seasons survive the weather by burrowing into the mud left on the bottom of disappearing pools of water. Budgett's frog is an example. It digs deep in the mud until it is completely covered, then sheds its outer layers of skin, which it wears like a blanket around its body. The dead skin cocoon helps the frog to stay moist inside during the dry period, which may last many weeks. When the rainy season returns, the water drenches the ground, softens up the cocoon, and the frog crawls out of its burrow.

Many of the frogs that live in climates with both dry and wet seasons mate in the rainy season. Some of those that live in areas that are wet and warm all year may mate during only a

NOISE POLLUTION—FROM A FROG?

Until recently, no frogs lived in Hawaii. When the 2- to 2.5-inch-long frog, called the Puerto Rican coqui, hitchhiked to Hawaii in some plants, it found a good place to live and multiply. It started to do what it does naturally: After the sun sets, the males performed their two-part calls: koh-kee, koh-kee. People in Hawaii, however, were used to a quieter night, and some soon began complaining about the "racket" from the frogs, claiming that it disturbed their sleep and would possibly turn away island visitors. Despite their grumbles, the frog still lives in Hawaii and is doing well there.

short time each year, or they may mate off and on all year long. Regardless of when they mate, they kick off a mating period with the calls of the males. Some, like the Cururu lesser escuerzo, call from water, but Perez's snouted frog and others call from their hiding places on land. Some males, including gray four-eyed frogs, do not call. When a female approaches, the male typically climbs onto her back and hangs on by either clinging to her at her front legs or in front of her hind legs. This piggyback position is called amplexus (am-PLEK-sus). Those frog pairs that are on land hop and crawl over to the water. Those that are already in the water mate there. While the male is still on her back, the female lays her eggs.

The females of some species, like the warty tree toad, drop their eggs in the water, and they develop into tadpoles there. Other species, like the Túngara frog, lay their eggs in foam nests. Depending on the species, one or both adults make the nest by using their hind legs to whip up the eggs, water, and some mucus from their bodies until it turns into a frothy foam. The eggs hatch into tadpoles inside the foam. Depending on the species, the tadpoles may leave the nest and turn into froglets in the water, or they may stay inside and make the change inside the nest. The females of few species in this family, including the Puerto Rican coqui, mate and lay their eggs in plants that grow in trees. In the case of the Puerto Rican coqui, the male then takes charge of the nest, often sitting on top of them. These eggs skip the tadpole stage and hatch right into froglets. The golden coqui is the only member of the family to give birth to froglets. Instead of laying her eggs, the female keeps them inside her body, where they hatch into froglets. She then gives birth to the live young. The females in some species lay a few dozen eggs, but others can lay hundreds at a time. Usually the biggest frogs have the greatest number of eggs.

LEPTODACTYLID FROGS AND PEOPLE

People hunt a few of the larger leptodactylid frogs for food and sometimes collect them and some of the pretty smaller

species for the pet trade. Introduced coqui frogs have made the news in Hawaii. Hidden inside plants shipped to Hawaii from their native lands, coquis have found their new home to be a good place to live and raise families, but some people there are less pleased with the new arrivals. They complain about the male frogs' loud mating calls.

CONSERVATION STATUS

Of the 1,124 species in this family, the World Conservation Union (IUCN) lists two as Extinct, which means they are no longer in existence; 133 are Critically Endangered and facing an extremely high risk of extinction in the wild; 209 are Endangered and at very high risk of extinction in the wild; 133 are Vulnerable and facing a high risk of extinction in the wild; 60 are Near Threatened and at risk of becoming threatened with extinction in the future; and 249 are Data Deficient, which means not enough information is available to make a judgment about the threat of extinction.



SPECIES ACCOUNTS

SURINAM HORNED FROG
Ceratophrys cornuta

Physical characteristics: Also known as the horned frog, Amazonian horned frog, or packman frog, the Surinam horned frog is a large, fat-looking frog. Its round, rather flat body has the shape of a doughnut without the hole. Its wide head has an immense mouth that stretches from one side to the other, light tan eyes, and pointy eyebrows that resemble little horns. The body, which has small, scattered, cone-shaped warts across the back and down the sides, is green to yellowish green. Its back is patterned with brown, blotchy stripes, and a thin, brown band runs across the head from one eyebrow horn



The Surinam horned frog is an opportunistic hunter, which means that it will eat just about anything that it can grab and swallow. (Photograph from the Kansas University Natural History Museum. Reproduced by permission.)

to the other. The frog usually sits with its rather small hind legs tucked up against the body and its short but thick front legs held pigeon-toed, or facing inward. Both its front and hind legs are lime green with brown to dark green bands. The toes on the front feet are unwebbed, while those on the hind feet are partly webbed. The belly is smooth and cream-colored, and the throat is dark brown to black. Males and females look alike except during the mating season, when the males develop rough pads on the inner toe of each front foot. Adult females can grow to as much as 4.7 inches (12.0 centimeters) long from snout to rump. The males are smaller, reaching 3.1 inches (8.0 centimeters) in length.

Geographic range: The Surinam horned frog lives in the Amazon Basin, which is a large, low area of northern South America. In this region, heavy rains, small creeks, and streams all eventually drain into Amazon River. It also can be found in the small countries of French Guiana, Guyana, and Suriname.

Habitat: During most of the year, the horned frog stays on land and among the thick plants of the rainforest floor. In the breeding season, however, it moves into small pools of water, which may or may not dry up later in the season.

Diet: The Surinam horned frog is an opportunistic (ah-per-too-NIS-tik) hunter, which means that it will eat just about anything that it

can grab and swallow. Prey includes grasshoppers and other insects, spiders, other frogs, and even quite large animals like snakes, lizards, and mice. The tadpoles, which have a long tooth-like poker on the bottom jaw, are also good hunters. They eat tadpoles, including other Surinam horned frog tadpoles, by opening their mouths and sucking them in. With a chomp of the jaws, the poker spears the prey, and the tadpole quickly swallows it.

Behavior and reproduction: Although it is a large frog, the Surinam horned frog can do quite a vanishing act. The ground of the rainforest is cluttered with growing plants and mounds of fallen leaves. This frog hops to such a mound, shuffles its body back and forth until all but its head is buried in the leaves, and then stops moving. With its pointy eyebrows that look like the edges of curled leaves and its camouflage colors, the frog nearly disappears. From here, it can watch for prey animals to walk unknowingly past. When one approaches closely enough, the frog lunges out, opens its immense mouth, and snaps it up. The frog may continue this style of sit-and-wait hunting, called ambush hunting, for several days from the same spot. It usually waits until dark on a rainy night to move to a new place.

Breeding season for this species is short, with all of the frogs mating and laying eggs when the first, heavy spring storms soak the land. The males hop to pools of water, sit on the edges, and make their deep calls. Some people describe the call as sounding like the "moo" of a cow or the "baa" of a sheep. When a female responds to a male's call, he climbs onto her back and hangs on by her front legs. The female lays up to 2,000 small eggs in the water. The eggs develop into tadpoles, which grow to about 2.5 inches (6.5 centimeters) long from head to tail before changing into froglets.

Surinam horned frogs and people: People see this frog more often in the pet store than in the wild.

Conservation status: The World Conservation Union (IUCN) does not consider this species to be at risk. Some of the areas where this frog lives are protected places, such as refuges and parks, but some are not. As more forests are logged and otherwise cleared, this frog's habitat is shrinking. ■



Budgett's frog *(Lepidobatrachus laevis)*

BUDGETT'S FROG
Lepidobatrachus laevis

Physical characteristics: With a body that is shaped like a flat, round pillow and a mouth that reaches almost from front leg to front leg, Budgett's frog is an odd-looking animal. Its head is extremely wide and has no noticeable neck to tell where the head ends and the back begins. It has two cream-colored eyes with round pupils. The eyes are set close together on top of its flat head with two nostrils below and between them on its rounded snout. Compared to its body, the four legs are quite short. The toes on its front feet are unwebbed, but those on the rear feet have webs almost to the tips. Each hind foot also has a large, black, shovel-like bump, or tubercle (TOO-ber-kul), that the



With a body that is shaped like a flat, round pillow and a mouth that reaches almost from front leg to front leg, Budgett's frog is an odd-looking animal. Its head is extremely wide and has no noticeable neck to tell where the head ends and the back begins. (Illustration by Dan Erickson. Reproduced by permission.)

frog uses for burrowing. Budgett's frog has an olive brown to gray back with dark blotches or pale streaks. Its underside is white. A large frog, adults usually grow to be 4.5 to 5.1 inches (11 to 13 centimeters) long from snout to rump.

Geographic range: Budgett's frog lives in the Chaco Region, a dry part of northern Argentina, southern Paraguay, and the southern half of Bolivia, which are located in central South America.

Habitat: During most of the year, Budgett's frog digs burrows in dry scrub areas and stays underground. In the breeding season, however, it comes on land and moves into shallow pools of water that dry up later in the year.

Diet: The adult diet includes snails and smaller frogs, which it finds in its pool of water. The tadpoles are also meat-eaters and eat other smaller tadpoles, which they swallow in one gulp.

Behavior and reproduction: Budgett's frog's life cycle is tied to the weather. During the long, dry season, it remains underground in burrows, but during the rainy season, it climbs onto land and into the water, where it will mate and eat a year's worth of food. After the

rains end and the land begins to dry up, the frog starts digging, using its shovel-like tubercles to burrow backward into the mud on the bottom of its one-time watering hole. When it is well underground, it stops digging and sheds the outer layer of its skin. It sheds several times, and each time, the peeled-off skin piles up around the frog's body, forming a coat, or cocoon, of dead skin. This cocoon, which is waterproof, helps the frog stay moist inside. Without it, the surrounding dirt would soon soak up the frog's moisture and dry out and kill the animal.

The frog stays in its protective cocoon for about nine months when the spring rains come and wet the land again. As the water soaks the soil, the cocoon softens, and the frog crawls out of its burrow, dragging the cocoon around its body. Before doing much else, it eats its cocoon. The frog is then active for about three months—November, December, and January, which are spring and summer months in South America. If a predator approaches one of these large frogs, it faces the attacker and opens wide its gigantic mouth. In many cases, this is enough to convince the predator to find something else to eat. Once the frog becomes active in the spring, breeding starts soon. The males float in shallow pools of water and squeal their calls. Females respond, and each male mates by climbing onto a female's back and holding onto her near her front legs. A single female can lay 1,200 eggs at a time. The eggs sink in water and hatch into tadpoles in less than a day. In about 20 days, the already 2-inch-long (5.1-centimeter-long) tadpoles turn into froglets.

Budgett's frogs and people: People rarely see these frogs in the wild. They are not popular in the pet trade.

Conservation status: The IUCN does not consider this species to be at risk, but its populations in Argentina have begun to disappear. Scientists are unsure why. ■



ROCK RIVER FROG
Thoropa miliaris

Physical characteristics: The Rock River frog has a typical frog shape: long hind legs with long toes, shorter front legs and toes, and a slender body and head with large, bulging eyes. The toes on its unwebbed front and back feet end in slightly widened tips. Eardrums show on each side of its rather wide head, just behind the rust-colored eyes. The frog is tan to reddish brown on its head, back, and legs, often with a noticeable dark stripe on each side of the body and running from almost the tip of the rounded snout to the start of the back leg. Its hind legs have dark brown to black bands. Its front legs have less banding. Its belly is gray, and it has a yellowish color at the



The Rock River frog lives in warm and moist forests, especially along streams. (Photograph from the Kansas University Natural History Museum. Reproduced by permission.)

tops of its hind legs. Males and females usually look alike, but in the breeding season, the males develop tiny spines on three of the front toes on each foot. Males are also slightly smaller than females. Females grow to 3.2 inches (8.1 centimeters) long from snout to rump, while males reach 2.8 inches (7.1 centimeters) in length.

Geographic range: It lives in a small area of southeastern Brazil near the Atlantic coast.

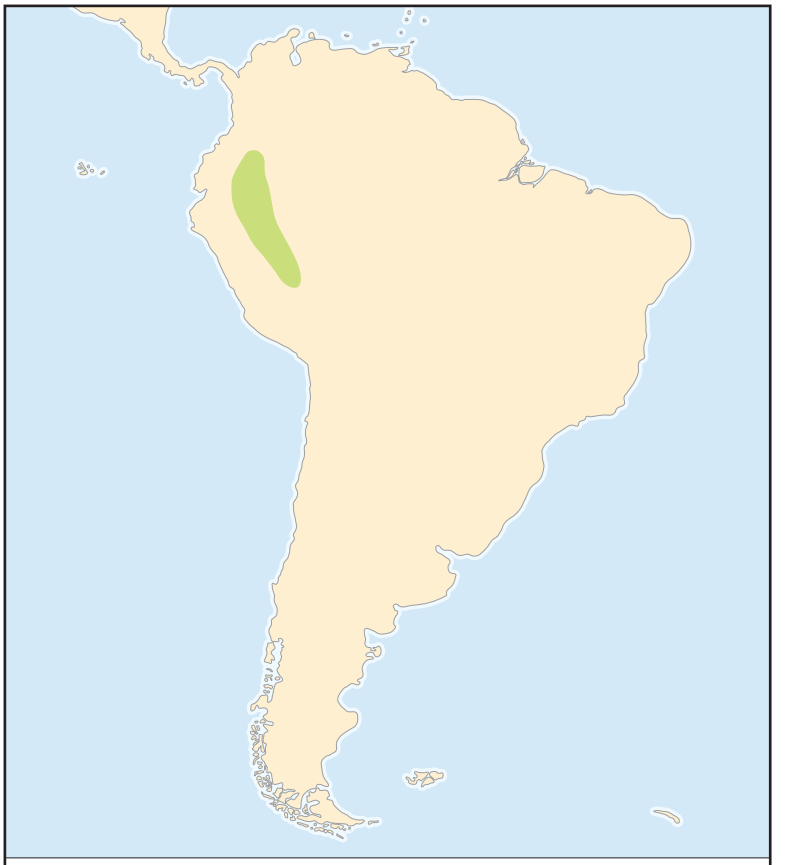
Habitat: It lives in warm and moist forests, especially along streams.

Diet: The Rock River frog probably eats arthropods, as do many of the other species in this family.

Behavior and reproduction: The Rock River frog becomes active at night, when it hops about on land looking for food. In the breeding season, the males climb onto streamside rocks and call. When females follow the calls to the males, they mate, and the females lay their eggs in the water. The eggs hatch into tadpoles, which use their long, strong tails to swim to the shoreline and up onto wet rocks.

Rock River frogs and people: People rarely see this species. It is not common in the pet trade.

Conservation status: The IUCN does not consider this species to be at risk, but it does live in areas where the habitat may disappear due to the cutting of trees and plants and the construction of buildings and dams. Scientists are also watching it to see whether a fungus that is killing off many different types of frogs worldwide may affect this species, too. ■



Perez's snouted frog *(Edalorhina perezi)*

PEREZ'S SNOUTED FROG
Edalorhina perezi

Physical characteristics: Perez's snouted frog has a dark brown to black stripe running along each side and separating its gray or brown back and head from its bright white underside. Its head has a rounded snout and two tan or gray and copper eyes are outlined on top with thin, finger-like bumps that look almost like long eyelashes. Its white belly has black markings, and its back has ridges that stretch from the back of the head to the rump. The back also sometimes has reddish brown stripes. Females are slightly larger than the males and grow to 1.4 inches (3.5 centimeters) long from snout to rump. The males reach 1.2 inches (3 centimeters) in length.



During the daytime, Perez's snouted frog hops through the piles of leaves on the rainforest floor and looks for things to eat. It relies on the dead-leaf colors of its head and back to hide it from predators. (Illustration by Dan Erickson. Reproduced by permission)

Geographic range: It lives in the Amazon River basin from southern Colombia to northern Bolivia.

Habitat: Perez's snouted frog lives in valleys and other low-lying areas of the wet and warm tropical rainforests. They breed in small pools of water, usually those that dry up later in the year.

Diet: The adult diet includes flies, crickets, and other insects, as well as spiders and other arthropods.

Behavior and reproduction: During the daytime, this frog hops through the piles of leaves on the rainforest floor and looks for things to eat. It relies on the dead-leaf colors of its head and back to hide it from the scanning eyes of predators. In the breeding season, each of the males begins to call from his spot in the leaves. When a female approaches, the male climbs on her back and hangs on near her front legs as they scuttle off to a pool of water. There, the female lays 78

to 98 eggs. The male and female together beat the water, eggs, and fluid from their bodies into foam, which floats on top of the water. In four to six days, the eggs hatch into tadpoles, which swim out of the foam nest into the water. The tadpoles have tan backs and greenish yellow bellies and can grow to about 0.8 inches (2 centimeters) before turning into froglets.

Perez's snouted frogs and people: People rarely see this species. It is not common in the pet trade.

Conservation status: The IUCN does not consider this common species to be at risk. While some of its habitat is disappearing as people move into the area or turn the forests into farmland, these frogs seem to be doing very well in the wild. ■



SOUTH AMERICAN BULLFROG
Leptodactylus pentadactylus

Physical characteristics: A large frog, the male South American bullfrog can grow to 7.3 inches (18 centimeters) long from snout to rump, while the female usually reaches 6.9 inches (17.6 centimeters) in length. It has a typical frog body with long, jumping hind legs, and shorter front legs. Its large head has a rounded snout with brown triangular patches on the upper lip, large eyes, and a noticeable ear drum on each side. Its head and back are usually tan to reddish brown, and two ridges run from the back of the head to the rump. Sometimes, the frog has reddish brown markings between the two ridges. The



A large frog, the male South American bullfrog can grow to 7.3 inches (18 centimeters) long from snout to rump, while the female usually reaches 6.9 inches (17.6 centimeters) in length. (Illustration by Dan Erickson. Reproduced by permission.)

front and back legs often have dark brown bands running across them. The toes on all four feet are unwebbed. Its underside is cream-colored with black or dark brown markings. For most of the year, the male and female look similar. During breeding season, however, the male's front legs swell, the inside toe on each front foot grows a spine, and two spines develop on each side of the chest. The large front legs and the spines help the male hold onto the female during mating.

Geographic range: This frog is found in Central and South America. It reaches as far north as Honduras in Central America and in much of northern South America, including the central and northern Amazon River basin, and parts of Ecuador and the Guianas.

Habitat: The South American bullfrog lives mainly in lowland rainforests, but it sometimes makes it home in drier forests and even slightly up the sides of mountains but below 3,800 feet (1,200 meters) above sea level. During breeding season, they move into slow-moving streams and ponds.

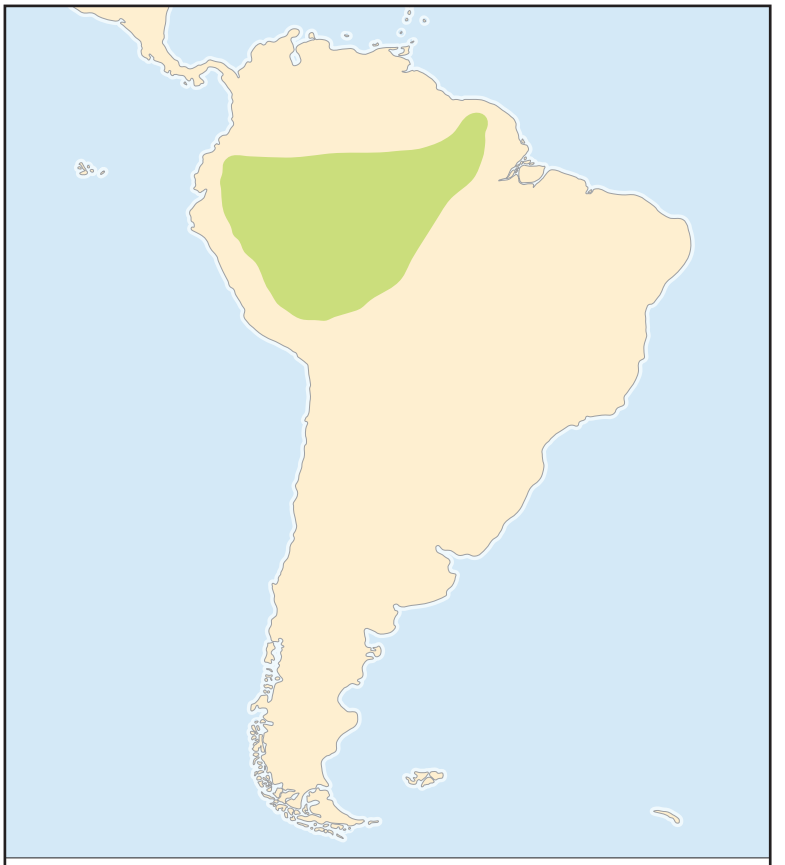
Diet: South American bullfrogs will eat almost anything. Adults eat large arthropods, frogs and other reptiles, and small mammals and birds. The younger bullfrogs tend to eat smaller arthropods. Tadpoles are both vegetarians and meat-eaters, gobbling up plants as well as frog eggs and tadpoles. They will even eat their own young relatives.

Behavior and reproduction: During the day, this frog hides under logs, inside burrows, or underneath leaf piles on land. Although this behavior protects it from being seen, predators sometimes spot the frog. To protect itself, the frog tries something different. It sucks in air to blow itself up to a larger size and stands as tall as it can on all four legs. The frog can also release a bad-tasting poison from its skin. Finally, as a last resort, the South American bullfrog often screams with a high voice when an attacker picks it up.

During breeding season, each male hops to water, either to the edge of a pond or a slow offshoot of a stream, and makes his loud, repeating "whoorup" calls. When a female arrives, he scoots onto her back and grasps her near her front legs. As she lays her 1,000 or so eggs, he flails his legs to whip up a foam nest. The nest lies in a dip in the ground just beyond the edge of the water. The eggs hatch into brown tadpoles about two or three days later. When rains come, the water floods the nest, and the tadpoles swim out and into the stream or pond. The tadpoles grow quickly, reaching 3.3 inches (8.3 centimeters) long, and turn into froglets when they are about a month old.

South American bullfrogs and people: Local people in some areas eat these frogs.

Conservation status: The IUCN does not consider this species to be at risk, although it is becoming rather rare in some areas where it is hunted as food. ■



Gold-striped frog *(Lithodytes lineatus)*

GOLD-STRIPED FROG
Lithodytes lineatus

Physical characteristics: True to its name, the gold-striped frog has two golden yellow stripes, each one running from its rounded snout above the brown eye and eardrum and down its slender, slightly warty back to the rump. Its legs are tan with black bands, often faded on the front legs, and end in unwebbed toes that are tipped with small pads. Small red blotches show at the top of the hind legs. The frog's smooth underside is light grayish brown. Males and females look alike, although the females are slightly larger. Females can reach 2.2 inches (5.6 centimeters) long from snout to rump, while males grow to 1.8 inches (4.5 centimeters) in length.



People often mistake this species for a poison dart frog. While poison dart frogs ooze what can be dangerous poison from their skin, the gold-striped frogs do not. (Illustration by Dan Erickson. Reproduced by permission.)

Geographic range: This frog is found in the Amazon River basin of northern South America, as well as in the Guianas.

Habitat: For most of the year, gold-striped frogs are found in hot, moist, low-lying rainforests.

Diet: Adults search the forest floor for earthworms and arthropods to eat.

Behavior and reproduction: Although young gold-striped frogs may hop about on land in the daytime and at night, the adults usually go out only after dark. In the daylight, the adults hide from sight in underground burrows, sometimes inside the nests of leaf-cutting ants. During breeding times, the males call from their daytime getaways. When a female approaches the male, he hops onto her back, and they head for water. She lays about 200 eggs inside a foam nest that they make near the edge of the water. The eggs hatch into tadpoles, which stay inside the nest for about one to two weeks, and then swim off into the water. In about nine weeks, when the bright pink tadpoles are as much as 2 inches (5 centimeters) long, they turn into froglets.

Gold-striped frogs and people: People often mistake this species for a poison dart frog. While poison dart frogs ooze what can be dangerous poison from their skin, the gold-striped frogs do not.

Conservation status: This common species is not considered endangered or threatened. ■



Gray four-eyed frog *(Pleurodema bufonina)*

GRAY FOUR-EYED FROG
Pleurodema bufonina

Physical characteristics: The gray four-eyed frog gets its name from the two, large, dark-colored glands on its hips. When looking at the frog from the back end, the glands look somewhat like oval-shaped eyes. This species has a short, rounded snout, small eardrums, short and chubby front legs that have unwebbed toes, and longer hind legs with slightly webbed toes. Its upper body is brown, sometimes with darker brown spots and often with a thin, light stripe down the middle of the back. Its underside is light tan. Males and females look alike, but females are a bit larger. Females grow to 2.2 inches

(5.6 centimeters) from snout to rump, while males can reach 1.8 inches (4.5 centimeters) in length.

Geographic range: This frog lives farther south than any other frog in the world. It makes its home in Chile and nearby parts of western Argentina, including the area around the Straits of Magellan near the southern tip of South America.

Habitat: Gray four-eyed frogs may live anywhere from the lowlands to mountain sites as high as 7,500 feet (2,300 meters) above sea level. Its home is in grasslands and scrubby areas, often alongside lakes.

Diet: Although they do not know for sure, scientists think these frogs eat small arthropods.



The gray four-eyed frog gets its name from the two, large, dark-colored glands on its hips. When looking at the frog from the back end, the glands look somewhat like oval-shaped eyes. (© Joseph T. Collins/Photo Researchers, Inc.)

Behavior and reproduction: Unlike many other frogs in this family, which are active mainly at night, adult gray four-eyed frogs may hop about on land both during the day and at night. They are especially active during wet weather and tend to move under stones or into cracks in or between rocks during drier spells. During the spring breeding season, males and females meet in shallow water along lakeshores. The males do not call. To mate, a male climbs onto a female's back and holds on near her hind legs. In the water, she lays a string of eggs, which hatch into grayish brown tadpoles. The tadpoles grow to as much as 1.4 inches (3.5 centimeters) long before changing into froglets.

Gray four-eyed frogs and people: People do not hunt this frog. It is not popular in the pet trade.

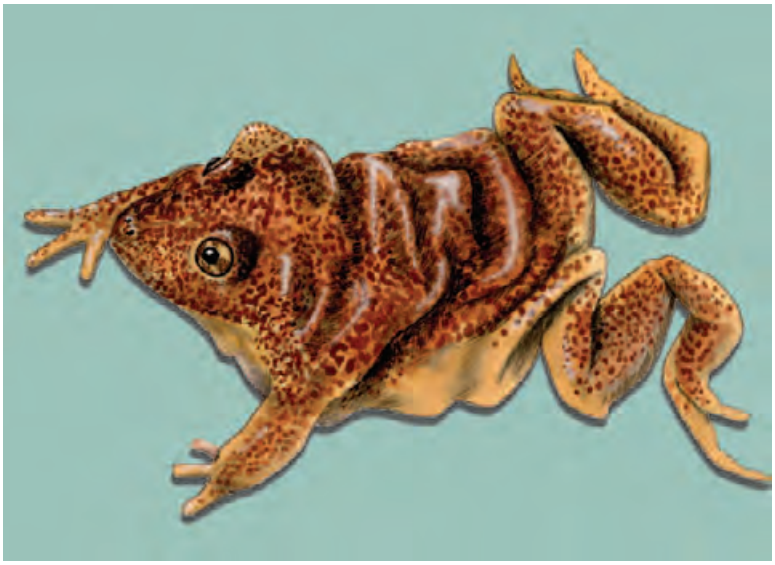
Conservation status: The IUCN does not consider this very common species to be endangered or threatened. ■



Patagonia frog *(Atelognathus patagonicus)*

PATAGONIA FROG
Atelognathus patagonicus

Physical characteristics: Saggy skin is a very noticeable characteristic of the Patagonia frogs, but not all of them have it. Only the adults, which live in the water, develop the loose folds of skin on the sides of the body and on the thighs of the hind legs. The skin on younger frogs is not saggy. The upper side of the frog is tan to brown with tiny, darker brown speckles, and the underside is light orange. The head has a rather long snout that narrows toward the rounded tip, small eyes that face slightly forward, and eardrums that are hidden beneath folds of skin. The front legs are short and have unwebbed toes, while the longer hind



In just the 10 years between 1994 and 2004, the number of Patagonia frogs fell by half, and the largest population, which lived in a lake called Laguna Blanca, has vanished completely. (Illustration by Dan Erickson. Reproduced by permission.)

legs have fully webbed toes. Adults grow to 2 inches (5 centimeters) in length from the tip of the snout to the end of the rump.

Geographic range: Found only in northern Patagonia, Argentina, it lives in Laguna Blanca and small lakes in the area.

Habitat: Patagonia frogs spend most of their lives in cold, shallow, rocky-bottomed lakes, but as young frogs, they hop onto land and live under stones in tall grassy areas.

Diet: Adult Patagonia frogs eat arthropods, especially amphipods (AM-fih-pawds), that they find in the water. Amphipods are beach fleas, water lice, and other small water-living invertebrates.

Behavior and reproduction: The adult's baggy skin helps it breathe underwater. Like other frogs, the Patagonia frog can breathe through its skin. This is possible because oxygen from the water can pass right through the frog's skin and right into its blood, instead of going through the lungs first, as it does in humans. In the cold water where the Patagonia frog lives, the water has a less-than-normal amount of oxygen. With the extra folds of skin that flap in the water as the frog swims on top and between rocks on the streambed, however, the frog can take up enough oxygen to survive.

The frog's life begins when an adult female lays her small eggs on underwater plants. They hatch into golden brown tadpoles that live in the shallow water until they grow to as much as 2 inches (5

centimeters) long. They then turn into froglets that hop onto land. When they are old enough to reproduce themselves, they take to the water and develop baggy skin.

Patagonia frogs and people: People do not hunt this frog. It is not popular in the pet trade.

Conservation status: According to the World Conservation Union (IUCN), this species is Endangered, which means that it faces a very high risk of extinction in the wild. In just the 10 years between 1994 and 2004, the number of Patagonia frogs fell by half, and the largest population, which lived in a lake called Laguna Blanca, has vanished completely. Scientists blame the disappearance at Laguna Blanca on new fishes introduced into this lake. The fishes are predators of the frogs and quickly wiped out the entire population. Environmentalists fear that fishes will also be introduced into the remaining lakes and ponds where the frogs live. ■

FOR MORE INFORMATION

Books:

Cogger, Harold G., and Richard G. Zweifel. *Encyclopedia of Reptiles and Amphibians.* San Diego, CA: Academic Press, 1998.

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians (Smithsonian Handbooks).* New York: Facts on File, 1991.

Mattison, Chris. *Frogs and Toads of the World.* New York: Facts on File Publications, 1987.

Patent, Dorothy Hinshaw. *Frogs, Toads, Salamanders, and How They Reproduce.* New York: Holiday House, 1975.

Ryan, Michael J. *The Túngara Frog.* Chicago: University of Chicago Press, 1985.

Showler, Dave. *Frogs and Toads: A Golden Guide.* New York: St. Martin's Press, 2004.

Stebbins, Robert C. *A Field Guide to Western Reptiles and Amphibians (Peterson Field Guide Series).* Boston: Houghton Mifflin, 1966.

Periodicals:

Raloff, Janet. "Hawaii's Hated Frogs: Tiny Invaders Raise a Big Ruckus." *Science News,* January 4, 2003 (vol. 163): 11.

Web sites:

"Amphibians - Leptodactylidae: Tropical Frogs." *Project Amazonas Inc.* http://www.projectamazonas.com/subpages/floraandfauna/

FloraFaunaGalleries/amphibians-tropical%20frogs%20gallery.htm (accessed on March 1, 2005).

"*Atelognathus patagonicus*." *CalPhotos.* http://elib.cs.berkeley.edu/cgi/img_query?query_src=aw_lists_genera_&elarge=1111+1111+111+2039 (accessed on March 1, 2005).

"Big Bark, Big Bite." *American Museum of Natural History.* http://www.amnh.org/exhibitions/frogs/featured/bigbark.php (accessed on March 1, 2005).

"*Ceratophrys cornuta*." *Amphibians.* http://www.rieo.net/amph/exfrog/tuno/cerato/amazon.htm (accessed on March 1, 2005).

"Family Leptodactylidae (Neotropical Frogs)." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/pictures/Leptodactylidae.html (accessed on March 1, 2005).

"Frog Legs." *American Museum of Natural History.* http://www.amnh.org/exhibitions/frogs/featured/froglegs.php (accessed on March 1, 2005).

"*Lepidobatrachus laevis*." *Amphibians.* http://www.rieo.net/amph/exfrog/tuno/lepido/laevis.htm (accessed on March 1, 2005).

"*Pleurodema bufonina*." *CalPhotos.* http://elib.cs.berkeley.edu/ cgi/img_query?stat=BROWSE_IMG&query_src=photos_browseimgs_amphibian_sci&where-lifeform=Amphibian&where-taxon=Pleurodema+bufonina+ (female) (accessed on March 1, 2005).

"Smokey Jungle Frog." *Wildherps.com.* http://www.wildherps.com/species/L.pentadactylus.html (accessed on March 1, 2005).

VOCAL SAC-BROODING FROGS

Rhinodermatidae

Class: Amphibia
Order: Anura
Family: Rhinodermatidae
Number of species: 2 species

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

The family of vocal sac-brooding frogs has only two species: Darwin's frog and Chile Darwin's frog. Both of these little frogs have flattened heads that come to a fleshy point at the tip of the snout. With their large eyes and thin, nearly beak-shaped snout, these frogs almost have a bird-like face. The pointy snout tip is especially noticeable because it comes at the end of two ridges, one found on each side of the body and extending from nearly the rump all the way to the snout. Another fainter ridge runs along the upper lip to the bottom of each large, gold-colored eye and down each front leg. The front legs are shorter than the hind legs, but all four are slender. The toes on the front feet have no webbing, but most if not all of the hind toes are at least partially webbed. Both species have a bump, or tubercle (TOO-ber-kul), on each hind foot. Their bodies may be light brown, reddish brown, brown, light green, or dark green, sometimes with brown, gray, or green markings. At least part of the underside, usually including the hind legs and lower part of the belly, is black with large white spots or blotches.

Although the two species look much alike, they are slightly different. The Chile Darwin's frog has webbing between all of the toes on its hind feet, while the Darwin's frog does not have any webbing between its outer two hind toes. In addition, the tubercles on the hind feet of the Chile Darwin's frog are larger than those on the Darwin's frog.

The two members of this family are small frogs. A male Darwin's frog grows to 0.9 to 1.1 inches (2.2 to 2.8 centimeters),

and the female reaches 1 to 1.2 inches (2.5 to 3.1 centimeters). The Chile Darwin's frog is slightly larger. The male grows to 1.2 inches (3.1 centimeters), and the female reaches 1.3 inches (3.3 centimeters) in length. The males and females of both species look much alike except during the breeding season when the male's chest may be puffed up with eggs or tadpoles.

GEOGRAPHIC RANGE

As its name suggests, Chile Darwin's frog lives in Chile. In particular, its home is in the central part of the country in areas between about 160 and 1,640 feet (50 to 500 meters) above sea level. Darwin's frog lives in the same area as Chile Darwin's frog and also farther south through Chile and into far western Argentina. They can be found from sea level to about 4,900 feet (1,500 meters) above sea level.

HABITAT

These frogs live in wet forests where beech trees grow and sometimes in open fields near houses and buildings. They usually do not wander too far from either wetlands or lazy streams.

DIET

Scientists do not know for sure, but they think these two species eat whatever insects and other invertebrates they can find.

BEHAVIOR AND REPRODUCTION

Mostly active during the day, the vocal sac-brooding frogs likely find a spot in the forest or field and settle in to wait for an insect or other small invertebrate to wander by. The frogs then quickly nab the passing meal. The two species are active most of the year, but disappear in cold, winter months. The frogs probably wait for warmer weather from a sheltered spot under a layer of moss or a rotting log, but scientists do not

DIFFERENT CALL, DIFFERENT SPECIES

Until scientists took a closer look, they thought Darwin's frog was the only member of the vocal sac-brooding family. One of the clues they used to decide that the frogs were actually two different species instead of one was that some males were making one type of call and others were making a different-sounding call. The call is very important among frogs because females use it to find males who are ready to mate. If a male's call is different—even if he looks just like every other male frog in the forest—a female will not answer his call and will not mate with him. An important requirement for animals to be of the same species is that the males and females must recognize each other as possible mating partners.

know for sure where the frogs go in the winter. When the Darwin's frog is threatened, it flips onto its back and lies still. This display shows off the frog's bright black-and-white pattern, which may scare off a predator. The Chile Darwin's frog, which also has the black-and-white underside, probably does the same thing.

Once spring comes, the frogs again appear in the woods and meadows. Each male performs his nighttime calls from land and draws in a female. Darwin's frog calls quickly repeat a "pi-i-i-i-ip" over and over again. The male Chile Darwin's frog sings a fast "pip-pip-pip-pip" and waits a few seconds before repeating the short call. In both species, the female lays her eggs on the ground and leaves the parenting job to the male. A female Chile Darwin frog lays one or two dozen small eggs, while a female Darwin's frog lays three to seven larger eggs. The male in both species stays with the eggs until they are almost ready to hatch, then scoops them up with his mouth. The eggs slide back into his vocal sac, a balloon-like structure in the areas of his throat and chest that inflates and deflates when he calls. Since he has already mated and no longer needs to use the vocal sac to call in females, it provides a safe spot for the eggs to hatch into tadpoles. In about eight days, the male Chile Darwin's frog hops over to a stream or pool, and the young tadpoles squirm out of his vocal sac and into the water, where they later turn into froglets. In Darwin's frog, the tadpoles remain in the male's vocal sac for 50 to 70 days until they turn into froglets. Only then do they crawl outside.

VOCAL SAC-BROODING FROGS AND PEOPLE

People do not hunt and eat these frogs, and they do not commonly see them in the pet trade. Scientists are interested in the frogs because of the unusual role of the male in the development of his young.

CONSERVATION STATUS

According to the World Conservation Union (IUCN), Chile Darwin's frog is Critically Endangered, which means that it faces an extremely high risk of extinction in the wild; and Darwin's frog is Vulnerable, which means that it faces a high risk of extinction in the wild.

The Chile Darwin's frog is especially at risk. Since 1994, at least 80 percent of all members of this species have disappeared,

and some scientists fear that it may already be extinct. People had seen Chile Darwin's frogs in their habitat until 1978, but trips to find the frog since then have found nothing. Scientists are not sure why this frog has vanished, but think that habitat loss, and particularly the removal of the plants where they live, may be part of the reason.



Darwin's frog *(Rhinoderma darwinii)*

SPECIES ACCOUNT

DARWIN'S FROG
Rhinoderma darwinii

Physical characteristics: Darwin's frog, which is also sometimes called Darwin's toad, is a pudgy frog with a triangle-shaped head that ends in a very pointy snout. A ridge runs down each side of the body from the snout over the eye and almost to the rump. Its gold-colored eyes are on the sides of its head. No eardrums show. Its back, the top of its head, and the top of its legs are light brown with gray blotches. The underside of the frog is often light to dark brown on the throat and chest, and black with white blotches toward the belly and on the back legs. The toes on the front feet are unwebbed, but most of the toes on the hind feet have at least some



The male Darwin's frog stays with his eggs until they are almost ready to hatch, then scoops them up with his mouth. The eggs slide back into his vocal sac. Since he no longer needs to use the vocal sac to call in females, it provides a safe spot for the eggs to hatch into tadpoles. (Illustration by Wendy Baker. Reproduced by permission.)

webbing. The space between the two outer toes on the hind feet has no webbing. The frog also has a small bump, or tubercle, on its hind foot.

Females are slightly larger than males and can grow to 1 to 1.2 inches (2.5 to 3.1 centimeters) long from snout to rump. Males usually reach 0.9 to 1.1 inches (2.2 to 2.8 centimeters) in length. Besides their size, males and females look alike except during the mating season, when the male's chest may be puffed out because of its unusual breeding behavior.

Geographic range: Darwin's frog lives in central and southern Chile and continues across the border into far western Argentina.

Habitat: Darwin's frogs live in beech-tree forests and in fields, sometimes in areas near houses and buildings. They also live near and often in slow streams and swamps.

Diet: Ambush hunters, they sit still and wait for an insect or other small invertebrate to wander by closely enough to grab and eat it.

Behavior and reproduction: Darwin's frogs are active during the daytime, and they spend a considerable amount of time sunbathing,

or basking. Although their body shape and color allow them to avoid notice much of the time, predators do sometimes discover this little frog. When the attacker approaches, the frog defends itself by throwing itself onto its back and playing dead. If the frog is near water, it jumps in first, then flips over and floats downstream while lying upside down. Both displays show off the frog's black and white underside and may frighten off a predator.

The most unusual behavior in this frog, however, is in its reproduction. Their breeding season begins in spring and continues into summer. In the daytime and occasionally at night during this time, each male makes his call, quickly repeating "pi-i-i-i-ip" over and over again. When he calls, he draws air into a vocal sac on his throat, which inflates and deflates like a balloon. When the female responds, he leads her to his nest, which is a hidden spot on land. She then squirms under his body, so that he winds up on top of her back. Instead of holding on to her back very tightly as other frogs do, the male Darwin's frog barely clasps her. She lays about three to seven eggs and leaves the male to take care of them for about 20 days when they are almost ready to hatch. He then gobbles them up. The eggs drop into his vocal sac, hatch there into tadpoles, and remain inside for another 50 to 70 days until they turn into froglets. During this time, the male's chest is puffed large with developing tadpoles. Scientists think the tadpoles survive by slowly eating the leftover yolk from their eggs, as well as some food provided by the male's body through the skin lining his vocal sac. The new froglets crawl out of the vocal sac, through their father's mouth, and to the outside, where they begin hopping about on land.

Darwin's frogs and people: Scientists are interested in this frog because of the unusual way that the male is involved in reproduction.

Conservation status: According to the IUCN, Darwin's frog is Vulnerable, which means that it faces a high risk of extinction in the wild. According to scientists who have studied the frog, it is now much less common than it was in the 1980s and 1990s, and it has vanished completely from some areas, including places inside national parks and other preserves. They believe a main reason for the frogs' disappearance in unprotected places is the loss of their habitat, especially due to logging of the forests where they live. In addition, the climate is becoming drier in this part of the world and may be making it harder for the frogs to survive. ■

FOR MORE INFORMATION

Books:

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians (Smithsonian Handbooks).* New York: Facts on File, 1991.

Mattison, Chris. *Frogs and Toads of the World.* New York: Facts on File Publications, 1987.

Miller, Sara Swan. *Frogs and Toads: The Leggy Leapers.* New York: Franklin Watts, 2000.

Patent, Dorothy Hinshaw. *Frogs, Toads, Salamanders, and How They Reproduce.* New York: Holiday House, 1975.

Showler, Dave. *Frogs and Toads: A Golden Guide.* New York: St. Martin's Press, 2004.

Web sites:

Churchman, Deborah. "Hoppy Birthdays - Frogs." *Ranger Rick.* http://www.findarticles.com/p/articles/mi_m0EPG/is_4_36/ai_90445325 (accessed on March 10, 2005).

"Dads at Work." *Time for Kids Classroom.* http://www.timeforkids.com/TFK/class/ns/article/0,17585,490974,00.html (accessed on March 10, 2005).

"Strange Breeding: Darwin's Frog." *Frogland.* http://allaboutfrogs.org/weird/strange/darwins.html (accessed on March 10, 2005).

THREE-TOED TOADLETS
Brachycephalidae

Class: Amphibia
Order: Anura
Family: Brachycephalidae
Number of species: 6 species

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

This family includes some of the smallest frogs in the world. Depending on the species, adults grow to just 0.3 to 0.8 inches (0.8 to 2 centimeters) long from the tip of the short, rounded snout to the end of the rump. Although the frogs are small, they have somewhat chunky, strong-looking bodies. Their front legs are thin and end in two, sometimes three, stubby toes. They have the bones for the other two toes under their skin, but these toes do not show. Their hind legs likewise show only three, sometimes four, very short toes. Each toe bone in the four feet is shaped like a "T" at the tip. The skeleton is also a bit odd in these frogs because it has no middle chest bone, or sternum, but does have a covering of bone across the front of the chest. Most species also have bony plates, or shields, under the skin of the back. The shield attaches to the backbone. Because of this shield, the three-toed toadlets are sometimes called saddlebacks. The southern three-toed toadlet does not have the shield.

Several of the frogs in this family, including the southern three-toed toadlet and some of the pumpkin toadlets, are bright orange. The pumpkin toadlet is sometimes yellow instead. The southern three-toed toadlet has black patches along its sides, parts of its legs, and around its eyes. Other frogs in this family are shades of brown and blend into the background a bit better.

Scientists either group all six species into one genus, called *Brachycephalus* or put two of the species in their own genus, named *Psyllophryne*. As of 2002, many scientists now use only *Brachycephalus* because they think all six species are very

closely related. At one time, scientists thought that the three-toed toadlets should be part of the "true toad" family, named Bufonidae. When they took a closer look, however, they found that the toadlets were missing an organ that the true toads have. It is called Bidder's organ and is a small growth of female-type tissue on part of the male's reproductive system.

GEOGRAPHIC RANGE

All six species live in different areas within the far eastern part of central and southern Brazil along the Atlantic Ocean coastline.

HABITAT

The tiny frogs in this family live among the leaves that cover the ground of warm, humid forests. They often live in forests on mountainsides up to 2,240 feet (750 meters) above sea level. They also breed on land.

DIET

Members of this family eat various arthropods (AR-thro-pawds). Arthropods are animals without backbones, or invertebrates (in-VER-teh-brehts), that have jointed legs. The diets of most three-toed toadlets include mites and springtails. Mites are small, spider-like arthropods. Springtails (sometimes called snow fleas in colder climates) are a type of very tiny insect that has a little clip on its underside. When the insect quickly unfastens its clip, the creature springs through the air. Three-toed toadlets find mites, springtails, and other small invertebrates in the leaves that are scattered on the ground.

BEHAVIOR AND REPRODUCTION

In the dry season of the year, these frogs find shelter under logs or beneath piles of leaves on the ground. They become active when the rainy season comes and wander about on land during the daytime. They typically walk rather than hop, using their thin front legs and longer hind legs to crawl among leaves on the forest floor. The males set up and defend territories against other males. A male calls to keep intruding males away, but if that does not work, he may begin wrestling with the other male and try to push him out of the area.

Scientists have not done careful studies of all six species, but they think that they probably all reproduce in the same general way. In the breeding period, which also takes place during

WHEN IS A TOADLET NOT A TOAD?

The three-toed toadlets of South America have a confusing name, because they are not actually toads at all. Scientists group all true toads into a single family, named Bufonidae. Young toads in this family are called toadlets. None of the other species of frogs are true toads, even if they have warty skin and look very much like toads. People who are not scientists, however, often are the ones who give frogs their common names, and they sometimes name warty-looking frogs "toads." The three-toed toadlets are an example. People called them toadlets because they look toad-y and they are small. Three-toed toadlets, however, are not part of the family Bufonidae and, scientifically speaking, are not really toads or toadlets at all.

the rainy season, the males call from their territories on land. The call of the pumpkin toadlet and the southern three-toed toadlet is a buzzy sound. The females hear the calls and approach the males. When a female comes close, a male will climb onto her back and use his front legs to hold onto her in front of her hind legs. The male frog, at least among the pumpkin toadlets, then scoots forward until he is hanging onto her body near her front legs. This type of piggyback grasp is called amplexus (am-PLEK-sus). Once the male is in the right position, the female lays her eggs, which are quite big compared to the size of the frog. She lays them on leaves or sometimes under a log. Because her eggs are so large, the female only has a few eggs. A female pumpkin toadlet, for example, lays five or fewer eggs, each of them 0.2 inches (5.1 to 5.3 millimeters) in diameter. The toadlet that is known by its scientific name *Brachycephalus didactyla* lays only one egg per clutch. Instead of hatching into tadpoles as happens in many other species of frogs, three-toed toadlet eggs hatch directly into baby toadlets, sometimes with a tiny bit of tail that disappears shortly. Pumpkin toadlets hatch 64 days after the female laid the eggs.

THREE-TOED TOADLETS AND PEOPLE

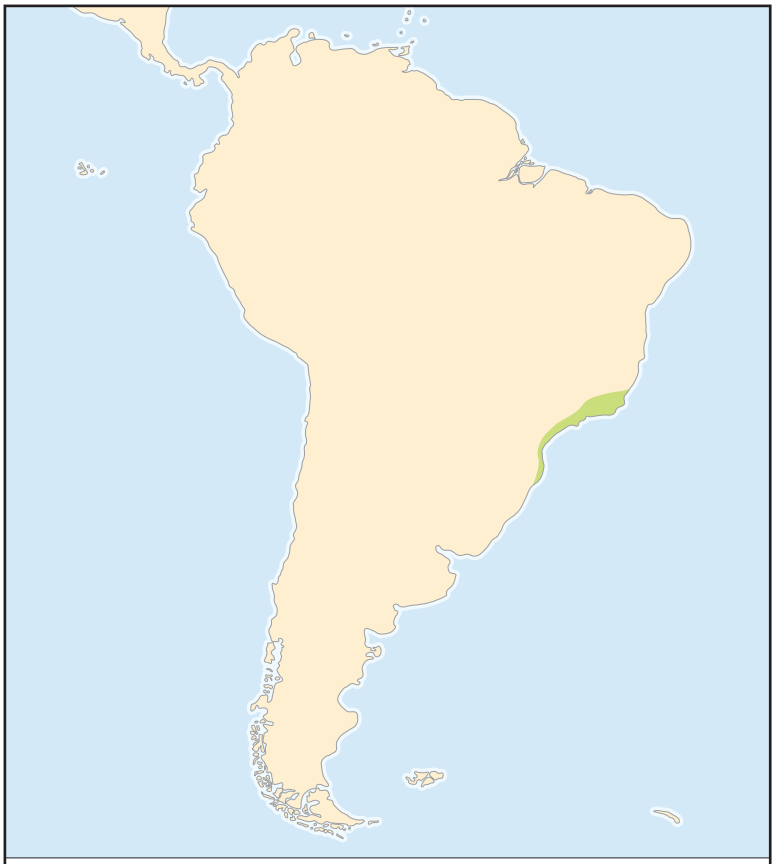
Scientists are studying the pumpkin toadlet because its skin oozes a poison that might be useful in making some medicines.

CONSERVATION STATUS

The World Conservation Union (IUCN) lists three species of three-toed toadlets as Data Deficient, which means too little information is available to make a judgment about the threat of extinction. The three species are *Brachycephalus nodoterga*, which is sometimes called a saddleback toad, *Brachycephalus pernix*, and *Brachycephalus vertebralis*.

Brachycephalus nodoterga lives in a very small area. In fact, it has only been found in one place: in forests that have never been

cut down and about 3,280 feet (1,000 meters) above sea level. More studies will help scientists learn details about this frog's life and what specific type of habitat and other things it needs to continue to survive in the wild. *Brachycephalus pernix* also lives in a small area. This species makes its home in mountain forests about 1,475 feet (450 meters) above sea level. Although its entire habitat is inside a protected area, conservationists fear that too many tourists in the forests may be trampling over the leaf-covered ground and accidentally harming the frogs that live there. *Brachycephalus vertebralis* is the third species listed by the IUCN as Data Deficient. This small frog also lives in the mountain forests of southern Brazil along the coast of the Atlantic Ocean. Its home is about 2,625 feet (800 meters) above sea level. First discovered in the late 1990s, it has not been seen since despite repeated searches. Destruction of the forests in southern Brazil may harm the toadlet, as well as the other two Data Deficient species in this family.



Pumpkin toadlet *(Brachycephalus ephippium)*

SPECIES ACCOUNT

PUMPKIN TOADLET
Brachycephalus ephippium

Physical characteristics: Reaching just 0.5 to 0.8 inches (1.25 to 2 centimeters) long, the pumpkin toadlet is one of the smallest frogs on the planet. Its name comes from its bright orange color, its warty skin, and its tiny size. Sometimes the frog's color is yellow rather than orange, and people call it a gold frog instead. Its head has a short, rounded snout and two large, black eyes. Beneath the skin of its back, this toadlet has a bony plate or shield that is attached to the backbone. The bony plate led to the third common name of this species, Spix's saddleback toad. Its front legs are thin and end in two, stubby



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toes. The slender hind legs, which are longer than the front pair, end in three stubby toes. The other toes on their feet are either just nubs or missing altogether. The bones inside the toes are each shaped like a "T" at the tip.

Geographic range: Pumpkin toadlets live in southeastern Brazil along the Atlantic coast.

Habitat: These frogs live and breed in humid, warm forests along the ocean. They spend most of their time in piles of dead leaves that cover the ground.

Diet: Pumpkin toadlets scrounge around in the leaf piles for small arthropods, including mites and tiny insects called springtails. Studies of pumpkin toadlets show that the frogs get more than half of their diet from springtails.

Behavior and reproduction: Pumpkin toadlets, which are active during the daytime in the rainy season, are not difficult to spot. Their bright orange or yellow color is very noticeable as these tiny frogs slowly walk over leaves. If the day is very humid, they may climb onto low branches of bushes and trees. In a rather unusual behavior, this frog swipes its front and back legs over its head on down its body. The frog performs this leg-waving movement when cleaning its body of dirt. A male frog also will wave its front legs in front of its eyes when another male comes close. This sometimes scares off the newcomer. If it does not work, the

male will protect his territory by wrestling with and shoving the other male until he leaves.

Each male calls from his own territory during the rainy season. He holds his body up high, draws in air to fill up his vocal sac, and performs his call, which is a repeated buzzing sound. When a female approaches, he wraps his front legs around her waist and then walks with her in this position as she shuffles around looking for a good spot to lay her eggs. Once she finds a site under a log or in a pile of leaves, the male scoots up to grab onto her near her front legs. For the next 30 minutes or so, she lays her eggs. Females usually lay five, large, yellowish white eggs at a time. After the female lays the eggs, the male leaves, but the female stays behind for a few moments to roll the eggs along the ground with her hind feet. Now covered with dirt, the eggs are well-hidden from the view of predators. The eggs hatch 64 days later, skipping the tadpole stage, and small, reddish brown toadlets crawl out. The newborn toadlets have a tiny tail, but this disappears soon.

Pumpkin toadlets and people: Scientists are studying the medical uses of the very strong poisons, or toxins, that ooze from this frog's skin. The toxins affect the heart and other muscles and the nerves.

Conservation status: The IUCN does not consider this frog to be at risk. Although it lives in a fairly small area, the pumpkin toadlet is quite common there. In addition, part of its habitat falls within various protected areas. ■

FOR MORE INFORMATION

Books:

Mattison, Chris. *Frogs and Toads of the World.* New York: Facts on File Publications, 1987.

Showler, Dave. *Frogs and Toads: A Golden Guide.* New York: St. Martin's Press, 2004.

Web sites:

"Brachycephalidae." *AmphibiaWeb.* http://elib.cs.berkeley.edu/aw/lists/Brachycephalidae.shtml (accessed on March 8, 2005).

"*Brachycephalus pernix*." *AmphibiaWeb.* http://elib.cs.berkeley.edu/cgi-bin/amphib_query?query_src=aw_lists_genera_&where-genus=Brachycephalus&where-species=pernix (accessed on March 8, 2005).

Cannatella, David. "Brachycephalidae." *Texas Memorial Museum, University of Texas, Austin.* http://www.zo.utexas.edu/research/

salientia/brachycephalidae/brachycephalidae.html (accessed on March 8, 2005).

"*Psyllophryne hermogenesi*." *AmphibiaWeb.* http://elib.cs.berkeley.edu/cgi-bin/amphib_query?query_src=aw_lists_genera_&where-genus=Psyllophryne&where-species=hermogenesi (accessed on March 8, 2005).

Watson, Eduardo Cörner. "Little Frog." http://www.grindelwald.com.br/sapo/ (accessed on March 8, 2005).

TRUE TOADS, HARLEQUIN FROGS, AND RELATIVES

Bufonidae

Class: Amphibia
Order: Anura
Family: Bufonidae
Number of species: 344 species

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

The toads in this family are known as the "true" toads. All other frogs that are called toads are not really toads. They may have a toad's body shape or have numerous warts, but they are not true toads. One of the features true toads have that no other type of frog has is a Bidder's organ. A Bidder's organ is a female body part that is found inside a male toad. This organ does not appear to do anything in a healthy male toad. It does, however, help to tell a true toad apart from all other species of frogs that exist on Earth.

True toads have other hidden features, too. They have an odd joint between their lower backbone, or spine, and their hip bones that makes it difficult for the toads to jump well. They can walk or hop short distances, but they cannot leap several feet like some of the other species of frogs. They have only seven bones in their spines instead of the eight that most other frogs have; they have fewer bones in their front and back feet, and they have shorter toes than other frogs typically have. In addition, the pair of shoulder blades, which are usually separate in other frogs, are fused together in toads into one big shoulder blade that stretches across the whole upper back. Their lack of teeth also sets the true toads apart. None of the true toads have teeth on the upper jaw, while almost all other frogs do.

The most noticeable feature of true toads is their warty skin, especially the huge "wart" on the back of the head. The big "wart" is called a paratoid (pair-RAH-toyd) gland and makes a

white, liquid poison that looks like milk. Not all true toads have paratoid glands, but the glands are usually very noticeable in the toads that do have them. The pair of paratoid glands on the American toad, for example, looks like large, flat water balloons that extend from behind the eye to the front of the back. Some species of frogs that are not true toads also have paratoid glands, so just seeing a paratoid gland is not enough to identify a frog as a true toad.

Many toads have plump bodies, short heads with rounded snouts and large mouths, eardrums that are visible on the sides of the head, short legs, and numerous warts on their backs and legs. The Houston toad is a good example. It has a fat-looking, round body that is covered with many small warts. Its head is short with a wide mouth and visible eardrums. Its front legs are thick but rather short, and its hind legs are much shorter than the legs of a leaping frog. Some of the toads in this family, however, look little like this typical toad. The harlequin frog, which is actually one of the true toads, has long and thin front legs, long hind legs, a thin body, no eardrums, and quite smooth skin.

In general, true toads are shades of brown, green, and/or gray, which allows these rather slow creatures to blend in with the background. The Chirinda toad, for instance, has a light brown back and legs and dark brown sides. When it sits still, it almost disappears against the dead leaves of its habitat. The green toad, which lives in Europe, Asia, and northern Africa, is brown with green blotches, a pattern that blends in with the ground where it lives. A few species, however, have very bright colors. The Yungas redbelly toad has a black and sometimes green back, but a bright red belly, and the male golden toad, which is now extinct, or no longer in existence, was vivid orange.

True toads also come in many different sizes. The Roraima bush toad, which lives in South America, grows to only 0.8 inches (2 centimeters) long from the tip of the snout to the end of the rump, while the marine toad can reach 9 inches (23 centimeters) in length. The Rococo or Cururu toad, can grow even larger, sometimes reaching nearly 10 inches (25.4 centimeters) long.

GEOGRAPHIC RANGE

Members of this family live throughout much of the world, including all continents except Antarctica. They do not naturally live in Australia, but people have introduced them there, and the toads are doing well.

HABITAT

True toads, harlequin frogs, and their relatives make their homes for most of the year in a variety of habitats from wet or dry forests to fields, and even some dry deserts. They can survive in very warm, tropical areas, as well as cooler places with snowy winter seasons. They do not live in far northern North America or northern Asia, but some exist without problem high on windswept or snow-capped mountains that are up to 16,400 feet (5,000 meters) above sea level. The vast majority of toads are terrestrial (te-REH-stree-uhl), which means they live on land. Examples of terrestrial toads include the American toad, the marine toad, and the Houston toad.

Only a few true toads climb and live in trees or spend most of their time in the water. One of the toads that is arboreal (ar-BOR-ee-ul), which means that it lives in trees, is the brown tree toad of Borneo, Sumatra, Malaysia, and Thailand, which are all in southeastern Asia. Using the wide pads on the tips of its toes to help it cling to twigs and branches, this toad usually stays in the trees except during mating season, when it enters streams. The aquatic swamp toad, on the other hand, is aquatic (uh-QUOT-ik), which means that it usually remains in the water. This large toad, which also lives in parts of southeastern Asia, has full webbing between its toes to help it swim.

DIET

Most toads eat insects, spiders, and other arthropods (AR-throe-pawds). Arthropods are animals that do not have backbones, but have jointed legs. Those that live in rainforests eat quite a few ants, which are plentiful there. Some, like the American toad, will also eat an occasional earthworm. The larger species, including the marine toads, eat a great many insects, but they can and sometimes do eat larger animals, including mice, other frogs, and lizards.

BEHAVIOR AND REPRODUCTION

Many true toads are mainly active at night, when they come out of hiding to hunt for food. One of these, the Colorado river toad, lives in the deserts of the western United States. It avoids the hot daytime sun by staying underground and comes out at night to search the sand for beetles, snails, and other invertebrates (in-VER-teh-brehts). Invertebrates are arthropods and other animals without backbones. A few toads, including the Yungas redbelly toad, are active during the day.

Like most other frogs, toads have small poison glands in their skin. In many toads, some of the poison glands group together to form the paratoid glands, one of which is located behind each eye. When the toad feels threatened, it can ooze and sometimes squirt the milky poison from these glands. To some predators the poison tastes bad, but it can make others sick or even cause them to die if they swallow enough. Some toads, like the harlequin frog, do not have paratoid glands, but still are able to ooze enough poison through their other skin glands to ward off predators. This is an important defense tactic in the toads, many of which can only hop short distances and often cannot escape a predator by running away. Some toads, like the American toad, will even turn to face a predator, which puts the paratoid glands in the attacker's face. Not all predators are bothered by a toad's poison. The hog-nosed snake, for instance, makes toads a regular part of its diet.

Some toads, like the Yungas redbelly toad, do something different when they feel threatened. They strike a stiff pose, called the unken (OONK-en) reflex. In this position, they arch the back while holding up their red-bottomed feet and showing off the red of the belly. This display and the flash of color probably helps to remind predators that the toads have poisonous skin.

Many true toads mate during wet times of the year, often in the spring rainy season. In many species, a heavy rain will bring hundreds of males to ponds, streams, or newly filled pools of water where they begin calling. Toads often mate in the small pools that are only filled with water part of the year. These pools do not contain fish, which might eat the toads and/or their young. The typical male true toad has a balloonlike bit of flesh on its throat that inflates and deflates. This flesh, called a vocal sac, allows the toad to call. The males of most other types of frogs also have vocal sacs. Most of the true toads call with a steady trill. The American toad, for example, has a beautiful, long trill that lasts several seconds. Others, like the brown tree toad, have voices that are more like squawks than trills.

True toads usually call in choruses, which means that the males of a species group together and call all at once. The females hear the calls and follow them to the males. They mate when the male grasps the female from behind and holds on near her front legs, while the female lays her eggs in the water. In some species, like the Houston toad, the male may have to cling to the female's back for several hours before the female

BELLY TO BELLY

Most toads, as well as other frogs, mate with the male on the female's back in a piggyback position. The female lays her eggs at the same time that the male releases a fluid that contains microscopic cells called sperm. The sperm and eggs mix, and the eggs start to grow. Malcolm's Ethiopian toads have their own style. The male and female mate belly to belly. Instead of the sperm mixing with the eggs after they leave the female's body, the sperm mixes with them while they are still inside her body. She lays the eggs later, long after the male has left.

is ready to lay her eggs. Malcolm's Ethiopian toad mates differently than other true toads. Instead of the piggyback position that other toads and the vast majority of frogs use, the male and female of this species mate belly to belly.

Usually, the female lays her eggs, often hundreds of them, in a long string. The egg string may wrap around underwater plants, but sometimes it simply floats in the water. Most toads leave their eggs after they are laid. Toad eggs commonly hatch in a week or two into tiny tadpoles. American toad tadpoles, including their tails, are often no longer than a person's fingernail. The tadpole stage is also quite short, and they can turn into toadlets in just a few weeks. The toadlets are typically very small. People walking through the forest are frequently surprised at toadlets' tiny size. Baby American toads are also no bigger than a fingernail. Even the enormous marine toad has small toadlets.

A few toads, like the Roraima bush toad, probably have eggs that turn into toadlets instead of changing into tadpoles first. Scientists are not sure about the bush toad, however, because they have never watched an egg hatch.

TRUE TOADS, HARLEQUIN FROGS, THEIR RELATIVES, AND PEOPLE

People have been interested in toads for many, many years, and they have written about toads in many, many books, especially make-believe children's books. Children find living toads interesting, in part because usually the toads are quite simple to catch. People should, however, be careful not to put their hands into their mouths after touching a toad until they have washed their hands. This is good practice after handling any animal. Toads are not hunted for food, but some toads are common in the pet trade.

CONSERVATION STATUS

The World Conservation Union (IUCN) lists five species in this family as Extinct, which means that they are no longer in

existence. These include the golden toad, the last of which was seen in 1989; the jambato toad, last seen in 1988; the longnose stubfoot toad, last seen in 1989; and two other species known only by their scientific names: *Adenomus kandianus*, last seen more than one hundred years ago; and *Atelopus vogli*, the only individuals of which were seen only during a 1933 expedition and in just one spot in the world. Scientists are especially concerned about the species that disappeared in the late 1980s. Although they are not certain, they believe that the frogs may have died off because of infection with a fungus, known as chytrid (KIT-rid) fungus, which has harmed many different species around the world. Global warming, which has changed the world's weather patterns, pollution, the introduction of fish that eat frogs, and loss of habitat may also have played a role in some of the species' extinctions.

ROCK AND ROLL

The Roraima bush toad defends itself from predators in a bizarre way. The toad, which grows to barely 0.8 inches long (2 centimeters), cannot leap or even take small hops. Instead, it slowly walks over the rocks in its habitat. When it feels threatened, this toad tucks itself into a little ball and rolls down the side of the rock, giving it the look of just another tiny stone falling away.

In addition, the IUCN lists the Wyoming toad as Extinct in the wild. This means that the frog is no longer alive except in captivity or through the aid of humans. The Wyoming has a typical toad appearance: chubby body, numerous warts on its back and legs, large paratoid glands, and a short, round-snouted face. It once lived in a larger part of Wyoming and was quite common in the 1950s, but began to disappear in the 1960s. Scientists had thought that it had already become extinct by the 1980s, but a small population turned up in 1987. The toad now only exists within a national wildlife refuge. Currently, ecologists are keeping a watchful eye on the population and are raising toadlets in captivity to release into the refuge. Without this help, scientists believe the toads would likely have already become extinct. They are unsure why the frogs are disappearing, but think that the chytrid fungus may have been a cause.

Other frogs noted by the IUCN include eighty-two species that are Critically Endangered and face an extremely high risk of extinction in the wild; seventy species that are Endangered and face a very high risk of extinction in the wild; forty-nine that are Vulnerable and face a high risk of extinction in the wild; twenty-six that are Near Threatened and at risk of

becoming threatened with extinction in the future; and sixty that are Data Deficient, which means that scientists do not have enough information to make a judgment about the threat of extinction.

The U.S. Fish and Wildlife Service lists three U.S. species as being Endangered and one as Threatened. The Endangered species are the Wyoming toad, which was described above, the Houston toad, and the arroyo or southwestern toad. The Threatened species is the Puerto Rican crested toad.

The Houston toad, which the IUCN also considers to be Endangered, once lived in Texas along the coast of the Gulf of Mexico. It became less common in the last half of the twentieth century when the city of Houston became bigger and people began building in what had been the toad's habitat. In addition, the area had a spell of extremely dry weather, which also hurt the toads. The toads now live in a much smaller area.

Half of the arroyo toads, listed by both the U.S. Fish and Wildlife Service and the IUCN as Threatened, disappeared between 1994 and 2004. The toads make their homes in parts of northwestern Mexico and California. The drop in their numbers probably happened as the result of several things, including the construction of roads, dams, and buildings; too much cattle grazing, which is hurting the plants in the frog's habitat, and the introduction of frog-eating fish to the toads' habitat.

Only twenty percent of the Puerto Rican crested toads that lived on Earth in 1994 were left by 2004. As of 2004, fewer than 250 adult toads remained in the wild. The species is listed as Threatened by the U.S. Fish and Wildlife Service and Critically Endangered by the IUCN. The toad, which is native to Puerto Rico and the British Virgin Islands, probably disappeared because people began cutting down and building in the forest where the toads lived so people could move into and live in the area. According to the IUCN, people drained the pools of water where the toads once mated and laid their eggs to make the area into parking lots. Scientists have been able to raise baby crested toads in captivity, but when they are set free, these young toads die. One small population of toads still survives in the wild. It lives inside a national forest and appears to be safe from further habitat destruction.



LONG-FINGERED SLENDER TOAD
Ansonia longidigita

Physical characteristics: Also known as the long-fingered stream toad, the long-fingered slender toad has very long and thin front and back legs. Its front legs are about as long as its body. The front legs and back legs also have very long, thin toes. The toad's body is rather slender, and its back is covered with small warts. It has a small head, but it has large, brown eyes and a large mouth. The snout hangs a bit beyond the lower jaw, making the frog look as if it has a slight overbite.

Unlike many other toads, it does not have the large poison "warts," called paratoid glands, behind its head. The frog is dark brown to reddish brown, sometimes with faded black bands noticeable on its hind legs. Males and females look similar, but the females are a bit bigger. Males typically grow to 1.4 to 2 inches (3.5 to 5 centimeters) long from snout to rump, while females usually reach about 1.8 to 2.8 inches (4.5 to 7 centimeters) in length.



The World Conservation Union (IUCN) has listed this toad as Near Threatened, because of destruction to its habitat. (Illustration by Brian Cressman. Reproduced by permission.)

Geographic range: The long-fingered slender toad is native to Borneo.

Habitat: The long-fingered slender toad lives among forests from the bottoms of mountains up to about 7,220 feet (2,200 meters). It breeds near fast-flowing streams and in steep places.

Diet: Adults eat small insects, especially ants, of the rainforest. Tadpoles eat plants that they find growing on rocks in the streams where they live.

Behavior and reproduction: Scientists know little about the behavior of these toads outside of their mating time. To breed, males group together next to rocky streams and call females with high-pitched trills. Eggs hatch into tadpoles, which have a sucking mouth on the underside. This helps the tadpole hang onto plants or rocks in the fast water of the stream in which they live until they change into toadlets.

Long-fingered slender toads and people: People very rarely see this toad in the wild, and scientists know little about it.

Conservation status: The World Conservation Union (IUCN) has listed this toad as Near Threatened, which means that it is at risk of becoming threatened with extinction in the future. It lives in areas around streams, and these areas are changing as the forests are cut.

Logging not only removes trees, but allows soil to flow into the streams, muddying them and making them unsuitable for the tadpoles. Scientists fear that the number of frogs will soon drop as their habitat is destroyed. Fortunately, some populations of this species live in areas where logging is not allowed. ■



Harlequin frog *(Atelopus varius)*

HARLEQUIN FROG
Atelopus varius

Physical characteristics: Also known as the harlequin toad, the harlequin frog may come in several different colors, always with a bright pattern of blotches on a dark, usually black, background. The bright pattern is often yellow, but may also be another color like green, orange, or red. The frog gets its common name from these colors. A harlequin is a court jester, a person who hundreds of years ago wore gaudy, colorful costumes to entertain an audience.

The frog has very thin but long front legs. Its back legs are a bit thicker and still longer. Its eardrum is not visible. Males grow to about 1.1 to 1.6 inches (2.7 to 4 centimeters) long from snout to rump. The females are larger, reaching 1.3 to 1.9 inches (3.4 to 4.8 centimeters) in length. In some populations, the females and males look much alike, but in others, the males and females come in different colors.



Also known as the harlequin toad, the harlequin frog may come in several different colors, always with a bright pattern of blotches on a dark, usually black, background. The bright pattern is often yellow, but may also be another color like green, orange, or red. (Photograph by Michael Fogden. Bruce Coleman Inc.)

Geographic range: Harlequin frogs live in Costa Rica and Panama in far southern Central America.

Habitat: Harlequin frogs live in moist forests in valleys and partway up the sides of mountains. Scientists have not seen the frogs mating in the wild, but they believe these frogs do so in rocky streams, because this is where they have found harlequin frog tadpoles.

Diet: They eat small arthropods, including spiders and insects, like caterpillars, flies, and ants.

Behavior and reproduction: At night, harlequin frogs sleep on top of large leaves above streams. They are active during the day, hopping about in plain view. Their bright colors help remind predators that the frogs can ooze a very poisonous and bad-tasting liquid from their skin. The poison in the liquid is the same as that found in the very dangerous puffer fish. Males set up territories and make short buzzing sounds to tell other males to stay away. Sometimes, the males will fight by jumping on or chasing one another. They may also circle a front foot in the air before or after a fight. Unlike the males of other frogs, harlequin frog males do not call females for breeding. They do, however, mate like most other frogs with males climbing onto the backs of females. A harlequin frog female may carry a male on her back for several days until she has finished laying her eggs.

Harlequin frogs and people: Humans almost never see this extremely rare frog.

Conservation status: The World Conservation Union (IUCN) has listed this frog as Critically Endangered and facing an extremely high risk of extinction in the wild, because most of them have disappeared since 1988. In 1996, in fact, scientists feared that all of the more than one hundred populations known to exist in Costa Rica were already gone. Seven years later, however, a tiny population was discovered there. Some populations still live in Panama, but their numbers appear to be dropping. Scientists believe that the frogs are mainly disappearing because of infection with a fungus, called chytrid fungus, which is also killing many other frogs worldwide. In addition, people have introduced trout, a popular game fish, to some of the waterways in which the frogs breed. The trout eat harlequin frogs. ■



Marine toad *(Bufo marinus)*

MARINE TOAD
Bufo marinus

Physical characteristics: The marine toad is an enormous toad that can grow to as much as 9 inches (23 centimeters) long from snout to rump and weigh up to 2.2 pounds (1.5 kilograms). Sometimes it is called the giant toad, and in Belize, its nickname is the spring chicken. It is a dark-colored toad, often gray to brown, and sometimes reddish brown. Frequently, it has darker brown blotches and sometimes white spots on its back. It has large paratoid glands spreading from the back of its head to the front legs. It has a short, rounded snout, large eyes, and a noticeable eardrum on each side of its head.



The marine toad is an enormous toad that can grow to as much as 9 inches (23 centimeters) long from snout to rump and weigh up to 2.2 pounds (1.5 kilograms). (R. Andrew Odum/ Peter Arnold, Inc.)

Geographic range: The marine toad naturally occurs in Mexico, Central America, South America, and southern Texas in the United States, but people have introduced it to many other places around the world, including Hawaii, Japan, the Philippines, Australia, and numerous islands of the West Indies. It is now a pest species in many countries.

Habitat: In its native areas within South, Central, and North America, the marine toad prefers to make its home in fields and open forests that have at one time lost their trees, perhaps to logging or to fires. It naturally breeds in ponds, at the edges of lakes, and in small pools that form in rainy parts of the year and dry up later on. This toad, however, is very adaptable. This means that it can adjust to live in other places, too. This has helped the toad move into new areas, including villages and towns, and make its home there.

Diet: The marine toad has a good appetite. It eats a wide variety of arthropods. It will sit down at night near a light in a town and spend hours flipping out its tongue to snap up insects that fly toward the light. It will also devour ants, cockroaches, and many other types of insects wherever it can find them. Besides arthropods, marine toads have a reputation for gobbling down cat food and dog food from the feeding dishes of family pets. They are also known to sometimes eat snakes, frogs, and even small mammals, like mice.

Behavior and reproduction: Marine toads often spend their days grouped together in an out-of-the-way spot. They become active at

night, which is when they do the bulk of their hunting. Sometimes, they travel quite a distance at night. Scientists are not sure how they do it, but the toads are always able to find their way back home. In the spring mating season, male marine toads move to water, sometimes even swimming pools, and begin calling for females. They usually prefer a shallow spot on the shore of a pond or small lake, or at the edge of a marsh. Here, a male pushes up on his front legs and makes his call, which is a long, low trill that may last ten or twenty seconds. When many of them call at once, the sound is something like a tractor engine. When a female approaches a male, he climbs onto her back, and grasps her behind her front legs. The two toads may swim about with the male still riding on the female's back until she finishes laying her eggs. One female may lay a string of twenty-five thousand eggs, sometimes more, and a single string may stretch nearly 10 feet long. In about two weeks, the eggs hatch into small, black tadpoles. The tadpoles may group together in schools, just as fish do, until they turn into toadlets.

Marine toads and people: In 1935, people brought the toad to Australia with the hopes that it would eat a type of beetle that was destroying the sugar cane crop. The toads, which got the nickname cane toad, found plenty to eat besides the beetles. The toads bred quickly, and since they had very few predators, soon became pests themselves. The toads are still very common in Australia. One of the reasons that people in that country dislike the toads is that pet dogs sometimes try to eat them. The poison in the toad's skin can cause illness and sometimes death.

Conservation status: The World Conservation Union (IUCN) does not list this species as being at risk, but rather notes that it is becoming more numerous and spreading to more places around the world. The toad's skin poison can make other organisms sick and even kill the eggs and tadpoles of other frogs that share water with marine toads and their tadpoles. ■



Golden toad *(Bufo periglenes)*

GOLDEN TOAD
Bufo periglenes

Physical characteristics: Only male golden toads are golden, and they actually are more orange than gold. Some people even call them orange toads instead. The females are very dark green, almost black, with red markings. Both males and females have thin, bony-looking bodies, much different than many of the plump toads in this family. Their front and hind legs are quite thin. Besides their colors, males and females are different in size. The females are the larger of the two, growing to 1.7 to 2.2 inches (4.2 to 5.6 centimeters) long from snout to rump. The males usually reach 1.5 to 1.9 inches (3.9 to 4.8 centimeters) in length.

Geographic range: Now extinct, golden toads once lived along a mountain ridge in the Monteverde Cloud Forest Preserve of



Only male golden toads are golden, and they actually are more orange than gold. Some people even call them orange toads instead. The females are very dark green, almost black, with red markings. (Illustration by Brian Cressman. Reproduced by permission.)

northwestern Costa Rica. For this reason, some people call it the Monteverde toad.

Habitat: Golden toads lived in mountain rainforests 4,920 to 5,250 feet (1,500 to 1,600 meters) above sea level.

Diet: Scientists had not yet learned about its diet before it became extinct in 1989.

Behavior and reproduction: The studies of this toad were mainly done during the breeding season, so very little is known about its behavior outside of mating and egg-laying. When heavy rains fell in the rainforest where this toad lived, hundreds of males would appear in groups. Scientists are not sure whether the males called. They did, however, notice that the number of males always outnumbered the females at a breeding site. Often, when a male would climb onto the back of a female to mate, one or more other males would begin wrestling with the first for the chance to push him off. If they were successful, one of these males would hop on the female, which would start yet another battle. The females laid their eggs in strings, and the eggs hatched into 1.2-inch (3-centimeter) tadpoles.

Golden toads and people: Following the extinction of this species, scientists became very concerned about the disappearance of frogs and toads around the world. The golden toad now serves as a symbol for amphibian conservation efforts.

Conservation status: Although scientists had seen large mating populations of the golden toad until 1987, its numbers dropped greatly in 1988 when only two females and eight males appeared at their normal breeding site. In 1989, a single, lone male arrived for mating season. He was the last golden toad ever seen. Although scientists do not know for sure, they think that infection with the chytrid fungus, pollution, and/or global warming, combined with the very small area in which they lived, may have caused the species to die out. ■

FOR MORE INFORMATION

Books:

Badger, David. *Frogs.* Stillwater, MN: Voyageur Press, 2000.

Crump, Martha L. *In Search of the Golden Frog.* Chicago: University of Chicago Press, 2000.

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians (Smithsonian Handbooks).* New York: Facts on File, 1991.

Inger, Robert F., and Robert B. Stuebing. *A Field Guide to the Frogs of Borneo.* Kota Kinabalu: Natural History Publications, 1997.

Mattison, Chris. *Frogs and Toads of the World.* New York: Facts on File Publications, 1987.

Meyer, John R., and Carol F. Foster. *A Guide to the Frogs and Toads of Belize.* Malabar, FL: Krieger Publishing Co., 1996.

Miller, Sara Swan. *Frogs and Toads: The Leggy Leapers.* New York: Franklin Watts, 2000.

Savage, Jay M. *The Amphibians and Reptiles of Costa Rica.* Chicago: University of Chicago Press, 2002.

Showler, Dave. *Frogs and Toads: A Golden Guide.* New York: St. Martin's Press, 2004.

Tyning, Thomas. *A Guide to Amphibians and Reptiles.* Boston: Little, Brown and Company, 1990.

Periodicals:

"Look Out for Toads on Roads!" *Current Events, a Weekly Reader publication.* April 25, 1994 (vol. 93): page 3.

O'Neill, William J. "Guard Your Garden With a Hungry Toad." *Child Life.* April-May 2002 (vol. 81): page 10.

Web sites:

"American Toad." *eNature, National Wildlife Federation.* http://www.enature.com/fieldguide/showSpeciesRECNUM.asp?recnum=AR0006 (accessed on April 12, 2005).

"*Ansonia longidigita*." *CalPhotos.* http://elib.cs.berkeley.edu/cgi/img_query?query_src=&enlarge=0000+0000+0903+0287 (accessed on April 9, 2005).

"Cane Toad, Giant American Toad, Marine Toad." *BBC.* http://www.bbc.co.uk/nature/wildfacts/factfiles/392.shtml (accessed on April 12, 2005).

"Colorado River Toad." *Yahooligans! Animals.* http://yahooligans.yahoo.com/content/animals/species/4529.html (accessed on April 12, 2005).

"Giant Marine Toad." *Utah's Hogle Zoo.* http://www.xmission.com/hoglezoo/animals/view.php?id=21 (accessed on April 12, 2005).

"Toothless Predator." *American Museum of Natural History.* http://www.amnh.org/exhibitions/frogs/featured/toothless.php (accessed on April 9, 2005).

POISON FROGS
Dendrobatidae

Class: Amphibia
Order: Anura
Family: Dendrobatidae
Number of species: 207 species

family
CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

Poison frogs are known for the very poisonous skin that many of them have. Actually, all frogs have poison glands, or small groups of cells, that ooze poison. In most species, the poison is very mild and, at most, only serves to make the frog taste bad. In some of the species in this family, however, the poison is far more potent and may even be deadly. The skin of the golden dart-poison frog, for instance, contains an especially dangerous poison, or toxin. Even the tiniest of droplets of this toxin in a predator's bloodstream can be fatal. Not all of the poison frog species are equally toxic, and some have no more poison than most other frogs in the world. Even within one species, different individuals may have different levels of toxin.

Scientists think that the especially toxic poison frogs may not actually make their toxins themselves, but instead get them by eating poisonous insects that, in turn, get their toxins by eating poisonous plants. The insects can eat the poisonous plants, and the frogs can eat the poisonous insects without having any health problems. When these especially toxic poison frogs are taken out of their natural habitat, placed in an aquarium, and fed non-poisonous food, the frogs eventually lose their high levels of toxins. The word toxicity (tox-ISS-ih-tee) means the level of toxins.

The toxic poison frogs are very colorful. These bright shades, called warning colors, caution predators against eating the frogs. The typical strawberry poison frog, for example, stands out with a bold red body and vivid blue legs. The Brazil nut

poison frog has a black body with white to cream-colored spots and blotches on its back and red patches on its front and hind legs. People often describe these lovely little frogs as "jewels."

Those poison frogs that do not have especially toxic skin typically have much more drab colors, such as browns, tans, and olive greens. Often, these colors are in patterns that blend in with the frogs' surroundings. Rather than alerting predators to their presence, their colors camouflage them from predators. Stephen's rocket frog and the Trinidad poison frog are examples. Both are brown with darker brown stripes on the sides of the body and have dark banded legs.

In some species, like the strawberry poison frog, individuals may come in different colors. Those that live in one part of Panama are red and blue as described above, but those that live in other parts of the country may be green, yellow, or orange and may have a variety of patterns on their backs, including stripes or spots. Trinidad poison frogs are an example of a species with different-looking males and females. Both the males and the females have brown backs, but the males have gray throats with a black collar, while the females have the black collar but have bright yellow throats.

Perhaps the most unusual species in its appearance is the imitating poison frog. This small frog takes on a whole new look depending on its neighbors. If it lives near a Zimmermann's poison frog, the imitating frog looks like that species with its black-spotted yellow back, black-spotted blue legs, and blue belly. If it lives in the same area as the Amazon or Amazonian poison frog, which is an orange or yellow frog with long black stripes or spots, the imitating poison frog has that pattern. In addition, when the imitating frog shares a habitat with the red-headed poison frog, which is also known as the crowned poison frog, it has the half-orange or -red, half-black body of that species. The imitating frog is the only frog or amphibian known to copy, or mimic, the appearance of another amphibian. The imitating

A CUP OF WATER

The tadpoles of some species of poison frogs can survive in even the tiniest pools of water. Tadpoles of the very small Stephen's rocket frog and the Brazil nut frog are some of the most amazing. The female Stephen's rocket frog lays her three to six eggs in the water within cup-shaped leaves that lie on the forest floor. The male stands guard, but does not carry the tadpoles to a bigger pool of water. The eggs hatch into tadpoles in the small puddle inside the leaf, and the tadpoles remain there until they turn into froglets. In the Brazil nut frog, the males carry the eggs to water, but that water is the tiny puddle that forms inside the empty shell of a Brazil nut.

frog and all three of the species it mimics are highly toxic, but they are not close relatives of one another.

Regardless of the types of toxins in their skin or their colors, all poison frogs have a few things in common. They have powerful, although short, hind legs for leaping and, in some species, for climbing. They have thick pads of skin on the tops of their front and rear toes. The vast majority of them are also quite small. Most grow to 0.75 to 1.5 inches (1.9 to 3.8 centimeters) long from the tip of the snout to the end of the rump. The Brazilian poison frog and the blue-bellied poison frog are especially tiny. Female Brazilian poison frogs reach 0.68 to 0.8 inches (1.72 to 2.03 centimeters) long, and males are even smaller at 0.63 to 0.71 inches (1.6 to 1.8 centimeters) in length. Female blue-bellied poison frogs grow to 0.47 to 0.61 inches (1.19 to 1.55 centimeters), while the males reach just 0.47 to 0.59 inches (1.19 to 1.49 centimeters) in length. The Venezuelan skunk frog is one of the largest poison frogs. Females of this olive-green frog can grow to 2.5 inches (6.35 centimeters) long.

GEOGRAPHIC RANGE

Poison frogs live in central to southern parts of Central America, including Nicaragua, Costa Rica, and Panama. They also live throughout much of northern to central South America, as far south as Bolivia and southern Brazil. The green and black poison frog, also known as the green poison frog, is the only poison frog to have jumped from its native home in Central and South America to Hawaii. In 1932, people brought the frogs from Panama to the Hawaiian island of Oahu with the idea that the frogs would eat some introduced insects on the island. The frogs liked their new home and still live on Oahu today.

HABITAT

Most of the frogs in this family live in moist forests or rainforests that have never been cleared. Such uncut forests are called primary forests. A few can also survive in old, now-overgrown pastures. Among the poison frogs, only one species spends its life in the water. This is the Venezuelan skunk frog that lives in small streams and has fully webbed rear toes to help it swim.

DIET

Poison frogs typically eat small insects and other arthropods (AR-throe-pawds), which are animals that have jointed legs and

no backbones. Some of the common arthropods in the typical poison frog's diet include mites, ants, and small spiders, flies, and/or beetles. Researchers have been particularly interested in why the especially toxic poison frogs are so poisonous. In 2004, a group of scientists announced that ants may be part of the reason for at least some of the frogs' toxicity. The ants have the same toxins as the frogs. When the frogs eat the ants, the frogs take on that poison and become toxic themselves. Although the scientists are not sure what makes the ants poisonous, they suspect that the ants eat poisonous plants that make the poisons.

BEHAVIOR AND REPRODUCTION

Almost all of the poison frogs are active during the daytime, usually at dawn and late in the afternoon, and especially when it rains. The most toxic species hop about in plain view of potential predators, but the predators normally leave them alone to avoid a dangerous mouthful of poison. The frogs that do not have dangerous toxins in their skin are typically dull-colored and blend in with their surroundings. This camouflage usually keeps them out of their predators' sights. If a predator does spot a frog, the poison frogs have strong legs to help them leap away. Some of the frogs also are very good climbers and can avoid ground-living predators by scrambling up bushes and trees. The family name, Dendrobatidae, actually comes from two words that mean tree and walker in Greek. The Brazilian poison frogs and the polka dot poison frogs are two species that spend their lives in the trees.

The Venezuelan skunk frog is unusual, in part, because it is active at night. This species has an odd but effective defense against predators. As its common name suggests, it has a very strong, skunklike odor that wards off attackers. Scientists are interested in this species, which was discovered in the 1980s, because it may help them figure out which other families of frogs are most closely related to the poison frogs. Although scientists are not sure, they think the poison frogs' nearest relatives may be the true toads in the family Bufonidae, or the leptodactylid frogs.

The males of many species set up and defend territories against other males. These territories can be important during the mating season. Studies of strawberry poison frogs, for example, have shown that the males with the best territories are the best at attracting females. In this case, the best territories are those that

are larger and have more tall places where the males can call to females. Often, male poison frogs defend their territories with a certain type of call, called an encounter call, that tells other males to stay away. In some species, like Stephen's rocket frog, the encounter call is different from the call that they use to attract females. In other poison frogs, the two calls sound much alike and may even be the same. The Trinidad poison frog is different because the females instead of the males are the ones who set up and defend territories. The females cannot call, so they defend their territories by rippling their bright yellow throats while sitting up tall in a high spot of the territory. In the green poison frog, the female does not set up territories, but she will fight with other females that approach her mate.

The breeding time for poison frogs is commonly during the rainy season, which runs from about November to April, although it may be a bit longer or shorter in some areas. Males call the most early in the day; then they quiet down. If the day is rainy, however, they may start calling again later in the afternoon. Some species, like Stephen's rocket frog, may call any time of day if it is raining. The males call from land. Some call from the leaf-covered ground, others from a hole in a tree trunk, and some species from plants that grow on the sides of trees.

For many species, scientists have never seen the males and females mate. In others, like the harlequin poison frogs, they have a good deal of detail. In this species, the male calls to attract a female. When she comes toward him, he continues calling while hopping away and leading her to the mating site, which is under leaves on the forest floor. This species is one of many, including the green poison frog, the blue-bellied poison frog, and the strawberry poison frog, that lay their eggs in leaves lying on the ground. The female blue-toed rocket frog places her eggs inside rolled or folded leaves. Other species of poison frogs lay their eggs in the trees. The female Brazilian poison frog, for instance, lays her eggs in small, wet tree holes just above a water puddle inside the hole. All of the poison frogs lay their eggs out of the water, except possibly the Venezuelan skunk frog. No one has seen where this water-loving frog lays its eggs. The female may lay them in the water, or she may come out to lay the eggs on land.

Some of the poison frogs have only a few eggs at a time. The female blue-bellied poison frog usually lays just two eggs, the

female Brazilian poison frog lays two or three, and the strawberry poison frog lays two to six in a clutch. Many additional species also have small clutches. Other frogs in this family, including the blue-toed rocket and phantasmal poison frog, have larger clutches. The female blue-toed rocket usually lays about nineteen eggs, while the female phantasmal poison frog lays between fifteen and forty eggs in a single clutch.

In most other types of frogs, both adults leave after the eggs are laid. In poison frogs, however, either the male or the female stays behind with the young until they hatch into tadpoles. Occasionally, both adults stay with the eggs. In the green poison frog, for example, the male continues to check on the eggs during the two weeks it takes them to hatch. During this time, he turns the eggs, adds water to them to keep them moist, and removes any fungus that may have started to grow on them. The male is also the caregiver in the blue-bellied poison frogs, the Amazonian poison frogs, the phantasmal poison frogs, the Trinidad poison frogs, and others. The harlequin poison frog is one of several species in which the female stays with the eggs. In a few species, including the strawberry poison frog and the Brazilian poison frog, the adults share the job.

Part of the care includes carrying the tadpoles to water where they will continue to grow and develop into froglets. In most cases, the adult sits in the middle of the hatching eggs, and the tadpoles squirm onto the adult's back. The adult then moves over to water, sometimes spending quite some time searching for the perfect spot, and drops off the tadpoles. In some species, the adult carries only one tadpole at a time and has to make a few trips from the nest to the water before he or she has moved the entire family. Once the adult has delivered all of the tadpoles to the water, the tadpoles are on their own. Among green poison frogs, one male may mate with and have young by more than one female during one breeding season. Since he is the caregiver for the eggs, he has to watch over several nests at once. Sometimes, he is not successful, and some of the tadpoles die before he can get all of the young to water.

In the strawberry poison frog, the male cares for the eggs by keeping them moist and clean, but the female takes over when the eggs are ready to hatch. She carries one tadpole at a time to plants that have puddles of water laying at the base of their leaves or filling a cup that forms from their overlapping leaves. These small puddles do not contain much, if anything, for the tadpoles

to eat, so the female comes back to her growing young every five days or so to feed them. The food she leaves is additional eggs that she lays. The eggs are infertile (in-FER-tul), which means that they will never develop into young. The tadpoles eat the infertile eggs until they grow and mature into froglets.

POISON FROGS AND PEOPLE

Many of the colorful poison frogs are common in the pet trade. They have also become popular attractions in exhibits at aquariums and zoos. Some local people in their native lands have dipped darts into the skin toxins of some of the especially poisonous species. Using blowguns, they shoot the darts at small animals they were hunting. The darts would kill the animals. Scientists, on the other hand, have become interested in these frogs' powerful toxins for the possible development of new pain-relieving drugs.

CONSERVATION STATUS

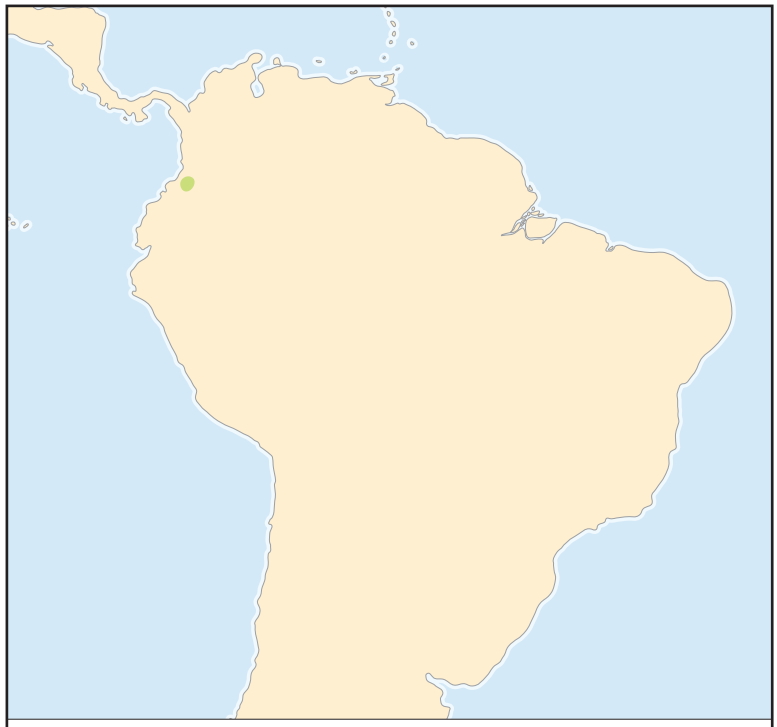
The World Conservation Union (IUCN) lists seventy-nine species—thirty-eight percent of all of the species in the family—as being at some risk. It also considers ninety-three others—another forty-five percent—as Data Deficient, which means that too little information is available to make a judgment about the threat of extinction.

Of the seventy-nine at-risk species, the IUCN lists nineteen as Critically Endangered and facing an extremely high risk of extinction in the wild. Several of these species, including the skunk frog and the Bloody Bay poison frog, have had huge drops in number during recent years. In just three generations, which would include the grandparents, parents, and children, the number of Bloody Bay poison frogs has plunged by eighty percent. In other words, for every one hundred individuals in the grandparents' generation, this species has only twenty individuals left in the children's generation. The number of skunk frogs also dropped by eighty percent in just a ten-year period. In the skunk frog's case, the decline is probably due to a loss of their habitat as people have built roads, farms, and ranches. In addition, a dry spell has lowered the level of water where the frogs mate and may have hurt the young. In the case of the Bloody Bay frog, scientists are not certain, but they think infection with a type of fungus may have been to blame for the frogs' disappearance. This fungus, called chytrid (KIT-rid) fungus, has

killed members of many different frog species worldwide and may be hurting some of the other poison frogs, too.

Many of the Critically Endangered poison frogs are very rare and live in small areas that are being destroyed or are under other threats from human activities, like the clearing of land through logging or the use of farm pesticides that are dangerous to frogs, including their eggs and tadpoles.

Besides the nineteen Critically Endangered species, thirty are Endangered and facing a very high risk of extinction in the wild; sixteen are Vulnerable and facing a high risk of extinction in the wild; and fourteen are Near Threatened and at risk of becoming threatened with extinction in the future. Some, like the splendid poison frog, were once common but are now extremely rare and may even be extinct. The IUCN currently lists the splendid poison frog as Endangered, noting its popularity in the pet trade and the loss of its habitat as likely causes for its much lower numbers. Scientists are unsure whether any of the frogs still live in the wild.



Golden dart-poison frog *(Phyllobates terribilis)*

SPECIES ACCOUNTS

GOLDEN DART-POISON FROG
Phyllobates terribilis

Physical characteristics: Golden dart-poison frogs, also known as golden poison frogs, come in different colors. In one, called the golden phase, the frogs have a yellow to orange yellow back and head and large dark eyes. Their legs may be yellow, orange yellow, or slightly greenish. In the mint green phase, the frogs' backs and legs are a very light greenish white color. The undersides of golden or mint phase golden frogs may have a few dark marks here and there, especially on the legs where they meet the body. Their backs are often quite smooth and shiny, but their back legs may have small bumps on them. Sometimes, their backs are also covered with tiny bumps. They have strong back legs for leaping and thin front legs. The head is short and becomes narrower toward the tip of the snout, giving it a triangular shape. They have a wide mouth that crosses the snout and reaches



Rather than climbing into trees like some of the other poison frogs do, the golden dart-poison frog stays on the ground. It is active during the daytime, when it hops about in plain view. It is one of the most poisonous animals on Earth. (© Steve Cooper/Photo Researchers, Inc.)

around the sides of the head, past each eye to a spot below the eardrum, which can be seen as a round area behind and below each eye. Females are usually a bit larger than males, but only barely. Females usually are 1.6 to 1.85 inches (4 to 4.7 centimeters) long from snout to rump, while males are usually 1.5 to 1.8 inches (3.8 to 4.5 centimeters) in length.

Geographic range: The golden dart-poison frog lives in Cauca, Colombia, which is in northwestern South America.

Habitat: It is found on land in lowland rainforests along the west coast of Colombia up to 656 feet (200 meters) above sea level. The tadpoles hatch in freshwater, but the exact kind of water body is unknown.

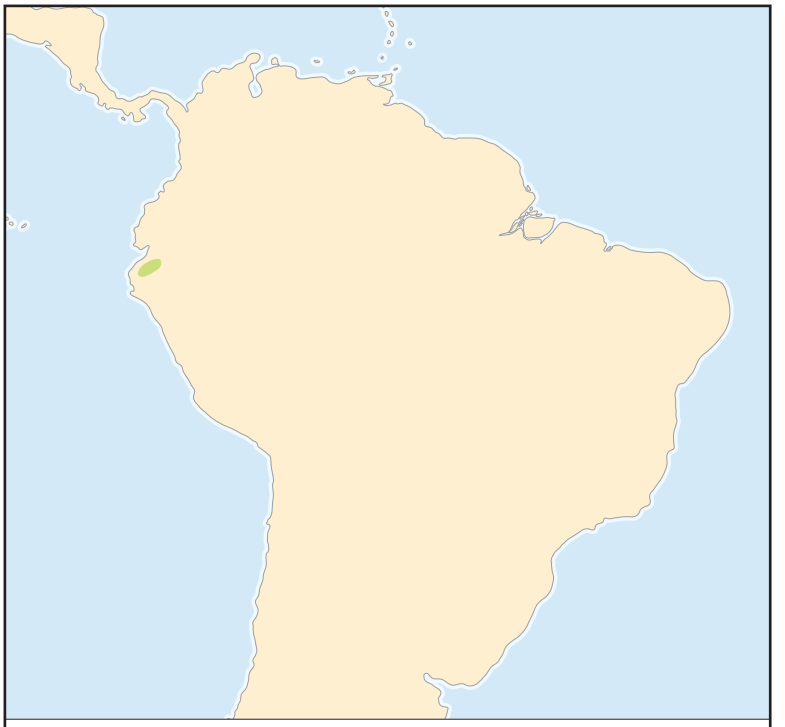
Diet: Adults eat various small arthropods, including insects.

Behavior and reproduction: Rather than climbing into trees like some of the other poison frogs do, the golden dart-poison frog stays on the ground. It is active during the daytime, when it hops about in plain view. It is one of the most poisonous animals on Earth. The poison in its skin is so powerful that even a tiny amount in another animal's bloodstream, including that of a human being, is enough to cause death. Called batrachotoxin (buh-TRAK-oh-tox-in), the poison attacks the nervous system.

Golden dart-poison frogs and people: This frog can be seen in the pet trade, but it is not common. Some local people use the poison in

the frog's skin to make deadly darts. The golden dart-poison frog is one of only three species of frogs—the other two are closely related species—that are used to make the darts.

Conservation status: The World Conservation Union (IUCN) considers the golden dart-poison frog to be Endangered, which means that it faces a very high risk of extinction in the wild. Although the frog is common where it lives, it lives only in a tiny area and only in places where the forest has never been cut. Conservationists are not sure whether it could survive if the trees were ever removed and are concerned because forests near the frog are already falling as people remove trees for lumber and to make way for farms or buildings. Conservationists also think that the spray poisons farmers use to kill crop-eating insects could hurt the frogs. So far, the frog's habitat is not protected from logging, but it is now illegal to capture the frogs from the wild. ■



Phantasmal poison frog *(Epipedobates tricolor)*

PHANTASMAL POISON FROG
Epipedobates tricolor

Physical characteristics: Phantasmal poison frogs are dark brown or brick red with three cream-colored, yellow, or light green stripes running from the head to the rump. The center stripe widens out at the front of the head to cover the whole snout, and the two side stripes may also come far enough forward to blend into this snout blotch. Sometimes, the stripes are broken into dotted lines or blotches. The green, yellow, or cream color also appears on the front and back legs in spots. The frog has long hind legs for leaping and fairly long but thin front legs. It has two large eyes on its head, which slopes toward the front. Often the frogs have a short green, yellow, or cream-colored line under each eye. The underside, including the belly and throat, has numerous green or cream blotches that sometimes almost completely color the underside. Females and males are nearly the



The poison in this frog's skin, while very dangerous, has helped scientists to design effective painkillers for human patients. (Illustration by Joseph E. Trumpey. Reproduced by permission.)

same size. As adults, females usually reach about 0.8 to 1.1 inch (2.1 to 2.7 centimeters) long from snout to rump. Males typically reach slightly less than an inch (2.5 centimeters).

Geographic range: Phantasmal poison frogs live in southwestern Ecuador and northwestern Peru to the west of the Andes Mountains.

Habitat: Adults live on land in mountain valleys. Although they survive in wet or dry areas, they usually remain near streams. Tadpoles develop in streams or small pools of water.

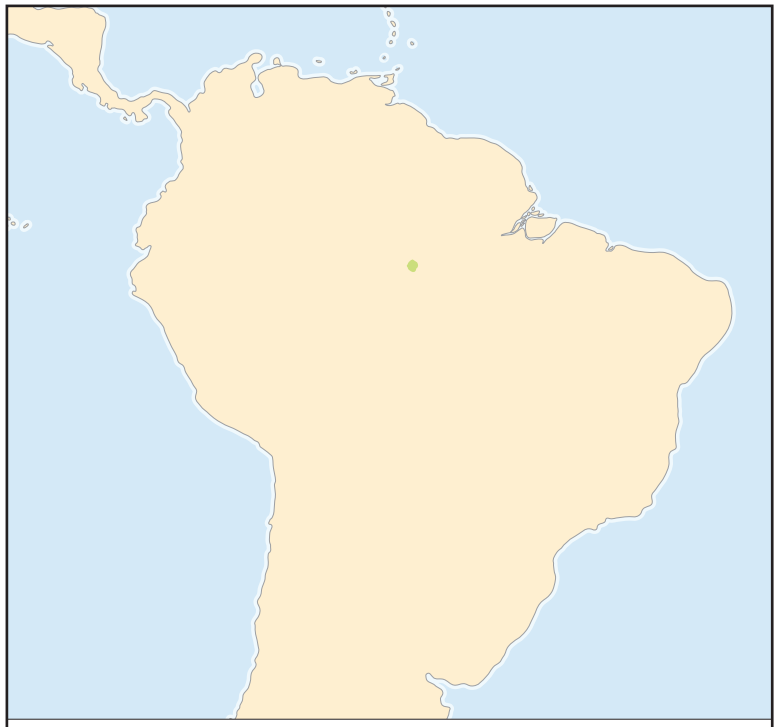
Diet: Adult phantasmal poison frogs eat various small arthropods, including insects.

Behavior and reproduction: Scientists know little about this species outside of its breeding behavior. Mating occurs on land, as it does in the other poison frog species, but phantasmal poison frogs mate differently. While the male mates by climbing onto the back of a female, he does not hold onto her near her front or back legs, as nearly all other frogs do. Instead, he grips her with his front legs around her head. From this awkward-looking position, the female lays fifteen to forty eggs. Afterward, the female leaves, but the male stays behind with the eggs and watches over them. As each egg hatches into a tadpole, the tadpole scrambles up the male's leg and onto his back, and

he carries the tadpole to a nearby stream or pool. The tadpole swims off, and the male returns to the hatching eggs to pick up the next tadpole. He continues until he has carried all the young to the water. The tadpoles develop into froglets in the water.

Phantasmal poison frogs and people: The poison in this frog's skin, while very dangerous, has helped scientists to design effective painkillers for human patients. By studying the frog's poison, which is two hundred times more powerful than the drug morphine (MORE-feen), scientists have made drugs that work in the same way that the poison does, but are not unsafe.

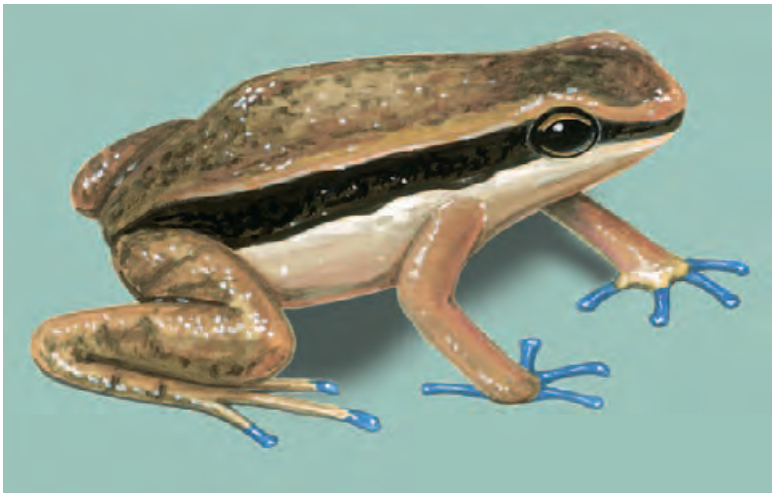
Conservation status: The World Conservation Union considers the phantasmal poison frog to be Endangered, which means that it faces a very high risk of extinction in the wild. This species lives in only seven spots on mountains in part of Ecuador, but it once lived over a larger area. In the remaining populations, the number of adult frogs is continuing to drop. Its small habitat is at risk because the land is being developed for farming, and because farming chemicals are polluting the water in the frogs' habitat. Conservationists are not sure, but they think that the frogs might also be at risk from people who collect them for the pet trade or from infection with chytrid fungus. This fungus has killed many different kinds of frogs around the world. ■



Blue-toed rocket frog *(Colostethus caeruleodactylus)*

BLUE-TOED ROCKET FROG
Colostethus caeruleodactylus

Physical characteristics: The blue-toed rocket frogs are named for their blue toes. During the breeding season, the males have blue front toes and blue pads on their back toes. Females have blue pads on both front and back toes during the breeding season, but their front toes are not all blue, as they are in males. Besides the blue toes and/or toe pads, the frogs have brown backs and heads and white chins and bellies. They have long hind legs and short front legs. The head narrows to a rather triangular-shaped snout. Females may be just a bit bigger than the males. Adult females usually grow to 0.59 to 0.67 inches (1.5 to 1.7 centimeters) from snout to rump, while males typically reach no more than 0.63 inches (1.6 centimeters).



The blue-toed rocket frogs are named for their blue toes. During the breeding season, the males have blue front toes and blue pads on their back toes. Females have blue pads on both front and back toes during the breeding season, but their front toes are not all blue, as they are in males. (Illustration by Joseph E. Trumpey. Reproduced by permission.)

Geographic range: Blue-toed rocket frogs have only been found in one place: about 25 miles (40 kilometers) south of Manaus, Amazonas, Brazil.

Habitat: The frogs live in a small piece of tropical rainforest valley that is flooded with water during the rainy season. The floods rush water into rivers of the valley, causing the rivers to overflow into small streams and create deep pools in the streams. The frogs live among the dead leaves that cover the slopes of forest floor above the streams. Their tadpoles develop in the deep stream pools.

Diet: Adult blue-toed rocket frogs eat various small arthropods, including insects.

Behavior and reproduction: Blue-toed rocket frogs live on land. The males set up territories that are about one thousand square feet (ten square meters). To keep others away, a male will give a short, loud call. Males and females mate on land during the rainy season, which lasts from January through April. Each female lays her eggs on the forest floor, hiding them away in folded or rolled leaves. The male then stays with his eggs, usually about nineteen in each clutch, even after they hatch into tadpoles. When the rainy season ends and the ground begins to dry up, the male carries all of the tadpoles to deep pools in the streams, where the tadpoles continue to grow.

Blue-toed rocket frogs and people: Very few people have ever seen this frog.

Conservation status: Too little information is available about this frog to make a judgment about the threat of extinction, so the World Conservation Union (IUCN) lists it as Data Deficient. Scientists only recently discovered this frog, naming it in 2001. They found it in just one spot, where it was very common, and have not yet found it anywhere else. The scientists believe that the logging of the forest would cause it to become extinct. The frogs' forest is on private property and therefore not protected from logging. ■

FOR MORE INFORMATION

Books:

Badger, David. *Frogs.* Stillwater, MN: Voyageur Press, 2000.

Fridell, Ron. *The Search for Poison-Dart Frogs.* New York: Franklin Watts, 2001.

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians (Smithsonian Handbooks).* New York: Facts on File, 1991.

Heselhaus, Ralf. *Poison-Arrow Frogs: Their Natural History and Care in Captivity.* London: Blandford, 1992.

Mattison, Chris. *Frogs and Toads of the World.* New York: Facts on File Publications, 1987.

Miller, Sara Swan. *Frogs and Toads: The Leggy Leapers.* New York: Franklin Watts, 2000.

Patent, Dorothy Hinshaw. *Frogs, Toads, Salamanders, and How They Reproduce.* New York: Holiday House, 1975.

Showler, Dave. *Frogs and Toads: A Golden Guide.* New York: St. Martin's Press, 2004.

Walls, Jerry G. *Poison Frogs of the Family Dendrobatidae: Jewels of the Rainforest.* Neptune City, NJ: TFH Publications, 1994.

Periodicals:

Jenkins, Jeanette. "The Poison Dart Frog." *Science News,* February-March 2002 (vol. 7): page 10.

Milius, Susan. "Toxin Takeout: Frogs Borrow Poison for Skin From Ants." *Science News,* May 8, 2004 (vol. 165): page 291.

"Strawberry Poison Dart Frog Born at Bristol Zoo Gardens." *Current Science, a Weekly Reader publication,* October 10, 2003 (volume 89): page 14.

Web sites:

"Blue Poison Frog." *Henson Robinson Zoo.* http://www.hensonrobinsonzoo.org/a002.html (accessed on April 14, 2005).

"*Dendrobates. WhoZoo.* http://www.whozoo.org/Intro98/jenntrev/jendex3.html (accessed on April 14, 2005).

"Frog Chemist Creates a Deadlier Poison." *Science News for Kids.* http://www.sciencenewsforkids.org-articles-20030910-Note3.asp (accessed on April 14, 2005).

"Frogs Get Poison from Ants." *Science News for Kids.* http://www.sciencenewsforkids.org-articles-20040512-Note3.asp (accessed on April 14, 2005).

"*Phyllobates terribilis* 'Mint'." *Frog of the Month, Arachnokulture.* http://www.pumilio.com/frogofthemonth/december2001.htm (accessed on April 14, 2005).

"Poison Dart Frog (*Dendrobates pumilio*)." *Basic Science and Remote Sensing Initiative, Michigan State University.* http://www.bsrsi.msu.edu/rfrc/tour/dendrobates.html (accessed on April 14, 2005).

"Poison Dart Frog (*Dendrobates pumilio*)." *Woodland Park Zoo.* http://www.zoo.org/educate/fact_sheets/psn_frog/psn_frog.htm (accessed on April 14, 2005).

"Poison Dart Frogs." *Smithsonian National Zoological Park.* http://nationalzoo.si.edu/Animals/Amazonia/Facts/fact-poisondartfrog.cfm (accessed on April 14, 2005).

"Poison Dart Frogs, Mantellas, etc." *All About Frogs.* http://allaboutfrogs.org/info/species/poison.html (accessed on April 14, 2005).

RUTHVEN'S FROG
Allophrynidae

Class: Amphibia
Order: Anura
Family: Allophrynidae
One species: Ruthven's frog *(Allophryne ruthveni)*

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

Ruthven's frog is a metallic brown color, sometimes yellow- or gray-brown, with darker marks and lighter yellow-brown or gold stripes down each side of the back. The back of its long body is scattered with tiny spikes, or spicules (SPIK-yuhlz), that are partly buried in the skin. The spicules in males are larger than those in females. Because of the spicules, which look somewhat like warts, people often describe this frog as toad-like. It has large eyes that bulge from each side of its head. The head becomes flatter toward the front. Its front and back legs are thin, and the toes end in rounded pads. The front legs often have noticeable light-colored spots that extend onto the chest and throat. Light-colored spots also cover the lower part of its head around the mouth. Often, the sides of the body and parts of the legs have a pink, see-through appearance.

Males have a dark, unspotted area on the throat that remains hidden except when they call. During calling, this area, called a vocal sac, blows up to a large size—at least the size of the head and sometimes much larger. The females grow slightly larger than the males. Females typically reach 0.85 to 1.20 inches (2.2 to 3.1 centimeters) long from snout to rump, and males usually grow to 0.8 to 1 inch (2.1 to 2.5 centimeters) in length.

Discovered in 1926, the single species of Ruthven's frog has at one time or another been listed in five different frog families, including the true toads, the glass frogs, the leptodactylid frogs, the tree frogs, and its own separate family, as it is listed here. Scientists have found no fossils to study. The confusion

in the listing of this frog's family comes from the fact that the frog has some features of all of the different families. For example, its toe bones are T-shaped at the tips, which scientists once thought was like the toes of the glass frogs or possibly the tree frogs. Studies since then showed that the toe bones of Ruthven's frogs are actually slightly different than those of either the glass or the tree frogs.

During the mating season, male Ruthven's frogs call from plants and trees above ponds, and females lay their eggs in the water, which is the same situation as seen in the tree frogs. Like true toads, Ruthven's frogs have no teeth. In fact, the scientific name of Ruthven's frogs, *Allophryne*, means "other toad," because it was thought to be a new kind of true toad.

Ruthven's frog's full scientific name is *Allophryne ruthveni*. Like many other species of plants and animals, the second part of its name refers to a person or to the place where it was collected. In this case, the name refers to Alexander Ruthven, a noted herpetologist (her-peh-TOL-eh-jist) who was very active in the first half of the twentieth century. A herpetologist is a person who studies amphibians and reptiles. Ruthven, who was curator of the Division of Reptiles and Amphibians at the University of Michigan Museum of Zoology, led eighteen of the museum's expeditions to places throughout the United States, Mexico, Central America, and South America.

In 2002, a group of scientists compared the DNA of Ruthven's frogs to the DNA of other frogs. DNA is a string of chemicals that provides the instructions for making a living thing. By comparing the DNA of different organisms, scientists can tell how similar they are. The comparison showed that Ruthven's frogs may be most closely related to the glass frogs and perhaps should be considered members of that family. Until more studies are done, however, many scientists list Ruthven's frogs as the lone members of its own family, called Allophrynidae, while some others still place it in the family Hylidae. In 2003, scientists

HERPETOLOGIST EXPLORERS

Helen Thompson Gaige, who in 1926 was the first person scientifically to describe Ruthven's frog, was one of the earliest, well-known, female herpetologists. Gaige, who lived from 1886 to 1976, named many new species of frogs, especially those from Central and South America. Ruthven's frog is a South American species. Her career included positions as scientific assistant and then curator of the Division of Reptiles and Amphibians at the University of Michigan Museum of Zoology (UMMZ). Ruthven's frog carries the name of Alexander Ruthven, another respected herpetologist from the early twentieth century. He traveled through much of the New World studying amphibians and reptiles. Ruthven was curator of the UMMZ Division of Reptiles and Amphibians from 1906 to 1936, the museum director from 1913 to 1929, and president of the University of Michigan from 1929 to 1951.



In 2002, a group of scientists compared the DNA of Ruthven's frogs to the DNA of other frogs. The comparison showed that Ruthven's frogs may be most closely related to the glass frogs and perhaps should be considered members of that family. (Illustration by Dan Erickson. Reproduced by permission.)

discovered what they believe may be a second species of Ruthven's frog. It is black with bright white and yellow spots and has two bulging eyes, one on each side of its head.

GEOGRAPHIC RANGE

Ruthven's frog was first found in Tukeit Hill below Kaiteur Falls in Guyana in northern South America. It has since been seen in many parts of South America, including north-central Brazil, French Guiana, Guyana, Suriname, and Venezuela. Since scientists have not yet fully explored the area around the Amazon River where this frog lives, other populations of Ruthven's frogs probably remain undiscovered. In addition, a possible second species of Ruthven's frog has been discovered in Peru.

HABITAT

Ruthven's frogs live in lowland forests rather than forests on hillsides or in the mountains. This frog usually goes no higher on hillsides than about 656 feet (200 meters) above sea level and stays in forests that have not been logged but, nevertheless, are not too thick with plants and trees. Throughout the year, they typically stay in areas near rivers and streams. During the rainy season, they group together around low spots in the forest that fill with rain or overflowing river water.

DIET

Scientists have not studied this small frog in enough detail to learn what it eats. If it follows the pattern of the glass frogs and many other types of frogs, however, it eats small insects.



Ruthven's frog *(Allophryne ruthveni)*

BEHAVIOR AND REPRODUCTION

They are nocturnal (nahk-TER-nuhl), which means that they are active at night. During this time, they move around the forests near rivers and streams. They climb through trees and large bushes and onto the leaves of branches that may be several feet (1 to 3 meters) above the forest floor. Sometimes they sit in bromeliads (BRO-mee-lee-adds), which are plants that grow in warm, usually tropical forests often on other plants. Many bromeliads have leaves that overlap into cup shapes that can hold water and are very attractive spots for frogs and insects.

One of the frog's predators is a snake known by its scientific name of *Leimadophis reginae*. Scientists learned about the snake's appetite for the frogs when they captured one of the snakes on the edge of a river in Suriname, which is in northern South America. They cut open the snake's stomach and found a pregnant female Ruthven's frog inside.

The rainy season in the part of South America where the Ruthven's frog lives lasts from about January to July, although it is shorter in some places. The rains create small pools of water in dips in the forest floor and also cause rivers and streams to overflow onto banks and into other small pools of water. As long as the rains continue, the pools stay wet, but when the rainy season ends, they start to dry up. Since the pools only remain wet for part of the year, they are called temporary pools. The frogs make use of these temporary pools. The males hop to the edges of the water, or sometimes onto the leaves of low-hanging tree and bush branches, and begin calling. The call is a string of short low notes that together sound like a trill. Researchers studied the call by making a recording as a male trilled. They were able to count eighteen notes per second in its trill. Many males may call from the same place. This kind of group singing is known as a chorus (KOR-us).

Scientists found an especially large chorus in a pond near Pará, which is in northern Brazil. The pond actually formed when rains flooded the Amazon River and its tributaries, which are the smaller rivers and streams that flow into the Amazon. One of the tributaries, the Rio Xingu, overflowed to make the pond. Only a few frogs called from the pond for two months, but on one night in March, several hundred frogs suddenly showed up. Apparently, the frogs waited to mate until the tributary had flooded enough to fill the pond with a great deal of water. This type of mating, which happens during a short period of time and includes a large number of frogs, is called explosive breeding.

To mate, the male grasps the female from behind and near her front legs. While the male is in this piggyback position, called amplexus (am-PLEK-sus), the female lays her eggs, which number in the hundreds, in the water. Scientists learned how many eggs they lay by capturing a pair of mating frogs, dropping them in a plastic bag, and then counting as the female laid three hundred eggs. None of the eggs lived to hatch, however, and scientists still do not know what the Ruthven's frog tadpoles look like.

RUTHVEN'S FROGS AND PEOPLE

People rarely see this frog in the wild, although it is actually quite common in the parts of South America where it lives. Scientists find it interesting because they do not know exactly

where it fits in the family tree of all frog species. Once they find tadpoles or possibly a fossil of a frog, however, they may learn details that will help them decide if the Ruthven's frog should stay in its own family or should be included in another family, such as the glass frogs.

CONSERVATION STATUS

The World Conservation Union (IUCN) does not consider Ruthven's frog to be at risk. It lives in an area that is seldom visited by humans, and the frog is quite common there. The frog has not been studied well, however, and scientists are unsure where all of the populations are located. Some populations that have not yet been discovered may live in parts of the South American forest that are currently being logged.

FOR MORE INFORMATION

Books:

Caldwell, Janalee P. "Diversity of Amazonian Anurans: The Role of Systematics and Phylogeny in Identifying Macroecological and Evolutionary Patterns." In *Neotropical Biodiversity and Conservation,* edited by A. C. Gibson. Los Angeles: Mildred E. Mathias Botanical Garden Miscellaneous Publications, 1996.

Showler, Dave. *Frogs and Toads: A Golden Guide.* New York: St. Martin's Press, 2004.

Zug, George. *Herpetology: An Introductory Biology of Amphibians and Reptiles.* San Diego, CA: Academic Press, 1993.

Web sites:

"*Allophryne ruthveni*." *Swissherp.* http://www.nouragues.cnrs.fr/NourAnimaux.htm (accessed on April 7, 2005).

"Genus *Allophryne*." *Animal Diversity Web,* University of Michigan Museum of Zoology. http://animaldiversity.ummz.umich.edu/site/accounts/classification/Allophryne.html#Allophryne (accessed on April 7, 2005).

"Pictures of Ruthven's *Allophryne* (Allophrynidae)." *Swissherp.* http://www.swissherp.org/Amphibians/Allophrynidae/Allophrynidae.html (accessed on April 7, 2005).

"Rapid Biological Inventories." *The Field Museum.* http://fm2.fieldmuseum.org/rbi/results_per11.asp (accessed on April 7, 2005).

GLASS FROGS
Centrolenidae

Class: Amphibia
Order: Anura
Family: Centrolenidae
Number of species: 134 species

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

In many of the species of glass frogs, the beating heart, other working organs, blood vessels, and the bones inside are clearly visible through their see-through, or transparent, undersides. Even from the top in many species, the frogs' bodies have the look of frosted glass and sometimes provide a glimpse of the animals' inner workings. In fact, the descriptions of some species include the size of their organs. The view from the topside is not as good as it is from the bottom, because the frog has thick muscles on its back that hide the organs from sight.

Most of the glass frogs are shades of green, although some are brown. Many have tiny spots, which are called ocelli (oh-CELL-ee). These ocelli in frogs should not be confused with the ocelli in insects. In insects, ocelli look like the spots on a frog's back, but they are actually tiny eyes. Lynch's Cochran frog, for instance, may be brownish green or tan and has black ocelli that are tipped in orange or yellow. It also has white warts. The Nicaraguan glass frog is green, sometimes with numerous black spots on its head, back, and legs. In the Atrato glass frog, the back is yellow green with small brown spots in all but a few large, round patches on its head, back, and legs. Regardless of their color or pattern, most glass frogs are extremely hard to see when they sit on green leaves. They almost look as if they melt into the leaves and become a part of them.

Since the bones are visible from the outside in most glass frogs, the color of the bones also helps to tell some species apart. The bones in the Pichincha glass frog, Pacific giant glass

frog, Ecuador Cochran frog, and many others, are green. In the Atrato glass frog, Fleischmann's glass frog, and La Palma glass frog, among others, the bones are white.

The typical glass frog has a delicate body that looks as if it would easily break if handled. These slender, and often very smooth, bodies have thin front and rear legs. Some species, like the grainy Cochran frog, have hundreds of tiny bumps on their heads and backs. All of their toe bones are T-shaped at the ends. On the outside, the toes are tipped with wide, rounded pads. Thin, transparent webs stretch between their toes.

The head in the average glass frog has large bulging eyes that face mostly forward rather than to the sides and are located more toward the top of the head than the eyes in most other frogs. In many frog species, the head blends into the body and does not appear to have a neck between the head and body. The typical glass frog's head, on the other hand, is obvious, even looking round when viewed from above.

Most members of this family are small, reaching 0.7 to 1.2 inches (1.8 to 3 centimeters) from the tip of the snout to the end of the rump. Males in many species are smaller than females. In the Pichincha glass frog, for example, females grow to 1.3 inches (3.23 centimeters) long, while males reach 1.1 to 1.2 inches (2.68 to 3.15 centimeters) in length. The Nicaragua glass frog is similar. The female in this species reaches 1.0 to 1.1 inches (2.54 to 2.68 centimeters) long, while the male grows to 0.9 to 1.1 inches (2.17 to 2.68 centimeters) in length. In other species, like the Ecuador Cochran frog, the males are the larger of the two. Female Ecuador Cochran frogs reach 0.8 to 1.0 inches (2 to 2.54 centimeters) in length, while males can grow to 1.9 inches (4.83 centimeters) long. The Pacific giant glass frog is truly a giant among glass frogs. Although not large when compared to frogs in some other families, the male's 3.2-inch (8.13-centimeter) body makes it the biggest of the glass frogs. Female Pacific giant glass frogs are not quite as large, but they are still giants compared to most other glass frogs. Females can reach 2.4 to 2.9 inches (6.09 to 7.36 centimeters) in length.

GEOGRAPHIC RANGE

Glass frogs can be found in North, Central, and South America. In North America, they only live in southern Mexico. Many species are found throughout Central America and in

many parts of South America as far south as southern Brazil and northern Argentina.

HABITAT

Glass frogs are mainly land species that live in humid mountain forests. Lower on the mountains where the weather is warm, these forests are called rainforests. In colder areas higher up mountainsides, they are called cloud forests. Both areas get a good deal of rain and are very humid. Most of the glass frogs live among trees and plants that line streams. Their tadpoles live and grow in slow-moving waters of the streams. The Pichincha glass frog, for instance, lives in cloud forests high on mountains that are 6,430 to 7,870 feet (1,960 to 2,400 meters) above sea level. The Nicaraguan glass frog chooses humid forests that are not so far up. It lives about 328 to 4,921 feet (100 to 1,500 meters) above sea level. Fleischmann's glass frog goes even lower on mountainsides, down to 200 feet (60 meters) above sea level, but also may live as high as 4,790 feet (1,460 meters) above sea level. Each of these three species makes its home in plants and trees around streams.

Some people think that a few species of glass frogs, especially those that survive in Mexico, may be able to make their homes in places away from streams by living in wet plants, like bromeliads (broh-MEE-lee-ads) that grow on the sides of trees. Bromeliads often have overlapping leaves that form cups and can hold rainwater. If the water is deep enough and does not drain out or dry up, the tadpoles might be able to survive there and develop into froglets. So far, however, the tadpoles of only one species, known by its scientific name of *Centrolene buckleyi*, has been found living in a bromeliad.

DIET

Although little research has been done on their food habits, scientists think these small frogs probably mainly eat tiny insects. The large Pacific giant glass frog, however, can and does consume larger prey, including fishes and other frogs.

BEHAVIOR AND REPRODUCTION

Glass frogs are usually active at night. This, combined with their transparent bodies, makes them very difficult to spot for people or for predators. A flashlight shown on a glass frog at night reveals little of the frog except its large eyes and a dark

smudge where the skull is. During the daylight, the frogs hide among the leaves. Since the rainforest and cloud forests are so full of plants and trees, the tiny green frogs can easily stay out of sight if they sit on a leaf and do not move. The frogs also become even more invisible because they squat their bodies down flat on the leaves. Even from the side, they look much like a slight lump on the leaf rather than a living frog. Only the most careful observers see the frog during the day or at night.

Because they are so well-hidden, most of the information about the glass frogs comes from studies done when the frogs are most noticeable. This happens when they breed. Some species that live in areas where the weather is about the same all year will mate on any night. Others that live in places with changing weather usually mate only at certain times. Like the Nicaraguan glass frogs, which live in Nicaragua, Costa Rica, Panama, Colombia, and Ecuador, they may mate only on nights following heavy rains.

The males of many glass frogs are fussy about the places where they want to mate and have their young. Once they find a good spot, they will often fight other males who try to take it from them. These "good spots" are known as territories. Male Nicaraguan glass frogs set up and defend the territories they will use as calling sites. Like the males of most other species of frogs, male glass frogs call to attract females for mating. In this species, two males may fight over a leaf by grasping onto a side of the leaf or a stem with their back feet, hanging upside down, and wrestling one another. The winner is the one that can knock the other off, or that can manage to scramble onto the leaf's surface and flatten down his body on it. In the Ecuador Cochran frog, males battle, again while hanging upside down but in a belly-to-belly position and with their front legs wrapped around one another's neck. They then pump their hind legs, which causes the wrestling pair to swing up and down and back and forth.

The males of many species have one sharp bony spine on the upper part of each front leg. The bone in this part of the leg is called the humerus (HYOO-mer-us). In a human, the humerus is the long bone in the arm that runs from the shoulder to the elbow. Because the spine is on the humerus, it is called a humeral (HYOO-mer-ul) spine. Males of these glass frog species often have scars on their faces, the backs of the head, and sides of the body, which suggests that the males use their humeral spines when fighting one another. For example,

NEW GLASS FROGS

People are still discovering new species of frogs, including glass frogs. In 2004, for instance, researchers from the University of Kansas announced a new species from northwestern Ecuador. In 2003, scientists from the University of Texas described a new species from western Guyana. Both of these species are green with tiny yellow dots.

the male Pacific giant glass frogs have powerful and thick front legs, unlike most other glass frogs, and long pointed humeral spines. Although no one has every seen the males of this species fighting, many males have numerous scars that match the marks that would be made if other males had sliced them with their spines. The males of many other species of glass frogs have humeral spines, too. In fact, all species that fall into one group, called the genus *Centrolene*, have humeral spines. This includes the Pacific giant glass frog, the Nicaraguan glass frog, and the Pichincha glass frog, among others. In species like the Pacific giant glass frog and the Nicaraguan glass frog, the humeral spines are sharp, but in other species, like the Pichincha glass frog, the spines have dull tips.

Males of different species have different calls, but most are some type of a whistling sound. Male Fleischmann's glass frogs call with a short trill that they repeat again and again. Male La Palma glass frogs also have a short call, but it does not trill like that of the Fleischmann's glass frog. The male Nicaraguan glass frog's call is made up of three short beeps. They may make this call as often as forty-three times an hour or as little as just once in an hour. Most males call at night and from leaves in plants or trees above streams. Some males, like the Ecuador Cochran frog, prefer spots over streams that are rushing downhill. Male Pacific giant glass frogs make their loud, trilled calls from behind waterfalls or on boulders in fast waters.

When a male glass frog attracts a female with his call and she approaches him, he climbs onto her back. This piggyback position is called amplexus (am-PLEK-sus). The male wraps his front legs around her and hangs on just behind her front legs. He remains there until she lays her eggs. As she does, he releases a fluid containing microscopic cells, called sperm, that trigger the eggs to start growing.

Usually, glass frogs mate at or near the place where the male was calling. This is the case with the Ecuador Cochran frog. She lays her eggs on the tip of the same or a nearby leaf where the male was calling. In a few species, like the Nicaraguan glass frog, the male may lead the female away from his calling site and to

another place where they actually mate. In this species, the female lays her eggs on the top of a leaf near the ground on in a plant up to 10 feet (3 meters) above the ground. Sometimes, she will instead lay her eggs on mossy rocks or branches. While they are mating and even for a short time after she lays her eggs, the male continues to call. The vast majority of species in this family lay their sticky eggs either on top of or on the bottom of leaves. The Ecuador Cochran frog is one species that lays eggs on the tops of leaves. Some of the species that lay their eggs on the bottom surfaces of leaves include the Atrato glass frog and the Fleischmann's glass frog. The only member of this family that does not follow this pattern of laying eggs on leaves is the Pacific giant glass frog. This species mates in the male's calling site, which is on a wet, splashed rock behind a waterfall or sticking up next to rapids.

AN OUT-OF-THE-WAY SPOT

The glass frog, known only by its scientific name *Cochranella saxiscandens*, makes its home in what was once an out-of-the-way spot: the stream at the bottom of a steep gorge in the mountains of northern Peru. People, however, have discovered the area and have begun cutting down the nearby forests for farms and for wood.

The typical number of eggs laid by a female glass frog is about two or three dozen. Female Fleischmann's glass frogs, for instance, lay about eighteen to thirty eggs, the Nicaraguan glass frog lays about twenty, and the Atrato glass frog lays twenty to twenty-five eggs in a clutch. Eggs come in different colors, depending on the species. Some, like the Nicaraguan glass frogs, have black eggs, while others, like the Atrato glass frog, lay transparent green eggs.

It is common to see an adult staying with the eggs for at least a short time. The female Nicaraguan frog stays with her clutch for at least the first night. In the Atrato glass frog, one of the adults either sits next to or on top of the eggs. In the Fleischmann's glass frog, it is usually the male that stays with the clutch. He sits nearby during the day, but covers them with his body at night. Despite his care, fruit flies often manage to land on the frog eggs and lay their eggs on them. The fly eggs hatch into maggots that eat the frog eggs, sometimes destroying almost all of them. In La Palma glass frogs, the males are the caregivers. A male will stay with his young day in and day out. Interestingly, the pattern on the adult frog's back looks very much like the pile of eggs and may confuse predators enough to cause them to leave alone both the male and his eggs.

Glass frog eggs hatch into tadpoles, which usually slide off the leaves and drop into the water below. Sometimes, a tadpole may slide off in the wrong direction and wind up on the shore instead of in the water. Fortunately, most tadpoles have strong tails that are powerful enough to flip them into the stream. The typical tadpole is long and thin with eyes on the top of its head. In Fleischmann's glass frogs, the tadpoles are bright red in color. The red is not, however, the color of the skin. It is the color of the tadpole's blood, which shows through the skin. Once a glass frog's eggs hatch into tadpoles, the adult leaves the clutch, and the tadpoles continue their development, eventually turning into froglets, on their own.

GLASS FROGS AND PEOPLE

People rarely see glass frogs in the wild or in the pet trade. Conservationists are especially interested in these little frogs because they may be good bioindicators (bie-oh-IN-dih-KAY-torz). A bioindicator is a living thing that provides clues about the health of the place where it lives. Glass frogs live in rainforests and cloud forests that are affected by global warming. As the Earth's weather changes, some of these forests are becoming too dry and making life difficult for the frogs, as well as other plants and animals. By watching the frogs, scientists can learn how much of a problem global warming might cause.

CONSERVATION STATUS

Of the 134 species in this family, the World Conservation Union (IUCN) considers sixty to be at risk, and another forty-nine to be Data Deficient, which means too little information is available to make a judgment about the threat of extinction. Of the sixty at-risk species, six are Critically Endangered and face an extremely high risk of extinction in the wild. These include *Centrolene ballux, Centrolene gemmatum, Centrolene heloderma, Centrolene puyoense, Cochranella anomala*, and *Hyalinobatrachium crybetes*. Many of the glass frogs are little known and have no common names in the English language. Two of these, *Centrolene ballux* and *Centrolene heloderma*, have lost eighty percent of their total number in a very short time. *Centrolene ballux*, which lives in Colombia and Ecuador, has become very rare in both countries and has not been seen at all in Ecuador since 1989. *Centrolene heloderma* also lives in Ecuador and Colombia, but has not been seen in Ecuador since

1979. The disappearance of both frogs may be tied to global warming. As the temperatures have changed, the sky is no longer as cloudy as it once was in the frog's habitat. Without the clouds, the weather may be becoming too dry for the frogs. In addition, people are cutting down the frog's forests to build homes, create farms, or to take the logs, and fires are also destroying the forest.

The other four Critically Endangered glass frogs live in very small areas. One makes its home in Honduras, and the other three in Ecuador. In each case, the frog's forest has been destroyed for purposes as farming or logging. The forests where the only known population of *Centrolene puyoense* lived, for example, was cut down and the land cleared out in 1996.

Besides the Critically Endangered species, sixteen are Endangered and face a very high risk of extinction in the wild, twenty-nine are Vulnerable and face a high risk of extinction in the wild, and nine are Near Threatened and at risk of becoming threatened with extinction in the future. Habitat loss and possibly infection with a fungus, called chytrid (KIT-rid) fungus, are likely causing many of the problems for these frogs. Others appear to be quite rare, but scientists are unsure about how many individuals actually live in the wild. The glass frogs are difficult to spot at night when they are active and during the day when they sit still on leaves. In addition, many of the species spend almost all of their time high up in trees and other hard-to-reach spots. An example is the species known by its scientific name of *Cochranella luminosa*. This glass frog is found on the western side of the Andes Mountains in Colombia, where it lives at the tops of trees. Recently, however, scientists have begun studying the tops of trees, called a forest's canopy (CAN-oh-pee), using ropes and tall platforms. With these new methods, they will likely learn much more about tree-living frogs, as well as other species of plants and animals.



LYNCH'S COCHRAN FROG
Cochranella ignota

Physical characteristics: Unlike most glass frogs, Lynch's Cochran frog is not green. This small frog is usually tan, although it is sometimes greenish brown, and has small, orange- or yellow-centered black spots on its back, head, and legs. Its body and all four legs are thin. The back legs are quite long and have webbed toes. The toes on both the front and back legs end in large, round pads. Its skin is smooth, except for numerous low, white warts. Its head has very large eyes pointed toward the front and a wide, rounded snout. Its bones are light green. Females are usually about an inch (2.42 to 2.44 centimeters) long from snout to rump. Males grow to 0.9 to 1.0 inches (2.23 to 2.54 centimeters) in length.



Lynch's Cochran frog lives in the western Andes Mountains of Colombia. (Illustration by Emily Damstra. Reproduced by permission.)

Geographic range: Lynch's Cochran frog lives in the western Andes Mountains of Colombia.

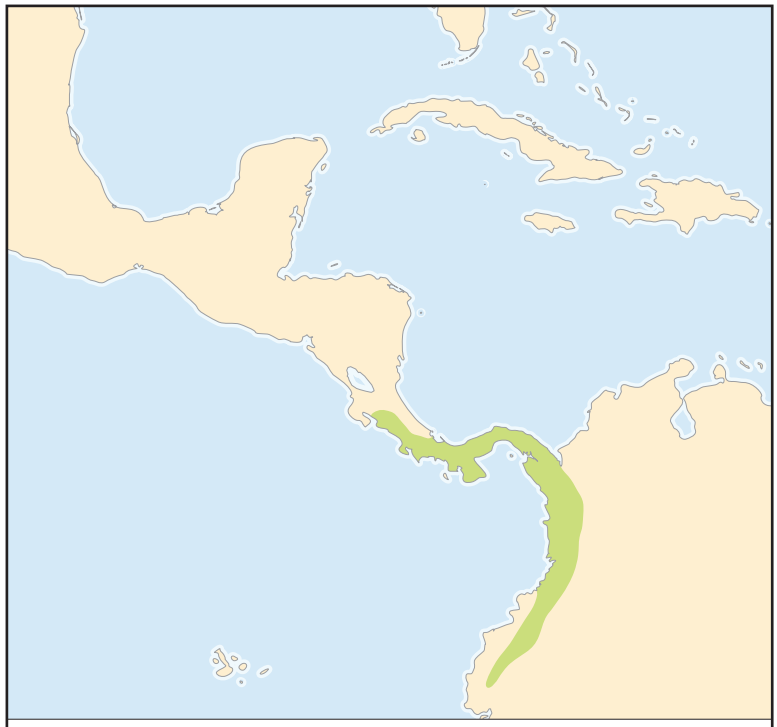
Habitat: This frog makes its home around streams in mountain cloud forests from 6,230 to 6,430 feet (1,900 to 1,960 meters) above sea level.

Diet: Its diet is unknown.

Behavior and reproduction: Scientists know little about its behavior, but if it is like many other glass frogs, it probably hides in plants during the day and becomes active at night. To mate, the males attract females with their call, which is a repeated chirping sound. The males call from plants above streams.

Lynch's Cochran frogs and people: Few people have ever seen this frog.

Conservation status: The World Conservation Union (IUCN) lists this frog as Near Threatened, which means that it is at risk of becoming threatened with extinction in the future. This is a common species, but it lives in a small area. Fortunately, most of the area falls within national parks, where the land is protected. Conservationists are still concerned that global warming may affect the future of this frog. A warmer climate may cause weather that is too dry for this species. ■

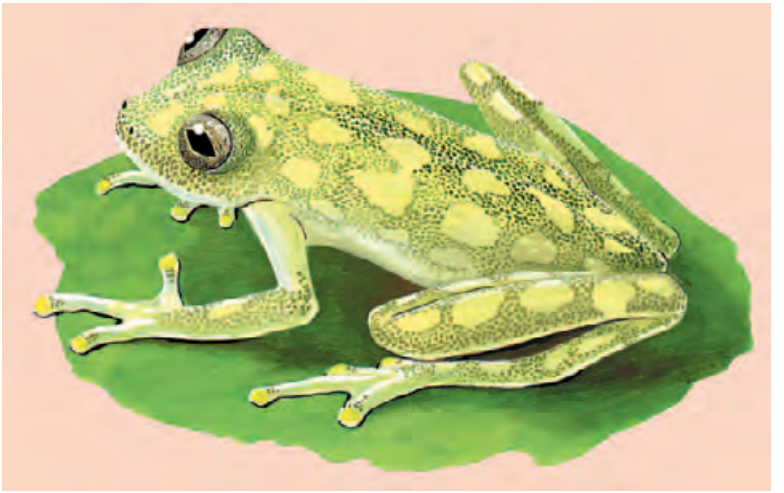


La Palma glass frog *(Hyalinobatrachium valerioi)*

LA PALMA GLASS FROG
Hyalinobatrachium valerioi

Physical characteristics: Also known as the reticulated glass frog, the La Palma glass frog's head and smooth back are yellow or slightly orange yellow with a net pattern that is green with dark spots. The net pattern forms a series of circles. Looked at another way, the back appears green with large yellow to slightly orange yellow spots. The legs have the same colors and pattern, and the hind legs are especially long and thin. The toes, which are almost completely transparent, have some webbing. Unlike the smooth back, the belly and the thighs are slightly wrinkly. Its bones are white. Males grow to 0.8 to 1.0 inches (2.03 to 2.54 centimeters) from snout to rump. Females are about the same size.

Geographic range: The La Palma glass frog lives in Costa Rica and Panama in Central America and in Ecuador and Colombia in South America.



Of all the glass frogs, most of which care for their eggs, the male La Palma glass frog spends the most time with his young. (Illustration by Emily Damstra. Reproduced by permission.)

Habitat: According to the IUCN, it lives in lowland forests below 1,312 feet (400 meters) above sea level, especially in plants and trees that line streams.

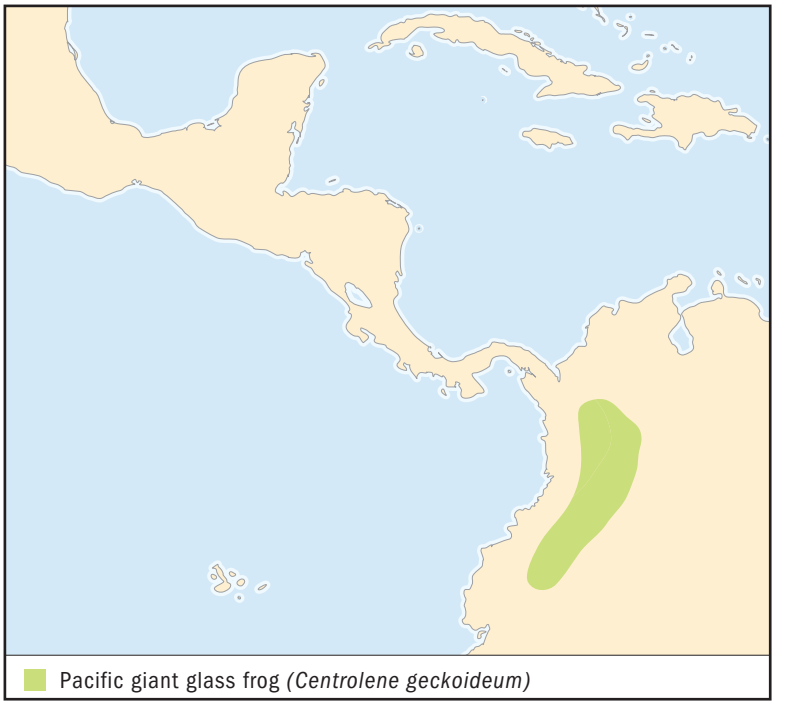
Diet: Its diet is unknown.

Behavior and reproduction: Scientists know little about its behavior outside of its breeding, but if the La Palma glass frog is like many other glass frogs, it probably hides in plants during the day and becomes active at night. To mate, the male calls in females with a short "seet" whistle that it repeats again and again. Males and females mate, and the females lay their eggs on leaves above streams. The eggs, which may number about three dozen, are pale green and surrounded with gel. After she lays her eggs, the female leaves, but the male stays behind to provide 24-hour-a-day protection to the eggs. Of all the glass frogs, most of which care for their eggs, the male La Palma glass frog spends the most time with his young. The color and pattern on the male's back looks very much like the clump of eggs he guards. This may confuse predators and cause them to leave both the adult male and the eggs alone.

La Palma glass frogs and people: Few people have ever seen this frog.

Conservation status: The IUCN lists this species as being of Least Concern, which means there is no known threat of extinction and the animal does not qualify for any of the "threatened" categories.

The La Palma glass frog lives over a large area and seems to be doing quite well, but conservationists are still watching it carefully. Parts of its forests are disappearing to farming, logging, and land for building, and this may eventually cause problems for the frog. Some of its forest home lies within protected areas, which are off limits to tree-cutting. ■



PACIFIC GIANT GLASS FROG
Centrolene geckoideum

Physical characteristics: The Pacific giant glass frog is the largest species in this family. The typical glass frog is about an inch (2.54 centimeters) long from snout to rump, but the Pacific giant glass frog is about three times as large. Females can reach 2.4 to 2.9 inches (6.09 to 7.36 centimeters) in length, while males can grow to 2.8 to 3.2 inches (7.1 to 8.1 centimeters) long. The Pacific giant glass frog looks different from other glass frogs in other ways, too. Unlike other glass frogs, its eyes are small compared to the size of its head; its legs are rather short and thick; its toes are well-webbed; and its toes have large toe pads that are rectangular shaped instead of round. Pacific giant glass frogs are dark green to lime green in color, and their skin is covered with small bumps, or tubercles (TOO-ber-kulz), and a few small white specks. Their bones are green. Besides being bigger overall, males have stronger front legs than females; they have bony spines, called humeral spines, that stick out of the upper part of each front



The Pacific giant glass frog is the largest species in this family. The typical glass frog is about an inch (2.54 centimeters) long from snout to rump, but the Pacific giant glass frog is about three times as large. (Illustration by Emily Damstra. Reproduced by permission.)

leg, while females have no spines; and their skin tubercles have tiny spikes that the females lack. Pacific giant glass frog tadpoles are long and thin with two eyes on the top of the head.

Geographic range: Pacific giant glass frogs live in Ecuador and Colombia.

Habitat: They live high in mountain cloud forests from 5,740 to 9,840 feet (1,750 to 3,000 meters) above sea level. They prefer forests that shade waterfalls or rapids.

Diet: This large species not only eats various insects, but it may also consume fishes or other frogs.

Behavior and reproduction: Like other glass frogs, the Pacific giant glass frog is active at night. But unlike the others, it may spend its days not only among leaves as other members of this family do, but on rocks. It also uses rocks rather than plants when it mates. The male Pacific giant glass frog hops onto wet rocks that are splashed by water from waterfalls or rapids. From there, it makes its call to attract females. The call is a high trill that is loud enough to be heard over the crashing water. It repeats its call every 1.5 to 5 seconds. Many of the male Pacific giant glass frogs have scars on their faces, heads, and sides. Scientists think the scars are the result of injuries suffered when males use their sharp arm spines to fight one another over the places where they call or where they mate. This is just a guess, however, because no one has seen the frogs fighting in this way.

Pacific giant glass frogs and people: Few people have ever seen this frog.

Conservation status: The World Conservation Union (IUCN) lists this species as Vulnerable, which means that it is facing a high risk of extinction in the wild. It already lives in a fairly small area of forests, much of which has already had parts cut down and cleared for farming. More habitat loss will likely occur. Besides the threat from habitat destruction, the frog is also in danger from fishes that have been introduced to the streams where its tadpoles live. The fishes eat tadpoles. In addition, some people have planted illegal crops in land near the forests where the frogs live and spray the crops with chemicals that are dangerous to the frogs. Rain washes the chemicals into the streams, and this can harm the tadpoles. These threats led the IUCN to predict in 2004 that the number of Pacific giant glass frogs would drop by another thirty percent by the year 2014. ■

FOR MORE INFORMATION

Books:

Beletsky, Les. *Costa Rica: The Ecotraveller's Wildlife Guide.* San Diego, CA: Academic Press, 1998.

Cogger, Harold G., and Richard G. Zweifel. *Encyclopedia of Reptiles and Amphibians.* San Diego, CA: Academic Press, 1998.

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians (Smithsonian Handbooks).* New York: Facts on File, 1991.

Lovett, Sarah. *Extremely Weird Frogs.* Santa Fe, NM: John Muir Publications, 1996.

Mattison, Chris. *Frogs and Toads of the World.* New York: Facts on File Publications, 1987.

Meyer, John R., and Carol F. Foster. *A Guide to the Frogs and Toads of Belize.* Malabar, FL: Krieger Publishing Co., 1996.

Showler, Dave. *Frogs and Toads: A Golden Guide.* New York: St. Martin's Press, 2004.

Web sites:

Cannatella, David. "Centrolenidae." *Texas Memorial Museum, University of Texas.* http://www.zo.utexas.edu/research/salientia/centrolenidae/centrolenidae.html (accessed on April 19, 2005).

"Emerald Glass Frog." *WildHerps.* http://www.wildherps.com/species/C.prosoblepon.html (accessed on April 19, 2005).

"Family Centrolenidae." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/classification/Centrolenidae.html (accessed on April 19, 2005).

Heying, H. "Centrolenidae." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Centrolenidae.html (accessed on April 19, 2005).

Kubicki, Brian. "Chiriqui Glass Frog." *Herps of Panama.* http://home.earthlink.net/%7Eitec1/Anura/Centronella/Hyalinobatrachium_pulvertum.html (accessed on April 19, 2005).

Kubicki, Brian. "La Palma Glass Frog." *Herps of Panama.* http://home.earthlink.net/%7Eitec1/Anura/Centronella/Hyalinobatrachium_valerioi.html (accessed on April 19, 2005).

Kubicki, Brian. "White-spotted Cochran Frog." *Herps of Panama.* http://home.earthlink.net/%7Eitec1/Anura/Centronella/Cochranella_albomaculata.html (accessed on April 19, 2005).

family CHAPTER

AMERO-AUSTRALIAN TREEFROGS

Hylidae

Class: Amphibia
Order: Anura
Family: Hylidae
Number of species: 854 species

PHYSICAL CHARACTERISTICS

The many species of Amero-Australian treefrogs often appear very different from one another. Inside their bodies, however, they have similar skeletons. For example, the set of bones on one side of the chest overlaps with the set on the other side, and the bones at the tips of the toes are shaped like claws. From the outside, most of the treefrogs have slender bodies, long legs, and wide toe pads that may be round or triangular-shaped. A few of them have plump bodies and short legs, and some have no toe pads. Most have webs that reach at least halfway up their rear toes. Webbing on the front toes is present in some species, but not in others.

All of the Amero-Australian treefrogs have teeth on the top of the mouth. Only a few have teeth or teethlike bones on the bottom of the mouth. Most have a round eardrum that shows on each side of the head. Some have smooth, shiny skin, but others are covered with small bumps. A few, like the horned treefrog, have large heads, small spikes above their eyes, and two large points on the top of the head that might be mistaken for ears or horns.

Most of the frogs in this family are green or brown with dark markings. These camouflage colors and patterns help them to blend in with their surroundings. Their undersides are typically light in color, sometimes with light brown, brown, or black marks. Many have bright patches on their sides and/or the insides of the hind legs. The red-eyed treefrog, for example, is a lime green frog with sides that are each colored with a set of

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

large blue areas separated by thin white to yellowish lines. A few treefrogs, such as the Chachi treefrog, are very colorful on their backs, too. This frog is yellow with a detailed pattern of red to reddish brown on its back and head.

Depending on the species, Amero-Australian treefrogs may be as small as 0.8 inches (2 centimeters) from the tip of the snout to the end of the rump or as large as 4.8 inches (2 to 12 centimeters). Males usually look similar to females, but commonly are smaller and may have bright yellow or dark gray vocal sacs. In addition, most males have rough patches and occasionally spines that form on their front legs and/or feet during the breeding season. These patches are called nuptial (NUHP-shul) pads and help the male hold onto the female during mating.

GEOGRAPHIC RANGE

Amero-Australian treefrogs live in much of North, South, and Central America, Europe, eastern and parts of southeastern Asia, Australia, and far northern Africa. They are not found in the northern reaches of North America, where the weather is frigid, nor in extreme southern South America.

HABITAT

Most Amero-Australian treefrogs live in rainforests or in other warm, moist forests. Some rainforests around the Amazon River in South America are home to more than 40 different species from this family. Numerous other species, however, live in cooler areas like the forests of the northern United States and Canada. Some treefrogs prefer drier spots, such as grassy fields and even deserts. The majority of treefrogs live up to their name and live in trees or at least on plants. Some, especially those that live in dry areas, may live on the ground or underground.

DIET

Amero-Australian treefrogs hunt by ambush, which means that they sit still, wait for a creature to wander by, and then quickly nab it and eat it. The majority of the treefrogs eat only arthropods (AR-throe-pawds), which are insects, spiders, and other animals that have no backbones, but have jointed legs. An animal without a backbone is called an invertebrate (in-VER-teh-breht). A few treefrogs are especially picky eaters. The greater hatchet-faced treefrog, for instance, is a small, green

frog that usually only eats ants. Some of the treefrogs, such as the Sumaco horned treefrog, have large heads and large mouths and are able to grab and swallow larger animals, including small lizards and frogs.

BEHAVIOR AND REPRODUCTION

Almost all of the treefrogs are active at night and hide during the daytime. Their hiding places may be underneath loose bark on the side of a tree, between two leaves or between a leaf and a stem, in a crack in a rock, or tucked into any number of other tiny openings. A few species, including the northern cricket frog of North America, are active during the day instead. Those that are active at night spend most of the time sitting still on leaves or branches, or on the ground, waiting for a meal to wander past. People usually see them most often during or after a rain when the frogs move around more.

The treefrogs that live in deserts and grassy fields take special steps to keep from drying out. The water-holding frog of Australia lives in very dry parts of Australia. To survive, it spends most of its life underground. Like other burrowing treefrogs, it has shovel-like bumps, called tubercles (TOO-ber-kulz), on its feet to help it dig backward into the ground. Once it is completely buried, it sheds its skin, which hardens into a waterproof coat. The frog remains inside the coat until the rainy season arrives, and then comes out of its burrow to mate and to eat until the dry weather returns. This resting period is called estivation (es-tih-VAY-shun). Some treefrogs in hot places in South America can survive above the ground. They ooze a goop from their skin and smear it on the rest of the body. The goop is waxy and prevents the frog from drying up.

Frogs that live in cold climates, such as the northern United States and Canada, spend the winter in a state of deep sleep. This is called hibernation (high-bur-NAY-shun). Cope's gray treefrog is an example. It crawls into a hiding place under leaves or underground and stays there until spring. During hibernation, much of the frog's body freezes solid, but the frog thaws out safely when the weather starts to warm up.

The typical treefrog avoids many of its predators by staying out of sight during the daytime and by remaining still for most of the night and blending into its surroundings. If a predator spots a treefrog and draws near, most treefrogs are good jumpers and will simply leap away. A few, like the black-eyed leaf frog,

TWIN FROGS

Two of the treefrogs that live in the forests of North America are able to change colors from a bright grass green to a brown-and-black, tree bark pattern—or vice versa—in a matter of about an hour. The two frogs, known as the eastern gray treefrog and Cope's gray treefrog, not only have the same color-changing ability, but they also look almost identical. Even frog experts often cannot tell one from the other unless they hear them. The males of both species make a trilling call, but when they are calling at the same time, the call of the male Cope's gray treefrog is noticeably faster.

can soar many feet (several meters) after leaping from a high branch. Others, such as the northern cricket frog, can hop to the water and continue scooting across the surface for a short distance. Some species of Amero-Australian treefrogs do not try to leap away and instead play dead by tucking their legs against the body and freezing in that position. Often a predator will lose interest and wander away, leaving the frog alive. The Amazonian milk frog and several other treefrogs have another way to avoid predators. These frogs ooze a milky substance from the skin that hurts the eyes and mouth of a predator.

Breeding season for the frogs that live in moist forests, such as cloud forests in the mountains or rainforests, may continue off and on throughout year after almost any heavy rain. These frogs usually mate in streams or ponds that are filled with water all year long. The frogs that live in cooler climates typically breed in the spring and use temporary pools of water that will dry up later in the year. Treefrogs that live in dry areas also use temporary pools, but they breed only when the rainy season arrives, which sometimes does not happen for a year, two years, or more. While many other species of treefrogs will call and mate in large groups, the males of those species that breed on land usually call alone. For example, a male spiny-headed treefrog calls alone from a tree hole or from a bromeliad (broh-MEE-lee-ad), which is a plant that grows on trees and holds little puddles of water between its leaves. When the male pairs with a female, the two also mate away from the other frogs.

The males' calls announce the breeding season. The males usually have a single vocal sac, a bit of flesh on the throat area that blows up and deflates when they call. Most call from the ground or on plants or trees. A few species, like the Manaus slender-legged treefrog, have two vocal sacs that inflate upward around the head, and they call while floating in the water. If they had the typical single vocal sac that inflates out and down from the throat, they would bob around in the water. In most species, the male finds a good spot for breeding and makes his

calls not only to attract a female but also to announce his territory to other males of his species. If another male tries to move into his territory despite his calls, the two may wrestle with one another, sometimes even resorting to biting. Perhaps the most vicious fighters are the male gladiator frogs, which have sharp spines on the inner toe of each front foot. Two battling males will swipe their spines at each other, often causing bad cuts and sometimes death. Spiny-headed treefrogs may also fight by gashing one another with their head spines.

Once a female approaches a male for mating, he scrambles up and lays flat against her back while hanging on with his front legs wrapped around the top of her back. The females of some treefrogs, including many of the species in North America, lay their eggs in the water, and the eggs hatch into tadpoles. Some treefrogs instead dig a shallow dip or a deeper hole in the ground or find an already-made dip and lay their eggs there. When rain floods the dip or the burrow, the tadpoles hatch and float off to a nearby pool of water. The females of other treefrog species lay their eggs on leaves that hang over the water or make foamy nests for them on plants above the water. A number of treefrog females lay their eggs on the sides of tree holes or on bromeliad leaves above a little puddle of water. These eggs hatch into tadpoles and slide off the leaves, drop out of the nests, or wriggle from the sides of bromeliad leaves and tree holes to fall into the water below. In some species of treefrogs, the eggs spend time inside a pouch on the female's back or simply stuck to her back. Among several of these species, the eggs hatch into tadpoles inside the pouch or on the female's back, and she drops them off at a pond or in a puddle inside a tree hole or bromeliad. The eggs in a few species never become tadpoles at all and hatch right into froglets.

AMERO-AUSTRALIAN TREEFROGS AND PEOPLE

Some local people in tropical areas eat the larger Amero-Australian treefrogs, including the very large tadpoles that are seen in some species. Some treefrogs, however, are not safe to eat. The giant waxy monkey treefrog, for instance, oozes a very powerful poison from its skin that can cause a person to become extremely sick or to die.

Many species of treefrogs can be found in the pet trade. The red-eyed treefrog with its green back, blue-and-white sides, orange toes, and large, red eyes is especially common.

CONSERVATION STATUS

The World Conservation Union (IUCN) lists one species that is Extinct, which means that it is no longer in existence; fifty-three species that are Critically Endangered and facing an extremely high risk of extinction in the wild; seventy-seven species that are Endangered and facing a very high risk of extinction in the wild; fifty-four that are Vulnerable and facing a high risk of extinction in the wild; twenty-seven that are Near Threatened and at risk of becoming threatened with extinction in the future; and 183 that are Data Deficient, which means that scientists do not have enough information to make a judgment about the threat of extinction.

The one Extinct species was from Brazil. Known as the spiny-knee leaf frog, the first—and only—one was seen more than eighty years ago. Scientists have looked for others since then, but have found none. Many of the fifty-three Critically Endangered species in this family have had die-offs because of infection with a fungus, called chytrid (KIT-rid) fungus. This fungus has also killed frogs from many other species in different frog families around the world. Morelet's treefrog, which is found in Central America and Mexico, is one of the species of Amero-Australian treefrogs that has had a loss in numbers because of the fungus. Some individuals have probably also died as their forests have been destroyed. This frog was once quite common, but now it has disappeared from many places. Scientists believe that its population will drop by another 80 percent by the year 2014.



Riobamba marsupial frog *(Gastrotheca riobambae)*

RIOBAMBA MARSUPIAL FROG
Gastrotheca riobambae

Physical characteristics: Also known as the Ecuadorian marsupial frog, the Riobamba marsupial frog gets its name from the pouch, or marsupium (mar-SOUP-ee-uhm), on the rear of the female's back. The male has no pouch. The Riobamba marsupial frog is a plump green to brown frog sometimes with darker colored oblong blotches of color on its back. The blotches are outlined in dark brown. Its back is smooth or has a cracked appearance. Its underside is grainy-looking, has a cream color, and is sometimes spotted with gray or brown. The frog has a small head with large, brown eyes and a wide mouth on its



The female Riobamba marsupial frog carries her eggs in pouch on her back (Photograph from the Kansas University Natural History Museum. Reproduced by permission.)

rounded snout. All four of its short legs have toes with slightly rounded pads on the tips. Males may be a bit shorter than females. Males usually grow to 1.4 to 2.3 inches (3.4 to 5.7 centimeters) from snout to rump, while females reach 1.4 to 2.7 inches (3.4 to 6.6 centimeters) in length. Until 1972, this frog's scientific name was *Gastrotheca marsupiata*, but that name is now used by a different species found only in Peru and Bolivia.

Geographic range: It lives in northwestern South America among the Andes mountains in parts of Ecuador.

Habitat: It lives along the ground, making its home in mountain fields, farmlands, and even city gardens.

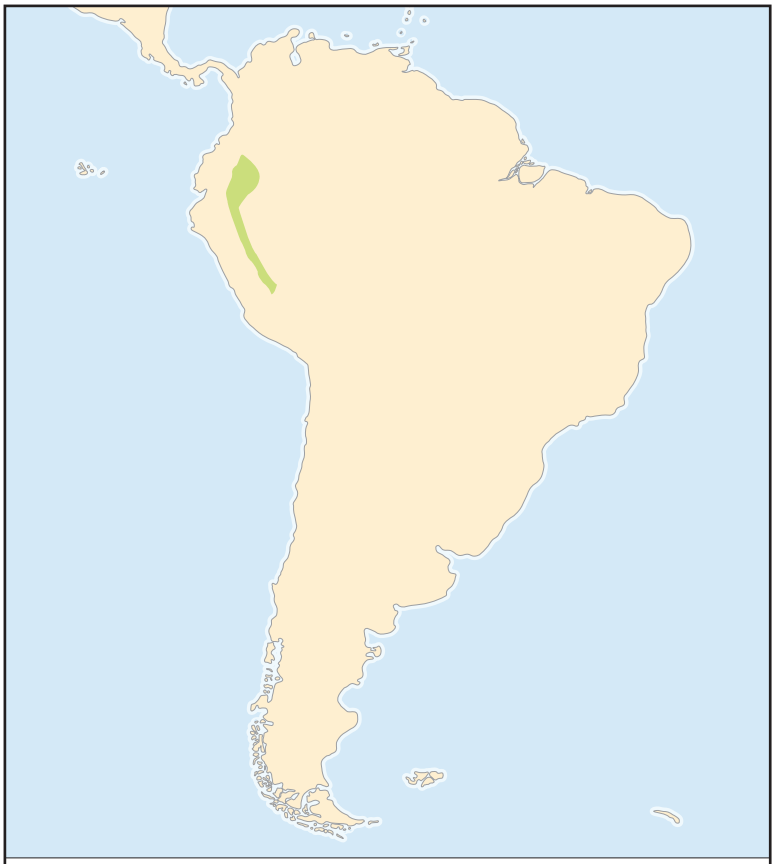
Diet: It eats beetles, as well as other arthropods.

Behavior and reproduction: The Riobamba marsupial frog hides during the day in small openings in rock piles and stone walls and among plant leaves. At night, it becomes active and looks for food on the ground. The frog is most known for the unusual way it has its young. Mating begins when the male calls with a "wraaack-ack-ack" sound and attracts a female. In most frogs, the male sheds fluid, which contains microscopic cells called sperm, over the female's eggs as she lays them. Only after the sperm mixes with the eggs can they start developing into baby frogs. In the Riobamba marsupial frog, the male sheds the sperm-filled fluid, but spreads it on her back behind her

pouch. As she lays her eggs, he pushes them through the fluid and into her pouch. A single female may lay sixty-four to 166 eggs at a time. The eggs hatch inside her pouch seventy to 108 days later. The female moves to shallow water, pulls open the pouch, and the tadpoles swim out. The female uses her hind feet to scoop out any stragglers. The tadpoles change into froglets in four to 12 months.

Riobamba marsupial frogs and people: Scientists are interested in the frog because of the unusual way it reproduces.

Conservation status: The IUCN lists this species as Endangered, which means that it faces a very high risk of extinction in the wild. It was once a common species, but now is rare. Scientists are not sure why its numbers have dropped, but they think that the change in its habitat from forests and meadows to farm fields is likely part of the reason. ■



Sumaco horned treefrog *(Hemiphractus proboscideus)*

SUMACO HORNED TREEFROG
Hemiphractus proboscideus

Physical characteristics: The many jagged edges of the Sumaco horned treefrog set it apart from most other frogs. Its head is very large compared to its body. The snout is wide and triangular with a very pointy front. It has other edges on its head that give it the appearance of having pointy "cheeks" and "ears." Its eyes are large and set toward the side, and it has additional small points above its eyes. The Sumaco horned treefrog is several shades of brown, often with noticeable dark streaks on its face and dark bands on its legs. Its body is a bit flattened, and parts of the backbone poke up enough



With its large mouth, this frog is able to eat large arthropods, as well as small lizards and other frogs. (Illustration by Amanda Humphrey. Reproduced by permission.)

that they are visible as bumps down the middle of the back. The underside is brown and spotted with light brown or orange. It has long, thin legs and long, knobby toes. The toes on the front feet have no webs, but the toes on the back feet do have some webbing. Females are larger than males. Males reach 1.8 to 2.0 inches (4.3 to 5.0 centimeters) long, but females grow to 2.3 to 2.7 inches (5.7 to 6.6 centimeters) in length.

Geographic range: The Sumaco horned treefrog lives in northwestern South America, including parts of Ecuador, Peru, and Colombia.

Habitat: This frog can be found climbing through moist forests of lowland areas or low on mountains. It does not mate or have its young in the water.

Diet: With its large mouth, this frog is able to eat large arthropods, as well as small lizards and other frogs.

Behavior and reproduction: The Sumaco horned treefrog is active at night, when it moves through the trees of the forest. When it stays still, its body color and shape blend into the leaves. If a predator approaches, the frog will open its quite large mouth to flash its bright yellow tongue. This display may startle a predator and convince it to leave the frog be. Like the female Riobamba marsupial frog, the female Sumaco horned treefrog carries her eggs on her back, but the Sumaco

horned treefrog does not have a pouch. Instead, the eggs stick to the top of her back. A typical female has about twenty-six large eggs at a time. The eggs skip the tadpole stage and hatch right into froglets.

Sumaco horned treefrogs and people: People rarely see or bother this frog.

Conservation status: The Sumaco horned treefrog is not considered endangered or threatened. ■



Hourglass treefrog *(Hyla leucophyllata)*

HOURGLASS TREEFROG
Hyla leucophyllata

Physical characteristics: The hourglass treefrog, which is also known as the Bereis' treefrog, is a small, slender, reddish brown frog that looks as if someone has dabbed it with streaks of cream or yellow paint. A triangle of color covers the head from one of its large eyes to the other and down onto its short, rounded snout. The color continues down each side of the smooth body, leaving a somewhat hourglass-shaped patch of brown in the middle of the back. An oblong cream or yellow patch sits on the rump, and additional rounded or oblong patches dot the front and back legs. It has long, thin legs,



The hourglass treefrog mainly eats moths, but will also eat other small insects. Tadpoles swim to the pond bottom and feed on large bits of plants and other items underwater. (Illustration by Amanda Humphrey. Reproduced by permission.)

and its toes are tipped in rounded pads. In some individuals, the toes are yellow. The undersides of its legs are orange, as is the slight webbing between its toes. Males are 1.3 to 1.5 inches (3.3 to 3.6 centimeters) from the snout to the rump. Females are larger at 1.6 to 1.8 inches (4.0 to 4.4 centimeters) in length.

Geographic range: This treefrog makes its home in northern South America, from northern and western Brazil through Bolivia to Peru, and also in Colombia, Ecuador, Suriname, French Guiana, and Guyana.

Habitat: It lives in hot and humid, lowland rainforests. Tadpoles develop in shallow ponds.

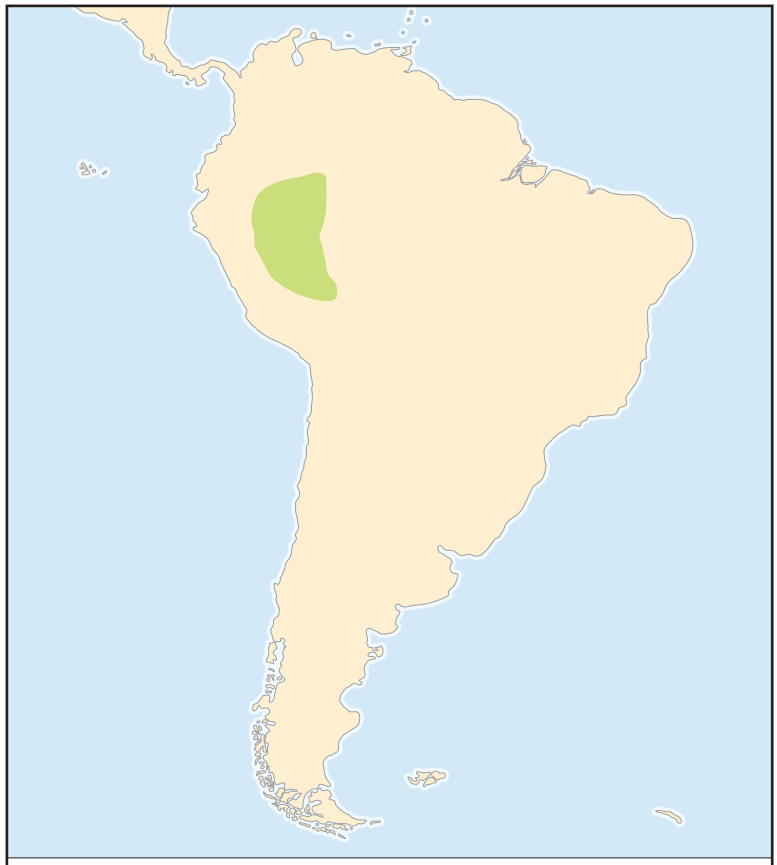
Diet: It mainly eats moths, but will also eat other small insects. Tadpoles swim to the pond bottom and feed on large bits of plants and other items underwater.

Behavior and reproduction: The hourglass treefrog is active at night, when it climbs through trees looking for food. To mate, a male

begins calling from a spot in plants above a pond. His call may be three to eight notes long, with the first being the longest. When a female approaches, he positions himself on her back, clutching her near her front legs, and she lays her eggs. One female can lay about six hundred eggs, which she drops onto the plants. In five to seven days, the eggs hatch into tadpoles, which plop down into the water below.

Hourglass treefrogs and people: It is occasionally seen in the pet trade.

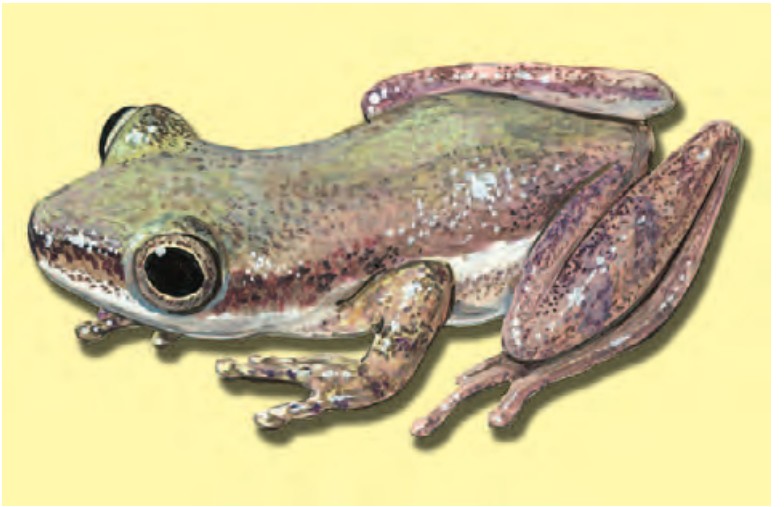
Conservation status: The IUCN does not consider this frog to be endangered or threatened. ■



Amazonian skittering frog *(Scarthyla goinorum)*

AMAZONIAN SKITTERING FROG
Scarthyla goinorum

Physical characteristics: The Amazonian skittering frog is a small and slender frog. Its head, back, and legs are light green and grainy-looking. Its head has a small, somewhat pointed snout and two large eyes, one on each side. The legs are thin, and the hind legs are long. All of its toes are webbed and have small rounded pads at the tips. Brown and white stripes run from the chin down the sides of its body. Its underside is white. Males, which grow to 0.6 to 0.8 inches (1.5 to 2.0 centimeters) long, are slightly smaller than females. Females reach 0.7 to 0.9 inches (1.8 to 2.3 centimeters) in length.



This small frog lives among the leaves of plants that stretch along and over ponds in warm and humid lowland rainforests. (Illustration by Brian Cressman. Reproduced by permission.)

Geographic range: It lives in western South America, including far western Brazil, Bolivia, Colombia, and Peru.

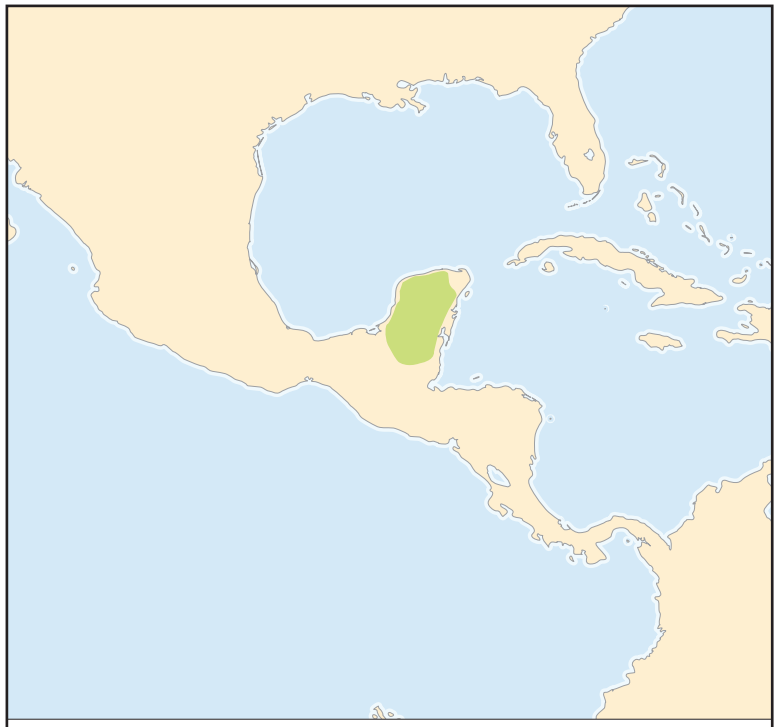
Habitat: This small frog lives among the leaves of plants that stretch along and over ponds in warm and humid lowland rainforests.

Diet: It mainly eats spiders, but also eats other small arthropods.

Behavior and reproduction: Active at night, it either sits among leaves that hang low over ponds or skitters across the water. When it skitters, it scoots across the surface of the water without sinking. To attract females for mating, the male makes his whistling calls with a pattern of eight to ten notes in a row. Each female lays 130 to 202 small eggs, which she drops in the pond water. The eggs hatch into tadpoles, each of which is able to flip its strong tail and soar free of the water and through the air, sometimes eight to twelve inches at a time. Usually, however, the tadpoles stay in the water, swimming just below the surface.

Amazonian skittering frogs and people: Although it is quite common, people rarely see this frog.

Conservation status: The Amazonian skittering frog is not considered endangered or threatened. ■



Yucatecan shovel-headed treefrog *(Triprion petasatus)*

YUCATECAN SHOVEL-HEADED TREEFROG
Triprion petasatus

Physical characteristics: The Yucatecan shovel-headed treefrog is a slender frog with a flattened head somewhat shaped like the blade of a shovel. It is sometimes called a duckbill frog or a casque (kask)-headed frog. The head has a flat outer rim on the snout and a V-shaped ridge on the top of the snout. The large, copper-colored eyes are set far apart on the sides of the head. Its hind legs are long and thin, but its front legs are strong. The toes on all four feet are widened at the tips into round pads. The front toes have little webbing, but the back toes are about two-thirds webbed. The frog is tan to dark brownish green with brown spots on its back and blotches on its legs. Its belly is white, and the bottoms of its legs are tan, sometimes with a pink tint. Females, which reach 2.6 to 3 inches (6.5 to 7.5 centimeters) long, are larger than males. Males grow to 2 to 2.5 inches (4.8 to 6.1 centimeters) in length.



Each male's call is a duck-like quacking sound. Together, the males sound like a whole flock of ducks. (Illustration by Brian Cressman. Reproduced by permission.)

Geographic range: It is found in far southern Mexico, as well as Guatemala and Belize in Central America. A small population also survives in northwestern Honduras.

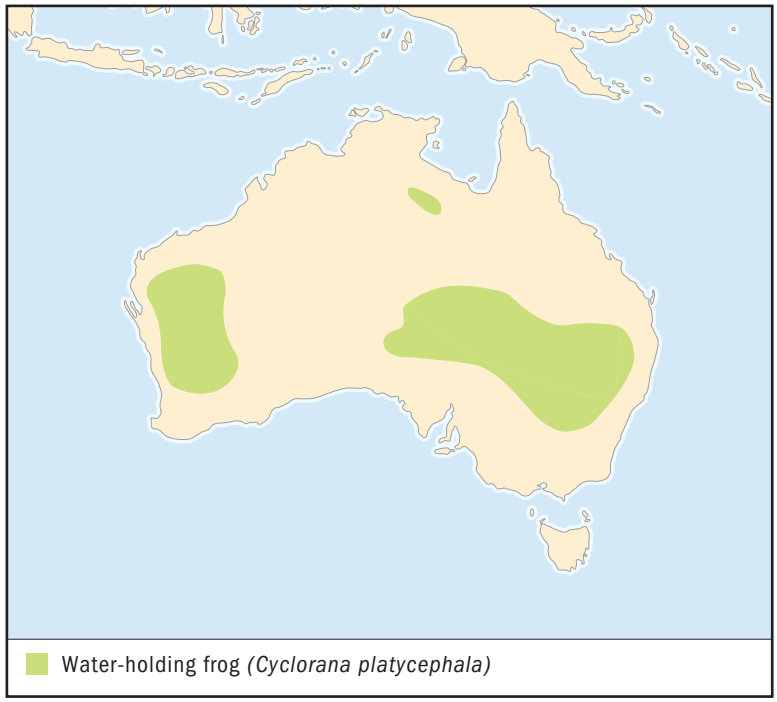
Habitat: It lives in fairly dry, shrubby forests and grasslands. Eggs and tadpoles develop in pools of water that form in the rainy season.

Diet: Like many other treefrogs in this family, it eats small arthropods. It also sometimes eats other, smaller frogs.

Behavior and reproduction: It is active at night, when it moves across the ground and through shrubs and low trees, looking for things to eat. Its body color provides excellent camouflage when it sits still against the trunk of a tree. After heavy rains create small pools on the ground, all of the males hop near the pools and begin calling from land and in bushes and trees. Each male's call is a duck-like quacking sound. Together, the males sound like a whole flock of ducks. The females approach the males and mate with them, laying their eggs in clumps in the water. All of the frogs mate in about a one-week period. The eggs hatch into tadpoles that remain in the pool until they change into froglets.

Yucatecan shovel-headed treefrogs and people: It is a very common frog that is often seen near towns.

Conservation status: This frog is not considered threatened or endangered. ■



WATER-HOLDING FROG
Cyclorana platycephala

Physical characteristics: The water-holding frog is a chubby frog that has a round but flattened body. Its head blends into its body and does not have an obvious neck. Its eyes sit toward the top of the head. Its legs are strong, but rather short, almost disappearing under the body when the frog is sitting still. Each hind foot has a bump, or tubercle, that is shaped like the edge of a shovel blade. The toes are webbed. The frog is dark brown, gray, or green with dark blotches on its back. It usually becomes greener in the mating season. Its underside is white. Females are the larger sex. Females grow to 2.0 to 2.9 inches (5.0 to 7.2 centimeters) in length, while males reach 1.7 to 2.6 inches (4.2 to 6.4 centimeters).

Geographic range: The water-holding frog lives in three parts of Australia: a large area of the far west, a small spot in the north, and a large area in the middle of the continent from the center to the east.



The water-holding frog inflates its flexible body full of water after floods on the arid floodplain of the Paroo River, Australia. As the water recedes, the frog will burrow underground and live on its stored water. (Photograph by Wayne Lawler. Photo Researchers, Inc.)

Habitat: It spends much of its life beneath the ground of deserts and dry grasslands. During the rainy season, males and females come to the surface to mate and have their young in new, small pools of water that have filled with the rain.

Diet: It eats various arthropods that it finds during the rainy season.

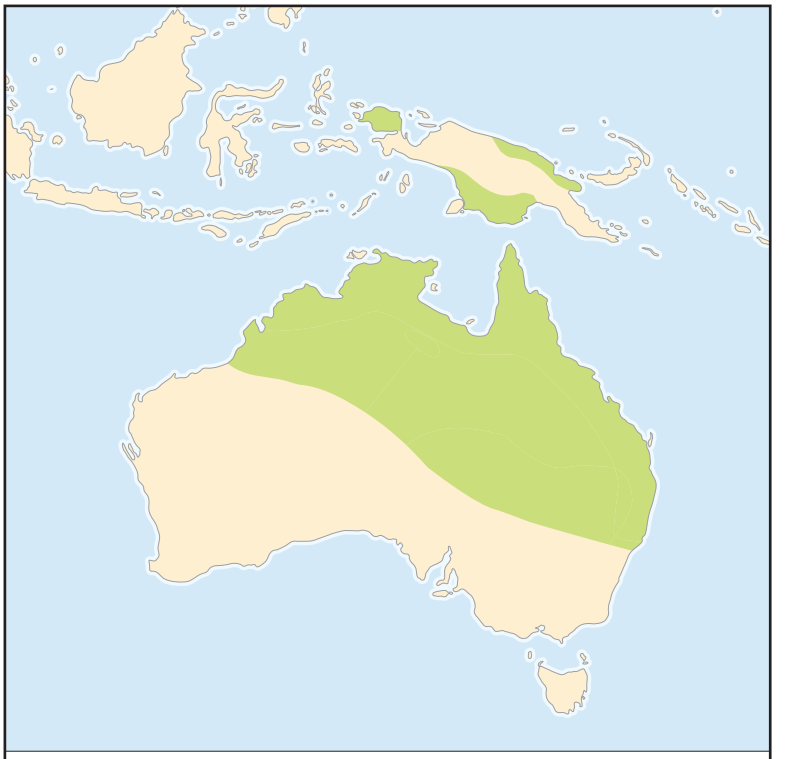
Behavior and reproduction: The weather for most of the year is very dry where this frog lives, and the frog survives by digging with its hind feet and tubercles and burrowing backward into the soil to bury itself. Once dug in, sometimes as much as 3.3 feet (1 meter) deep, it sheds a few layers of skin, which harden into a cocoon that keeps its body from drying out. The frog enters a deep resting stage, called estivation, and remains in that state until the rainy season begins. In some years, even the rainy season is not wet enough, and the frogs stay underground for the entire year to wait for the next heavy rains.

When the rains fall hard enough to make shallow pools on the ground, the frogs crawl out from underground. The males call with long, snore-like sounds. Females find the males and mate with them. Each female lays clumps of eggs—sometimes several hundred—in the pools. The eggs hatch into tadpoles, which must turn into frogs before the pools dry up. This can take as little as thirty days. As the rainy

season ends, the frogs fill their bodies with water before digging back underground to wait for the next bout of wet weather.

Water-holding frogs and people: Native people, called Australian aborigines (ab-or-RIJ-ih-neez), live in the same area as the frogs. The people sometimes dig the animals from their underground burrows and squeeze them to get a sip of water out of the frog.

Conservation status: The water-holding frog is not considered threatened or endangered. ■



Green treefrog *(Litoria caerulea)*

GREEN TREEFROG
Litoria caerulea

Physical characteristics: The green treefrog, also known as White's treefrog, is a pudgy animal with skin that drapes over its sides to make the frog appear almost as if it were melting. The flabby-looking skin behind each side of the back of the head covers large, flat, poison glands. The green treefrog is a round frog with a head that blends back into the body rather than having an obvious neck. Its head has large, white eyes, a short snout, and a wide mouth. Its eardrums are visible on the sides of its head. Its legs are rather short, but its webbed toes are thick and long, ending in wide, triangular-shaped pads. The typical green treefrog is the color of a lime, sometimes with a tinge of yellow on its face and legs. It has a grayish or yellowish white underside. Females, which grow to 2.9 to 4.5 inches (7.0 to 11.0 centimeters) long, are



These Australian treefrogs have enormous toe pads. Front toes are partially webbed, but the back toes are completely webbed. The skin is covered with a thick cuticle that allows it to retain moisture as an adaptation to arid areas. (Photograph by Harald Schüetz. Reproduced by permission.)

larger than males. Males reach 2.7 to 3.1 inches (6.6 to 7.7 centimeters) in length. Sometimes this frog is listed with the scientific name *Pelodryas caerulea* instead of the name listed here.

Geographic range: It lives in northern and eastern Australia and has also been introduced to New Zealand.

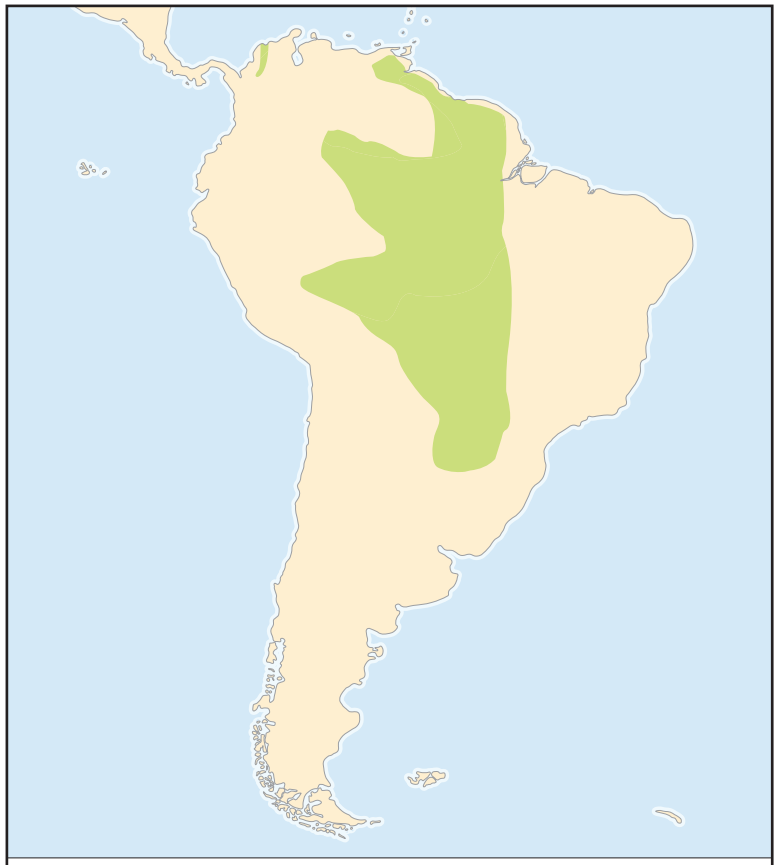
Habitat: It spends most of its life in the trees of forests, which may be dry or humid. Eggs and tadpoles develop in the calm water of swamps or slow streams.

Diet: This rather large frog eats various arthropods, as well as larger organisms, such as other frogs and even small mammals.

Behavior and reproduction: It often sits in trees with its front feet crossed and held close to its body. It becomes active at night. Following rains, usually from November until February or March, the males begin calling with a deep, repeated "crawk" or barking sound. They call from spots near the water. Females follow the calls to the males and they mate. The females may lay as few as two hundred eggs or ten times that many, dropping them onto the surface of calm water. The eggs soon sink and later hatch into tadpoles. The tadpoles turn into froglets in about six weeks.

Green treefrogs and people: The skin of this frog oozes a substance that can help control high blood pressure in people. High blood pressure, which happens when the blood moves with too much force through the blood vessels in the body, is a dangerous condition. Scientists now make the frog's skin substance in laboratories as a human drug.

Conservation status: The green treefrog is not considered threatened or endangered. ■



Paradox frog *(Pseudis paradoxa)*

PARADOX FROG
Pseudis paradoxa

Physical characteristics: The paradox frog, also known as the paradoxical frog, has large, bulging eyes on the top of its head and a rounded and somewhat pointed snout. It has long and powerful hind legs and shorter but still strong front legs. Its toes are webbed. Its back is light brown to greenish brown, sometimes with light-colored stripes, and its underside is white. Females grow to 1.7 to 3.2 inches (4.0 to 6.5 centimeters) from snout to rump, while males reach 1.6 to 2.7 inches (3.8 to 6.5 centimeters) in length.



This frog remains in the water most of the time, often with just its eyes poking above the surface. (R. Andrew Odum/Peter Arnold, Inc.)

Geographic range: Populations of this frog are scattered through parts of northern and central South America, from Uruguay and southern Brazil in the south to Venezuela in the north.

Habitat: It lives in grassy or open forest areas near marshes, ponds, or slow-moving creeks.

Diet: It eats water-living arthropods, as well as small frogs.

Behavior and reproduction: This frog remains in the water most of the time, often with just its eyes poking above the surface. It is mainly active at night except during its breeding season, when the males may make their loud, croaking calls at any time of night or day. Females come to the males and mate with them, laying their eggs among the plants that grow in the water. The eggs, which are grouped together in foamy clusters, hatch into tadpoles. Tadpoles continue to grow in the water and can reach lengths of 11 inches (27 centimeters) before changing into froglets. Much of the length of the tadpole is in its tail, and once that shrinks away, the froglet is much smaller.

Paradox frogs and people: Some local people eat the large tadpoles of this species.

Conservation status: The paradox frog is not considered threatened or endangered. ■

FOR MORE INFORMATION

Books:

Badger, David. *Frogs*. Stillwater, MN: Voyageur Press, 2000.

Barker, John, Gordon Grigg, and Michael J. Tyler. *A Field Guide to Australian Frogs.* Chipping Norton, Australia: Surrey Beatty and Sons, 1995.

Duellman, William E. *Hylid Frogs of Middle America.* Ithaca, NY: Society for the Study of Amphibians and Reptiles, 2001.

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians (Smithsonian Handbooks).* New York: Facts on File, 1991.

Mattison, Chris. *Frogs and Toads of the World*. New York: Facts on File Publications, 1987.

Meyer, John R., and Carol F. Foster. *A Guide to the Frogs and Toads of Belize*. Malabar, FL: Krieger Publishing Co., 1996.

Miller, Sara Swan. *Frogs and Toads: The Leggy Leapers*. New York: Franklin Watts, 2000.

Patent, Dorothy Hinshaw. *Frogs, Toads, Salamanders, and How They Reproduce.* New York: Holiday House, 1975.

Showler, Dave. *Frogs and Toads: A Golden Guide.* New York: St. Martin's Press, 2004.

Tyning, Thomas. *A Guide to Amphibians and Reptiles.* Boston, MA: Little, Brown and Company, 1990.

Periodicals:

Milius, Susan. "Wafting Pesticides Taint Far-flung Frogs." *Science News* (December 16, 2000): 391.

Milius, Susan. "Wasps Drive Frog Eggs to (Escape) Hatch." *Science News* (October 14, 2000): 246.

Turner, Pamela S. "The Extreme Team." *Odyssey* (May 2002): 26.

Web sites:

"Sticky Fingers." *American Museum of Natural History.* http://www.amnh.org/exhibitions/frogs/featured/sticky.php (accessed on April 10, 2005).

"Wax On, Wax Off." *American Museum of Natural History.* http://www.amnh.org/exhibitions/frogs/featured/waxon.php (accessed on April 10, 2005).

TRUE FROGS
Ranidae

Class: Amphibia
Order: Anura
Family: Ranidae
Number of species: 686 species

family CHAPTER

PHYSICAL CHARACTERISTICS

With nearly seven hundred species, the true frog family is very large. As in other big families, the true frogs come in many shapes and sizes, but they do have a few common features. All have teeth along the top of the mouth. Most of them have at least some webbing between the toes of the hind feet, and some have webbing all the way to the tips of the hind toes. In many species, the females are larger than the males, but the males have longer hind legs and more webbing between their rear toes. The males typically also have thicker front legs, which they use to hold onto the females during mating.

Most true frogs are shades of greens or browns and blend in well with their surroundings. Those that live in the water, such as Roesel's green frog and Indian tiger frog, are commonly green to olive green in color, which matches well with their homes. Often, species that live in forests, like the wood frog and Beddome's Indian frog, are tan or brown like the dead leaves that cover the forest floor. Most true frogs have rather stocky bodies. The African bullfrog is especially pudgy-looking. Some, like the leopard frog and pickerel frog, have more slender bodies. Many members of this family have long and strong hind legs for leaping. This includes the leopard, pickerel, and green frogs that are found in North America, as well as many others. Some, like the large African bullfrog, have shorter hind legs.

Many of the frogs in this family have a dark, horizontal bar through the center of each eye. Some also have a dark, vertical

bar through the eye. In addition, many have a noticeable eardrum on each side of the head behind the eye. In a few species, like the green frog, the size of the eardrum can help tell a male from a female. In this species, the male's eardrum is much larger than the eye, while the female's is about the same size or smaller than the eye.

Many true frogs are between 1.6 and 3.3 inches (4.1 to 8.4 centimeters) long from the tip of the snout to the end of the rump. The smallest frogs in this family, however, are 0.4 inches (1 centimeter) long. These include several tiny African species. The largest members of this family, including the goliath frog, can reach more than 12.2 inches (31 centimeters) long.

GEOGRAPHIC RANGE

True frogs live in much of the world, including most of North and Central America, the north end and parts of central South America, most of Europe and Asia, much of Africa, and Australia. Some members of the family are also found on islands in the ocean. Some populations, like those in much of Australia, were introduced to these areas by humans and previously did not live there.

HABITAT

Many species live near water, such as a pond, quiet stream, or marsh. A few, like the goliath frog, make their homes in fast-moving rivers and rapids. Other true frogs, however, spend most of their lives away from water in forests or grasslands, and only return to ponds or wetlands once a year for breeding. Of these land-living frogs, some do not return to the water at all and instead lay their eggs in moist places on land.

DIET

Most of the true frogs are active at night and eat insects and other invertebrates (in-VER-teh-brehts), which are animals without backbones. The larger members of this family have more variety in their diets and will eat tadpoles of other species and sometimes their own, as well as animals like snakes, birds, and small mammals. Some of the true frogs hop about looking for food. Others are ambush hunters, which means that they sit still and wait for an insect or other animal to walk past. With a simple flick of the tongue or grasp of the mouth, they capture the victim and eat it whole.

BEHAVIOR AND REPRODUCTION

Although most members of this family are active at night, some that live next to lakes and ponds, or in cooler areas, are out and noticeable during the daytime. They sunbathe, or bask, by sitting in a warm spot on land or, if they are in the water, by floating in the warm, top layer. Some commonly seen daytime-basking frogs in North America include the green frog and leopard frog.

Those true frogs that live in moist forests in warm climates remain active all year. Others do not. Some live in dry areas and have to find ways to survive the weather. The African bullfrog, for example, makes its home in dry regions of southern Africa. It becomes active and breeds during the rainy season, but when the ground dries out, it buries itself underground. It then sheds a few layers of skin that it wears like a watertight coat to keep its skin from losing too much water. This skin cocoon stays around its body while the frog rests during a period that is known as estivation (es-tih-VAY-shun). The frog remains in its cocoon until the next rainy season arrives.

Frogs that live in places with cold winters also enter a resting period, known as hibernation (high-bur-NAY-shun). Both hibernation and estivation are long resting periods, but one happens when the weather is cold, and the other when the weather is dry. The hibernating frogs typically bury themselves in the ground or in mud at the bottom of their pond or wetland and stay there until the temperatures warm the following spring. A few species, like the wood frog of North America, are able to freeze solid in the winter and recover the next spring to live another year.

Most of the species in this family avoid predators by restricting their activity to the dark of night or by remaining still and blending in with the background. Since many of them live near the water, they also have the option of leaping and then diving down to make a fast escape if predators come too close. A few, like the African bullfrog, will stand their ground. They will nip at predators that approach them or their young.

Most of the frogs in this family breed during one season a year. Those that live in dry areas mate during the rainy season. Others that live in climates with cold winters start their breeding seasons when warmer spring temperatures arrive. Some breed in early spring, and others in late spring. Those that live in warm,

FROG POPSICLE

The wood frog of North America survives the cold of winter by freezing solid and remaining that way until it thaws out in the spring and hops away. Most other animals would die if frozen in this way. The wood frog prepares for winter by scooting under a pile of leaves when the chilly weather arrives in the fall. Then its body starts to make a sugary substance called glucose (GLOO-cose) that acts as antifreeze in its heart and other major organs and protects them from damage. Even though its heart does not beat, and the frog does not breathe all winter long, it continues to live to face another year.

tropical areas may breed more than once a year, often following heavy rains. Often, true frogs mate together in large groups. In the wood frogs, for example, dozens of males will hop over to the water and begin calling all at once. This type of group calling is called a chorus (KOR-us). With their quacking calls, the wood frog chorus sounds something like a large group of ducks. They, like many other species of true frogs, are explosive breeders, which means that they breed over a very short period of time. All of the wood frogs in a population, for instance, may mate over just seven to fourteen days. The male true frogs may have one or two balloon-like vocal sacs in the throat area. These fill with air and deflate as the frog makes his call. Many species, like the green frog and leopard frog, have one large vocal sac. The wood frog is one of the species with two smaller vocal sacs. They typically both inflate at the same time—one on each side of its throat.

Like females of other frog species, female true frogs follow the males' calls. Different species have different calls. The green frog, for instance, has a short "gung" call, while the leopard frog's call is more of a snoring sound. In many species, including the bullfrog, males may wrestle with one another for a good calling area. Once males and females are together, one male and one female typically pair off, the male scrambles onto her back and hangs onto her while she lays her eggs. The male in most species clings to the female by gripping near her front legs. Depending on the species, the female may lay a few or many eggs. The female Penang Taylor's frog, for instance, lays five to thirteen large eggs; the female Sanderson's hook frog lays twelve to seventeen; the female African bullfrog lays three to four thousand; the female Roesel's green frog lays two to six thousand; and the bullfrog female can lay up to twenty thousand eggs. In some species, like the African bullfrog, one male may mate with more than one female.

In most species, the females lay their eggs in the water, and the eggs hatch into tadpoles. The tadpoles may turn into froglets in a few weeks or, in some cases, in a few years. Bullfrog

tadpoles are an example. They can survive as tadpoles for up to four years and even hibernate just as their parents do. In a few species, like Penang Taylor's frog, the female lays her eggs in a moist place on land, and the eggs hatch right into froglets, skipping the tadpole stage. In either case, eggs typically hatch in a matter of days to weeks. In most true frogs, neither parent provides any care for the young once the eggs are laid. In others, however, the parent may remain nearby to make sure that predators do not eat the young and/or to help keep the eggs moist if they are laid on land. The female Sanderson's hook frog even returns to her eggs every night to cover them with her body. In the African bullfrog, it is the male that watches over his young. He will bite at any intruder who comes close to his eggs or tadpoles, even if the intruder is as large as a lion or a person. If the weather becomes dry very quickly and the tadpoles are trapped in a small puddle away from the main pond, he may also dig a path through the mud to the pond so the tadpoles can swim from the puddle to the deeper water of the pond, where they continue their development.

TRUE FROGS AND PEOPLE

People from many countries, including the United States, eat frog legs. The legs usually come from large true frogs, often bullfrogs that have been captured from the wild. Some Asian and African people also make frog soups and other meals out of entire frogs and tadpoles. In addition, some people in different parts of the world use certain parts of frogs as medicines.

CONSERVATION STATUS

The World Conservation Union (IUCN) lists two of the species as being Extinct, which means that they are no longer in existence; twenty species that are Critically Endangered and face an extremely high risk of extinction in the wild; fifty-nine species that are Endangered and face a very high risk of extinction in the wild; eighty-four that are Vulnerable and face a high risk of extinction in the wild; fifty-nine that are Near Threatened and at risk of becoming threatened with extinction in the future; and 132 that are Data Deficient, which means that scientists do not have enough information to make a judgment about extinction threat.

The two Extinct species are the Las Vegas leopard frog, which is also known as the Vegas Valley leopard frog, and another

species known only by its scientific name of *Nannophrys guentheri*. The Las Vegas leopard frog was only found in a few places north of Las Vegas Valley in Nevada, but it has not been seen since 1942. Ecologists believe that it died off when people rerouted water from the frog's breeding areas to the growing city of Las Vegas. A few small areas with enough water still remain, but people introduced bullfrogs to those areas. Since bullfrogs eat other, smaller frogs, any remaining Las Vegas leopard frogs would probably have been gobbled up. No one has seen the other Extinct species, *Nannophrys guentheri*, since the first one was seen in Sri Lanka more than a century ago.

One of the twenty Critically Endangered true frogs is the dusky gopher frog of the United States, which is also known as the Mississippi gopher frog. Although this species once lived in parts of Louisiana, Mississippi, and Alabama, it now only survives in a small area called Glen's Pond, which is in Mississippi's Desoto National Forest. The last members of this species were seen in Alabama in 1922 and in Louisiana in 1967. In 2001 fewer than one hundred adult frogs were still alive in Glen's Pond. Ecologists mainly blame the drop in numbers on two diseases caused by fungi. One of the fungi, known as chytrid (KIT-rid) fungus, has also killed many other frogs around the world. A Gopher Frog Recovery Team is now watching over the frog and its habitat and is trying to treat the tadpoles infected with the fungus.

In addition to the at-risk true frogs noted above, the U.S. Fish and Wildlife Service also considers four to be Endangered or Threatened. These include the California red-legged frog and the Chiricahua leopard frog, which are Threatened or likely to become endangered in the near future; and the Mississippi gopher frog described above and the mountain yellow-legged frog, which are Endangered or in danger of extinction throughout all or a significant portion of their ranges.



Micro frog *(Microbatrachella capensis)*

MICRO FROG
Microbatrachella capensis

Physical characteristics: As its name suggests, the micro frog is tiny. In fact, they are some of the smallest frogs in the world. Adults reach just 0.4 to 0.7 inches (1.0 to 1.8 centimeters) long from the end of the snout to the back of the rump. Their hind legs are fairly short and end in long-toed feet. The front legs are short and thin. The toes have some webbing between them, but the very long fourth toe on each rear foot is mostly free of webbing. These frogs come in several different pale or dark colors, including green, tan, reddish brown, gray, and black. A dark stripe runs from the eye to the front leg. Many frogs have a noticeable, but thin, light-colored or greenish line that starts at the snout and continues over the top of the head and down



The male and the female look very much alike. The male, however, has a large vocal sac that covers half of his underside. The vocal sac is usually not noticeable unless the male is calling. (Illustration by Jacqueline Mahannah. Reproduced by permission.)

the back to the rump. Some micro frogs also have dark patches low on their sides and dark-colored speckles on top of the back and head. The back and top of the head have a few, small, scattered warts. The underside of the frog is smooth and dappled with black and white. Sometimes the underside is pale-colored without the black-and-white pattern. The eyes are large and brownish, and the snout is short and slightly narrower toward the front. The male and the female look very much alike. The male, however, has a large vocal sac that covers half of his underside. The vocal sac is usually not noticeable unless the male is calling. To make his call, he blows up the vocal sac to a size almost as big as his entire body.

Geographic range: The micro frog lives at the bottom of Africa in southwestern Cape Province, South Africa.

Habitat: It makes its home in rotting plant roots of shrub-filled woodlands near small pools that fill with water only during part of the year.

Diet: Scientists are not sure what it eats, but if it is like other small frogs in its family, it probably eats small insects or other invertebrates.

Behavior and reproduction: Scientists know little about this frog outside of its breeding season, which runs from June to July. When they are ready to breed, the males sit in the water along the edge of the pool. There, hidden among plants that grow in the shallow water, they call with about half of their bodies above the surface. Each male

calls with a one-second long scratchy noise that sounds like "tschik," which they repeat five or six times. Females follow the calls, and a male and female pair off. The female lays about twenty eggs, each of which is small and coated with gel. The eggs stick together in a clump and attach to underwater plants. The eggs hatch into tadpoles. They continue to grow in the water for the next six or seven months. In December, when they have reached about 1 inch (2.5 centimeters) long—70 percent of which is tail—they turn into baby frogs.

Micro frogs and people: People rarely see this tiny frog.

Conservation status: The IUCN considers this frog to be Critically Endangered, which means that it faces an extremely high risk of extinction in the wild. It lives in a very small area and does not do well around humans. People are, however, moving closer to the frog to construct homes and enlarge their farms. In addition, they are draining water from the wetlands where the frogs breed and have introduced new plants, which are also using up water. ■



Goliath frog *(Conraua goliath)*

GOLIATH FROG
Conraua goliath

Physical characteristics: True to its name, the goliath frog is huge. It is the largest frog living on Earth today. An adult can reach a whopping 12.6 inches (32 centimeters) long from snout to rump. One frog can weigh 7 pounds (3.25 kilograms). The frog has a wide, flattened body that blends into its also-wide head without a noticeable neck. Its head is shaped like a triangle with a blunt point at the end of the snout. The frog's back, head, and the upper surface of all four legs are dark gray, sometimes a bit brownish or greenish, and covered with tiny bumps. Faint dark bars and/or spots sometimes show on the legs and lips. The underside is a lighter color, often appearing a greenish



The goliath frog is at home in rapids and other fast-moving parts of rivers. (Photograph by Paul A. Zahl. Photo Researchers, Inc.)

tan. The hind legs are long. The front legs are shorter, but thick. The toes on the front feet have a bit of webbing at their base but not out to the ends. The hind toes have full webbing all the way to their tips.

Geographic range: It lives in a small part of west-central Africa from southern Cameroon to parts of Guinea.

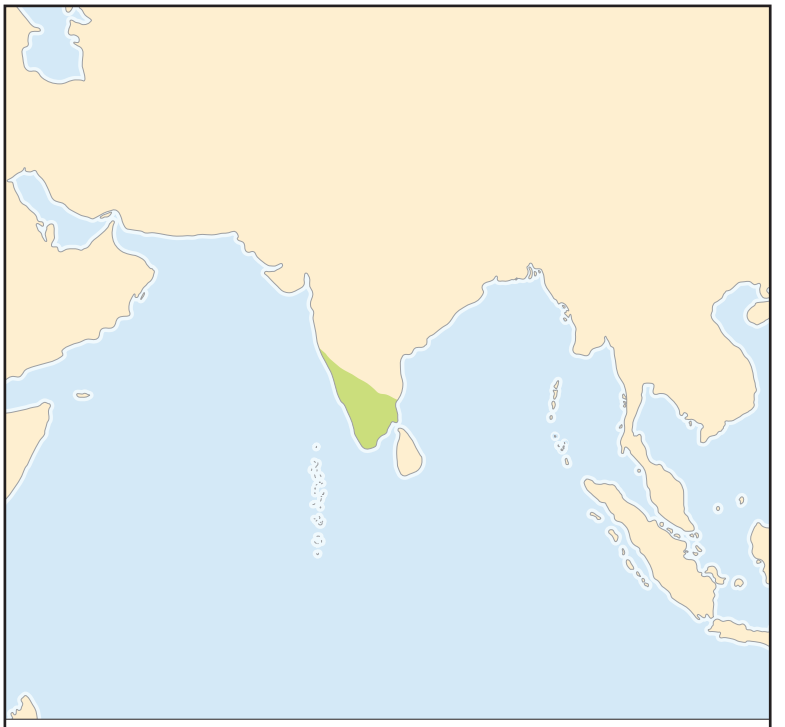
Habitat: The goliath frog is at home in rapids and other fast-moving parts of rivers.

Diet: Scientists are not sure what it eats. Given its enormous size, many types of food are possible.

Behavior and reproduction: Scientists know little about this frog's behavior outside of the breeding season. At that time, the males begin calling, but they do it in a way that is different than most other frogs. Most male frogs suck air into vocal sacs and blow it out to make their calls. The goliath frog and other closely related species have no vocal sacs and instead hold the mouth barely open and make a long whistling noise. Females follow the whistling to the males. One female can lay several hundred eggs at a time. Each egg is very small, about 0.14 inches (3.5 millimeters) in diameter, and sticks to plants growing in rocky areas of the river rapids. The eggs hatch into tadpoles, which can grow to 1.9 inches (4.7 centimeters) long over the next eighty-five to ninety-five days. They then turn into froglets.

Goliath frogs and people: Local people often hunt this frog for food by searching for it from boats and using a gun to shoot at it. Once they have wounded or killed it, the hunters leap into the water to snatch up the frog. New traps for capturing the frogs are making the hunters even more successful. The hunters may either eat the frogs themselves or sell them to markets. Some people also capture goliath frogs alive to sell in the pet trade, to zoos, or to people who hold frog races.

Conservation status: According to the IUCN, this species is Endangered, which means that it faces a very high risk of extinction in the wild. In the fifteen-year period from 1989 to 2004, the number of goliath frogs dropped by more than half. Hunting them for meat and collecting them for the pet trade are the main reasons for the fall in numbers. In addition, the frog's forests are also disappearing as people cut down trees, farm the land, and construct buildings. These activities are also allowing soil to run downhill and muddy up the streams where the frog breeds, and this may hurt the tadpoles. Some people believe that ecologists should begin breeding the frogs in captivity to make sure the species survives into the future. ■



Nilgiri tropical frog *(Micrixalus phyllophilus)*

NILGIRI TROPICAL FROG
Micrixalus phyllophilus

Physical characteristics: The typical Nilgiri tropical frog is a greenish brown, smooth-skinned frog with darker patches scattered on its back and dark bands across its front and back legs. Some pink color shows on its underside beneath the legs and toward the rump. It has a ridge of skin running down each side from the snout to the rump. Its hind legs are fairly long, and their toes are fully webbed. The toes on all four feet have small, rounded tips. Males and females look much alike, except that the males develop rough pads during the mating season. Adults reach about 1.25 inches (3.175 centimeters) long from snout to rump.

Geographic range: It lives in southern India.

Habitat: The Nilgiri tropical frog makes its home in moist, humid forests on hills from about 984 to 4,593 feet (300 to 1,400 meters)



The Nilgiri tropical frog is only known from one national park and two reserves, but it may live in areas between these three spots. (Illustration by Jacqueline Mahannah. Reproduced by permission.)

above sea level. The forests all have thick layers of dead leaves and other bits of plants lying on the ground. The frog appears to live only in forests that humans have not logged or otherwise changed.

Diet: Scientists are not sure what it eats.

Behavior and reproduction: This frog is still mostly a mystery. Other than the tadpole's appearance, scientists know little else about it. The tadpole is long with a slender tail and a mouth that opens on the bottom rather than on its front, as is the case in many other tadpoles.

Nilgiri tropical frogs and people: This frog does not survive well in disturbed forests, and people are doing just that by logging trees from woods where the frog lives.

Conservation status: The Nilgiri tropical frog is only known from one national park and two reserves, but it may live in areas between these three spots. Because the frog's home areas are small and separated from one another, and its forests are being logged, the IUCN has listed the Nilgiri tropical frog as Vulnerable, which means that it faces a high risk of extinction in the wild. It is protected by the government of India. ■



Pointed-tongue floating frog *(Occidozyga lima)*

POINTED-TONGUE FLOATING FROG
Occidozyga lima

Physical characteristics: The pointed-tongue floating frog goes by several other names, including floating spotted frog, java frog, green puddle frog, and pearly-skin puddle frog. It has a fairly plump body and a short head that narrows to a somewhat-pointed snout. It has a pointed tongue. Many small bumps cover its back, head, and legs. It is usually dark brownish green, but is sometimes pinkish brown. Some of the frogs have a thin stripe down the middle of the back. Although the webbing of their feet is thin and may be difficult to see, it is there and stretches fully between their pointy toes. Males and females look much alike, except that the males develop rough pads during the mating season. Adults reach about 1.5 inches (3.9 centimeters) long from snout to rump.

Geographic range: It lives in southeastern Asia, including southern China, India, Cambodia, Vietnam, Indonesia, and Malaysia.



The pointed-tongue floating frog goes by several other names, including floating spotted frog, java frog, green puddle frog, and pearly-skin puddle frog. (Illustration by Jacqueline Mahannah. Reproduced by permission.)

Habitat: It is believed to spend most of its time in the water of slow-moving streams, marshes, wet rice paddies, and other wetland areas. These areas are often surrounded by grasslands.

Diet: Scientists are not sure what it eats.

Behavior and reproduction: Scientists know little about its behavior outside of the breeding season. During breeding, males call with two short notes. Females answer the calls, and male and female pairs form. The male climbs onto the female's back and grips her by her front legs. She then lays her small eggs. The eggs hatch into long, pointy-snouted, small-mouthed tadpoles. The tadpoles grow in the water until they turn into froglets.

Pointed-tongue floating frogs and people: People rarely see this frog.

Conservation status: The IUCN does not consider this frog to be at risk. It lives over a large area and is usually quite common. ■



Bullfrog *(Rana catesbeiana)*

BULLFROG
Rana catesbeiana

Physical characteristics: The largest frog in North America, the bullfrog can grow to 8 inches (20.3 centimeters) and weigh more than 3.3 pounds (1.5 kilograms). It may be green, brown, or greenish brown, sometimes marked with dark spots on its back and legs. It has long, strong hind legs with toes that have full webs between them. It has a pair of large eardrums showing on each side of the head. Males and females look much alike, except the male's throat is yellowish and the female's is cream-colored, and the male's eardrum is much larger than the eye, while the female's is about the same size as the eye. The bullfrog looks similar to another species, known as the green frog (*Rana clamitans*). The green frog, however, is smaller and has a fold of skin running down each side of the back. The

Many high school students are familiar with this species as the frog they dissect in biology class. It also has other uses. This frog is captured for food, and its legs are served at restaurants across the United States and elsewhere. (Hans Pfletschinger/ Peter Arnold, Inc.)



bullfrog does not have these long folds. Instead, it has a smaller fold that curls from the back of the eye around the eardrum.

Geographic range: The bullfrog is an eastern North American species that lives in northern Mexico, the United States, and southern Canada. Over the years, it has also been introduced to other places in the world, where it does very well including parts of Central and South America, the West Indies, several countries in Europe and southeastern Asia, and some ocean islands, including Hawaii.

Habitat: It makes its home in almost any large, calm body of water, including ponds, bays of the Great Lakes, slow backwaters of rivers and streams, and marshes that are filled with water all year long. Adults

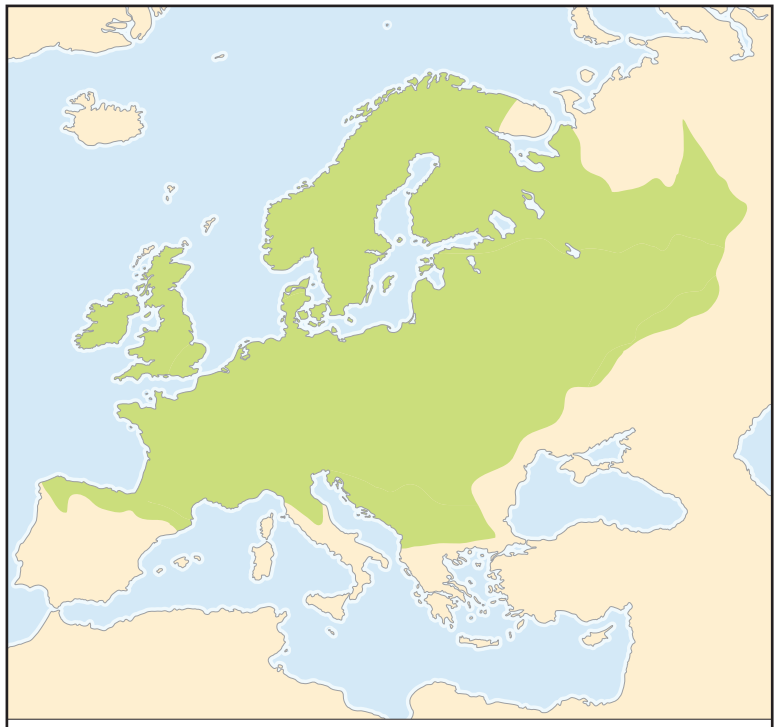
are not found in wetlands that dry up for part of the year. In Hawaii, some bullfrogs can even survive in somewhat salty water.

Diet: Bullfrogs hunt by ambush, which means that they sit still and wait for their meals to come to them. Meals may include other frogs, including bullfrog tadpoles and other, younger bullfrogs; various animals, such as snakes, fish, ducklings, and other birds; and many different kinds of invertebrates, like insects, worms, spiders, and snails.

Behavior and reproduction: It usually stays along the edge of its water body, sitting among reeds and other plants that are in the water or just on shore. This frog is active during warm weather. When the cold autumn temperatures arrive, it buries itself in the muck at the bottom of the water and enters hibernation until warm weather returns in the spring. During the breeding season, which runs from spring to mid-summer, each male will defend his piece of shoreline against other male bullfrogs by first making a short warning call, and if that does not work, by pushing the male frog, sometimes even getting into wrestling matches. Males make loud, deep calls, which some people describe as sounding like a slurred "jug-o-rum." A male and female pair may mate at the calling site or move a sort distance away. A female can lay three thousand to twenty thousand eggs, each of which measures only 0.05 to 0.07 inches (1.2 to 1.7 millimeters) across. The eggs hatch within a week into small tadpoles. Unlike the tadpoles of most other species, which turn into froglets within a few months, bullfrog tadpoles may wait from two to four years and grow to 6.7 inches (17 centimeters) long before making the change.

Bullfrogs and people: Many high school students are familiar with this species as the frog they dissect in biology class. It also has other uses. This frog is captured for food, and its legs are served at restaurants across the United States and elsewhere.

Conservation status: This is a very common frog and is not considered to be at risk. Instead, it has become a pest species in many areas of the world where humans have introduced it. This is because the bullfrog not only competes with other species for their food but also eats the other frogs. ■



Brown frog *(Rana temporaria)*

BROWN FROG
Rana temporaria

Physical characteristics: The brown frog is sometimes called the European common frog or the grass frog. It is typically a tan frog, but some are darker brown, brownish green, gray, or black, and a few are tinted with red or yellow. Warts are scattered on its back, and these usually sit in small, dark brown blotches. The frog also has dark brown bands on its hind legs. Similar bands on its front legs are usually broken and fainter. It has a light-colored thin fold of skin down each side of its back and a dark patch of color behind each eye. Its head narrows toward the front to a somewhat pointy snout. The front feet are unwebbed, but the hind toes have a good deal of webbing between them. The underside of the frog is usually off-white or yellowish white in males and yellowish white to orange in females. During the mating season, the male's throat becomes blue-colored.



Although this frog is found in much of Europe and is fairly common, scientists still are unsure what it eats. (© Stephen Dalton/Photo Researchers, Inc.)

Adults grow to 2.4 to 3.7 inches (6.0 to 9.5 centimeters) long from snout to rump.

Geographic range: It lives throughout Europe.

Habitat: Adults mainly live along the forest floor or in grasses for most of the year. In the north where temperatures are cooler, they stay in lowland areas, but they may live high in mountains in the south, as much as 6,562 feet (2,000 meters) above sea level. The tadpoles develop in wetland areas.

Diet: Although this frog is found in much of Europe and is fairly common, scientists still are unsure what it eats.

Behavior and reproduction: In daytime it stays out of sight in damp areas. It becomes more active at night, when it does much of its hunting. It may also become active on rainy days. In northern climates where the weather turns cold in the winter, the brown frog hibernates at the bottom of a pond or under piles of rotting leaves and plants. As soon as the spring sun has melted the snow and ice from the ground and the frogs awaken, the breeding season begins. Males gather at the water and start calling, sometimes wrestling with one another over the females. To mate, a male climbs on the back of a female. The pair may remain together in this piggyback position for a few days. Each female lays one thousand to four thousand small eggs in shallow water. In about two weeks, the eggs hatch into tadpoles,

which grow to as much as 1.77 inches (4.5 centimeters) long before they turn into froglets.

Brown frogs and people: They are common in country gardens and other places near humans. Some people in Europe eat these frogs.

Conservation status: Even though this frog is not considered at risk, some populations of it have become small because of over-collecting for various purposes, such as their use as food or their sale in the pet trade. Ecologists are also concerned about the effects of pollution on the frogs and about the draining of their breeding areas. ■

FOR MORE INFORMATION

Books:

Badger, David. *Frogs*. Stillwater, MN: Voyageur Press, 2000.

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians (Smithsonian Handbooks).* New York: Facts on File, 1991.

Harding, James H. *Amphibians and Reptiles of the Great Lakes Region*. Ann Arbor, MI: The University of Michigan Press, 1997.

Mattison, Chris. *Frogs and Toads of the World*. New York: Facts on File Publications, 1987.

Miller, Sara Swan. *Frogs and Toads: The Leggy Leapers*. New York: Franklin Watts, 2000.

Showler, Dave. *Frogs and Toads: A Golden Guide.* New York: St. Martin's Press, 2004.

Tyning, Thomas. *A Guide to Amphibians and Reptiles.* Boston, MA: Little, Brown and Company, 1990.

Periodicals:

Turner, Pamela S. "The Extreme Team." *Odyssey* (May 2002): 26.

Chiang, Mona. "Where Have All the Gopher Frogs Gone?" *Science World* (September 22, 2003): 10.

Milius, Susan. "Singing Frog in China Evokes Whales, Primates." *Science News* (September 14, 2002): 173.

Web sites:

"American Bullfrog." *St. Louis Zoo.* http://www.stlzoo.org/animals/abouttheanimals/amphibians/frogsandtoads/americanbullfrog.htm (accessed on April 14, 2005).

"Bullfrogs." *Kildeer Countryside Virtual Wetlands Preserve.* http://www.twingroves.district96.k12.il.us/Wetlands/Frogs/Bullfrog.html (accessed on April 14, 2005).

"Common Frog." *Reptiles and Amphibians of the UK.* http://www.herpetofauna.co.uk/common_frog.htm (accessed on April 14, 2005).

"Green Invaders." *American Museum of Natural History.* http://www.amnh.org/exhibitions/frogs/featured/index.php (accessed on February 1, 2005).

Mercer, Phil. "Australia Hunts Down Toxic Toads." *BBC News, Sydney.* http://news.bbc.co.uk/2/hi/asia-pacific/4242107.stm (accessed on February 6, 2005).

Ramos, M. "*Rana temporaria*." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Rana_temporaria.html (accessed on February 6, 2005).

"What Is the Biggest Frog?" *All About Frogs.* http://allaboutfrogs.org/weird/strange/big.html (accessed on April 14, 2005).

SQUEAKERS AND CRICKET FROGS

Arthroleptidae

Class: Amphibia

Order: Anura

Family: Arthroleptidae

Number of species: 77 species

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

The squeakers and cricket frogs have smooth skin without the large warts seen in toads and many other types of frogs. A few, like the Ugandan squeaker, have some warts, but the warts are so small that they almost look like grains of sand. Depending on the species, some of the members of this family are reddish, greenish brown, brown, or almost black. Their toes have no webs between them, but the toes in some species end in large pads. Most have thin front and back legs. A few are burrowers, though, and have heavier legs to help them dig. Some of the burrowers also have thick, shovel-like bumps, or tubercles (TOO-ber-kulz), on the heels of their hind feet, which are also used in digging. Many species in this family grow to less than 1 inch (2.5 centimeters) long from the tip of the snout to the end of the rump, but some can grow much bigger. In many species, the adult's size is enough to tell a male from a female. In some, like the crowned forest frog, the male is much larger than the female, but in others, like the common squeaker, the female is bigger than the male.

Squeakers and cricket frogs are usually split into two groups, called subfamilies, although some scientists think the two subfamilies are so different that they should instead each have their own family. Others think the squeakers and cricket frogs should not have their own family at all and should instead be combined into the large family of true frogs, known as Ranidae. Many people disagree with this idea because of the breastbone. The breastbone, or sternum, is made of bone in the true frogs,

but is different in the squeakers and cricket frogs. The sternum in squeakers and cricket frogs has some flexible material, called cartilage (CAR-tih-lej), in it. In this volume the squeakers and cricket frogs are all listed together in one family, separate from the true frogs. Inside this family are two subfamilies.

The larger of the two subfamilies is called Arthroleptinae and contains about two-thirds of the 77 species in the entire family. This group includes such species as the common squeaker, Tanner's litter frog, the Bush squeaker, and the Ugandan squeaker. Some of the features that most of these frogs share are a thin crease or ridge of skin that runs down the middle of the back and a dark pattern on the back that may be a row of diamonds, an hourglass, or something similar. The back of Tanner's litter frog, for instance, has a row of V-shaped markings. These patterns may be difficult to see on very dark-colored frogs.

The adult males also have a very long third toe on each of their front feet. Toes are counted from the inside to the outside, or from the big toe to the little toe, if compared to humans. This third toe on the West African screeching frog is as long as its thigh. In some species, the toe may be almost half as long as the frog's entire body. Many of the frogs in this subfamily, which as a group are called arthroleptins, have no teeth. Most of these frogs are small, but the female Tanner's litter frog grows to 2.4 inches (6 centimeters) in length, sometimes longer.

The second subfamily is called Astylosterninae and contains species like the crowned forest frog and the hairy frog, among others. Most of the frogs in this group have large bodies. The male crowned forest frog, for instance, grows to 2.7 inches long, and the male hairy frog can reach 5.2 inches in length. In both of these species, the males are bigger than the females. Members of this subfamily also have sharp, curved bones at the ends of their front toes. These bones poke out of the flesh at the tips of the toes, and sometimes look like claws. The front toes are also usually bent. All of these frogs have teeth on the upper jaw.

MY HOME, MY RAINFOREST

Like thousands of other animals, many squeakers and cricket frogs live in only one place in the world: a tiny spot inside a rainforest. Scientists often do not know much about these animals because rainforests are typically so thick with plants that animals—especially small, secretive species like frogs—can easily remain hidden from sight. People, however, are removing more and more of the rainforests to make the land into farms or to use wood from the trees for building. Since some of the rainforest animals live in very small areas, this kind of destruction can wipe out entire species. Conservationists are now trying to save the rainforests and, in doing so, protect the animals that live there.

GEOGRAPHIC RANGE

The squeakers and cricket frogs are found throughout much of central to southern Africa, but not in the southwest portion of the continent. Some live in lowland forests and others in mountains up to 9,800 feet (3,000 meters) above sea level.

HABITAT

Squeakers and cricket frogs live in hot and humid tropical forests, where they spend much of their time under dead and rotting leaves on the forest floor. Sometimes, those in the subfamily Arthroleptinae will also make their homes in fields that have a good cover of leaves on the ground. Frogs in this subfamily live and breed on land. Members of the other subfamily, Astylosterninae, remain on land for most of the year, often in mountain forests. Some, like the Nsoung long-fingered frogs, hide on land under rocks and stones. Member of this subfamily move into fast-flowing streams and rivers to breed, but they usually stay in calm areas and not in the rushing current.

DIET

The smaller frogs in this family eat invertebrates (in-VER-teh-brehts), which are animals without backbones. In particular, they eat tiny insects, spiders, and other arthropods (AR-throe-pawds). Arthropods are invertebrates that have jointed legs. The larger frogs will eat bigger prey, often anything they can find, capture, and stuff into their mouths. Sometimes, this includes other small frogs.

BEHAVIOR AND REPRODUCTION

For many of the squeakers and cricket frogs, time is spent mainly searching along the forest floor, or the shores of streams and rivers, for something to eat. Some, like Tanner's litter frog, hunt by ambush. In this type of hunting, the frog sits very still in one place, waits for an unsuspecting insect or spider to wander past, and quickly grabs and eats it. Other species, including the Ugandan squeaker, take a more active role and slowly move along the ground looking for insects to eat.

Those frogs that live in meadows and in bright, open forests usually stay out of sight during the day and do their hunting at night. Others that live in thick, shady forests may venture out during the daytime, as well as at night. Whether they are active only at night, or during both night and day, squeakers

and cricket frogs will seek shelter under leaves if the weather becomes too dry and stay there until it rains again. Some species dig burrows and remain underground instead. This period when the frogs rest and wait for less-dry weather is called estivation (es-tih-VAY-shun).

The frogs mate during the rainy season, when storms soak the land. Squeakers and cricket frogs are named for the sounds of their calls. Some, like the West African screeching frog, have a little flutter in their calls. The West African screeching frog has a high call that lasts less than a second. Many people think this species, and others with calls like it, sounds like crickets. The common squeaker has a short high peep of a call. The calls of the males in each species draw in females of the same species. Those frogs in the subfamily Arthroleptinae mate and lay their eggs in a moist spot on land. The female Tanner's litter frog, for instance, lays about thirty eggs in a small dip in the ground underneath the leaves.

The female Bush squeaker follows the male's long, high "wheep" or "wheepee" call, pairs with him, and lays eleven to eighty eggs under leaves at the base of a bush or other thick, leafy plant. In some species, like the Ugandan squeaker, the female may lay more than one batch of eggs in one breeding period. Since this species only lives for about six months, these two or more sets of eggs are the only young she will have. The female West African screeching frog also lays more than one set of eggs in a breeding season. In each of her two or three clutches, she usually lays ten to thirty eggs. Like the Ugandan squeaker, the West African screeching frog only lives for about six months.

The eggs of most members of this subfamily are each covered in a capsule of gel. The gel provides extra moisture for the baby frog developing inside. While it is growing inside the egg, scientists call the frog an embryo (EHM-bree-oh). They use this same word to describe other types of animals, such as chickens, snakes, and lizards, while they are inside the egg. In squeakers and cricket frogs, the embryo must remain moist. If the egg were to dry out, the embryo would die. These eggs typically have a large yolk, which feeds the growing embryo until the egg hatches.

In some species, an adult stays with the eggs until they hatch. Bush squeakers are one of the species that have this type of care for the eggs. Instead of hatching into tadpoles, the eggs of the

frogs in this subfamily hatch right into froglets. The froglets usually look much like the adults. The froglets of the West African screeching frog, for example, have the same dark, hourglass-shaped pattern on their backs as the adults do. By the time they are three months old, these froglets are old enough to reproduce themselves.

Frogs in the subfamily Astylosterninae do things a bit differently. Instead of mating and laying their eggs on land, they mate and lay their eggs in a fast-flowing stream or river. The males select a spot off to the side where the water is calm, and they mate with females there. The females lay their eggs in the water. In some species, like the hairy frog, the male stays with the sunken eggs until they hatch. The eggs of species in this subfamily hatch into tadpoles, which usually head out of the calm water and into the rushing flow. Some tadpoles, like those of the hairy frog, have large suckers, which the tadpoles use to grab onto rocks and other surfaces, and fight the current. Other tadpoles, like those of the crowned forest frog, have no suckers, but still swim into the fast waters of the stream or river. The tadpoles change into froglets, which then leave the water for a life on land.

SQUEAKERS, CRICKET FROGS, AND PEOPLE

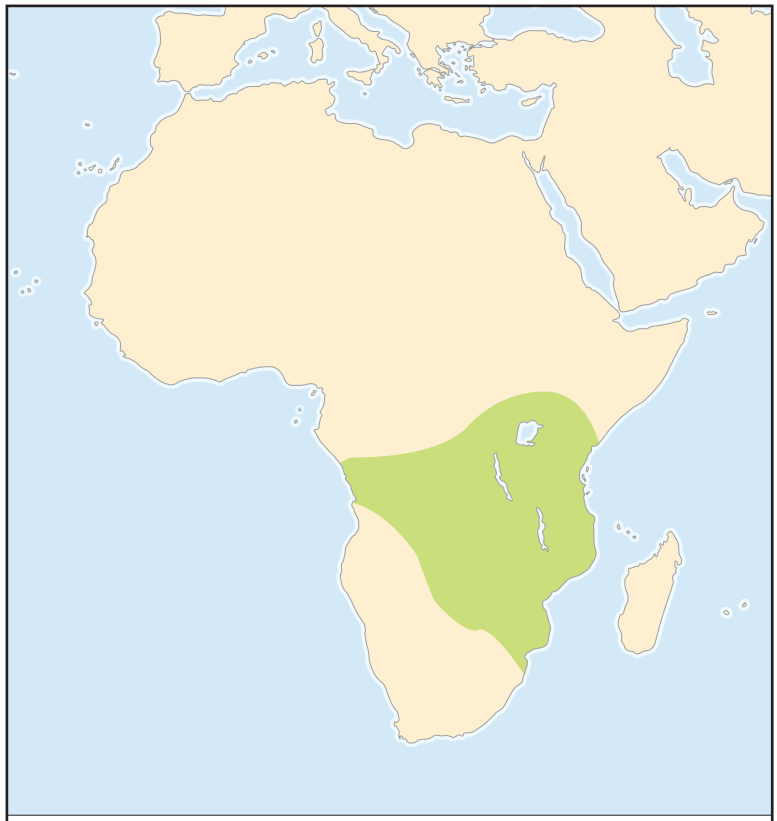
Some people hunt for and eat the larger species of squeakers and cricket frogs. They do not bother the smaller species. Squeakers and cricket frogs are rare in the pet trade.

CONSERVATION STATUS

The World Conservation Union (IUCN) lists two species, the cave squeaker and the Nsoung long-fingered frog, as being Critically Endangered. Critically Endangered species face an extremely high risk of extinction in the wild. Both the cave squeaker and the Nsoung long-fingered frog live in very small areas. In the case of the cave squeaker, all of the individuals appear to live in just one area in the mountains of eastern Zimbabwe. Scientists have only seen this frog once, when it was first discovered in 1962 in a grassy field and nearby caves on the mountain. This spot on the mountain is part of a national park. Nsoung long-fingered frogs are scattered over several spots in western Cameroon, all of which are high on the south side of a mountain. People have begun cutting down the nearby forests to make way for farmland and other uses. If the frog's tiny habitat is also lost, the frog will be in danger of extinction.

The IUCN lists nine other species as Endangered and facing a very high risk of extinction in the wild. All of the nine species are found only in small areas on mountains. One species lives in Guinea, one in Malawi, one in Tanzania, one in Sierre Leone, three in Cameroon and Nigeria, and two in just Cameroon. In many cases, these species are split up into small groups, each of which lives far away from the others. When a species is separated like this, scientists term it fragmented. In other words, the species is divided into small pieces, or fragments. This is usually not healthy for a species, because the males and females have no chance to mate with males and females from other groups. After many generations of breeding within the same group, some of the young may begin to have birth defects that can be fatal. This problem is seen in other types of animals too. Conservationists also are concerned because the endangered frogs all live in habitats that are being threatened by logging, clearing of the land for farming, or other human activities.

The IUCN considers two more species to be Vulnerable and facing a high risk of extinction in the wild; and three to be Near Threatened, which means they are at risk of becoming threatened with extinction in the future. In addition, it names sixteen as Data Deficient, which means that too little information is available to make a judgment about the threat of extinction. Often, this Data Deficient category is used for species that scientists have heard about, but have not yet studied in any detail. In the case of the squeakers and cricket frogs, more than one-fifth of the 77 species in this family fall under the Data Deficient category.



SPECIES ACCOUNTS

COMMON SQUEAKER
Arthroleptis stenodactylus

Physical characteristics: The common squeaker is sometimes called a dune squeaker or savanna squeaking frog. It is a brown or copper-colored frog with a faded, darker brown pattern on its back that looks something like an hourglass. It has two dark brown spots near the rump and sometimes a thin, lighter-colored stripe running down the middle of the back. It also has dark brown bands on its thin legs. The front legs are quite long compared to the front legs of other frogs, while the rear legs are rather short when compared to many other frogs. It has quite long toes, but no webbing between them. A dark brown line or patch runs from the snout down each side of its face and to its front legs. Its belly is whitish, often with noticeable



The common squeaker is sometimes called a dune squeaker or savanna squeaking frog. (Illustration by Wendy Baker. Reproduced by permission.)

but small gray blotches. It has a plump body. Its wide head narrows toward the front, and it has two large, bulging eyes. It is also known as the shovel-footed squeaker because it has a large, rough bump, or tubercle, on each of its back feet. This tubercle, which has a shape something like the edge of a shovel blade, is as long as its first toe. Females and males look much alike, although the male frog has a black throat and a much longer third toe on the front foot. Toes are counted from the inside toe (in humans, the big toe) out. In addition, females are usually larger overall. Females grow to about 1.8 inches (4.5 centimeters) from snout to rump, while males reach about 1.3 inches (3.3 centimeters) when full grown.

Geographic range: The common squeaker lives in much of the southern half of Africa, including parts of the Democratic Republic of the Congo, Kenya, northern South Africa, Zimbabwe, and Mozambique.

Habitat: The common squeaker typically makes its home along the coast in sandy-soiled forests where dead leaves cover the ground. It can live in lowland forests or quite high up on mountainsides. In all, it has been found in places that are from 130 to 6,600 feet (40 to 2,000 meters) above sea level.

Diet: Common squeakers eat many different types of invertebrates, including insects, earthworms, and snails. They may also eat a small frog once in a while.

Behavior and reproduction: When the weather is dry, this frog often stays hidden under damp, dead leaves that lie on the forest floor or beneath grasses in fields. When it rains, however, it will come out during the daytime or at night to look for its next meal. In the breeding season, which is also during the rainy season, the males may use these same hiding places to call day and night for females. The call is a quick, high-pitched peep, similar to the sound a squeaky wheel might make as it spins around. The females lay their eggs in damp places, including little dips in the ground and burrows that are typically under layers of rotting leaves or in tangles of roots at the base of a tree. A female lays about thirty-three to eighty eggs at a time. The eggs are white, about 0.1 inches (2.5 millimeters) in diameter, and are each surrounded in gel. In about one month, these eggs hatch right into froglets, skipping the tadpole stage seen in many other frogs.

Common squeakers and people: The common squeaker does quite well around humans and is often found in gardens. People do not hunt this frog, and it is not common in the pet trade.

Conservation status: The World Conservation Union (IUCN) dos not consider the common squeaker to be at risk. It is very common and found over a large area, including some protected places where logging and other human activities are not allowed. ■



Hairy frog *(Trichobatrachus robustus)*

HAIRY FROG
Trichobatrachus robustus

Physical characteristics: The hairy frog is a large, heavy-bodied frog that is most known for the long frills, or "hairs," that grow only on the males and only during the mating season. These frills are actually very thin bits of flesh that develop on the male's thighs and on the sides of the body from his front legs to the rump. Frogs breathe in oxygen with their lungs and through their skin. Actually, it is the blood vessels in the skin that are able to take up the oxygen. Hairy frogs have very small lungs. Scientists believe that the male's frills help them draw in extra oxygen by giving the frogs more skin, and therefore more blood vessels, through which to breathe. This is important for the



Scientists believe that the male's frills help them draw in extra oxygen by giving the frogs more skin, and therefore more blood vessels, through which to breathe. (Photograph by R. Wayne Van Devender. Reproduced by permission.)

males, which need all the oxygen they can get once they mate and start caring for their young.

Males also have many rough pads on the bottoms of their unwebbed front feet. Their back feet, which are webbed, also have a few pads, but not as many as the front feet have. The pads probably help them hang onto the female during mating. They have very long toes on their back feet. Both males and females are dark greenish brown to black and have a long dark blotch down the center of the back and smaller dark spots toward the rump. In especially dark frogs, the blotch and spots may be difficult to see. Hairy frogs have a yellow throat. Males grow larger than females. Males can reach 5.2 inches (13 centimeters) long, while females reach 3.6 inches (9 centimeters) in length.

Geographic range: Hairy frogs live in the western part of central Africa, including eastern Nigeria, Cameroon, Equatorial Guinea, and parts of the Democratic Republic of the Congo and Gabon. Scientists think it may also live in Angola, although they have not seen any there yet.

Habitat: Hairy frogs especially like to make their homes in areas where thick, lush forests surround fast-flowing streams and rivers. Sometimes, the frogs live on farms, such as tea plantations, but they usually prefer mountain forests. Hairy frogs stay on land nearly all year, but enter the streams and rivers to mate.

Diet: Hairy frogs eat insects and other arthropods that they find along the ground of the forest and the shores of streams.

Behavior and reproduction: Hairy frogs spend most of the year hopping along the forest floor looking for things to eat. When the rainy season comes, their attention turns to mating. Males enter streams and sometimes rivers that have a fast current, but they stay in a quiet spot where the water is very still. After spending a few extra days in the forest, the females join the males in the streams and rivers and mate with them. During mating, the male climbs onto the female's back and holds on near her front legs while she lays her eggs. The pads on his front feet probably help him cling to her body, which is wet and quite slippery.

Each female lays her eggs in the water, and the male stays with them. Water contains oxygen, and the frog's skin, including the frills on his sides and legs, take up this oxygen so the frog can breathe even when he is completely underwater. For this reason, the male can stay beneath the surface with the eggs for days without having to come up for air. The eggs hatch into tadpoles that have a large sucker on the belly side. The sucker helps them attach to rocks and other surfaces in the water. The tadpoles continue to live there, sometimes even venturing into the tumbling foam at the bottom of small waterfalls, before turning into froglets and climbing out onto land.

Hairy frogs and people: Some people collect and eat these large frogs and even the tadpoles. In places where a great deal of hunting takes place, the frogs can become scarce.

Conservation status: Although people do hunt the frogs for their meat, the World COnservation Union (IUCN) does not consider the species to be at risk for now, because the frogs live over a fairly large area, are quite common, and are not hunted everywhere they live. Conservationists are, however, keeping a watchful eye on the frogs. Some streams and rivers where the frogs mate are becoming more polluted, and this may be killing a number of the eggs, tadpoles, and/or frogs. ■

FOR MORE INFORMATION

Books:

Channing, Alan. *Amphibians of Central and Southern Africa.* Ithaca, NY: Comstock Publishing Associates, 2001.

Passmore, Neville, and Vincent Carruthers. *South African Frogs: A Complete Guide.* Revised edition. Halfway House, South Africa: Southern Book Publishers and Johannesburg: Witwatersrand University Press, 1995.

Rödel, Mark-Oliver. *Herpetofauna of West Africa.* Vol. 1, *Amphibians of the West African Savanna.* Frankfurt: Chimaira, 2000.

Showler, Dave. *Frogs and Toads: A Golden Guide.* New York: St. Martin's Press, 2004.

Web sites:

"Breathing." *The Frog.* http://www.thefrog.org/biology/breathing/breathing.htm (accessed on April 10, 2005).

"Common Squeaker." *Herpetology Department, California Academy of Sciences.* http://www.calacademy.org/research/herpetology/frogs/list6.html (accessed on April 10, 2005).

"South Malawi Montane Forest-Grassland Mosaic." *World Wildlife Fund.* http://www.worldwildlife.org/wildworld/profiles/terrestrial/at/at014_full.html (accessed on April 10, 2005).

family CHAPTER

SHOVEL-NOSED FROGS
Hemisotidae

Class: Amphibia
Order: Anura
Family: Hemisotidae
Number of species: About 9 or 10 species

PHYSICAL CHARACTERISTICS

The species of shovel-nosed frogs have wide, rounded, and rather flattened bodies with thick, strong front and rear legs. The very short front toes have no webs between them. The hind toes, which are much longer than the front toes, have a little webbing in some species, but no webbing in others. The spotted snout-burrower, for instance, has no webbing between its back toes. The head of all species is short and blends back into the body without a noticeable neck. The frogs have rather small eyes with vertical pupils and a pointed snout with a hard, sharp end. This makes the snout look a bit like the edge of a shovel blade. The tongue in these frogs has a notch in the tip. They also have a groove or fold that runs across the top of the head from behind one eye to behind the other.

A close look at the heels of the rear feet reveals a large, flat bump, or tubercle (TOO-ber-kul). The tubercle, which is hard and rough like the callous a person might get on his or her hand, is located on the inside of each heel.

Beneath the skin, the shovel-nosed frogs have a thick skeleton, which gives them a very solid body. The bones in much of the frogs' front and back feet, not including the toe bones, are fused together for added strength. The shovel-nosed frogs do not, however, have a breastbone, also known as the sternum.

Many frogs in this family are brown or purple with yellow markings. The spotted snout-burrower, for example, is dark purple or brown with small yellow spots. The marbled snout-burrower is a bit different. It may have a brown or a dark green

head and back. The back is covered with numerous dark brown to black blotches. Its head often has noticeable dark stripes extending from the snout past the eye and to the back of the head. Its sides and legs have yellow- to cream-colored speckles.

Many of the shovel-nosed frogs are quite small and only reach 1 inch (2.5 centimeters) long from snout to rump. The spotted snout-burrower is an exception. This species, the biggest member of the family, grows to 3 inches (8 centimeters) long.

GEOGRAPHIC RANGE

Shovel-nosed frogs live in central and southern Africa, a region known as Sub-Saharan Africa. In particular, the frogs make their homes in a stretch of land from the west coast of central Africa across to Ethiopia in the east, down the east coast, and back across to the west side of the continent around Angola. Some, like the marbled snout-burrower and Guinea snout-burrower, live over a very large area, including many countries in Africa. Others live in very small areas. In 2002, a new species was found in western Zambia, which is in southern Africa, but nowhere else. The Ethiopian snout-burrower, which is also known as the Lake Zwai snout-burrower, is only known to live in parts of Ethiopia.

HABITAT

Shovel-nosed frogs live underground in dry, grassy areas. During the wet season, however, the rains fill the land with small, deep pools of water, and the frogs come out to feed and to mate. They lay their eggs underground, but the tadpoles move into these pools of water or in other small ponds that remain filled with water all year and develop there. Shovel-nosed frogs may live in lowland areas or in places as high as 5,900 feet (1,800 meters) above sea level.

DIET

These frogs search for food during the rainy season. At night, they may look about on land for insects. They are also good diggers and put this talent to use when finding a meal. They tunnel along just a few inches below the surface and seek out termites and earthworms there.

BEHAVIOR AND REPRODUCTION

The strong body, muscular legs, heavy skeleton, and shovel-like snout together help these frogs to be excellent diggers. They

all dig head first into the muddy banks near water pools or small ponds, moving the head up and down to take advantage of the "shovel nose" to push away soil. Even the tubercles on the heels of their hind feet give them an added push when they are forcing their front ends into the ground. Most other burrowing frogs use their rear legs as the main digging limbs and dig themselves backward into the soil. During the dry season of the year, the frogs stay in their burrows and rest. This resting period during dry weather is called estivation (es-tih-VAY-shun). When the rains come, the frogs come out to look for food or to mate.

When the mating season starts, the males call to attract females. They call from the ground in a hiding spot under plants next to a pool of water or small pond. The call is a long buzzing sound. The call of a male marbled snout-burrower, for instance, is a buzz that lasts about two seconds. When a female pairs up with a male, he crawls onto her back and holds on as she starts digging head first into the ground to make a burrow under a log or stone. With the male still on her back, she continues tunneling. When the pair are completely buried, she lays a clump of one hundred fifty to two hundred eggs, although some females only lay about three dozen eggs. Each egg is about 0.1 inches (2 to 2.5 millimeters) in diameter and has a capsule around it.

After mating, the male digs back out of the ground and leaves, but the female stays behind with her eggs. As the eggs develop, rains continue to fall, eventually filling the pools and ponds. Water overflows and soon rises to cover and soak into the underground chamber where the female is staying with her eggs. By this time, usually less than two weeks later, the eggs begin to hatch into tadpoles. The female may dig a tunnel out of the burrow. The tadpoles use the tunnel to swim in the flooding water, out of the chamber, and into the pools and ponds. If the tadpoles hatch before the nest chamber is flooded, or in a year when the rains are not hard enough to overflow the pool or

A PINCH OF THIS, A DASH OF THAT

Depending on which features a scientist considers, the shovel-nosed frogs may look a bit like frogs in other families. As a result, researchers have had a hard time figuring out where the shovel-nosed frogs belong. Some think they should really be listed as part of another family. These families include the true frogs in the family Ranidae, which share several characteristics with the shovel-nosed frogs including a notched tongue tip; the rain frogs, which are members of the family Microhylidae and are burrowers like the shovel-nosed frogs are; and the African treefrogs of the family Hyperoliidae, which have vertical pupils in their eyes like those in the shovel-nosed frogs. Other scientists, however, consider the shovel-nosed frogs to be unusual enough to be listed in their own family, as they are in this volume.

pond and flood the nest, the tadpoles in some species scramble onto the female's back, and she carries them out of the nest and to the water.

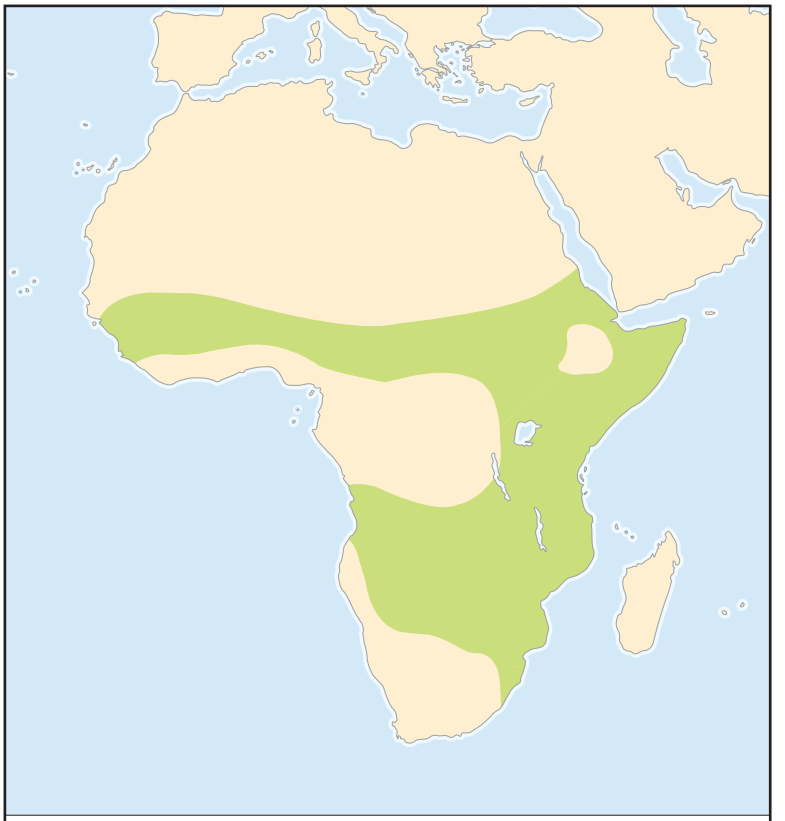
SHOVEL-NOSED FROGS AND PEOPLE

People rarely see this frog, which remains underground much of the year.

CONSERVATION STATUS

Of the nine or ten species in this family, the World Conservation Union (IUCN) considers one to be Vulnerable and facing a high risk of extinction in the wild; and four to be Data Deficient, which means that too little information is available to make a judgment about the threat of extinction. The Vulnerable species is the spotted snout-burrower, which is found in South Africa and probably in Swaziland, although scientists have not yet discovered it there. Members of this species live in groups, or populations, in several small areas that are separated from one another. The future of the frogs is threatened by the clearing of trees and plants in the frog's habitat. People clear the land to make way for sugar cane farms and housing developments. Fortunately, some of the frogs live in several protected areas, including parks, where land cannot be cleared. People are also, however, introducing fishes to the pools of water and small ponds that the frogs use for breeding. Often, these fishes eat the frogs and/or their tadpoles.

The four species listed as Data Deficient include the Masiliwa snout-burrower, Perret's snout-burrower, De Witte's snout-burrower, and a species known only by its scientific name of *Hemisus barotseensis*. Scientists have not done thorough searches for the Masiliwa snout-burrower or for De Witte's snout-burrower for many years and know little about either species. Perret's snout-burrower, which is found in Congo and Gabon, is rarely seen. Since it usually stays underground, however, it may be more common than it appears. Scientists also know little about *Hemisus barotseensis*, which was just discovered in 2002.



Marbled snout-burrower *(Hemisus sudanensis)*

MARBLED SNOUT-BURROWER
Hemisus sudanensis

SPECIES ACCOUNT

Physical characteristics: The marbled snout-burrower also goes by the common names of marbled shovel-nosed frog, mottled shovel-nosed frog, pig-nosed frog, and mottled burrowing frog. The marbled snout-burrower is typically brown with darker brown markings on its back and head and often a light-colored stripe down the middle of the back. Its back toes have a little webbing, but the front toes have none. Its front legs are thick and strong. Females sometimes grow to as much as 2.2 inches (5.5 centimeters) long from snout to rump. Some scientists consider this frog not to be a separate species, but instead to be a subspecies of another species, known as *Hemisus marmatorus*. Sometimes species are split into one or more subspecies.



The marbled snout-burrower also goes by the common names of marbled shovel-nosed frog, mottled shovel-nosed frog, pig-nosed frog, and mottled burrowing frog. (Illustration by Gillian Harris. Reproduced by permission.)

This means that the frogs are still members of the same species, but are slightly different. Perhaps they live in separate places or have slightly unusual looks or behaviors.

Geographic range: It lives in much of central and southern Africa.

Habitat: This is a burrowing frog that spends most of the year underground in dry areas, often with few if any trees.

Diet: Marbled snout-burrowers eat a variety of insects above and below the ground.

Behavior and reproduction: Much of the time, marbled snout-burrowers search for and eat various insects that they either find along the ground or in the underground tunnels that they dig. They are especially fond of termites, particularly when the termites develop wings, which they do during part of their life cycle, and leave their termite hills. The frogs wait near the exits to the hills and grab the termites as they fly out.

The frogs mate and have their young next to pools of water or small ponds that remain filled with water all year. Males call and

attract females. When a female approaches a male, he grabs hold of her, and she begins digging head first into the soft mud near but outside the pool or pond. When she has dug out a burrow—with the male still clinging to her—she lays her eggs inside the underground nest chamber. The male leaves, but the female stays with her eggs as they hatch into tadpoles underground. When rains come, the pool or pond overflows and soaks the burrow. The tadpoles then swim out. If too little rain falls and the burrow does not flood, scientists think that the tadpoles probably squirm onto the female's back and she carries them out of the burrow and into the nearby pool or pond. In that water body, the tadpoles develop into froglets.

Marbled snout-burrowers and people: People rarely see this mainly underground frog.

Conservation status: The World Conservation Union (IUCN) lists only nine species of shovel-nosed frogs and does not consider this species to be separate from *Hemisus marmatorus*. According to the IUCN, *Hemisus marmatorus* is not at particular risk. It lives over a large part of Africa, including protected areas, and is probably quite common. ■

FOR MORE INFORMATION

Books:

Burnie, David, and Don E. Wilson. *Animal.* New York: DK Publishing Inc., 2001.

Channing, A. *Amphibians of Central and Southern Africa.* Ithaca, NY: Cornell University Press, 2001.

Showler, Dave. *Frogs and Toads: A Golden Guide.* New York: St. Martin's Press, 2004.

Web sites:

Cannatella, David. "*Hemisus*." *Tree of Life Web Project.* http://tolweb.org/tree?group=Hemisus&contgroup=Neobatrachia (accessed on February 21, 2005).

"*Hemisus marmoratum*." *Amphibans (Mamoru Kawamura).* http://www.rieo.net/amph/exfrog/aka/hemisus/marmo.htm (accessed on February 21, 2005).

"*Hemisus marmoratum*." *California Academy of Sciences.* http://www.calacademy.org/research/herpetology/frogs/list7.html (accessed on February 21, 2005).

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Amphibians
volume 3

African treefrogs to Caecilians

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AFRICAN TREEFROGS
Hyperoliidae

Class: Amphibia
Order: Anura
Family: Hyperoliidae
Number of species: 240 species

family CHAPTER

PHYSICAL CHARACTERISTICS

African treefrogs are also known as reed and sedge frogs. The typical African treefrog has a slender body, large and often bulging eyes usually with horizontal pupils, and rounded pads on the ends of its webbed toes. Its back legs are long and thin, and its front legs are also quite thin. The treefrogs with this appearance are good climbers and leapers. Some of the African treefrogs look quite different. These species, which are often called running frogs, remain on the ground; have no toe pads or toe webbing; have shorter hind legs, frequently only a bit longer than the front pair; and walk or run rather than hop.

The males of this family have large vocal sacs, which are pouches in the throat area that blow up and then deflate when they call. Male African treefrogs have a vocal sac, which may blow up to be three or more times as big as the head. In many species, this sac is covered with an oval-shaped flap that can be seen even when the frog is not calling.

The African treefrogs come in many different colors and patterns. In some cases, even members of the same species do not look alike. One member of the species known as the painted reed frog, for example, may be green with a few dozen, tiny, black-centered, yellow spots on its back, orange toes, and orange upper legs. Another might be greenish gray with large black blotches, tan with black and yellow markings on its sides, or cream with black and orange stripes. The following examples will show the varying colors among different species within this family:

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

- Greater leaf-folding frog, also known as the spiny leaf-folding frog—Chocolate brown with a wide silvery to light brown back, which is sometimes split down the middle with a chocolate brown stripe; also with silvery to light brown color on the top of the hind legs
- Yellow-striped reed frog—Light green with a yellow stripe on each side of its body from the snout over the large, orange-colored eye to the rump; orange toes and a yellow underside with orange on its rear legs
- Yellow-legged kassina, also known as the yellow-legged treefrog—Beige with many brown spots on its back, brown bands on its legs and toes, and yellow on the underside of upper rear leg
- White-spotted reed frog—White, covered with small yellow dots that are outlined in dark brown
- Transparent reed frog, also known as the water lily reed frog—Light green with orange toes
- Malagasy variable reed frog—Orange yellow with small brown spots on the head and front half of the back and a narrow brown stripe on each side of the snout
- Madagascar reed frog, also known as the blue-back frog—Baby blue head and back, orange yellow underside, dark orange toes, two black stripes from the snout to the eyes, and a few black spots on both sides between the eye and the front leg and on the front leg

Depending on the species, African treefrogs may have eyes that are all brown, gold, whitish, or some other solid color, or that are one color on the top half and another on the bottom half. The Malagasy variable reed frog, for instance, has large eyes that are white on the bottom and pinkish on the top. Most of the treefrogs have large eyes, but in some species they are enormous. The Seychelles treefrog is an example. Its pearly white eyes look almost like big headlights.

Often the color of the frog changes as it grows older. Young froglets in many species are yellow or brown with dark markings down the back, while the adults are brightly colored and patterned. In some species, the youngsters are green, while the adults are brownish. Scientists call these colors the "juvenile phase." Sometimes, many of the adult males have the juvenile colors during the breeding season, too.

Adult African treefrogs may be as small as 0.5 inches (1.2 centimeters) long from the tip of the snout to the end of the rump or as large as 4.3 inches (11.0 centimeters) in length. While males

and females are the same size in many species, the females are larger in others. The African wart frog and the greater leaf-folding frog are two species in which the males and females reach the same size. Adult African wart frogs grow to 1.4 inches (3.6 centimeters) long, and adult greater leaf-folding frogs reach 1.6 inches (4.1 centimeters) in length. Female toad-like treefrogs, on the other hand, are larger than males. In this species, females grow to 1.4 to 1.6 inches (3.6 to 4.1 centimeters), while males reach only 1.1 to 1.3 inches (2.9 to 3.3 centimeters) in length. The difference between the sexes is even more noticeable in the big-eared forest treefrogs. Here, females reach up to 3.3 inches (8.4 centimeters) long, while males are about half that size at 1.6 to 1.8 inches (4.1 to 4.6 centimeters) in length.

GEOGRAPHIC RANGE

African treefrogs live in most of central and southern Africa. Some species are also found on the large island of Madagascar and the tiny island of Seychelles, which are in the Indian Ocean east of southern Africa.

HABITAT

Many species in this family live in often dry and hot grassy fields or in areas that are humid and covered in thick bushes and trees. In addition, some live in rainforests, and others tend to make their homes in land that is currently being farmed or in abandoned and overgrown farmland. Some of the African treefrogs live high in mountains, but many others do not. Many species are arboreal (ar-BOR-ee-ul), which means that they live above the ground in trees. Other species stay on the ground, and some are able to dig beneath it.

DIET

They eat mainly invertebrates (in-VER-teh-brehts), which are animals without backbones. They especially eat insects and other arthropods (AR-throe-pawds), which are invertebrates with jointed legs, but they will often add any other animal they can capture and swallow. Usually treefrogs and other species of frogs only eat things that are moving, but at least one of the African treefrogs will eat non-moving things. This treefrog, called the greater leaf-folding frog, will eat the eggs of other frogs that make foam nests for their young. The greater leaf-folding frog pokes its head through the nest and eats the eggs inside.

BEHAVIOR AND REPRODUCTION

African treefrogs are active at night, which is when they look for food and mate. During the day, some of the species that live in hot, open areas dig down into the soil where it is cooler and moister. Scientists are not sure, but they think that some of them, including the toad-like treefrog, either remain underground for the entire dry season in a state of deep sleep, known as estivation (es-tih-VAY-shun), or come out on humid mornings to search for food. Some of these burrowing species shed their skin when they are underground, and this skin dries into a sort of cocoon. The frog remains inside the cocoon, which helps to keep the frog moist. Other species of treefrogs are outdoor types and stay outside even on very hot and dry days. They are not active during the day, however, and simply sit still on leaves until the evenings arrive. The painted treefrog survives hot and dry days by oozing mucus from its skin. This mucus is waterproof, but instead of keeping moisture out, it keeps the moisture in. Even so, they often lose some water from their bodies. Some young painted treefrogs are able to survive even after their bodies have lost half their weight in water. The sharp-nosed reed frog protects itself from dry weather simply by staying down low in grasses on hot days. There, the air is more humid.

The typical African treefrog mates during the rainy season. Males head to the water, often a small pool formed by the rains, and begin calling. Sometimes, the males reach the mating area even before the rains have filled the pools. Not all species mate in new pools on the ground. The African wart frog and others mate inside a tree hole above a puddle of water. Scientists still do not know where some species, such as the toad-like treefrog, mate.

Using their often-enormous vocal sacs, the males make a variety of calls. The greater leaf-folding frog, for instance, calls with a creaking sound followed by several clicks in a row. The bubbling kassina makes a sound like tiny bubbles popping. The males of the *Afrixalus brachycnemis* and other similar species are unusual because their calls have two parts. In this species, the first part is a zipping sound, and the second is a trill. The zipping sound tells other males of the same species to stay away, and the trill is an invitation to females interested in mating. The males of a few species, including the African wart frog, may not be able to call at all.

For those species that mate at tree holes, only one male uses each tree hole, and the female follows his call to him. It is not so easy for those that mate in ground pools. There, many males of several different species of African treefrogs may use the same pool for mating and call at the same time. Despite the confusion of calls and the large number of frogs, a female can pick out the call of a male from her own species and follow that call to a mate. In some species, the female is stopped on her way to a calling male by another male that is not calling, and she mates with him instead. These quiet males that hang around a calling male waiting for a chance to meet a female are called satellite (SAT-eh-lite) males.

The majority of the species in this family lay their eggs on leaves that hang over pools of water on the ground. For example, the female Betsileo reed frog of Madagascar lays her sticky eggs on leaves just above the water. These eggs hatch into tadpoles, and the tadpoles use their tails to wriggle off the leaves and fall into the water. The leaf-folding frogs also lay their eggs on grass blades or other leaves above a pool of water, but then fold the leaf around the eggs. Since the gel-covered eggs are sticky, the leaf stays folded. When the eggs hatch into tadpoles, the tadpoles wriggle off the leaf and into the water below. In at least one species of leaf-folding frogs, known as the delicate spiny reed frog, the female may mate with more than one male in a night, so the young in her batch of eggs may have different fathers.

The gray-eyed frog is the only species of African treefrog in which the parents provide a foamy nest inside the folded leaf for their eggs. The female makes mucus and then beats it with her hind legs until it turns into foam. She lays her eggs in the foam, and the male folds the leaf around them. The foam helps keep the eggs moist. The eggs hatch, and the tadpoles fall off the leaf and into the water below. Some species of treefrogs, including the kassinas and the sharp-nosed reed frog, lay their eggs right in pools of water along the ground. They typically stick their eggs, sometimes one at a time, onto underwater plants.

Several species, such as the African wart frog, mate in tree holes that hold water. The female lays her eggs on the inside wall of the hole just above the water. The eggs are coated in a gel and stick to the wall. When they hatch into tadpoles, the tadpoles drop into the water. The big-eared forest treefrog and a few other species do not lay their eggs in the water. Instead, these frogs

NOW, THAT'S A SUPER SPECIES!

To some scientists, the painted reed frog should actually be divided into several species. This is because painted reed frogs from one area can look much different than painted reed frogs from another area and because frogs from these separate groups sometimes will not mate with one another even when they live together in the same place. For now, the painted reed frog is often called a super-species, which means that it is a group of two or more species instead of just one.

bury their eggs in moist soil that may be 33 feet (10 meters) or more away from any water. Their eggs are large and filled with yolk, which provides food for the young. Eventually, the tadpoles are strong enough to wriggle along the ground to the water, where they continue to grow. In at least one egg-burying species, known as the giant big-eyed treefrog, the eggs do not hatch into tadpoles at all but hatch right into froglets.

Depending on the species, the number of eggs that a female lays may be as few as a dozen or as many as two hundred or more. The female sharp-nosed reed frog and the Seychelles treefrog are two examples of African treefrogs that lay large numbers of eggs. A typical clutch for a sharp-nosed reed frog is about two hundred eggs, while that of the Seychelles treefrog may be as many as five hundred. In most species of African treefrogs, the adult females lay the eggs and leave them to develop on their own. The African treefrog species known as the midwife frogs are different. The females stay with the gel-covered eggs until they hatch and then help the tadpoles escape from the gel.

The tadpoles of many African treefrogs change into froglets within weeks. Some, like the African wart frog, may wait until they are about three months old before going through the change, which is known as metamorphosis (meh-tuh-MOR-foh-sis). They may need this much time to grow because they live in small pools of water inside tree holes, where food may be very scarce. The sharp-nosed reed frog, on the other hand, lays its eggs in larger pools on the ground. When the tadpoles hatch from the eggs, they find plenty of food and grow so quickly that they can turn into froglets and be ready to mate and have their own young before the end of the breeding season in which they were born.

AFRICAN TREEFROGS AND PEOPLE

Some people keep African treefrogs as pets, but most people are happy to enjoy the frogs only by listening to them calling in the wilds of Africa.

CONSERVATION STATUS

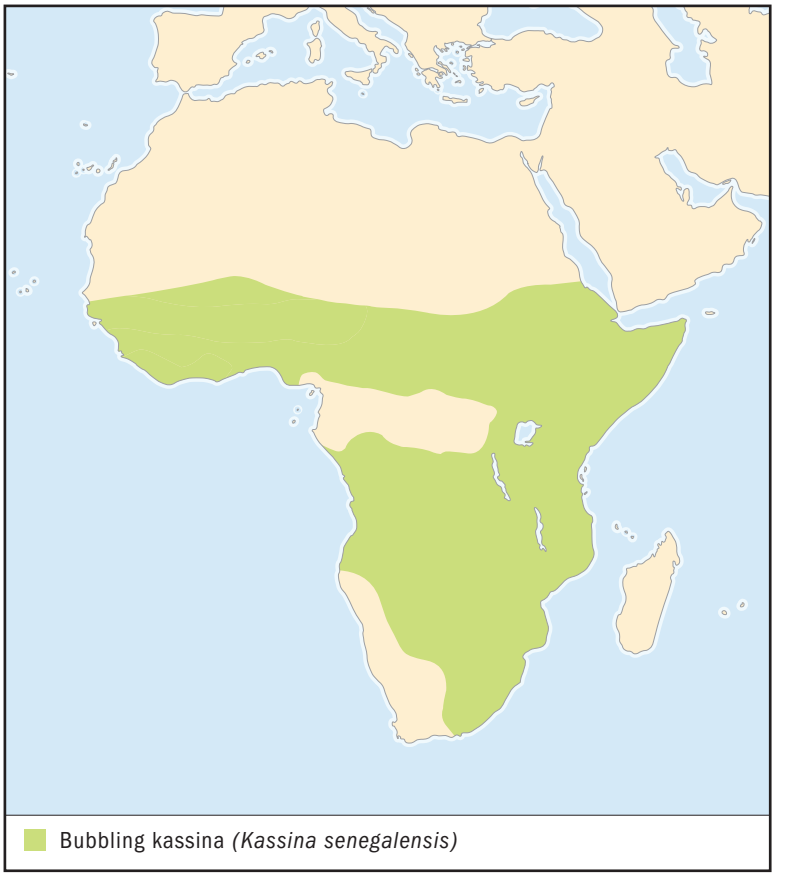
The World Conservation Union (IUCN) lists one species as Critically Endangered and facing an extremely high risk of extinction in the wild; nineteen species as Endangered and facing a very high risk of extinction in the wild; twenty-nine that are Vulnerable and facing a high risk of extinction in the wild; sixteen that are Near Threatened and at risk of becoming threatened with extinction in the future; and fifty-three that are Data Deficient, which means that scientists do not have enough information to make a judgment about the threat of extinction.

The one Critically Endangered species is known by its scientific name of *Alexteroon jynx*. It has only been found in two small areas on hillsides in southwestern Cameroon. This frog lives among thick plants along forest streams that are shaded by overhead trees. It lays a few eggs together in a group on leaves above the water. These eggs hatch into tadpoles, which slide off the leaf and into the stream. Ecologists are concerned not only because it lives in such a small area but also because the forests are not protected and are disappearing as people cut down the trees. Unless the area is protected soon, they fear that the frogs will become extinct.

The Knysna banana frog, Pickersgill's reed frog, and the long-toed treefrog are examples of the Endangered species in this family. All three live in South Africa. The Knysna banana frog is a rare species that lives along the southern coast of South Africa in shrubs, forests, and sometimes farmland; it mates among plants that grow in small pools of water and dams. Pickersgill's reed frog lives in shrubby areas and grasslands farther up the coast of South Africa and uses small pools of water that may dry up later in the year. The home of the long-toed treefrog is in inland grasslands, often on mountainsides between 3,280 to 6,000 feet (1,000 to 1,830 meters) above sea level. It mates in marshes and other grassy pools that may dry up later on.

Human activity, such as the construction of buildings, cutting of trees, and draining of water from wetlands for farms, is causing problems for all three species. In the case of the Pickersgill's reed frog, people are also using the insect-killing chemical known as DDT to control mosquitoes. These mosquitoes can bite people and spread a sometimes-fatal disease called malaria (muh-LAIR-ee-uh). DDT, however, can also kill frogs. Besides this threat, the frogs are in danger because people have brought in eucalyptus (yoo-cuh-LIP-tus), a new

plant that can soak up much of the water in a wetland. Water-loving introduced plants, as well as fires, are causing a problem for the long-toed treefrogs. Although each of these species is endangered, some of them make their homes at least partially inside a protected area, such as a national park or nature reserve.



Bubbling kassina *(Kassina senegalensis)*

BUBBLING KASSINA
Kassina senegalensis

Physical characteristics: The bubbling kassina, also known as the Senegal running frog, is a light greenish gray to tan frog with wide, dark, often brown or black striping or spots on its head and back and dark blotches on its front and rear legs. In many, the markings on the back and head include one long stripe beginning between the eyes and continuing almost to the rump, one broken stripe on each side, a stripe from the tip of the snout to at least the shoulder, and another blotch or several spots low on each side. On its head, the large eyes may look light olive gray to tan or gold, and each has a vertical pupil. Most other African treefrogs have horizontal pupils. Its front legs are not overly long, and its hind legs are only a bit lengthier than the



With its small hind legs, the bubbling kassina does not hop but instead walks or runs, which is why it is sometimes called the Senegal running frog or simply a running frog. (© K. H. Switak/ Photo Researchers, Inc.)

front pair. Both have a pattern of dark bars on lower legs and onto the feet. The front toes have no webs between them; the rear toes have a little webbing. Its belly is white.

Males and females are about the same size. They each reach about 1 to 1.9 inches (2.5 to 4.9 centimeters) long from the tip of the snout to the end of the rump. In some areas, the size of the frogs is on the small side, but in others, most grow closer to the maximum size of 1.9 inches (4.9 centimeters) in length.

Geographic range: It lives over the southern two-thirds of Africa from South Africa north to parts of Sudan, Mali, Ethiopia, Senegal, Niger, and Chad.

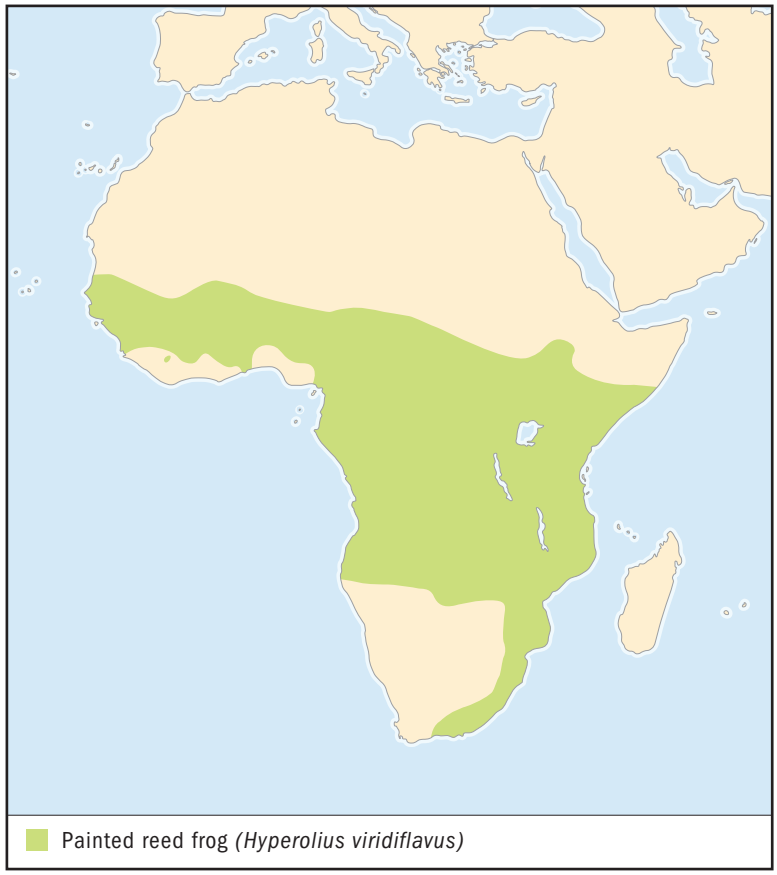
Habitat: These frogs are terrestrial (te-REH-stree-uhl), which means they live along the ground. For much of the year, they are usually found in grassy areas, although some make their homes in more shrubby areas, in pastures, or in country gardens. They mate in shallow spots in ponds or swamps, usually those places with a good deal of plants living in the water.

Diet: These frogs probably eat arthropods.

Behavior and reproduction: With its small hind legs, the bubbling kassina does not hop but instead walks or runs, which is why it is sometimes called the Senegal running frog or simply a running frog. When it sits still, this small striped frog almost disappears against the blades of grass in the grasslands where it lives. It becomes much more noticeable when the rainy season arrives and the males begin calling. The male's call is a high "poink" sound that is rather similar to a bubble bursting or a drop of water landing in a small, metal tub. The male only makes one "poink" sound at a time, usually waiting a while between the sounds. Males call at night while sitting in grass, often on the shore of a pond or swamp and under an overhang, such as a low, dirt cliff. They may also call from a spot in shallow water and surrounded by grass. Females join the males to mate with them in the water. A female lays her eggs one at a time on underwater plants. Each egg has a gel coating, and groups of them may stick together in a clump on the plants. The eggs hatch into tadpoles, which have wide fins, and pointy tails.

Bubbling kassinas and people: Many people in the grasslands of Africa enjoy the call of the bubbling kassina. Yet they very rarely actually see one. As a person nears a calling frog to find it, the frog stops calling and sits still. When the frog is not moving, its color and pattern help it to blend into the grass and make it very difficult to spot.

Conservation status: The IUCN lists this species in the category of "least concern," which means that it is under no known threat of extinction and the animal does not qualify for any of the Threatened categories. The bubbling kassina is a common species that lives over a large part of Africa, including numerous parks and other protected areas. ■



PAINTED REED FROG
Hyperolius viridiflavus

Physical characteristics: Painted reed frogs, also known as common reed frogs, are hard to describe because they come in so many colors and patterns. Some of them are striped in black and yellow from head to rump and on their legs. Some are speckled in green and black on a cream background or have a black-and-white spotted back and brown sides. Others are tan to brown with wide yellow and black bands on their sides and dark gray toes with orange tips. They have many different common names based on what they look like and where they live.

Despite the differences in colors and patterns, all painted reed frogs share certain features. They all have slender bodies, no noticeable



Unlike most frogs that hide during the daytime, some of the painted reed frogs sit out in the open. (Illustration by Emily Damstra. Reproduced by permission.)

neck separating the short head from the body, two large eyes with one on either side of the head, and thin legs. Their pupils are horizontal, and no eardrum shows on the side of the head. Their snouts narrow toward the front and are rounded at the end. The front and hind feet have webbing between the toes, and the toes have rounded pads at the ends. Their bellies are usually white, but sometimes may be pink. Male painted reed frogs have one large, dark gray vocal sac on their throats that blows up and deflates like a balloon when they call. Sometimes the vocal sac has tiny orange spots. The females do not have this sac, but they do have a side-to-side fold across the throat. They typically grow to about 1.2 inches (3 centimeters) in length.

Geographic range: They live over most of the southern two-thirds of Africa.

Habitat: Many of the painted reed frogs live in grasslands, but one group found in central Africa and a small area in West Africa makes its home in forests. They mate and lay their eggs in ponds and sometimes in swamps and even slow-moving streams.

Diet: These frogs probably eat arthropods.

Behavior and reproduction: Unlike most frogs that hide during the daytime, some of the painted reed frogs sit out in the open. Often, the frogs that sit in plain view are those that are brightly colored. These colors may be a warning sign to the predators that the frogs are not good to eat because they have poisonous skin. Many of the painted reed frogs that live in dry, hot grasslands are able to rest in the sun without drying out and dying because they can make a thin layer of mucus to cover their bodies. This mucus hardens into a waterproof coat that keeps the frog's skin moist inside. Some, especially the younger frogs, are also able to survive even if their bodies lose up to half of their weight in water. In particularly dry weather, many of the frogs become white. Darker colors soak up more heat from the sun, so the white color helps to keep the frog a bit cooler.

Painted reed frogs mate during the rainy season. The males sing together in choruses (KOR-us-es) or groups, which sounds like the ringing of small bells and can make a lovely music in the African grasslands and forests. Males call from tall grass-type plants, called reeds and sedges, along the shores of ponds, but sometimes also call from taller bushes and trees. Females lay up to a dozen eggs underwater on plants. In captivity, the frogs will often mate and lay eggs every few weeks during the breeding season, but this behavior has not been seen in the wild. The eggs hatch into tadpoles that turn into froglets. The young froglets may be quite large, and they may be able to become parents themselves later that same year. At least one research team reported that a female painted reed frog may sometimes turn into a male.

Painted reed frogs and people: The frogs may have poisonous skin, and some people in Africa believe that a cow will die if it eats a frog.

Conservation status: In its listing, the IUCN has split up the painted reed frog into several different species, which include the "main" species *Hyperolius viridiflavus*, the marbled or painted reed frog with the scientific name *Hyperolius marmoratus*, *Hyperolius marginatus*, and several others. The IUCN lists these three to be of "least

concern," which means that they are under no known threat of extinction and the animals do not qualify for any of the Threatened categories. According to the IUCN, all three are very common, and one (the marbled reed frog) is even spreading into new areas, especially any new water pools that people make. These three frogs also make their homes inside various protected areas, which should limit the clearing of land where they live. ■



AFRICAN WART FROG
Acanthixalus spinosus

Physical characteristics: The African wart frog is covered with warts on its head, back, and the tops of its legs. It is an olive green, gray, or brown frog with dark bands—sometimes broken bands—that run from one side of its back to the other. It has thin legs, some webbing between the toes of its front and hind feet, and round pads on the tips of its toes. It has large brownish eyes and a rather long snout that narrows toward the front. This frog has an orange tongue. It can grow to 1.4 inches (3.6 centimeters) long from its snout to its rump. Young frogs are orange and maroon.



The African wart frog is active at night. During the day, it typically sits in a puddle of water that has formed inside a tree hole or a pocket on a branch. (Illustration by Emily Damstra. Reproduced by permission.)

Geographic range: It lives in west-central Africa, including Cameroon and the Democratic Republic of the Congo.

Habitat: This frog makes its home in rainforests that are thick with trees and plants. It spends most of its time in water-filled holes of either living or dead trees, sometimes in holes of large branches.

Diet: Although scientists are not sure what they eat, they suspect that these frogs probably eat arthropods, as do many other species in this family.

Behavior and reproduction: The African wart frog is active at night. During the day, it typically sits in a puddle of water that has formed inside a tree hole or a pocket on a branch. Usually, the frog floats underwater with just its nostrils sticking out into the air. The frog may hop out of the water at night to find food. Its body colors and patterns help to hide it from predators, but if a predator does see the frog and comes too close, the African wart frog closes its eyes, tucks its legs in tight against its body, and thrusts out its tongue. This may startle a predator enough that it leaves the frog alone.

This frog mates near the water of its tree hole or branch. Unlike other frogs, the male African wart frog does not have a vocal sac and does not make a call, so a female cannot find him by hearing him. Instead, scientists think the male and female locate each other by smell. The pair mate above the water, and the female lays eight to ten yellow-colored eggs that attach with a sticky gel to the wall of the tree or branch hole barely above the water. The eggs hatch into tadpoles, and the tadpoles drop down into the water, where they live and grow for about three months. During that time, they eat little bits

of food that they find in the water, such as pieces of plants. They then turn into froglets.

African wart frogs and people: People rarely see this frog. Since the males make no calls, people never hear them either.

Conservation status: The IUCN lists this species in the category of "least concern," which means that it is under no known threat of extinction and the animal does not qualify for any of the Threatened categories. With many species of frogs, scientists estimate the size of the population during the mating season when the males are calling and the frogs are easiest to find. Since the males in this species of frog are quiet, scientists have not been able to make good estimates about the frogs' numbers. Nonetheless, they believe the frogs are quite common. Since the frogs mate and lay their eggs in the holes of trees, the logging of these trees may cause a problem for the frogs in the future. ■

FOR MORE INFORMATION

Books:

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians (Smithsonian Handbooks).* New York: Facts On File, 1991.

Lovett, Sarah. *Extremely Weird Frogs*. Santa Fe, NM: John Muir Publications, 1991.

Mattison, Chris. *Frogs and Toads of the World*. New York: Facts On File Publications, 1987.

Miller, Sara Swan. *Frogs and Toads: The Leggy Leapers*. New York: Franklin Watts, 2000.

Schiotz, Arne. *Treefrogs of Africa.* Frankfort am Main, Germany: Edition Chimaira, 1999.

Showler, Dave. *Frogs and Toads: A Golden Guide.* New York: St. Martin's Press, 2004.

Wager, Vincent A. *The Frogs of South Africa.* Johannesburg, South Africa: Purnell and Sons (S.A.) Pty., Ltd., 1965.

Web sites:

"African Tree Frogs (Hyperoliidae): Herpetology." *Chemistry Biology Pharmacy Information Center.* http://www.infochembio.ethz.ch/links/en/zool_kriecht_froesche_laub_afrikan.html (accessed on May 10, 2005).

"Family Hyperoliidae (African tree frogs)." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/pictures/Hyperoliidae.html (accessed on May 10, 2005).

Heying, H. "Family Hyperoliidae (African tree frogs)." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Hyperoliidae.html (accessed on May 10, 2005).

Opisthothylax immaculatus. *AmphibiaWeb.* http://elib.cs.berkeley.edu/cgi-bin/amphib_query?query_src=aw_lists_alpha_&where-genus=Opisthothylax&where-species=immaculatus (accessed on May 10, 2005).

Razzetti, Edoardo R., and Charles Andekia Msuya. *Field Guide to the Amphibians and Reptiles of Arusha National Park (Tanzania).* http://www.gli.cas.cz/SEH/files/tanzie2002.pdf (accessed on May 16, 2005).

ASIAN TREEFROGS
Rhacophoridae

Class: Amphibia
Order: Anura
Family: Rhacophoridae
Number of species: 341 species or more

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

Asian treefrogs come in many sizes and colors, but they have a few common features. Almost all have sticky pads on the tips of their front and rear toes, which help them to move through trees and on leaves, even when they have to climb straight up. Most Asian treefrogs also have heads that are attached to the body with a noticeable neck. In many other frogs, the head blends back into the body without an obvious neck. The typical Asian treefrog has large eyes with horizontal pupils. Some members of this family have full webbing between all of their toes. In these frogs, which are known as flying or gliding frogs, the webs reach all the way to their toe tips. When their toes are spread wide, the feet almost look like fans. In a few species, including Wallace's flying frog, the frog also has a flat body and flaps of skin or fringe down the sides of the legs. These features give the frog's body a shape rather like that of a kite.

Asian treefrogs may be colored green, brown, gray, black, or white, often with markings on their backs. The underside may be a lighter version of the back color, or it may look completely different. Buerger's frog, for instance, is brown to gray on its back, but white on its belly. The Betsileo golden frog has a gray to brown back, but its underside is black. Most Asian treefrogs can hide well against their surroundings. Perhaps the species with the best camouflage is the Vietnamese mossy frog, which not only has a back and head that are the same green and brown as the moss on the ground, but also has spines and tall bumps, or tubercles (TOO-ber-kulz) that stand up just like the stems

and leaves of the moss do. When this frog sits still on moss-covered rocks near streams or at the entrance of caves, a person could walk right past without ever seeing it.

The mantellas look different than most other members of this family. They do not have the toe pads that are common to other species, and they are very brightly colored. Some have red, orange, or yellow backs, while others have black backs and bright-colored legs. The painted mantella is an example. This frog has a black body, a white stripe on its head, legs that are orange on top and yellow underneath, and yellow shoulders.

Depending on the species, Asian treefrogs may be as small as 0.6 inches (1.5 centimeters) long from the tip of the snout to the end of the rump, or as much as 4.9 inches (12 centimeters) in length. The female is a bit longer than the male in many species, but in others, they are about the same size.

GEOGRAPHIC RANGE

Asian treefrogs live in southeastern Asia, the southern half of Africa, and Madagascar. In southeastern Asia, species live in southern India, Sri Lanka, central and southern China, Japan, Taiwan, the Philippines, Vietnam, Cambodia, and Indonesia. In Africa, they live in a stretch of land across the center of the continent from about the Ivory Coast in the west to Somalia in the east, and then down the eastern side.

HABITAT

Some species in this family live in forests. These include such frogs as Buerger's frog, the forest bright-eyed frog, Eiffinger's Asian treefrog, and the Luzon bubble-nest frog. Others, like the gray treefrog, prefer very dry grasslands. This gray treefrog, which is also known as the foam nest frog, is different from the eastern gray treefrog and Cope's gray treefrog of North America. Both of the North American species are members of a separate family, called the Amero-Australian treefrogs.

Some species in this family live near the water and use it to breed. They also use the water to lay their eggs. Buerger's frog is an example. The adults live in forests near rocky streams and enter the water to mate and lay their eggs. The eggs hatch into tadpoles, which remain in the water until they turn into froglets. Other species, like the free Madagascar frog, mate on the leaves of branches that overhang swamps or other water, and the female lays her eggs there on the leaves. As they hatch, the tadpoles plop

down into the water, where they continue growing. Some Asian treefrogs live close to people. The golden treefrog, also sometimes called the banana frog, is often seen on the sides of trees in city parks and on bathroom walls.

DIET

Scientists know little about the diet of many species in this family. In those frogs that they have studied, the adult frogs eat ants, fruit flies, tiny spiders, and other small invertebrates (in-VER-teh-brehts), which are animals without backbones. They suspect that the other Asian treefrogs have a similar diet. Their tadpoles, however, are mostly vegetarian. They nibble at bits of algae (AL-jee) and dead plants that are stuck to and lying on underwater rocks or the water bottom. The tadpoles of two species, the Burmese bubble-nest frog and Eiffinger's Asian treefrog, also eat the eggs of other frogs.

BEHAVIOR AND REPRODUCTION

The Asian treefrogs are perhaps best known for three reasons: Some can glide through the air; some are poisonous; and some build foam nests. Although they are often called flying frogs, they can actually only glide. In other words, they cannot flap their legs to go higher in the air as a bird can with its wings, but they are able to soar from tree to tree. They do this by stretching out the webbing between their toes into a fan shape and using these large web-fans to catch the air and prevent them from falling too quickly. To glide, the frog typically reaches out in a Superman-like pose, but with the legs slightly bent. They adjust the angle of their feet to change direction in flight. Wallace's flying frog is an excellent glider. When this frog leaps from a height of 17.7 feet (7.3 meters), it can soar through the air for a distance of up to 24 feet (7.3 meters). Other gliding frogs include such species as the jade treefrog and the Himalaya flying frog. Besides being a quick way to get around the forest, gliding helps the frogs escape predators that cannot soar or fly.

The poisonous members of this family are called mantellas. Like the poison frogs of South and Central America, they have poison in their skin. Most of the other members of this family are active at night, which helps hide them from would-be predators. The mantellas, on the other hand, are not only active in the daytime, but they also sit right out in the open. Their bright

colors draw even more attention to them. The golden mantella, for example, is bright yellow to orange, while the Betsileo golden frog is gold or orange gold with black sides. Scientists think the bright colors warn predators to leave the frogs alone. The poison in the mantellas is like that found in many of the poison frogs of South and Central America, but it is not as strong. It is, however, powerful enough to convince predators to pass by the frogs and look for something else to eat.

Some of the Asian treefrogs build foam nests. The gray treefrog is an example. First, a pair of frogs finds a spot in a tree branch that hangs over the water. Next, the female oozes a fluid before she lays her eggs, and she alone, or she and her mate, kick the fluid with their hind legs to whip it into foam. Once they have made a large amount of foam, she lays her eggs inside. The outside of the foam nest dries and hardens, but the inside stays moist. The eggs soon hatch into tadpoles inside the nest. By this time, the nest's bottom has become soft, often dissolving in a rain storm, and the tadpoles drop out of the bottom to the water below.

Except for the mantellas, mating in Asian treefrogs is mainly a nighttime activity. The males call to keep other males away and to attract females. The male common treefrog has a call that sounds like a deep quack; the male golden mantella makes quick, clicking noises; and males of other species have their own calls. In most species, the males call from or near a hidden spot or from a place where predators cannot easily reach. The male Buerger's frog calls from rocks in fast-moving streams, for instance, and the male Eiffinger's Asian treefrog does his calling next to the tree hole where he will mate. The mantellas, however, are very bold. These brightly colored males call loudly from open places in plain sight. Their colors serve them well at this time of year. They not only continue to warn predators of their poisonous skin and usually keep the frog safe, but they also tell other male frogs that an area is already taken. Sometimes two males fight over a good calling site. One will grab the other around the head and upper legs and try to push it away. This same type of fighting sometimes happens with female mantellas, but it is less common.

During mating, males typically climb onto the female's back and slowly squirt a fluid, which contains microscopic cells called sperm, onto the eggs while the female lays them. In the foam-nesting species, the male adds his fluid to the foam. In

the gray treefrog, more than one male may add fluid. The eggs all have the same mother, but the father is whichever male added the sperm to the egg. In this way, the eggs in one nest may have several fathers.

In those species of Asian treefrogs that do not make foam nests, only one male mates with each female, and her young all have the same father. Sometimes, however, one male may mate with more than one female, and therefore be the father to several clutches of eggs. Depending on the species, the frogs may lay their eggs in foam nests, as described above, in tree holes, on the ground, or in still water. The painted Indonesian treefrog is one of the species that uses tree holes. A male and a female mate inside the tree hole over a puddle of water inside. The eggs stick to the inside wall of the tree. When they hatch, the tadpoles fall out of the eggs and into the water below. The Luzon bubble-nest frog is one of many species in which the female lays her eggs on the ground. In these species, the female usually lays only one dozen to three dozen eggs at a time. The Luzon bubble-nest frog, for instance, lays between five and nineteen large eggs. Like many other ground layers, she actually lays her eggs on the base of a leaf. Her eggs develop right into froglets there on the leaf, never becoming tadpoles in between.

Although the male golden mantellas usually do their calling from spots where they can be seen, male and female pairs mate in secret. Once a female approaches a calling male, the two find a hiding spot under a piece of bark or a rock that is next to some water. The eggs hatch into tadpoles, which then wriggle over the ground a short way until they plop into the water. The arboreal mantella, which is also sometimes known as the Folohy golden frog, mates differently. In this species, the female lays only one egg, which she sticks on an object above a puddle of water. Often, this puddle is inside a broken, standing piece of bamboo. The arboreal mantella is one of the only frogs in the world that lays one egg at a time.

Other frogs in this family breed in water. These include Buerger's frog and the forest bright-eyed frog, which both mate and lay their eggs in streams. The eggs hatch into tadpoles that continue growing in the water and eventually change into froglets.

Most of the frogs in this family breed over many weeks each year, but a few species mate during a very short period of only a few days. After they mate and lay their eggs, the males and

females of many species leave their young to develop on their own. In a few species that do not lay their eggs in the water or in foam nests, the males will sit atop the clump of eggs while they develop. This may help to keep them moist or may help protect them from predators that might otherwise eat them. Some females of the foam-nesting species also stay nearby, sometimes returning to the nest to add more foam if necessary. They may even urinate on the nest to keep it moist enough for the eggs to survive.

The female Eiffinger's Asian treefrog lays her eggs on the inside of a tree hole and cares for her young. Instead of protecting them from predators or making sure they are moist, she feeds them. The water in the tree hole sometimes has little to feed the growing tadpoles, so she lays extra eggs in the water for her tadpoles to eat. Since these extra "blank" eggs have never mixed with sperm from a male, they would never have developed into young frogs, even if the tadpoles did not eat them. Arboreal mantellas do something similar. The female will drop a "blank" egg into the water for her tadpole to eat. Sometimes, however, the male becomes involved and leads another female to the water where one of his tadpoles is developing. If she lays her egg there, it may hatch into a tadpole that will become food for its older sibling.

The tadpoles of the common treefrog get no extra food from their parents. When they drop from their foam nests into the water, these hungry youngsters use their sharp and powerful beaks to eat almost anything in sight. If the water is just a small puddle, they may even eat their nest mates. Sometimes, only one tadpole is left in the puddle by the time it changes into a froglet.

Depending on the species, tadpoles take different amounts of time before they change into froglets. The western white-lipped treefrog usually needs one or two months. Golden mantellas also take one-and-a-half to two months, but other mantella species may need a longer time to change into froglets.

JUST HOW MANY?

The number of species in the Asian treefrog family is uncertain. Some people separate out a group of the frogs into a separate family, called Mantellidae, but even when they are included, the overall number of species may differ by nearly one hundred. For example, the World Conservation Union (IUCN), which keeps track of risks facing different species, has a different total number than AmphibiaWeb, which is an online system offered through the University of California at Berkeley. The IUCN lists 156 species in the Mantellidae family and another 262 Asian treefrogs for a total of 418 species. AmphibiaWeb, on the other hand, counts 150 species in Mantellidae and 224 Asian treefrogs, which adds up to 374 species.

ASIAN TREEFROGS AND PEOPLE

People rarely see most of the species in this family, which live in forests and other areas away from human activity. Some of the Asian treefrogs, like the Kinugasa flying frog, often turn up in gardens where people notice them. A few species, including the beautifully colored mantellas, are popular in the pet trade.

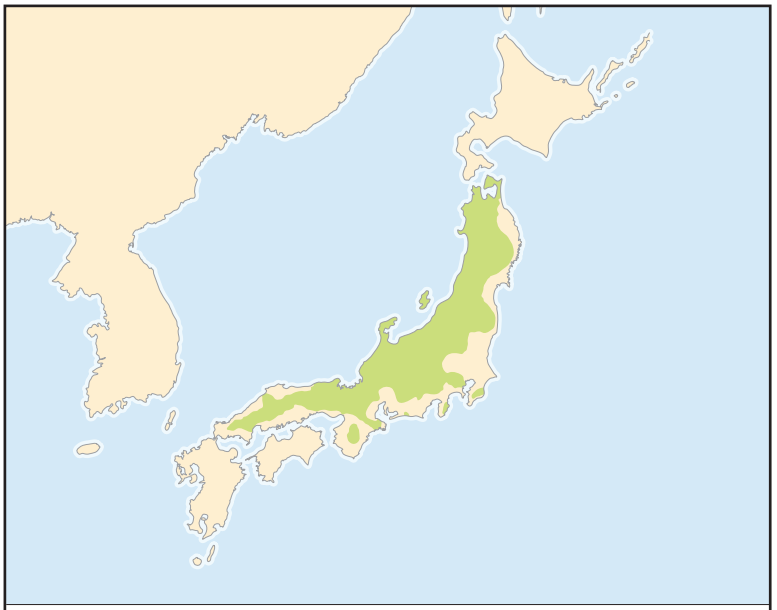
CONSERVATION STATUS

The World Conservation Union (IUCN) lists eighteen species that are Extinct, which means that they are no longer in existence; twenty-five species that are Critically Endangered and face an extremely high risk of extinction in the wild; fifty-six species that are Endangered and face a very high risk of extinction in the wild; forty-nine that are Vulnerable and face a high risk of extinction in the wild; thirty-eight that are Near Threatened and at risk of becoming threatened with extinction in the future; and ninety-four that are Data Deficient, which means that scientists do not have enough information to make a judgment about the threat of extinction.

The eighteen Extinct species have not been seen in the wild for at least fifty years, and some of them for more than one hundred years, even though scientists have searched for many of them again and again. One of the Critically Endangered species is the Chalazodes bubble-nest frog. Scientists had thought this species was extinct for 125 years when a population was discovered in a small area of moist forest on a hillside in India. It is still in danger, however, because it only appears to live in this one spot, and the forests are disappearing as people turn them into farms.

The Shillong bubble-nest frog, which is also Critically Endangered, lives in a different small area of India. The frog was quite common in its forest as late as the 1970s, but it has now become so rare that scientists have not even been able to hear a single male calling during the frog's breeding season. Like the Chalazodes bubble-nest frog, the Shillong bubble-nest frog's forests are disappearing as people cut the trees for lumber or firewood or to make room for houses and buildings. Another of the Critically Endangered species, known only by its scientific name of *Philautus papillosus*, is also facing habitat loss, but this time it is mainly due to mining for gemstones. Miners cut down trees that are in the way of their work. The endangered

Romer's treefrog, which lives in Hong Kong, has lost some of its habitat as people move into its forests and marshes but has also been pushed out by the building of a new airport. Ecologists tried to protect the frog by moving some populations. As of 2004, they had moved the frogs to eight new locations in protected areas, and seven of these populations were doing well.



KINUGASA FLYING FROG
Rhacophorus arboreus

Physical characteristics: Also known as the forest green treefrog or the Japanese treefrog, the Kinugasa flying frog may be a solid, lime-green color, dark green, or green with many reddish brown, brown, or black speckles. The reddish brown and brown speckles are outlined with black. The frog's back, head, and legs are rough and covered with small bumps, or tubercles. Whether solid or speckled, its underside is white or cream-colored, often with somewhat-faded, brown blotches on the chest and throat. They have two large eyes bulging from the sides of a rather flattened, but large head. The eyes, which are orange to brown, often have a noticeable dark band running between them. They also have a noticeable ridge on each side of the head, stretching from the end of the snout to the middle of the eye and continuing on the other side of the eye where it curves down toward the top of the shoulder. The snout narrows toward the front. The legs are slender, and the underside of the rear legs has black lines and blotches near the body. The front toes are slightly webbed, but the hind toes are fully webbed. The toes on all four feet are long and



The home of the Kinugasa flying frog is in Honshu, the largest of the islands that make up Japan, as well as on a small island, called Sado, just to the northeast of Honshu. In addition, it has been introduced to two other areas in Japan. (Illustration by Brian Cressman. Reproduced by permission.)

have very large, triangular-shaped pads on the tips. Females are larger than males. Females reach 2.3 to 3.2 inches (5.9 to 8.2 centimeters) from the tip of the snout to the end of the rump, while males grow to 1.7 to 2.4 inches (4.2 to 6.0 centimeters) in length.

Geographic range: Its home is in Honshu, the largest of the islands that make up Japan, as well as on a small island, called Sado, just to the northeast of Honshu. In addition, it has been introduced to two other areas in Japan.

Habitat: Although they can live in lowland forests, Kinugasa flying frogs usually prefer wooded locations high in the mountains, sometimes more than 6,560 feet (2,000 meters) above sea level. Tadpoles develop in the water of rice fields, marshes, and other wetland ponds.

Diet: Its diet is made up of insects.

Behavior and reproduction: Usually found in mountains, the Kinugasa flying frog sits among trees or under piles of leaves along the ground for much of the year. It sometimes also enters people's gardens and makes its home there. In the cold winters of this area of Japan, the frog finds a spot under a layer of moss or buried just under the ground

and enters a state of deep sleep, called hibernation (high-bur-NAY-shun), until the weather warms again the following spring. The breeding season for this frog is about four months long, from April to July. The breeding season begins when males hop to the edge of a pool or wet rice field and start calling. Each male makes a similar call, which is two to six clicking noises followed by several lower clucks. After a female follows a call to a male, he climbs on her back, and she releases a fluid rather like the raw egg white from a chicken's egg. She then kicks the fluid with her feet, beating it into a foam. Sometimes the male helps her in whipping up the fluid. The longer the foam is beaten, the larger it grows. When it reaches an oblong shape about 3.5 inches (8.8 centimeters) wide and 4.7 inches (12.0 centimeters) long, she lays her eggs inside the frothy nest. As she does, the male adds his own fluid, which is filled with microscopic cells, called sperm. When the sperm combine with the eggs, the eggs can start to develop into young frogs. A female may lay three hundred to eight hundred eggs in the nest.

Sometimes, the mating pair is not alone. Other males may join in by beating up the foam and by adding their own sperm-filled fluid to the nest. In this way, the eggs in one nest may not all get sperm from the same male. When this happens, the young frogs from one nest may have different fathers. Once all the eggs are laid, the outside of the nest starts to dry into a hard shell. The shell protects the eggs from other animals that might want to eat them, and it also keeps the foam inside from drying out. The eggs eventually hatch into tadpoles inside the nest. By this time, the bottom of the nest becomes soft, and the tadpoles fall out, dropping into the water below. There, they continue their growth and turn into froglets.

Kinugasa flying frogs and people: In some ponds in Japan, the frogs have become a tourist attraction. Here, hundreds of male and female frogs arrive together to mate at night and during the day, and people come from miles away to watch this natural scene. Away from these busy ponds, people who live in the countryside also enjoy hearing smaller groups of males calling from rice fields and pools of water on summer nights.

Conservation status: This frog is quite common, and the IUCN lists it as being of Least Concern, which means it has no known threat of extinction and does not qualify for any of the "threatened" categories. It lives in numerous protected areas, and because some populations are tourist attractions, people keep a careful watch over them. ■

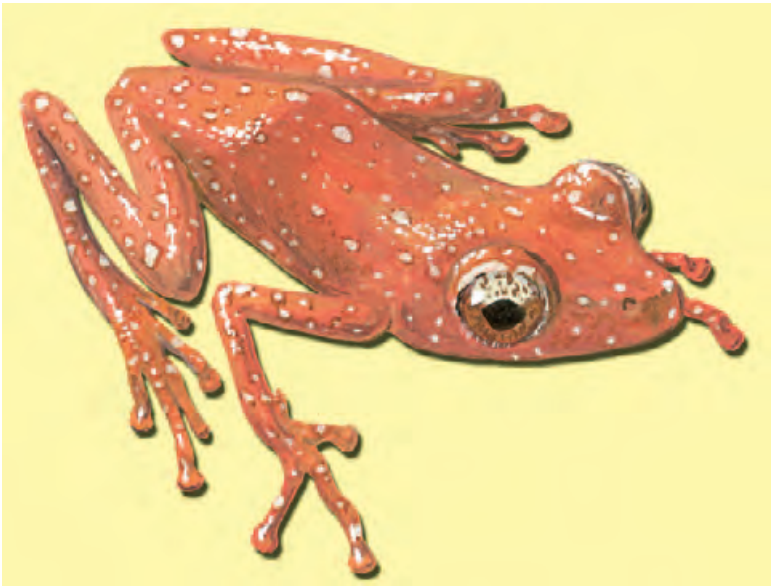


Painted Indonesian treefrog *(Nyctixalus pictus)*

PAINTED INDONESIAN TREEFROG
Nyctixalus pictus

Physical characteristics: The painted Indonesian treefrog, also known as Peter's treefrog or the cinnamon treefrog, may be bright orange, red, orange brown, or brown in color and looks as if it has been painted with tiny white dots. This dotted pattern gives the frog another of its common names, the spotted treefrog. Sometimes the dots form a broken line from the snout over the eye and to the back. The frog has a rough back with small and pointy bumps on its upper surface. On its underside, the frog is a paler orange or orange brown color. The head is flat like the body and narrows to a dull point at the end of its fairly long snout. It has two very large eyes, one on each side of the head. The eyes are white on top and brown on the bottom.

This species is a slender frog with very long and thin hind legs that fold neatly against its flattened body when it is sitting still. Its



The painted Indonesian treefrog, also known as Peter's treefrog or the cinnamon treefrog, may be bright orange, red, orange brown, or brown in color and looks as if it has been painted with tiny white dots. (Illustration by Brian Cressman. Reproduced by permission.)

front legs are also quite thin, and the frog likewise holds them tucked close to its body. On the front feet, the toes may be unwebbed or may have a small amount of webbing between them. The toes of the rear feet have more webbing. Females are larger than males. Females reach 1.46 to 1.54 inches (3.7 to 3.9 centimeters) from the tip of the snout to the end of the rump, while males grow to 1.12 to 1.5 inches (3.0 to 3.7 centimeters) long.

Geographic range: It lives in southeastern Asia, including Sumatra and Borneo in Indonesia, Palawan Island of the Philippines, Malaya, Sumatra, Singapore, and the southern edge of Taiwan.

Habitat: Adults live in moist forests either in lowlands or high in mountains up to 5,400 feet (1,650 meters) above sea level. For the frogs to survive, the forests must not be disturbed by humans. Tadpoles develop in puddles of water inside tree holes.

Diet: Although they do not know for sure, scientists believe they probably eat the same types of food as other members of this family: small invertebrates.

Behavior and reproduction: Scientists know little about this frog's behavior. Some adult frogs have been spotted from 3.3 to 9.8 feet (1 to 3 meters) above the ground on the leaves of small trees and shrubs, but they may climb even higher in the trees. The frogs breed in tree

holes and rotting logs that contain puddles of water from the rain. Females lay about ten eggs at a time in a clump of gel that sticks to the inside wall of the tree hole or hollow log just above the puddle. The eggs hatch into tadpoles, which drop down into the water. They are able to survive by eating little bits of dead leaves or other material that is in the puddle. The tadpoles grow inside the puddle and eventually turn into froglets.

Painted Indonesian treefrogs and people: This frog does not survive well in forests that have been changed by people. Even a small amount of logging can cause a population to die off.

Conservation status: The IUCN considers this species to be Near Threatened, which means that it is at risk of becoming threatened with extinction in the future. Although the frogs live in many areas of southeastern Asia, they are not common anywhere. Ecologists are concerned about the future of this frog because more and more of its forests are being cut down by local people and by loggers. Some populations of the painted Indonesian treefrog live in areas that are protected from logging. ■



FREE MADAGASCAR FROG
Mantidactylus liber

Physical characteristics: This is a slim frog with slender front and rear legs and extremely thin toes. Its front legs, including the long toes, would be about as long as the frog's body if they were stretched out. The toes on all four feet end in large pads. The front toes have no webbing between them; the back toes are slightly webbed. The frog's back, head, and legs are red, gray, or green, often smeared with patches of a slightly different second color. For example, a frog may have a pinkish brown back colored with light brown or greenish brown patches. A faint light line runs from the snout over the head and down the back. Some white or yellow spots may be noticeable low on the sides, especially toward the rump, and a few white speckles may show on the sides of the head and neck. The underside of the frog may be black. Its head has a rather long snout that narrows



This little known genus from Madagascar has many color variations of color, even within the same species. (Photograph by Harald Schüetz. Reproduced by permission.)

toward the front, and one eye of the large, gold to copper-colored pair of eyes on either side. A dark bar may show between the eyes. A narrow ridge runs from the back of the head to the shoulder.

Males have a flat structure, called a gland, under the skin on the upper rear leg, and a large, white vocal sac in the throat region. The vocal sac, which is also seen in other species of Asian treefrogs and many other types of frogs, blows up like a balloon when the male makes his call. Males are often a bit smaller than females, but both can grow to the same size. Males reach 0.8 to 1.1 inches (2.1 to 2.9 centimeters) from the tip of the snout to the end of the rump, while females grow to 1.06 to 1.1 inches (2.7 to 2.8 centimeters) long.

Geographic range: They live on the eastern side of Madagascar, as well as in the central region of the country.

Habitat: They live in moist rainforests from lowland areas at sea level to mountain locations up to 3,900 feet (1,200 meters) above sea level. Tadpoles develop in shallow water of swamps and other wetlands.

Diet: The diet is probably like that of many other treefrogs: small arthropods, including insects and spiders.

Behavior and reproduction: Most of the time, this frog sits in or near plants with cup- or tube-shaped parts that fill with water. The rainiest time of year is the mating season for the free Madagascar frog,

and males begin calling from plants around the still or slow-moving water of small pools and swamps. The male's call is a ticking sound. When a female answers his call, she approaches him and may even give him a little push from behind. He then climbs onto her back and begins to wiggle. As he does, she lays her eggs onto the leaves. Each female may lay thirty to ninety eggs. When the eggs hatch into tadpoles, the tadpoles drop off the leaves and plop into the water below. They stay in the water until they develop into froglets.

Free Madagascar frogs and people: This frog survives quite well in rainforests that humans have not disturbed and in rainforests that have seen a good deal of human activity, such as the cutting of some trees for farming or other purposes.

Conservation status: This frog is quite common, and the IUCN lists it as being of Least Concern, which means it has no known threat of extinction and does not qualify for any of the "threatened" categories. Scientists are, however, watching this and other frog species as the rainforest disappears. Fortunately, the free Madagascar frog lives in many places that are protected from habitat destruction. ■

FOR MORE INFORMATION

Books:

Alcala, A. C., and W. C. Brown. *Philippine Amphibians: An Illustrated Field Guide.* Makati City, Philippines: Bookmark, Inc., 1998.

Channing, A. *Amphibians of Central and Southern Africa.* Ithaca, NY: Comstock Publishing Associates, 2001.

Glaw, F., and M. Vences. *A Fieldguide to the Amphibians and Reptiles of Madagascar.* Frankfurt, Germany: Edition Chimaira, 1999.

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians (Smithsonian Handbooks).* New York: Facts on File, 1991.

Inger, R. F., and R. B. Stuebing. *A Field Guide to the Frogs of Borneo.* Kota, Indonesia: Natural History Publications, 1997.

Maeda, N., and M. Matsui. *Frogs and Toads of Japan.* Tokyo, Japan: Bun-Ichi Sogo Shuppan Co., 1990.

Mattison, Chris. *Frogs and Toads of the World*. New York, NY: Facts on File Publications, 1987, pp. 177–179.

Miller, Sara Swan. *Frogs and Toads: The Leggy Leapers*. New York: Franklin Watts, 2000.

Passmore, N. I., and V. C. Carruthers. *South African Frogs: A Complete Guide.* Johannesburg, South Africa: Witwatersrand University Press, 1995.

Showler, Dave. *Frogs and Toads: A Golden Guide.* New York: St. Martin's Press, 2004.

Schiøtz, A. *Treefrogs of Africa.* Frankfurt, Germany: Edition Chimaira, 1999.

Zug, G. R., L. J. Vitt, and J. P. Caldwell. *Herpetology: An Introductory Biology of Amphibians and Reptiles.* San Diego, CA: Academic Press, 2001.

Periodicals:

Milius, Susan. "Lifestyles of the Bright and Toxic Overlap." *Science News* (April 14, 2001): 230.

Williams, Wendy. "Flash and Thunder." *Animals* (July 2000): 25.

Web sites:

"Common Tree Frog." *Wetlands, a publication of Sungei Buloh Nature Park.* http://wetlands.sbwr.org.sg/text/99-6-2-1.htm (accessed on May 6, 2005).

"Frog Wrestling." *American Museum of Natural History.* http://www.amnh.org/exhibitions/frogs/featured/wrestling.php (accessed on February 1, 2005).

"Golden Mantella." *St. Louis Zoo.* http://www.stlzoo.org/animals/abouttheanimals/amphibians/frogsandtoads/goldenmantella.htm (accessed on May 6, 2005).

"Golden Mantella." *theBigZoo.com.* http://www.thebigzoo.com/Animals/Golden_Mantella.asp (accessed on May 6, 2005).

"*Mantellidae*." *AmphibiaWeb.* http://elib.cs.berkeley.edu/aw/lists/Mantellidae.shtml (accessed on May 6, 2005).

"*Mantidactylus liber*." *Naturalia.* http://www.naturalia.org/ZOO/ANFIBI/e_24.html (accessed on May 6, 2005).

"Parachuting/Defying Gravity." *American Museum of Natural History.* http://www.amnh.org/exhibitions/frogs/featured/parachuting.php (accessed on February 1, 2005).

"Rhacophoridae." *Frogs of the Malay Peninsula.* http://frogweb.org/Families.aspx?FamilyID=22 (accessed on May 6, 2005).

"Spotted Tree Frog." *Ecology Asia.* http://www.ecologyasia.com/verts/amphibians/spotted_tree_frog.htm (accessed on May 6, 2005).

NARROW-MOUTHED FROGS
Microhylidae

Class: Amphibia
Order: Anura
Family: Microhylidae
Number of species: 362 species

family
CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

With 362 species, this large family of narrow-mouthed frogs comes in many shapes and sizes. Most species are brown, tan, or yellow-brown on their backs, sometimes with brighter colors on their undersides. The horned land frog, for example, has a brown back and gray sides, but may have an orange or red underside. The saffron-bellied frog has a black back with yellowish to silvery flecks, and large, bright yellow spots on its black sides and belly. Some, like the rubber frog, stand out even more. The rubber frog has a dark brown to black body with pink or red markings on its back.

Many, but not all, of the narrow-mouthed frog species have a round, wide, often chubby-looking body and a short head that ends in a narrow or pointed snout. This gives these species an overall shape that resembles a pear or a teardrop. Others do not have this body shape. Some are long and thin, and others have rounded bodies with fairly wide heads. The New Guinea bush frog, for example, has a head that is just as wide as its body. Rain frogs of the genus *Breviceps* are also plump and round. They have such tiny legs that they cannot hop, and walk instead. Another rather plump frog, known as the ornate narrow-mouthed frog, has longer legs than *Breviceps* and is an excellent hopper.

Many, but not all, of the narrow-mouthed frogs have noticeable, small warts on their backs and legs. The typical member of this family has little or no webbing on its toes. Many have pads on their toe tips. The horned land frog, for instance, has

large pads, especially on the toes of its front legs. The eyes of species in this family are frequently small, but some, like Boulenger's callulops frog, have large eyes. A few, including the New Guinea bush frog and the horned land frog, have eyelids decorated with small spines that almost look like thick eyelashes.

The majority of the frogs in this family share a few somewhat hidden characteristics. Unlike other frogs, most species of narrow-mouthed frogs have two or three zigzag folds on the roof of the mouth. The roof of the mouth is called the palate (PAL-ett). The majority of the species in this family also have no teeth. In addition, most narrow-mouthed frogs have smaller bones in the shoulder and chest than other frogs typically have. Some, like the Malaysian painted frog, have no neck bones and, therefore, no neck. In this case, the head almost blends in with the body, which makes the frog look quite chubby. In fact, the nickname of the Malaysian painted frog is chubby frog.

The typical narrow-mouthed frog grows to 1.6 inches (4 centimeters) long from snout to rump, and some never even reach 0.5 inches (1.3 centimeters) long as adults. The largest species, like the Malaysian painted frog, can top 3 inches (7.5 centimeters) long, and some can reach 4 inches (10 centimeters) in length. In most species of narrow-mouthed frogs, females are at least a little larger than the males. In some cases, like Bushveld's rain frog, the female is almost twice the size of the male.

GEOGRAPHIC RANGE

Depending on the species, narrow-mouthed frogs may live in southern North America, central and northern South America, Central America, southern Africa and Madagascar, southeast Asia including the Philippines and the East Indies, and/or northern Australia and New Guinea.

HABITAT

The members of this family live in many different habitats. Most prefer hot and humid rainforests, where many live in underground burrows. Some live along but above the ground, and others spend at least part—and sometimes all—of their lives in the trees. A few species, like those with the scientific genus names of *Oreophryne* and *Oxydactyla*, live high in the mountain grasslands of New Guinea. The rain frogs of southern Africa, on the other hand, survive the dry, almost desert-like sand dunes by spending much of their time in underground

burrows. These odd frogs, with their exceptionally plump bodies and four tiny legs, will venture out of their burrows during the rain or on humid nights.

DIET

Most narrow-mouthed frogs eat only small invertebrates (in-VER-teh-brehts), which are insects and other animals without backbones. Many species have small mouths that come to a point at the end and can only eat tiny invertebrates. Ants are a favorite food for these frogs, but they will also eat other insects that are small enough to fit in their mouths. The Bolivian bleating frog is one of many species that are especially fond of ants. Other narrow-mouthed frogs have slightly larger mouths and are able to eat larger invertebrates. The New Guinea bush frog has a large head and especially wide mouth, which allows it to eat insects, as well as larger animals, like other frogs and lizards.

Scientists have not seen most of the frogs feeding, so they have to guess about how they go about eating. Some of the frogs probably eat insects that they find while they move about in trees or along the ground, but scientists think that many of these frogs may hunt by ambush. In this type of hunting, the frog sits very still. An insect that does not notice the frog may approach closely enough for the frog to grasp it and eat it.

Not all narrow-mouthed frog species have a tadpole stage, but in those that do, the tadpoles suck in water, sift out tiny microorganisms, and eat them. Microorganisms (MY-crow-OR-gan-izms) are living things that are too small to see. Scientists call this type of eating filter feeding, because the tadpoles sift, or filter, their food from the water. Some of the tadpoles have funnel-shaped mouths that are perfectly designed for filtering food from the surface of the water.

BEHAVIOR AND REPRODUCTION

Most of the narrow-mouthed frogs are active at night, but they sometimes come out during the day. Those that live high in mountains are more likely to be active in the day time. Many of the narrow-mouthed frogs are burrowers and use flat scoops, or spades, on the heels of their feet to help them dig backward into the soil. The Bushveld rain frog, for example, has spades on each of its hind feet to help it dig. This frog can burrow as far as 20 inches (50 centimeters) below the surface. Others that

burrow do not have the spades and instead use their front feet to dig into the soil head first. A few, like Boulenger's callulops frog, make their homes in burrows that they probably take from other animals, rather than build themselves. Many of the burrowing frogs stay underground during dry periods, only coming out during heavy rains. This behavior allows desert-living frogs to survive, but even the burrowing species that live in rainforests will crawl underground when the weather is dry.

Like many other frogs, most narrow-mouthed frogs defend themselves from predators by quickly jumping off, perhaps into a shrub where they can hide or into a nearby pond where they can dive out of sight. Some will also disappear into a burrow or try to dig down into the soil. A few narrow-mouthed frogs have more unusual defense tactics. One of the most bizarre is the tomato frog, a plump frog that lives on the northeast coast of Madagascar, a large island that lies east of southern Africa. The males are orange and grow to about 2.5 inches (6.5 centimeters), but the females are red and can reach 4 inches (10.1 centimeters) long and weigh half a pound (227 grams). Like many other frogs, the tomato frogs have skin that oozes, or secretes, a poisonous substance that tastes bad to predators. The substance in the tomato frog's skin goes a step farther. When a snake or other predator bites a frog, not only does the predator get a mouthful of white, bad-tasting goop, but the goop is exceptionally sticky—so sticky, in fact, that it can seal shut the mouth and eyelids of the retreating predator for several hours, sometimes days. Studies have shown that the substance is five times stronger than rubber cement.

Another narrow-mouthed frog with an unusual way of protecting itself is a broad-headed frog of New Guinea, near Australia. When it feels threatened, it holds its ground rather than running away, blows up its body, and opens its mouth to show off its bright, blue tongue. If the predator is not already frightened off by this display, the frog clamps its jaws on the predator and hangs on for several minutes. When the frog finally lets go, the predator often has had enough and leaves the frog alone.

Most of the frogs in this family mate when the weather is warm and rainy. In tropical rainforests, where it is almost always wet and warm, some species may be able to mate any time of the year. Those that live in very dry areas, however, mate only during the very short rainy season. The Bushveld rain frog

spends most of its life underneath the dry ground of the desert-like areas where it lives. When the rains come, it comes out, usually at night, to search on land for termites and eat until it is fat. This fat helps the frog survive underground until the next rainy season. It also mates during this rainy period.

Depending on the species, narrow-mouthed frogs may mate in or near the water or on land. In both cases, the males begin calling when they are ready to mate. Some call with single or groups of ringing notes, while some have harsher voices. Many males have a bag of skin, called a vocal sac, on the throats. The vocal sac fills with air and deflates when the male calls. Other species have no vocal sacs, but still manage to call. In 2002, scientists reported that one narrow-mouthed frog, called the Borneo tree-hole frog, actually practices and adjusts its call, making it higher or lower to get the best echo from the tree cavity where it does its singing. The scientists said this was the first time any animal had ever been shown to change its call or song based on the place from which it calls. For other narrow-mouthed frogs, the males simply call. The females hear the calls and follow them to find the males. In the species that mate on land, a male's call may not only attract a female, but may also tell other males to find somewhere else to mate. The male horned land frog is such a frog. Males will often call back and forth, apparently to set up and keep their territories.

Species that mate on land usually do so in various hidden-away spots. These may include burrows that the males dig themselves, piles of leaves on the ground, tree holes, or plants that grow on the sides of the trees. The male Fry's whistling frog, for example, moves to the top of the pile of leaves where it lives and calls from there. Boulenger's callulops frog, on the other hand, calls from inside or near the entrance to its burrow, which it does not make but instead takes over from another burrowing animal. More than half of the narrow-mouthed frogs mate in or near water. The water may be a stream or other body of water that remains filled with water all year, or it may be a pool of water that dries up once the rainy season ends. Some frogs use very small pools of water that they find inside tree holes or within plant leaves that grow together to form small cups. Boulenger's climbing frog is an example of a frog that makes use of puddles inside tree holes.

Little information is available about reproduction in most of the 362 species in this family. Scientists assume, however, that

the males and females of most if not all narrow-mouthed frogs mate like many other frogs: the male climbs onto the female's back as she lays her eggs. This piggyback position is called amplexus (am-PLEK-sus). In some species, like Bushveld's rain frog, the females are much larger than the males of the same species, which would make it difficult for the male to hold on if he didn't have some help. The help comes in the form of a sticky substance that oozes from the skin. It glues the pair together while they mate. In other species, like Boulenger's climbing frog, the males have sharp spines on one toe of each front foot. They probably use the spine to hang onto the females during mating.

In the species that mate on land, the females lay their eggs in a moist spot. In the Bushveld rain frog, the stuck-together male and female pair dig backward into the soil until they find a moist spot and she lays her eggs there. The eggs of this frog and most other land-mating species of narrow-mouthed frogs develop right into froglets, rather than turning into tadpoles first. The froglets usually look like miniature versions of the adults. Scientists use the term direct development to describe the growth of eggs right into froglets instead of tadpoles and then froglets. The food for each developing egg comes from a large yolk. Because the yolk is so large, the females usually lay only a few eggs at a time. A female Fry's whistling frog lays seven to twelve eggs, while a female Timbo disc frog lays just four to six eggs at a time. The males typically stay behind to watch over the young, sometimes even carrying them around on their backs. The males nab and gulp down insects that would otherwise eat the eggs and may also huddle with the eggs to keep them moist.

In the species of narrow-mouthed frogs that mate in the water, the females of some species drop their eggs in a pond or stream, while others lay their eggs in a pool of water inside a tree hole or within water held in plant leaves. The saffron-bellied frog is a species that mates around small pools that fill with water after a heavy rain. The females lay their eggs in the pools. The eggs of water-mating species may clump together as they do in the

FREAKY FRIENDS

A tarantula could easily kill a frog, so why does the Great Plains narrow-mouthed toad make its home inside the large spider's burrow? This frog, which lives in parts of the United States, has formed an unusual relationship with the spider. The tarantula does not bother the frog, which is quite safe from other predators in the spider's home. At the same time, the frog eats ants and other insects inside the burrow that might harm and possibly devour the tarantula's eggs.

A GOOD YOLK

Even when scientists have never actually seen a particular frog species' eggs develop, they can predict whether they will turn into tadpoles or whether they will skip the tadpole stage and change right into froglets. The clue is in the yolk. Some frogs, including many of the narrow-mouthed frogs, lay eggs with a lot of yolk. This yolk feeds the frog developing inside. If the yolk is large enough, it can contain enough food for the developing frog to hatch right into a froglet. If the egg has a small yolk, scientists assume that the egg hatches into a tadpole, which must then find food on its own.

Bolivian bleating frog; they may float on the surface as they do in the ornate narrow-mouthed frog, or they may sink or float in other patterns. Frogs that mate in the water often lay hundreds of eggs at a time. One of these frogs, the ornate narrow-mouthed frog, lays several hundred. The Bolivian bleating frog lays about two hundred at a time, but the female may lay several clutches in a single season. One female Bolivian bleating frog was found with more than two thousand eggs in her body.

Once most water-mating narrow-mouthed frogs lay their eggs, both adults leave the eggs to hatch on their own. The females that lay their eggs in larger bodies of water, like streams or ponds, lay small eggs. For instance, two hundred eggs of the Bolivian bleating frog can fit into a cluster just 4 inches (10 centimeters) in diameter. These eggs hatch into tadpoles, sometimes in as little as a day and a half, and the tadpoles search for food in the water. In some species, like the ornate narrow-mouthed frog, the tadpoles have see-through bodies that make them nearly invisible. This helps them avoid predators.

Those water-mating frogs that use small pools of water for mating have eggs with yolks that are larger than the pond or stream species. Even after the tadpoles hatch from the eggs, they continue to rely completely on the egg yolk for food. This is important, because their tiny pools would likely not have enough food in them to keep the tadpoles alive. In some species, like Boulenger's climbing frog, the male stays in the tree hole with the eggs until they develop into froglets.

NARROW-MOUTHED FROGS AND PEOPLE

Some native people in South America, New Guinea, and perhaps some other areas eat narrow-mouthed frogs, but they do not take enough of the frogs to threaten the survival of any species. A few species, such as the Malaysian painted frog, are fairly common in the pet trade. Most, however, are rarely seen by humans in the wild or in the pet trade.

CONSERVATION STATUS

The World Conservation Union (IUCN) considers six species are Critically Endangered, which means that they face an extremely high risk of extinction in the wild; twenty-five species are Endangered and face a very high risk of extinction in the wild; thirty-six are Vulnerable and face a high risk of extinction in the wild; seventeen are Near Threatened and at risk of becoming threatened with extinction in the future; and 155 are Data Deficient, which means that scientists do not have enough information to make a judgment about the threat of extinction.

The Critically Endangered species include the beautiful nursery frog, which is also known as the elegant frog, and five others known only by their scientific names. These are *Albericus siegfriedi, Microhyla karunaratnei, Parhoplophryne usambarica, Scaphiophryne gottlebei*, and *Stumpffia helenae*. Most of these live in very small areas that are changing as people clear the land for purposes such as farming. Often, the frogs cannot survive these changes. Some of the species are also in danger from pollution and from global warming. Scientists believe that global warming in the future will cause weather-related problems, such as especially long-lasting, dry spells, that will harm the frogs and may lead to extinction for some species.

Since many of the narrow-mouthed frogs live in rainforests, and people continue to cut down rainforests, many environmentalists are worried about the future of these frogs, many of which scientists know little about. If the frogs have no place left to live, they will likely die off.

The U.S. Fish and Wildlife Service does not list any United States species of narrow-mouthed frogs to be at risk.



Wilhelm rainforest frog *(Cophixalus riparius)*

SPECIES ACCOUNTS

WILHELM RAINFOREST FROG
Cophixalus riparius

Physical characteristics: The Wilhelm rainforest frog has a dark brown or purplish brown body with yellowish tan spots and blotches on its back and legs. The snout is short and slightly upturned at the end. Its long, thin legs have lengthy toes that are tipped with wide, triangular-shaped pads. This species grows to 2 inches long (5 centimeters) from snout to rump.

Geographic range: The Wilhelm rainforest frog lives in the mountains of Papua, New Guinea, between 6,000 to 9,000 feet (1,900 to 2,800 meters) above sea level.



Wilhelm rainforest frogs may be found in many areas in the rainforest. They often climb high into trees, where they hide away in tree holes or inside plants that grow on the sides of the trees. They may also spend time along the ground, frequently tucked into burrows on the sides of stream banks or other steep areas. (Illustration by Brian Cressman. Reproduced by permission.)

Habitat: This species hides among rainforest trees and in holes along the ground in steep areas, especially on the edges of roads, and sometimes in grass near streams.

Diet: Scientists are not sure what specific kinds of food these frogs eat. If they are like many other members of the family, however, they eat some types of invertebrates.

Behavior and reproduction: Wilhelm rainforest frogs may be found in many areas in the rainforest. They often climb high into trees, where they hide away in tree holes or inside plants that grow on the sides of the trees. They may also spend time along the ground, frequently tucked into burrows on the sides of stream banks or other steep areas. The males call females from inside ground burrows or from hiding spots high in the trees. They mate in either place. Females lay strings of two dozen or so eggs in the burrow or high in the trees. Scientists have little information on their reproduction, but one report noted a string of 27, 0.2-inch (5-millimeter) eggs in a burrow, along with a frog—probably the male—staying with them. Instead of hatching into tadpoles, the eggs hatch right into froglets.

Wilhelm rainforest frogs and people: People rarely see this frog in the wild. It is not common in the pet trade.

Conservation status: The World Conservation Union (IUCN) does not consider Wilhelm rainforest frogs to be at risk. This frog lives in a fairly small area, but the area is in good shape and the frog is quite common. ■



Eastern narrow-mouthed toad *(Gastrophryne carolinensis)*

EASTERN NARROW-MOUTHED TOAD
Gastrophryne carolinensis

Physical characteristics: The eastern narrow-mouthed toad has the typical teardrop-shaped body common to many members of this family. Its back and legs are light brown, gray, or reddish brown with patterns of darker brown lines or spots. The sides have a more faded color than the back. The frog's snout comes to a point, and it has a fold of skin that crosses the head just behind its small eyes. Its feet are unwebbed, and each of the hind feet has a spade for digging. Males have a dark throat, but the females do not. The frogs can reach 1.5 inches (3.8 centimeters) long from snout to rump.

Geographic range: Eastern narrow-mouthed toads live in the southeastern quarter of the United States. They have also been



Eastern narrow-mouthed toads live in the southeastern quarter of the United States. They have also been introduced to two islands in the Bahamas and to Grand Cayman Island. (© Kenneth M. Highfill/ Photo Researchers, Inc.)

introduced to two islands in the Bahamas and to Grand Cayman Island.

Habitat: Although members of this species can survive in many on-land habitats, they prefer areas along the coastline. They usually stay off mountains and out of dry places.

Diet: Eastern narrow-mouthed toads eat mainly small invertebrates, especially ants, termites, and beetles that are 0.25 inches (6 millimeters) long at most.

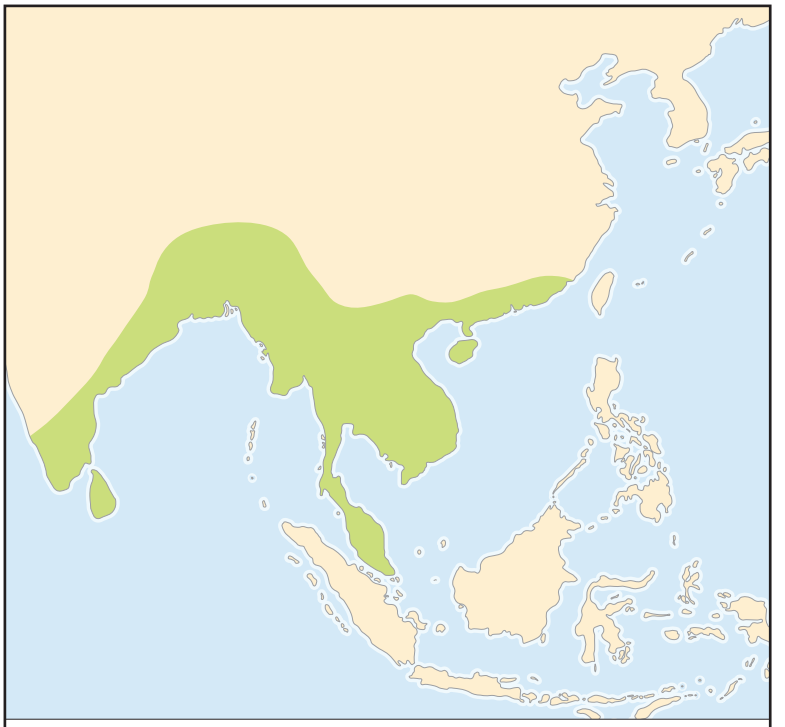
Behavior and reproduction: During the day, eastern narrow-mouthed toads usually stay beneath leaves, under stones, or in other hidden spots along the ground. When discovered, they typically try to hop quickly away. They come out at night, which is when they eat. By remaining active at night and hiding during the day, the toads can avoid many of their predators, including garter snakes, bullfrogs, and large wading birds called egrets. When they are attacked, however, the toads can ooze a bad-tasting substance from their skin. This substance may be poisonous to a predator. The

substance provides protection from the predators as well as the biting ants that the toad eats.

During wet periods of the year, the males begin calling for females from ponds and small rain-filled pools of water or from hidden places on land along shore. In southern areas, such as Florida, the males call from April to October. In cooler areas, they begin calling later and stop earlier. The calls last about 4 seconds and sound like the "baa" of a lamb. When a female finds a male, he holds onto her back with his front arms and makes a gluey substance with his belly that helps him stick to her. The female then lays her approximately five hundred eggs in several batches. The eggs float on the top of the water, hatch into tadpoles, which then turn into froglets. In warmer areas, the tadpoles may change into froglets in as little as twenty days, but in colder places, they may need as long as sixty-seven days to make the change.

Eastern narrow-mouthed toads and people: For most of the year, people only see this species in the wild if they search for them by flipping over rocks, logs, and piles of leaves that lay on the ground. The toads' loud mating calls, however, may help people find them during the mating season.

Conservation status: Neither the World Conservation Union (IUCN) nor the U.S. Fish and Wildlife Service consider this species to be at risk. It is very common throughout the southeastern United States, including suburbs where people live. ■



Malaysian painted frog *(Kaloula pulchra)*

MALAYSIAN PAINTED FROG
Kaloula pulchra

Physical characteristics: The Malaysian painted frog is also known as the painted or Asian bullfrog, chubby frog, rice frog, and bubble frog. It has the teardrop-shaped body common to many narrow-mouthed frogs. This frog has no neck bones and, therefore, no neck, which gives it a chubby look. Its back is mostly chocolate brown with a wide, light yellowish to cream-colored band on each side of the body. The band is outlined with a thin, dark brown line. The yellowish cream color also covers the top of its snout between its large eyes. The frog has rather short legs, which are mottled with brown, light gray, and cream colors, and barely webbed feet. Each of its back feet has a spade for digging. The toes on its feet end in small pads. Malaysian painted frogs are one of the largest species in this family and grow to 3 inches (7.5 centimeters) long from snout to rump.



The Malaysian painted frog is also known as the painted or Asian bullfrog, chubby frog, rice frog, and bubble frog. (Photograph by Joe McDonald. Bruce Coleman Inc. Reproduced by permission.)

Geographic range: The Malaysian painted frog lives in southeastern Asia, including China and Taiwan, and parts of Indonesia. Populations also live in Borneo and Sulawesi, but people probably brought the frogs to these areas.

Habitat: The Malaysian painted frog is different from most frogs, which tend to stay away from towns and other places where people have moved in and made changes to the environment. Instead, this species lives in and around towns and avoids quiet, people-free areas.

Diet: The Malaysian painted frog eats a variety of small insects, especially ants.

Behavior and reproduction: For much of the time, the frogs stay out of sight by digging backward into underground burrows, into piles of trash, and into other secretive spots they find along the ground. When the rains come, however, the frogs come out to mate in pools that have filled with water. The males float in the pools and blow up their bodies to make calls that sound like loud honks. Females arrive and mate with the males. The female's eggs quickly turn

into tadpoles, which rapidly change into froglets. This speedy growth is important because the water in their pools usually dries up in a very short time after the rains end.

Malaysian painted frogs and people: This species is fairly common in the pet trade. Although it lives near homes and buildings, people rarely see this usually underground frog in the wild. Some people, however, do hunt it for food.

Conservation status: The World Conservation Union (IUCN) does not consider the Malaysian painted frog to be at risk. This frog lives in a large area, and the area is in good shape. Moreover, even though it is collected as food and is seen in the pet trade, the frog remains very common in the wild. ■



Pyburn's pancake frog *(Otophryne pyburni)*

PYBURN'S PANCAKE FROG
Otophryne pyburni

Physical characteristics: Pyburn's pancake frog has a wide rather flat back and a pointy snout that makes it look somewhat like a dead leaf. The frog is brown to yellowish gray with scattered, tiny, blue to cream speckles and sometimes dark stripes or other markings. It also has two, thin, light yellow to cream stripes, each of which begins at the snout and runs down the side of the body to the hind leg. The stripe widens onto the back where it has a ragged edge. The pancake frog's legs are short. The females can reach 2.2 inches (5.6 centimeters) long from snout to rump, while the males are a bit smaller.



Scientists know little about this frog outside of its breeding behavior, but they think the frog remains tucked away underground most of the time. When it breeds, the males call females from hidden spots near a stream. (Illustration by Brian Cressman. Reproduced by permission.)

Geographic range: Pyburn's pancake frog lives in northern South America, from southeastern Colombia in the west to French Guiana in the east.

Habitat: For most of the year, this frog moves along sandy ground in the rainforest. When it breeds, however, it enters the water of a nearby stream, which is also where the eggs hatch and tadpoles grow.

Diet: Scientists are not sure exactly what this frog eats, but they think it probably eats ants, which is what other closely related frogs eat.

Behavior and reproduction: Scientists know little about this frog outside of its breeding behavior, but they think the frog remains tucked away underground most of the time. When it breeds, the males call females from hidden spots near a stream. These hiding places may be underneath piles of leaves or inside tangles of plant and tree roots that poke up from the ground. The females lay eggs, which can be 0.2 inches (5 millimeters) across, in the quiet ponds of water or nearby. The eggs hatch into tadpoles that have sharp teeth, which they perhaps use to sift out sand as they suck water into their mouths. They then filter out tiny organisms from the water and eat them. The tadpoles scoot among leaves in the small stream where they were born until they develop into froglets and hop onto land.

Pyburn's pancake frog and people: People very rarely see this frog in the wild.

Conservation status: The World Conservation Union (IUCN) does not consider Pyburn's pancake frog to be at risk. This frog lives in a fairly large area. Logging, farming, and other activities are under way in part of its area and may be hurting the frogs that live there, but people have still not bothered most of the frog's habitat. Currently, Pyburn's pancake frog remains a common species. ■



Banded rubber frog *(Phrynomantis bifasciatus)*

BANDED RUBBER FROG
Phrynomantis bifasciatus

Physical characteristics: The banded rubber frog is black and pear-shaped with a wide body that becomes increasingly narrow toward the head. Two wide, red to orange red stripes run down the sides of the body from the snout over the eye and to the front of the hips. A red to orange red splotch also colors the rump. The body is smooth and quite shiny. Its short, front and back legs have numerous red spots. Its toes, which have almost no webbing, end in small pads. The front toes are quite long. Its underside is decorated with small white spots. Banded rubber frogs grow to about 2.75 inches (6.8 centimeters) long from the tip of the snout to the end of the rump. The tadpoles have a rather fish-like look, because their eyes are on the sides



During the day, they dig backward into the soil or into termite hills. Sometimes, they simply climb into holes in trees. They are active at night, when they come out on land. (© E. R. Degginger/Photo Researchers, Inc.)

of the head rather than on top, like many other tadpoles' eyes are.

Geographic range: The banded rubber frog lives along the far eastern side of central to southern Africa.

Habitat: Even though they do not have spades on their feet like many other digging frogs have, banded rubber frogs are burrowers. They spend much of their time in underground burrows that they dig themselves.

Diet: The adults eat small insects, especially ants and termites. Tadpoles suck in water and sift out tiny organisms, which they eat.

Behavior and reproduction: During the day, they dig backward into the soil or into termite hills. Sometimes, they simply climb into holes in trees. They are active at night, when they come out on land. Instead of hopping, they either walk or run. By remaining underground during the day, they avoid most predators. When necessary, however, they can also protect themselves by oozing a substance from their skin that predators find to be bad-tasting.

In rainy times of year, the males move into or alongside puddles and small pools of water and begin making their calls. The call is a high-pitched trill that lasts several seconds and then repeats. Like other frogs, the males and females mate when the male crawls up onto the female's back. The female can lay up to 1,500 eggs, which drop into the water and stick to underwater plants. The eggs hatch into tadpoles that float heads up in the water, while wiggling their whip-like tails below. In about a month, the tadpoles change into half-inch (1.3-centimeter) tadpoles.

Banded rubber frogs and people: People rarely see this burrowing frog, except in the pet trade, where it is fairly common. If a person handles the frog, it may ooze from its skin the same substance it uses to protect itself from predators. This substance may bother human skin.

Conservation status: The World Conservation Union (IUCN) does not consider the banded rubber frog to be at risk. This frog lives in a large area and has a large population, even though it is a fairly common pet species. ■

FOR MORE INFORMATION

Books:

Halliday, Tim, and Kraig Adler, eds. *The Encyclopedia of Reptiles and Amphibians (Smithsonian Handbooks).* New York: Facts on File, 1991.

Mattison, Chris. *Frogs and Toads of the World.* New York: Facts on File Publications, 1987.

Parker, H. W. *A Monograph of the Frogs of the Family Microhylidae.* London: British Museum, 1934.

Passmore, N. I., and V. C. Carruthers. *South African Frogs.* Johannesburg: Witwatersrand University Press, 1979.

Showler, Dave. *Frogs and Toads: A Golden Guide.* New York: St. Martin's Press, 2004.

Periodicals:

Milius, Susan. "Frogs Play Tree: Male tunes his call to specific tree hole." *Science News,* December 7, 2002 (vol. 162): 356.

Web sites:

"Chubby Frog." *Frogland.* http://allaboutfrogs.org/info/species/chubby.html (accessed on March 26, 2005).

"Eastern Narrow-Mouthed Toad *Gastrophryne carolinensis*." *USGS Northern Prairie Wildlife Research Center.* http://www.npwrc.usgs.gov/narcam/idguide/gcarolin.htm (accessed on March 26, 2005).

"The Fragile World of Frogs: Paternal Instincts." *National Geographic.* http://www.nationalgeographic.com/ngm/finaledit/0105/ (accessed on April 8, 2005).

"*Gastrophryne carolinensis*, Eastern Narrowmouth Toad." *Herps of Texas — Frogs and Toads.* http://www.zo.utexas.edu/research/txherps/frogs/gastrophryne.carolinensis.html (accessed on March 26, 2005).

"Painted Chorus Frog, *Microhyla butleri*." *Wildlife Singapore.* http://www.wildsingapore.per.sg/discovery/factsheet/frogpaintchorus.htm (accessed on March 26, 2005).

"Red-banded rubber frog, *Phrynomerus bifasciatus*." http://www.calacademy.org/research/herpetology/frogs/list22.html (accessed on March 26, 2005).

"Tomato Frog." *Woodland Park Zoo.* http://www.zoo.org/educate/fact_sheets/day/tomato.htm (accessed on March 26, 2005).

MADAGASCARAN TOADLETS
Scaphiophrynidae

Class: Amphibia
Order: Anura
Family: Scaphiophrynidae
Number of species: About 9 species

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

The Madagascaran toadlets are small frogs that look like toads. Many come in shades of brown or green, as do many toads. One of the toadlets is called the green burrowing frog. It, for instance, is green with brown blotches on its back, head, and legs. The red rain frog, however, is a more brightly colored member of this family. This species, which is also known as the rainbow burrowing frog, is red, orange red, or pink on its back and the top of its head, but white or light yellow green on its sides, legs, lower face, and underside. It also has considerable black markings on its body, along with a few yellow or whitish blotches on the back and head. Many of the toadlets have detailed, darker brown patterns on their backs. From one side of the back to the other, the patterns are usually mirror images of each other. This type of mirror-image pattern is known as a symmetrical (sim-MET-rih-kul) pattern.

Most Madagascaran toadlets have small warts. In some species, like Mocquard's rain frog, the warts may be as little as grains of sand, if they are there at all. The red rain frog has no warts on its back. Madagascaran toadlets have short back legs, but both their front and back legs have rather long toes. Each of the back feet has a noticeable bump, or tubercle (TOO-ber-kul). Their toes are either unwebbed or barely webbed. A few species, like the red rain frog and green burrowing frog have large pads on the tips of their front toes. The undersides of the frogs may be light or dark-colored. Mocquard's rain frog is a species with a white underside. It does, however, have red or

dark purple patches on the undersides of its upper legs. The red rain frog, on the other hand, has a dark underside that is usually a dark grayish purple.

The web-foot frog, also known as the narrow-headed frog, looks different from the other eight species of Madagascaran toadlets. This frog has a teardrop-shaped, pudgy-looking body with a snout that comes to a point. Its hind legs are rather long. It has very small eyes that only barely bulge from the sides of the head. The toes on the back feet are fully webbed.

Males and females look much alike, although the males in some species may have darker throats and be a bit smaller than females. Depending on the species, adults may be 0.8 to 2.4 inches (2 to 6 centimeters) long from the tip of the snout to the end of the rump. Red rain frogs can grow to 1.4 inches (3.6 centimeters) long as adults. Mocquard's rain frogs are a bit smaller, and the males are even smaller than the females. Female Mocquard's rain frogs grow to 1.1 to 1.3 inches (2.8 to 3.3 centimeters) long, while males only reach 0.8 to 1.1 inches (2 to 2.7 centimeters) long. Adult web-foot frogs reach to 0.8 to 1 inches (2 to 2.4 centimeters) long. In this species males are a bit larger than females.

This family contains about nine species. Some scientists count more, mostly by splitting one or more of these nine species into two, or count fewer by grouping two into one species. Although this volume lists the Madagascaran toadlets in their own separate family, some scientists believe they should be grouped with the family of narrow-mouthed frogs.

GEOGRAPHIC RANGE

All of the species in this family live in Madagascar, a large island nation in the Indian Ocean off southern Africa.

HABITAT

Madagascaran toadlets live in many areas of Madagascar from low areas at sea level to slopes up to 6,600 feet (2,000 meters) above sea level. Although the tadpoles of all species are found in the still waters of swamps and pools of water that dry up later in the year, the adults live in a variety of different habitats. Some, like the brown rain frog and the red rain frog, prefer hot, dry places in the western and southern regions of the country. The red rain frog spends the daytime hours under stones scattered along the ground of rather humid forests that cover slopes and

AN ANCIENT LINK

Scientists are interested in the Madagascaran toadlets because they think the toadlets may be a link between two major groups of frogs. One group, called the Ranoidea, includes the true frogs of the family Ranidae and others. The second group, called the Microhyloidea, includes the narrow-mouthed frogs and others. The skeletons of the adult Madagascaran toadlets include some bones that are like those found in both of these two groups. Madagascaran toadlet tadpoles also have a few features of each group. Because of the similarities between Madagascaran toadlets and the two major groups, scientists believe that both the Ranoidea and Microhyloidea probably had the same ancestor—one that, like the Madagascaran toadlets, had a combination of their characteristics. The species in Ranoidea kept some of those characteristics, and the species in Microhyloidea kept others.

canyons in the dry area. Other members of this family live in much colder places high on mountains where even the trees do not survive. These frogs, including the Madagascar rain frog, which is also known as the green rain frog, exist in grassland habitats. Rainforests, on the other hand, are the surroundings for the green burrowing frog and the web-foot frog. The web-foot frog, for instance, usually stays among fallen, rotting, and damp leaves lying on the forest floor.

DIET

Scientists know very little about the diet of Madagascaran toadlets, but they believe the frogs are mainly insect-eaters. Although toadlets, like the red rain frog, will eat crickets in captivity, this does not necessarily mean that they normally eat crickets in the wild. The tadpoles are filter-feeders, which means that they strain out tiny bits of food from the water.

BEHAVIOR AND REPRODUCTION

The Madagascaran toadlets usually remain hidden during the day, staying out of sight underground, often beneath stones or logs. The green burrowing frog sometimes comes out during the day. This frog's color and pattern help it to blend in as it wanders about on leaves along the ground or climbs up green moss-covered trees. The color and pattern of the web-foot frog is also an excellent camouflage. Unless the frog moves, most people cannot see the brown and yellowish frog against the muddy ground, plants, and trees of its habitat.

Scientists have learned most of the information about this family during the frogs' mating seasons and believe that the frogs bury themselves underground and rest for much of the rest of the year. This resting period is known as estivation (es-tih-VAY-shun).

The frogs mate during the summer's rainy season, which usually begins in Madagascar in December, January, or February.

After heavy rains soak the ground and fill pools and swamps with water, males will group together at the watering holes and begin calling together. Group calling is known as a chorus. The sound of the loud choruses can carry over long distances and attract females. Each male calls by using his body and his vocal sac, which is extra flesh on his throat. He sucks in air, blows up both his body and his vocal sac, and lets out the air to make his call. This can be a dangerous time for the male frogs, which not only call in females with their calls, but may call in predators. While the males are calling and their bodies are full of air, the frogs cannot dive down into the water to escape, and this makes them easy targets for predators.

Mating in each of these frog species typically occurs all at once and over a very short time. A frog species that mates together and over a short time is known as an explosive breeder. To mate, the male holds onto the female's back by grasping her near her front legs. From this position, she lays her eggs. Many species, including the web-foot frog and Mocquard's rain frog, lay several hundred tiny eggs measuring just 0.04 inches (1 millimeter) in diameter. Usually, the eggs float together and form a film on the water surface. The eggs hatch into tadpoles. The warmer the temperature outside, the faster the tadpoles turn into froglets.

MADAGASCARAN TOADLETS AND PEOPLE

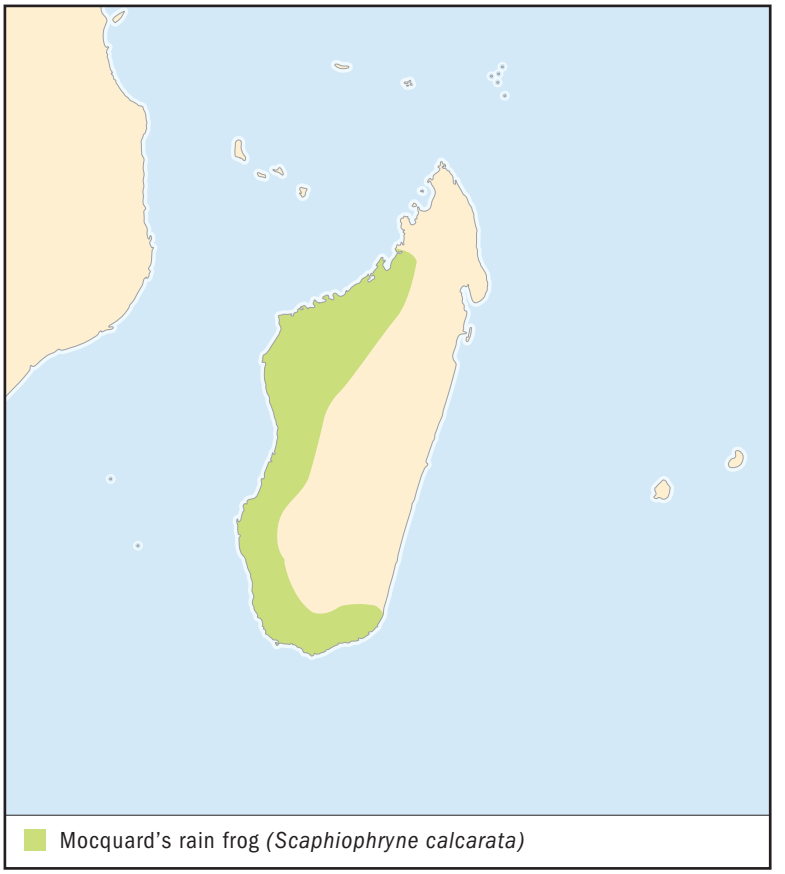
The more colorful Madagascaran toadlets are common in the pet trade.

CONSERVATION STATUS

The World Conservation Union (IUCN) considers one species in this family to be Critically Endangered, which means that it is facing an extremely high risk of extinction in the wild. All of the members of this species, the red rain frog, live in two tiny spots in south-central Madagascar. One of these spots is inside a national park. People sometimes collect this beautiful species to sell in the pet trade, but this could be hurting the species because its numbers are so low.

According to the IUCN, other species in this family are at risk. It lists the species known only by its scientific name of *Scaphiophryne boribory* as Endangered and facing a very high risk of extinction in the wild; the green burrowing frog as Vulnerable and facing a high risk of extinction in the wild; and the

Madagascar rain frog as Near Threatened and at risk of becoming threatened with extinction in the future. Two other species known by the scientific names of *Scaphiophryne obscura* and *Scaphiophryne verrucosa* are Data Deficient, which means that too little information is available to make a judgment about the threat of extinction. Some scientists think that these two species are actually one and the same and often list them both as *Scaphiophryne verrucosa*.



Mocquard's rain frog *(Scaphiophryne calcarata)*

MOCQUARD'S RAIN FROG
Scaphiophryne calcarata

SPECIES ACCOUNT

Physical characteristics: Mocquard's rain frog is a tiny species with small legs, a slightly pointy snout, and smooth to slightly warty skin on its back. Its back and head may be brown, gray, or green, often with a dark brown and symmetrical pattern on its back. Many also have a light-colored stripe running from head to rump down the middle of the back. Their legs are brown, usually with noticeable dark brown bands. Their sides are dark brown, the belly is white, and the undersides of the thighs are red or purple. The back toes have very little webbing between them, and the front toes have none at all. Males have a black throat, while females' throats are white with brown markings. Males and females are also a bit different in size. Males grow to



Mocquard's rain frog is active at night during the rainy season and likely spends the dry season buried underground. (Illustration by Bruce Worden. Reproduced by permission.)

00.8 to 1.1 inches (2 to 2.7 centimeters) long from snout to rump, and females reach 1.1 to 1.3 inches (2.8 to 3.3 centimeters) in length. This species, along with the web-foot frog at 0.8 to 1.0 inches (2 to 2.4 centimeters) long, are the smallest Madagascaran toadlets.

Geographic range: They live in western and southern Madagascar.

Habitat: Mocquard's rain frogs live in dry areas up to 1,000 feet (300 meters) above sea level. They can survive in forests, shrubby or grassy spots, and even farmland.

Diet: Scientists know little about the frog's diet, but the stomach of one captured frog was filled with large ants.

Behavior and reproduction: Like other Madagascaran toadlets, Mocquard's rain frog is active at night during the rainy season and likely spends the dry season buried underground. Heavy rains soak the earth during the summer in Madagascar, and males of this species group together at newly water-filled pools and swamps. The males begin calling in choruses for females and create quite a racket. When a female approaches a male, he calls even faster before climbing onto her back to mate. He holds on near her front legs as she lays several hundred small eggs. The eggs hatch into tadpoles. The tadpoles, which are almost completely see-through, sift food out of the water or pick small particles out of the water to eat. The tadpoles change into froglets in a few weeks, not long before their watering hole dries up for another year. The tiny newborn froglets are just 0.2 to 0.3 inches (5.5 to 7.5 millimeters) long from snout to rump.

Mocquard's rain frogs and people: This frog disappears underground in all but the rainy season, when some may hop into people's homes.

Conservation status: The World Conservation Union (IUCN) does not consider this species to be at risk. Mocquard's rain frog is quite common in its habitat, some of which is located in protected areas. ■

FOR MORE INFORMATION

Books:

Glaw, Frank, and Miguel Vences. *A Fieldguide to the Amphibians and Reptiles of Madagascar.* 2nd ed. Köln: Vences & Glaw Verlag, 1994.

Web sites:

"How Animal Camouflage Works." *How Stuff Works.* http://science.howstuffworks.com/animal-camouflage.htm (accessed on April 15, 2005).

"Narrow-headed frog." *Madagascar Biodiversity and Conservation.* http://www.mobot.org/mobot/madagascar/image.asp?relation=A56 (accessed on April 15, 2005).

"*Paradoxophyla palmata*." *AmphibiaWeb.* http://elib.cs.berkeley.edu/cgi-bin/amphib_query?query_src=aw_lists_alpha_&where-genus=Paradoxophyla&where-species=palmata (accessed on April 15, 2005).

"Species: *Scaphiophryne marmorata*." *Naturalia.* http://www.naturalia.org/ZOO/ANFIBI/e_39.html (accessed on April 15, 2005).

Staniszewski, Marc. "Madagascan Burrowing Frogs FAQ." *Marc Staniszewski's Amphibian Information Centre.* http://www.amphibian.co.uk/scaphiophryne.html (accessed on April 15, 2005).

SALAMANDERS AND NEWTS
Caudata

Class: Amphibia
Order: Caudata
Number of families: 10 families

order
CHAPTER

phylum
class
subclass
order
monotypic order
suborder
● **order**

PHYSICAL CHARACTERISTICS

Caudata (kaw-DAY-tuh) is the group of animals most people call salamanders but that also includes newts, sirens, hellbenders, olms, mudpuppies, and amphiumas (AM-fee-yoo-muhs). Salamanders are four-legged amphibians that have a long tail and short legs. Amphibians (am-FIB-ee-uhns) are vertebrates (VER-teh-brehts), or animals with a backbone, that have moist, smooth skin; are cold-blooded, meaning their body temperature is the same as the temperature of their surroundings; and, in most instances, have a two-stage life cycle. The word "amphibian" comes from a Greek word that means "having a double life." One of the life stages is a larva (LAR-vuh) that lives in water and has gills, and the other is an adult that lives on land and has lungs. Larvae (LAR-vee, the plural of larva) are animals in an early stage that go through metamorphosis (meh-tuh-MOR-foh-sus), or a change in body form, before becoming adults. Other amphibians are frogs, toads, and caecilians (sih-SILL-yuhns).

The head of a salamander is the same width as or narrower than the trunk. The trunk has twelve to eighteen vertebrae (ver-teh-BREE), which are the bones that make up the spinal column, also called the backbone even though it is made up of more than one bone. The tail of a salamander usually is about the same length as the head and body combined. Most salamanders are 1.5 to 8 inches (4 to 20 centimeters) long, but some can be as long as 5 feet (1.5 meters). Sirens and amphiumas look different from other salamanders in that they have a long, snakelike body, a short tail, and tiny legs.

The moist skin of a salamander contains many glands. Some of these glands make mucus, and some make poison. Most salamanders have camouflage coloring, but some are brightly colored. The brightly colored ones are poisonous or look like the poisonous ones in order to trick predators. Salamander skin is thick and tightly attached to the bone and muscle under it. Salamanders get 90 percent of their oxygen through their skin and also drink through their skin. Salamanders cannot survive if their skin dries out.

Salamanders have a long, fast tongue that contains as many as eleven bones. The tongue shoots from the mouth through the action of specialized muscles. The muscles that bring the tongue back into the mouth are extremely long, being anchored on the animal's hip bones. Salamanders have large eyes they use mainly for finding prey and watching out for predators. Salamanders also have an excellent sense of smell. Although they can hear, salamanders have no outer ears, and sound appears to play little role in their lives.

IS IT A SALAMANDER OR A LIZARD?

Many people confuse salamanders and lizards. In the southern parts of the United States, salamanders often are called "spring lizards." Salamanders are amphibians, but lizards are reptiles. Salamanders have smooth, moist skin, but lizards have dry, scaly skin. Salamanders have rounded toes, but lizards have claws.

GEOGRAPHIC RANGE

Almost all salamanders live in the Northern Hemisphere. One species even lives north of the Arctic Circle. Only a few species of salamanders live south of the equator, and those live in North and South America as far south as Bolivia.

HABITAT

Salamanders live in cool, damp places. Most live on land, some live in water, and some move between water and land. Salamanders live in areas ranging from northern forests to tropical rainforests and from sea level to high mountains. Some salamanders live in trees, and some live in caves. Salamanders that live on land often spend long periods in underground burrows, especially when they are not breeding and during cold winters and dry summers.

DIET

Adult salamanders eat spiders, insects, worms, crustaceans such as crayfish, mollusks such as slugs and snails, fish and fish eggs, tadpoles, other salamanders, and even small rodents.

WORLD CONSERVATION UNION CATEGORIES

Extinct No longer in existence.

Extinct in the Wild No longer alive except in captivity or through the aid of humans.

Critically Endangered Facing extremely high risk of extinction in the wild.

Endangered Facing very high risk of extinction in the wild.

Vulnerable Facing high risk of extinction in the wild.

Lower Risk/Conservation Dependent If the conservation program were to end, the animal would be placed in one of the threatened categories.

Low Risk/Near Threatened At risk of becoming threatened with extinction in the future.

Least Concern There is no known threat of extinction, and the animal does not qualify for any of the threatened categories.

Data Deficient There is not enough information to make a judgment about the threat of extinction.

Not Evaluated The species has not been evaluated for the threat of extinction.

Crustaceans (krus-TAY-shuns) are water-dwelling animals that have jointed legs and a hard shell but no backbone. Mollusks (MAH-lusks) are animals with a soft, unsegmented body that may or may not have a shell.

BEHAVIOR AND REPRODUCTION

Adult salamanders live alone rather than in groups. They hide during the day under leaves, rocks, or logs and are active at night but sometimes come out on rainy days. Salamanders hunt mainly by sight but also by smell. They sit and wait for prey to come close and then capture it with an explosive motion of their tongues. The tongue action is so fast it cannot be seen by human eyes.

Salamanders live as long as thirty years in the wild. The type of life cycle and method of development vary from species to species. In many species female salamanders lay eggs in the water, and the male releases sperm on them. Fertilization (FUR-teh-lih-ZAY-shun), or the uniting of egg and sperm to

start development, takes place outside the female's body. The eggs hatch into larvae that have gills and live in the water, sometimes for years, before going through metamorphosis. During the transformation the larvae lose their gills, develop lungs, grow legs, and crawl onto land. After metamorphosis, the adult salamanders spend all or most of their time on land. In some species, female salamanders guard their nests of eggs in order to protect them from predators and to keep them from drying out.

About one-half of salamander species do not have a water-dwelling larva stage. When they hatch from eggs laid on land, the young salamanders have the same body form as adults and continue to live the rest of their lives on land. In some species of salamanders, larvae that hatch from eggs laid on land wriggle to nearby water or are caught up by rising waters in the spring. They live in water for a while and then undergo metamorphosis. Still other species of salamanders live their entire lives in water with their bodies in the larva body form. Their reproductive organs do mature, however, and these salamanders do produce young.

Some male salamanders do not spread sperm on eggs but deposit a sperm packet in or near the water. The female takes the sperm into her body, and fertilization takes place inside her. In a few species of salamanders, the developing larvae stay inside the female for one or two years or even longer. These larvae go through metamorphosis inside the female. The young animals are quite large when they are born, having received their nourishment first by eating their siblings and later by eating secretions in the female.

Most salamander larvae can be classified as the pond type or the stream type. The pond type usually change form in one season and have large, feathery gills and a large tail fin. Stream-type larvae have a small tail fin, very short gills, and a flat body with short, fat legs and hard toes. These larvae may live for several seasons before going through metamorphosis.

U.S. FISH AND WILDLIFE SERVICE CONSERVATION CATEGORIES

Endangered In danger of extinction throughout all or a significant portion of its range.

Threatened Likely to become endangered in the near future.

SALAMANDERS, NEWTS, AND PEOPLE

Some people keep salamanders as pets. Salamanders also have been the subjects of myth, folklore, and literature. According to

Aztec myth in Mexico, a god trying to escape from his enemies dove into water and changed himself into a salamander. From at least the time of the ancient Romans people have believed that salamanders cannot be harmed by fire. This belief arose because salamanders were seen crawling out of the flames after people placed logs on a fire. People also once believed that salamanders had magical powers. In the play *Macbeth* by William Shakespeare, three witches brew a potion using "eye of newt."

CONSERVATION STATUS

The World Conservation Union (IUCN) lists two species of salamanders as Extinct, forty-six as Critically Endangered, 105 as Endangered, eighty-one as Vulnerable, and fifty-six as Near Threatened. Extinct means no longer in existence. The U.S. Fish and Wildlife Service lists six species of salamanders and newts as Endangered and five as Threatened.

FOR MORE INFORMATION

Books:

Bernhard, Emery. *Salamanders.* New York: Holiday House, 1995.

Lawlor, Elizabeth P. *Discover Nature in Water and Wetlands.* Mechanicsburg, PA: Stackpole, 2000.

Llamas Ruiz, Andres. *Reptiles and Amphibians: Birth and Growth.* New York: Sterling, 1996.

Petranka, J. W. *Salamanders of the United States and Canada.* Washington, DC: Smithsonian Institution Press, 1998.

Web sites:

Hawes, Ales. "On Waterdogs, Mudpuppies, and the Occasional Hellbender." *Zoogoer.* http://nationalzoo.si.edu/Publications/ZooGoer/2000/2/waterdogsmudpuppieshellbender.cfm (accessed on March 28, 2005).

"Order Caudata (Salamanders)." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/classification/Caudata.html (accessed on March 28, 2005).

"Order Caudata: Salamanders." Northern Prairie Wildlife Research Center. http://www.npwrc.usgs.gov/narcam/idguide/index.htm#ambystom (accessed on March 28, 2005).

family CHAPTER

SIRENS AND DWARF SIRENS
Sirenidae

Class: Amphibia
Order: Caudata
Family: Sirenidae
Number of species: 4 species

PHYSICAL CHARACTERISTICS

Sirens and dwarf sirens are salamanders with eel-like bodies, no hind legs, and front legs that are extremely small. The jaws are covered with a hard, beaklike structure. The gills are large and stick up from the head like feathers. The body is shaped like a tube with a flat tail. Young sirens have a clear fin on their back that extends to the tip of the tail. On older sirens the part of the fin on the back disappears, and the tail fin that is left becomes solid rather than clear. The legs of sirens have three or four toes that have hard tips.

Sirens and dwarf sirens never leave the water. They get oxygen from water passing through their gills and skin, but they also have lungs. These salamanders live their entire lives with a larva body form. A larva (LAR-vuh) is an animal in an early stage that changes form, or goes through metamorphosis (meh-tuh-MOR-foh-sus), to become an adult. Sirens and dwarf sirens do not respond to the environmental signals that tell other salamanders to start metamorphosis.

Sirens and dwarf sirens are 5 to 40 inches (12 to 100 centimeters) long. Newly hatched sirens and younger larvae (LAR-vee, the plural of larva) are deep black with yellow, red, or silvery white markings. There is a band across the nose and another on the top of the head. Many of these animals have stripes on the body. When the animals are older the markings become dull or disappear.

GEOGRAPHIC RANGE

Sirens live in North America from the far northeastern part of Mexico north to the southwestern part of Michigan and east to Maryland. Dwarf sirens live in the southeastern part of the United States from Florida to South Carolina.

HABITAT

Sirens and dwarf sirens live in still to slowly flowing, often swampy, water with a muddy bottom and sometimes with floating and rooted plants.

DIET

Sirens and dwarf sirens eat any water animal small enough for them to swallow.

BEHAVIOR AND REPRODUCTION

Sirens and dwarf sirens hide in burrows near the water's edge during daylight hours and come out at night to look for food along the water bottom and among plants. These salamanders swim by making wavy movements of their body and tail, but they also move their small legs in walking motions when they are near the bottom.

To find food, sirens and dwarf sirens poke around with their snouts and find prey using their sense of smell. They suck food into their mouth by rapidly expanding their throat and opening the mouth so that the food is sucked inside with a rush of water. Gill rakers keep the food inside the throat, and the water passes to the outside through gill slits. Sirens and dwarf sirens are greedy eaters. They shake their prey vigorously and swallow larger animals in a series of gulps without breaking the prey into pieces.

Even though they look like larvae, adult sirens and dwarf sirens have reproductive organs and produce young. Scientists do not know how fertilization (FUR-teh-lih-ZAY-shun), or the joining of egg and sperm to start development, takes place in these salamanders. They believe it happens outside the body because males do not have glands for making a sperm packet, and females do not have a sac for sperm storage. The large eggs are laid singly, sometimes attached to plants, or in groups.

SIRENS, DWARF SIRENS, AND PEOPLE

Dwarf sirens have been sold as fishing bait.

CONSERVATION STATUS

Sirens and dwarf sirens are not considered threatened or endangered.

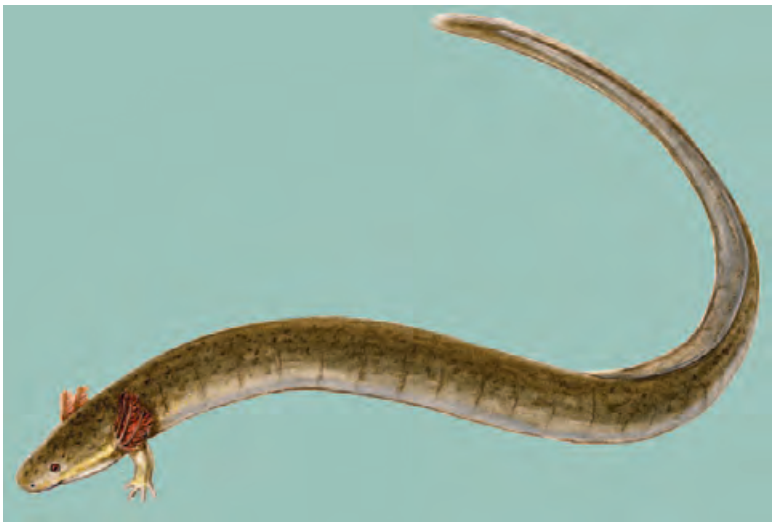


Lesser siren *(Siren intermedia)*

SPECIES ACCOUNT

LESSER SIREN
Siren intermedia

Physical characteristics: In addition to having a long, tubular body, no hind legs, and very short front legs, lesser sirens have thirty-one to thirty-seven grooves along their sides, four toes, and three gill slits. They are 7 to 27 inches (18 to 69 centimeters) long. The head is broadly rounded when looked at from the top. Newly hatched larvae are densely black and have bright red bands across the tip of the snout, across the head, and on the body. Older lesser sirens may keep a pale snout band, but the other markings disappear. The adult color pattern appears to vary from place to place in the geographic range, but there is always a greenish to gray background color with different amounts of shimmery speckling. The clear fin on the young siren's back and tail becomes solid in older lesser sirens and is present only on the tail.



Lesser sirens eat almost any water animal they can catch and fit into their mouths. (Illustration by Joseph E. Trumpey. Reproduced by permission.)

Geographic range: Lesser sirens live in North America from the far northeastern part of Mexico north to the southwestern part of Michigan and east to Florida and the southeastern part of Virginia.

Habitat: Lesser sirens live in many types of still or slowly flowing water, such as swamps, ponds, and ditches.

Diet: Lesser sirens eat almost any water animal they can catch and fit into their mouths, including small crustaceans such as crayfish, worms, mollusks such as snails, insect larvae, and small fishes. Crustaceans (krus-TAY-shuns) are water-dwelling animals that have jointed legs and a hard shell but no backbone. Mollusks (MAH-lusks) are animals with a soft, unsegmented body that may or may not have a shell.

Behavior and reproduction: Lesser sirens spend all their time in the water. Large numbers of them may live in one place. These salamanders spend the daylight hours burrowed into the water bottom or near the water's edge. They look for food along the water bottom at night. They suck the prey into their mouths and swallow it whole.

Salamanders usually do not make a sound, but when bitten or forced from a hiding spot by another salamander, lesser sirens yelp. Lesser sirens placed in unfamiliar surroundings may make several types of sounds. If there is not enough oxygen in the water, these lesser sirens come to the surface to gulp air.

If their pond, ditch, or mud hole dries out, lesser sirens move into burrows at the bottom and wait for water. They make a cocoon by

shedding their skin several times and become inactive until water returns. The gills do not work unless the salamander is underwater, and they become small nubs while the lesser siren is in its burrow and breathing with its lungs.

Female lesser sirens lay as many as fifteen hundred eggs in a nest at the water bottom. Scientists believe one of the parents guards the nest. Each egg is enclosed in four jelly envelopes. The eggs hatch forty-five to seventy-five days after being laid. At this point the larvae are about 0.4 inches (10 millimeters) long.

Scientists do not know how lesser sirens find their mates or how the eggs are fertilized (FUR-teh-lyzed). They have found that during the breeding season most lesser sirens large enough to reproduce have a number of bite marks on them that match the size of the mouth of this species. Scientists believe males and females may bite each other during mating or that males bite one another while fighting over females or over territory.

Lesser sirens and people: Lesser sirens have no known importance to people. Some people are afraid of these salamanders because they confuse them with amphiumas (AM-fee-yoo-muhs), which give a dangerous bite.

Conservation status: Lesser sirens are not considered threatened or endangered. ■

FOR MORE INFORMATION

Books:

Bernhard, Emery. *Salamanders.* New York: Holiday House, 1995.

Llamas Ruiz, Andres. *Reptiles and Amphibians: Birth and Growth.* New York: Sterling, 1996.

Petranka, J. W. *Salamanders of the United States and Canada.* Washington, DC: Smithsonian Institution Press, 1998.

Web sites:

Gabbard, J. "*Siren intermedia.*" *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Siren_intermedia.html (accessed on March 28, 2005).

family CHAPTER

ASIATIC SALAMANDERS
Hynobiidae

Class: Amphibia
Order: Caudata
Family: Hynobiidae
Number of species: 43 species

PHYSICAL CHARACTERISTICS

Asiatic salamanders are small to medium-sized salamanders. Most of these salamanders are 4 to 10 inches (10 and 25 centimeters) long, although some species grow to a length of 12 inches (30 centimeters). Most of these salamanders are dull sandy brown to dark olive, but a few species have colorful spots on their backs.

There are two main groups of Asiatic salamanders. One group lays a large number of eggs, and the larvae (LAR-vee), or animals in an early stage, spend one year in development before metamorphosis (MEH-tuh-MORE-feh-sis), or a change in body form to become an adult, is finished. The other group lays a much smaller number of eggs, and the larvae take two to three years to go through metamorphosis.

Some Asiatic salamanders that live in mountain streams have a hard structure on their toes. One species has claws. Some species have a horny covering on their feet. These structures and coverings help the salamanders grasp the ground. Some Asiatic salamanders have four instead of five toes. The arrangement of the teeth, which are located on the roof of the mouth, is an important characteristic for identifying the genus (JEE-nus) and species (SPEE-seez) of Asiatic salamanders. Some species of Asiatic salamanders have very small lungs, and others have no lungs at all. The small size or lack of lungs may be part of the salamanders' water-dwelling lifestyle. The larvae of Asiatic salamanders have four pairs of gill slits. Gills are organs for obtaining oxygen from water.

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

EYE OF NEWT, BREAKFAST OF BAT?

Paghman mountain salamanders have the most bizarre diet of all Asiatic salamanders. Baby bats have been found in their stomachs. The salamanders live in caves, which they share with bats. The baby bats fall into the water, where they are caught and eaten by the salamanders.

GEOGRAPHIC RANGE

Asiatic salamanders live only in Asia. Their range extends from Japan, Taiwan, and the mainland of China westward to Afghanistan, Iran, and Kazakhstan in central Asia. To the north, Asian salamanders live on the Kamchatka peninsula, the island of Sakhalin, and in Siberia and Mongolia westward beyond the Ural Mountains. Siberian salamanders are the only Asiatic salamanders that enter European Russia and are the only salamanders that live north of the Arctic Circle.

HABITAT

Some Asiatic salamanders, such as clouded salamanders, live only in lowlands. Others live only in the mountains. Many live 6,600 to 13,000 feet (2,000 to 4,000 meters) above sea level. The record for highest home belongs to the Tibetan stream salamander, which lives in western China at a height of 14,000 feet, or about 2.5 miles (4,250 meters).

Some Asiatic salamanders live in water all year. These salamanders live mainly in mountain streams with cool, fast-flowing water. During daylight hours, they stay under rocks in the water. Sometimes they hide under large rocks on shore, but they are never far from water. In some species of Asiatic salamanders the adults spend most of the year on land, but in the breeding season (February to June) they travel to and gather at breeding sites, which are either ponds or mountain streams with running water. Most species breed in only one of the types of water. For example, Korean salamanders breed only in ponds. Some species, however, such as Chinese salamanders, breed in both ponds and streams. They have been found under rocks and grass and in burrows. Some species have been dug out of soil.

DIET

Asiatic salamanders, both larvae and adults, eat insects and other invertebrates (in-VER-teh-brehts), which are animals without backbones. Hokkaido salamanders and Longdong stream salamanders eat others of their own species.

BEHAVIOR AND REPRODUCTION

Asiatic salamanders hunt for food at night. Scientists know little else about how these salamanders behave outside of breeding season. The breeding season varies from late winter to early summer. Some Asiatic salamanders breed in late winter and early spring. The eggs develop in ice-cold water mixed with ice and snow. Others breed in early summer. The breeding season may be as late as July for some species in western China.

Males of all but one species of Asiatic salamanders release sperm into the water while the females are laying sacs of eggs. The exception is male Semirechensk salamanders, which place sacs of sperm on rocks or plants. In all species, fertilization (FUR-teh-lih-ZAY-shun), or the joining of egg and sperm to start development, takes place outside the body. The females lay two groups of eggs, one batch of eggs coming from each ovary. The ovaries (OH-vuh-reez) are the organs that make eggs. The eggs are contained in jelly-like sacs, which attach to rocks or plants in ponds, streams, or marshes. Egg sacs that do not attach to something usually are not fertilized (FUR-teh-lyzed). The number of eggs in each sac varies, ranging from three in Japanese clawed salamanders to 105 in Siberian salamanders.

In most species of Asiatic salamanders the female chooses an object such as a rock or plant, grasps it firmly, and lays her egg sacs on it. The sacs stick to the rock or plant. After she releases part of the egg sac, the female lets go of the plant or rock and floats backward. A male waiting nearby immediately moves onto the egg sac. The male often pushes and kicks the female with its legs and presses on the egg sacs with its cloaca to fertilize the eggs. The cloaca (kloh-AY-kuh) is a chamber in both males and females that holds waste from the kidneys and intestines as well as eggs and sperm before they are released to the outside. The male's activity may help to speed up egg laying. Male clouded salamanders guard and vigorously defend the egg sacs they have fertilized.

Most Asiatic salamander eggs hatch in three to five weeks, depending on the temperature. The larvae of some salamander species that are not well developed when they hatch have a balancer on each side of the head. The balancers, which look like whiskers, support the head until the front legs develop, and then they fall off. The larvae of most stream-breeding Asiatic salamanders are well developed when they hatch and do not have balancers.

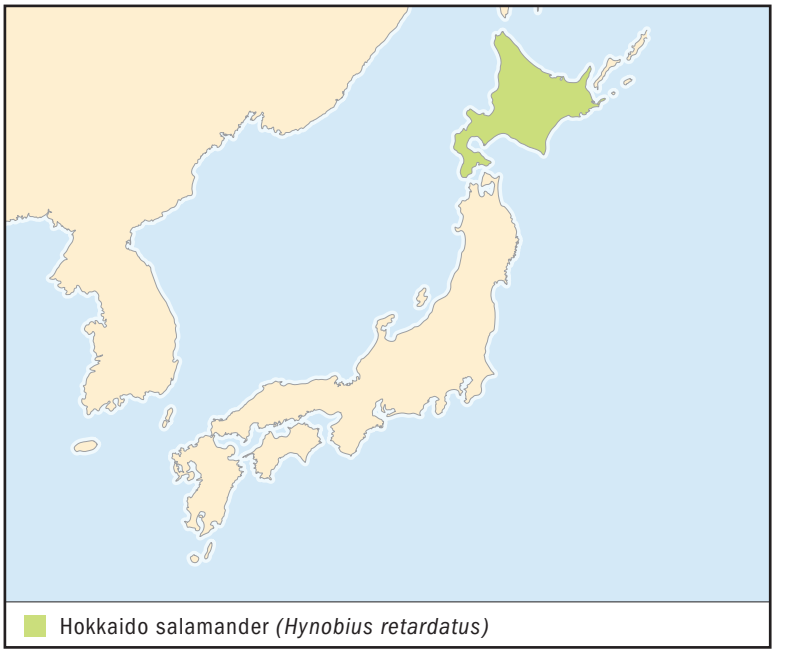
ASIATIC SALAMANDERS AND PEOPLE

Asiatic salamanders have no known importance to people.

CONSERVATION STATUS

The World Conservation Union (IUCN) lists five species of Asiatic salamanders as Critically Endangered, ten as Endangered, twelve as Vulnerable, and two as Low Risk/Near Threatened. Critically Endangered means facing extremely high risk of extinction in the wild. Endangered means facing very high risk of extinction in the wild. Vulnerable means facing high risk of extinction in the wild. Low Risk/Near Threatened means at risk of becoming threatened with extinction in the future.

The primary threats to the survival of Asiatic salamanders are their small geographic ranges and small numbers. Many Asiatic salamanders live in only a small area on one island or mountain. These areas in Japan and China are getting smaller and are being separated from one another. Damage to habitat caused by people is another problem for these salamanders.



HOKKAIDO SALAMANDER
Hynobius retardatus

Physical characteristics: Hokkaido salamanders are 4 to 7 inches (10 to 18 centimeters) long. There are eleven or twelve grooves along the sides of the body, and the tail is long. The legs and toes are long compared with those of other Asiatic salamanders. The back is dark brown with a few blurry spots. Some Hokkaido salamanders keep the larval body form even though they grow to adult size.

Geographic range: Hokkaido salamanders live on Hokkaido, the northernmost of the main islands of Japan.

Habitat: Hokkaido salamanders live less than 6,600 feet (2,000 meters) above sea level. During the breeding season they live in slow-moving streams and ponds. When they are not breeding, these salamanders live on land under grass, rocks, and leaf litter on the forest floor but often visit bodies of water.

Diet: The larvae of Hokkaido salamanders eat small water-dwelling invertebrates. Adults eat insects, crustaceans, water worms, and,



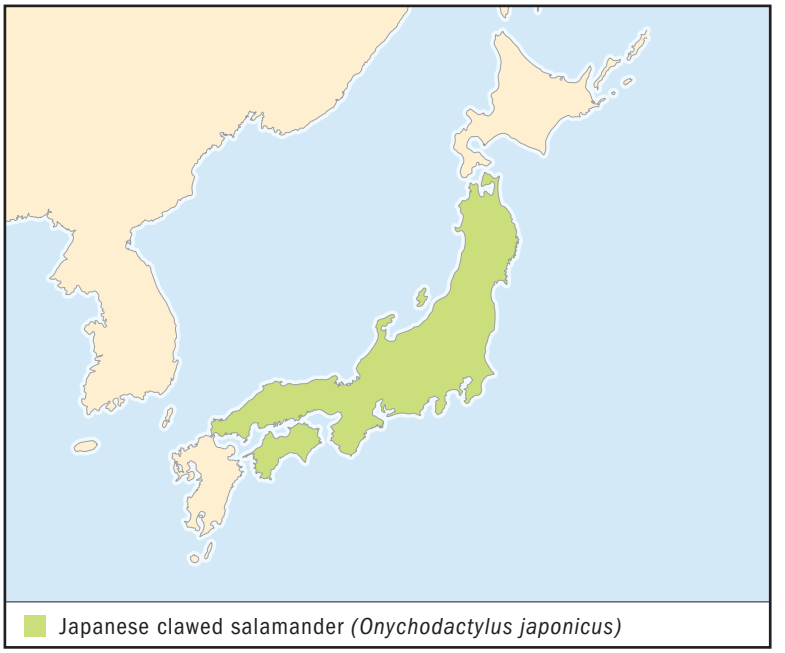
Hokkaido salamander larva finish metamorphosis within one year, but if the water is cold, metamorphosis can take two or even three years. (Photograph henk.wallays@skynet.be. Reproduced by permission.)

sometimes, fish. Crustaceans (krus-TAY-shuns) are water-dwelling animals that have jointed legs and a hard shell but no backbone. Hokkaido salamander larvae packed close together in large groups sometimes eat other Hokkaido salamander larvae but usually do not eat their brothers and sisters.

Behavior and reproduction: Scientists know how Hokkaido salamanders reproduce but little else about how these salamanders behave. Breeding starts when the snow begins to melt and the water temperature is 37 to 41°F (3 to 5°C). In most areas, the breeding season is in April, but at higher elevations, breeding may not start until early June. Both male and female Hokkaido salamanders travel to and gather at their breeding sites. Mating and egg laying take place at night. The females lay two egg sacs, which attach to twigs and grass. Each egg sac usually contains thirty to fifty eggs, but there may be as many as ninety-three eggs in a sac. Larvae finish metamorphosis within one year, but if the water is cold, metamorphosis can take two or even three years.

Hokkaido salamanders and people: Hokkaido salamanders have no known importance to people.

Conservation status: Hokkaido salamanders are not considered threatened or endangered. ■



JAPANESE CLAWED SALAMANDER
Onychodactylus japonicus

Physical characteristics: Japanese clawed salamanders are 4 to 7 inches (10 to 18 centimeters) long. The body is thin, and the tail is long. The back is brown with orange spots. There also are orange spots on the back of the head and on the legs. Orange stripes run along the center of the back. The larvae have clawlike structures on their toes. Adults have these "claws" only during the breeding season. Japanese clawed salamanders do not have lungs.

Geographic range: Japanese clawed salamanders live on two Japanese islands, Honshu and Shikoku.

Habitat: Japanese clawed salamanders live more than 3,300 feet (1,000 meters) above sea level. When they are not breeding, these salamanders live on land but very close to water. Their favorite places are under wet rocks or logs beside a stream. They also live under logs on the forest floor, in tree holes, and in other damp places.

Diet: Japanese clawed salamanders eat insects and their larvae, spiders, millipedes, snails, tadpoles, and fish larvae.



Japanese clawed salamanders live on two Japanese islands, Honshu and Shikoku. (© Joseph T. Collins/Photo Researchers, Inc.)

Behavior and reproduction: Scientists know how Japanese clawed salamanders reproduce but little else about how these salamanders behave. The males breed every two years, and the females breed every three years. The breeding season is in May, but in some areas it extends into June. The females lay eggs at night, usually at the source of a mountain stream. Each of the two egg sacs contains three to eight eggs, for a total of seven to fifteen eggs per female. Larvae take three years to finish metamorphosis.

Japanese clawed salamanders and people: Japanese clawed salamanders have no known importance to people.

Conservation status: Japanese clawed salamanders are not considered threatened or endangered. ■



Semirechensk salamander *(Ranodon sibiricus)*

SEMIRECHENSK SALAMANDER
Ranodon sibiricus

Physical characteristics: Semirechensk salamanders are 6 to 10 inches (15 to 25 centimeters) long. The tail is as long as the rest of the body and has a ridge along the top. The body is brown with scattered black spots. Adult Semirechensk salamanders have small lungs.

Geographic range: Semirechensk salamanders live in the Ala Tau mountains and the Tien Shan mountains of eastern Kazakhstan and western China.

Habitat: Semirechensk salamanders live in mountain streams and marshes 5,000 to 9,000 feet (1,500 to 2,750 meters) above sea level.

Diet: Larvae of Semirechensk salamanders and salamanders that have just completed metamorphosis eat the larvae of water-dwelling invertebrates. Adults eat water-dwelling and land-dwelling invertebrates.

Behavior and reproduction: Semirechensk salamanders hunt for food at night. The larvae begin hunting four to eight days after they hatch. These salamanders continue to hunt during metamorphosis.



Semirechensk salamanders live in mountain streams and marshes. (© Joseph T. Collins/ Photo Researchers, Inc.)

The breeding season is May to July. Semirechensk salamanders take two to three years to go through metamorphosis. Male Semirechensk salamanders are the only Asiatic salamanders that make bags of sperm. They attach the sperm bags to the undersides of rocks and plants, and females attach their egg sacs to the same rocks and plants, where fertilization takes place. Male Semirechensk salamanders, not the females, choose the breeding sites.

Semirechensk salamanders and people: Semirechensk salamanders have no known importance to people.

Conservation status: The World Conservation Union (IUCN) lists Semirechensk salamanders as Endangered, or facing very high risk of extinction in the wild. They are under protection in both Russia and China. The small geographic range and damage to their habitat are the main threats to the survival of Semirechensk salamanders. These salamanders do well in captivity, and some scientists are trying to return them to the wild. ■

FOR MORE INFORMATION

Books:

Bernhard, Emery. *Salamanders.* New York: Holiday House, 1995.

Duellman, William E., and Linda Trueb. *Biology of Amphibians.* Baltimore: Johns Hopkins University Press, 1994.

Gunzi, Christiane. *Amphibians and Reptiles of North America.* San Diego, CA: Thunder Bay, 1995.

Lawlor, Elizabeth P. *Discover Nature in Water and Wetlands.* Mechanicsburg, PA: Stackpole, 2000.

Llamas Ruiz, Andres. *Reptiles and Amphibians: Birth and Growth.* New York: Sterling, 1996.

Petranka, J. W. *Salamanders of the United States and Canada.* Washington, DC: Smithsonian Institution Press, 1998.

Web sites:

Heying, H. "Hynobiidae." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Hynobiidae.html (accessed on April 5, 2005).

"Hynobiidae (Cope, 1859) Asiatic Salamanders." *Livingunderworld.org.* http://www.livingunderworld.org/caudata/families/index.htm#hynobiidae (accessed on April 5, 2005).

ASIATIC GIANT SALAMANDERS AND HELLBENDERS

Cryptobranchidae

Class: Amphibia
Order: Caudata
Family: Cryptobranchidae
Number of species: 3 species

family CHAPTER

PHYSICAL CHARACTERISTICS

Asiatic giant salamanders and hellbenders are the largest salamanders, and the largest amphibians. Amphibians (am-FIB-ee-uhns) are vertebrates (VER-teh-brehts), or animals with a backbone, that have moist, smooth skin; are cold-blooded, meaning their body temperature is the same as the temperature of their surroundings; and, in most instances, have a two-stage life cycle. Asiatic giant salamanders and hellbenders are born in the water and spend their entire lives there, never moving to land the way many other amphibians do. There are only three species in this group: Chinese giant salamanders, Japanese giant salamanders, and hellbenders. Asiatic giant salamanders grow to a length of almost 6 feet (1.8 meters) and weigh as much as 50 pounds (23 kilograms). The longest hellbender is about half that length. Asiatic giant salamanders and hellbenders have a broad, flat head and body that makes it easy for them to get under rocks. The tail is flat, too, but from side to side rather than from top to bottom, making it look like an eel's tail.

Asiatic giant salamanders and hellbenders have loose flaps of skin along the sides of their bodies and on the legs. This skin is filled with blood vessels only one cell thick that allow oxygen to pass directly from the water into the salamander's blood. This is how these salamanders breathe. They have lungs and go to the surface sometimes to gulp air but use the lungs mainly for staying stable in the water. The skin of these salamanders also makes lots of slime.

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

Asiatic giant salamanders and hellbenders have many colors and patterns. They can be gray, brown, greenish brown, yellowish brown, orange-red, or, rarely, white. Some of them have dark blotches or speckles. Japanese giant salamanders and Chinese salamanders have bumps on their heads and throats. The bumps on Japanese giant salamanders are large and separate from one another, but those on Chinese giant salamanders are small and paired.

The legs of Asiatic giant salamanders and hellbenders are thick and strong but short. The eyes are small and do not have eyelids. Hellbenders usually keep one pair of gill openings on each side of their head throughout life, but Asiatic giant salamanders lose these openings during metamorphosis, which can take as long as three years. Gills are organs for obtaining oxygen from water. Metamorphosis (MEH-tuh-MORE-feh-sis) is the process by which some animals change body form before becoming adults. The jaws of Asiatic giant salamanders and hellbenders are very flexible. Bundles of elastic tissue called cartilage (CAR-tih-lej) allow each side of the lower jaw bone to move by itself, so these salamanders can open their mouths very wide to suck in large prey.

GEOGRAPHIC RANGE

Asiatic giant salamanders and hellbenders live in the eastern part of China, the southern part of Japan, and the eastern part of the United States.

HABITAT

Asiatic giant salamanders and hellbenders live in cool streams and rivers with gravel- or rock-covered bottoms. Chinese giant salamanders live in mountain streams, usually at heights less than 5,000 feet (1,500 meters) above sea level. Japanese giant salamanders live at heights less than 2,300 feet (700 meters) above sea level. Hellbenders live below 2,500 feet (750 meters) above sea level.

DIET

Asiatic giant salamanders and hellbenders mainly eat crustaceans and fish. They also eat worms, mollusks, insect larvae, crustaceans, lampreys, fish and fish eggs, frogs and toads and their tadpoles, water-dwelling reptiles, and small mammals as well as the meat of dead animals, their own shed skin and eggs,

and one another. Mollusks (MAH-lusks), such as slugs and snails, are animals with a soft, unsegmented body that may or may not have a shell. Larvae (LAR-vee) are animals in an early stage that change form before becoming adults. Crustaceans (krus-TAY-shuns), such as crayfish, are water-dwelling animals that have jointed legs and a hard shell but no backbone.

WHAT'S IN A NAME?

People believed the side-to-side movements of hellbenders and the wavy motion of their skin made these animals look like they were experiencing the tortures of hell.

BEHAVIOR AND REPRODUCTION

Asiatic giant salamanders and hellbenders spend their entire lives in water, rarely coming to the surface. They hunt at night. These salamanders capture prey by quickly opening their flexible jaws and sucking in the prey with a rush of water.

Asiatic giant salamanders and hellbenders breed from August through January, as the days get shorter and the water becomes colder. As the breeding season approaches, these salamanders, especially the males, become more active during the day as they look for places to mate and build nests. They usually choose a place under a rock or log that is protected on the upstream side but has an entrance facing downstream. Tunnels and cracks in the stream or river bank also are good places for hellbender nests.

After finding a good breeding place, a male Asiatic giant salamander or hellbender places himself at the entrance to the nest and lures in or forces in one or more egg-filled females. The male fights a female if she tries to leave before laying her eggs. As the female lays two strings of eggs, the male places himself alongside her. He rocks the lower part of his body and releases sperm over the egg masses. Fertilization (FUR-teh-lih-ZAY-shun), or the joining of egg and sperm to start development, takes place outside the body. The male then guards the eggs and the nest from predators, which include other salamanders in the same species. The larvae are usually 1 to 1.3 inches (2.5 to 3.3 centimeters) long when they hatch. In the wild, Asiatic giant salamanders live more than sixty years, and hellbenders live more than thirty years.

ASIATIC GIANT SALAMANDERS, HELLBENDERS, AND PEOPLE

People have eaten Asiatic giant salamanders and hellbenders for centuries. In parts of Asia these animals were used as

Save the Hellbenders

If you accidentally catch a hellbender while you are fishing, set it free. Do not take it home to keep as a pet.

medicines and in religious ceremonies and were considered delicacies until they gained protected status. In North America hellbenders have been used for food and fish bait. Asiatic giant salamanders and hellbenders usually are harmless but if attacked can give a severe bite to a finger or hand.

CONSERVATION STATUS

The World Conservation Union (IUCN) lists one species of Asiatic giant salamanders and hellbenders as Critically Endangered and two species as Low Risk/Near Threatened. Critically Endangered means facing extremely high risk of extinction in the wild. Low Risk/Near Threatened means at risk of becoming threatened with extinction in the future.

Much of the habitat of Asiatic giant salamanders and hellbenders has been destroyed or damaged by pollution and by people trying to control the flow of rivers by removing rocks and building dams. Rock removal takes away the salamanders' hiding and breeding places. Dam building forms lakes, which do not have enough fast water flow and are too warm for these salamanders. Habitat also is destroyed by the buildup of silt, which is dirt that is almost like sand. When river or stream banks do not have enough plant life on them to keep the soil in place, as happens when livestock eat all the grass away, when all the trees are cut down, or when farmers do not use good planting practices, the soil is washed from the land into streams and rivers. The silt smothers the eggs of salamanders and other animals and also smothers the invertebrates (in-VER-teh-brehts), or animals without backbones, that they eat.

People may be collecting too many Asiatic giant salamanders and hellbenders. Scientists are successfully breeding Japanese giant salamanders in zoos, and they are trying to figure out how to breed hellbenders, so that these animals can be returned to the wild.



Hellbender *(Cryptobranchus alleganiensis)*

HELLBENDER
Cryptobranchus alleganiensis

SPECIES ACCOUNT

Physical characteristics: Most hellbenders are 11 to 20 inches (28 to 51 centimeters) long and weigh 4 to 5 pounds (1.8 to 2.3 kilograms). The record length is 29 inches (74 centimeters). Male hellbenders are smaller than females. Hellbenders have a broad, flat body and head, like those of a catfish. The tail, however, is flat from side to side, looking like an eel's tail, and has a ridge along the top and the bottom to help in steering. Hellbenders are brown or gray, but during the breeding season some of them change from greenish brown or yellowish brown during the day to orange at night. The toes have rough pads that help the salamanders keep their traction on slippery rocks. Other names for hellbenders are devil dogs, water dogs, mud devils, mountain alligators, and walking catfish.

Hellbenders have floppy folds of skin along the sides of their bodies and on their legs. This skin is filled with many tiny blood vessels that absorb oxygen from the water flowing over the salamander.



The larvae of Hokkaido salamanders eat small water-dwelling invertebrates. Adults eat insects, crustaceans, water worms, and, sometimes, fish. (© Dr. Paul A. Zahl/Photo Researchers, Inc.)

Hellbenders get about 95 percent of their oxygen this way. They have lungs and can gulp air through them if necessary, but they rarely come to the surface. The lungs are used mainly as internal balloons to help keep the hellbender light enough to walk along the bottom. Hellbenders are very slimy. The slime is made in glands in the skin and tastes bad to predators.

Geographic range: Hellbenders live only in North America. Their range is southern New York south to northeastern Mississippi and west to eastern Missouri and Arkansas. The hellbenders that live in this region are called eastern hellbenders. Other hellbenders live only in south central Missouri and a few rivers in north central Arkansas. These are called Ozark hellbenders.

Habitat: Hellbenders live in clear, fast-moving, rocky streams and rivers less than 2,500 feet (750 meters) above sea level. The riffling movement over rocks keeps the water full of oxygen, and the rocks give the hellbenders places to hide and breed.

Diet: Crayfish are the main prey of hellbenders, but these salamanders also eat insects, snails, fish eggs, and worms. Hellbenders eat by sucking in their prey with a rush of water.

Behavior and reproduction: Hellbenders spend their entire lives in the water. They never make the change to land the way many salamanders do. When they are not breeding, hellbenders live alone. They hide during the day, sometimes with their head sticking out from under a rock. Even though they have an eel-like tail, hellbenders almost

never swim. They walk slowly along the river or stream bottom on their short legs. When they are too hot or when there is not enough oxygen in the water, hellbenders rock their bodies from side to side to get more water on their loose flaps of skin.

Hellbenders breed in the late summer to early fall. At breeding time, male hellbenders dig nests under rocks or logs and lure in one or more females. The males sometimes fight one another for the best rocks. Each female lays two strands of 150 to 750 round eggs, which end up in clusters in the nest. Because more than one female may breed with the same male, some nests have almost two thousand eggs, which expand to the size of Ping-Pong balls. The larger a female, the larger are her eggs. The male releases a cloud of sperm over the eggs. Fertilization and development take place outside the body. After they lay their eggs, the male forces the females out of the nest. The males then guard their nests from predators until after the larvae hatch.

Larvae hatch in two to three months, when they are about 1 inch (2.5 centimeters) long. When they start eating small invertebrates, the larvae turn dark brown or black. Newly hatched hellbender larvae have gills that stick up behind their heads. These gills disappear when the larvae are 1.5 to two years old and are 4 to 5 inches (10 to 13 centimeters) long. Over the next five to six years the young hellbenders grow about 0.8 inches (2 centimeters) per year while their heads and bodies flatten. Hellbenders can reproduce when they are about seven years old. Hellbenders live more than thirty years.

Hellbenders and people: Hellbenders are harmless to people. Because they can live only in very clean water, the presence of hellbenders is a sign of good water quality. Some people believe hellbenders interfere with fishing, but they are wrong. Some people try to trap hellbenders to sell as pets, but removing these salamanders from the wild is illegal. In Pennsylvania scientists have found evidence of huge piles of hellbender skeletons that date back ten million years. The scientists believe these fossils are evidence that early people used hellbenders for food and in tribal ceremonies.

Conservation status: The World Conservation Union (IUCN) lists hellbenders as Low Risk/Near Threatened, which means they are at risk of becoming threatened with extinction in the future. The main danger to hellbenders is damage to their habitat through silt buildup, which smothers eggs and the animals the hellbender need for food; loss of trees, which allows silt to wash into the water and removes the shade hellbenders need to keep cool; and pollution of river water by chemicals used on crops and from old mines. Hellbenders absorb the

chemicals in polluted water through their skin the same way they absorb oxygen. Some scientists believe too many hellbenders are being collected. They are researching the best conditions for breeding hellbenders so that someday these salamanders can be returned to the wild. ■

FOR MORE INFORMATION

Books:

Bernhard, Emery. *Salamanders.* New York: Holiday House, 1995.

Duellman, William E., and Linda Trueb. *Biology of Amphibians.* Baltimore: Johns Hopkins University Press, 1994.

Gunzi, Christiane. *Amphibians and Reptiles of North America.* San Diego, CA: Thunder Bay, 1995.

Lawlor, Elizabeth P. *Discover Nature in Water and Wetlands.* Mechanicsburg, PA: Stackpole, 2000.

Llamas Ruiz, Andres. *Reptiles and Amphibians: Birth and Growth.* New York: Sterling, 1996.

Petranka, J. W. *Salamanders of the United States and Canada.* Washington, DC: Smithsonian Institution Press, 1998.

Web sites:

Anft, Michael. "Amphibian Assault." *Citypaperonline.* http://www.citypaper.com/special/story.asp?id=6657 (accessed on April 19, 2005).

Flanagan, William P., III. "Taxon Management Account: Hellbender Salamander *Cryptobranchus alleganiensis alleganiensis* (Daudin)." *Caudata.org.* http://www.caudata.org/cig/taxon_management_account.html (accessed on April 18, 2005).

"Hellbender, *Cryptobranchus alleganiensis*." *Northern Prairie Wildlife Research Center.* http://www.npwrc.usgs.gov/narcam/idguide/crypto.htm (accessed on April 19, 2005).

Herman, J. "Cryptobranchus alleganiensis." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Cryptobranchus_alleganiensis.html (accessed on April 19, 2005).

Heying, H. "Cryptobranchidae." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Cryptobranchidae.html (accessed on April 19, 2005).

Johnson, Tom R., and Jeff Briggler. "The Hellbender." *Missouri Department of Conservation.* http://www.conservation.state.mo.us/documents/nathis/herpetol/amphibian/hellbend.pdf (accessed on April 16, 2005).

"What's a Hellbender?" *The Hellbender Homepage.* http://hellbenders.sanwalddesigns.com/whats.html (accessed on April 18, 2005).

PACIFIC GIANT SALAMANDERS
Dicamptodontidae

Class: Amphibia
Order: Caudata
Family: Dicamptodontidae
Number of species: 4 species

family CHAPTER

PHYSICAL CHARACTERISTICS

Pacific giant salamanders are large, strong salamanders that live as larvae for several years. Larvae (LAR-vee) are animals in an early stage that change body form in a process called metamorphosis (MEH-tuh-MORE-feh-sis) before becoming adults. After metamorphosis Pacific giant salamanders live on land. These salamanders are 7 to 14 inches (17 to 35 centimeters) long. There are only four species: the Idaho giant salamander, Cope's giant salamander, the California giant salamander, and the coastal giant salamander.

Pacific giant salamanders have a large head, a stout body, well-developed eyes, and large, thick legs. They have strong jaws and many small but well developed teeth. The tail is short for a salamander tail—about an inch (2.5 centimeters) shorter than the length of the head plus the body. The tail is flat from side to side and has a ridge along the top and the bottom. Adult Pacific giant salamanders are dark brown and often have blotches of different shades of gray. The belly is light brown or yellowish white.

The larvae of Pacific giant salamanders are somewhat flat from back to belly and are dark in color. The short, strong tail is flat from side to side and has a small fin. Larvae that live in small, rapidly flowing streams have short, bushy red gills, but those that live in lakes and large streams have large, filmy gills. Gills are organs for obtaining oxygen from water.

GEOGRAPHIC RANGE

Pacific giant salamanders live in the Pacific Northwest of North America from north of San Francisco, California, to the

SILTATION

Siltation (sihl-TAY-shun) is what happens when soil is washed from land and builds up in streams and rivers. The buildup is called silt and looks and feels like sandy dirt. Siltation happens when river or stream banks do not have enough plant life on them to keep the soil in place, as when all the nearby trees are cut down, grazing livestock eat all the grass away, or when the soil is not healthy because of poor farming practices or drought.

northern end of the Olympic Peninsula in Washington and from the southern Cascade Mountains of Oregon in the United States into the coastal mountains of southwestern British Columbia, but not on Vancouver and the neighboring islands, in Canada. Idaho giant salamanders are geographically separated from the other species and live in the mountains of northern Idaho and northwestern Montana, west of the Continental Divide in the United States.

HABITAT

Pacific giant salamanders live in wooded areas that have clear streams for larvae. Most of these salamanders live in coniferous woodlands, or those covered with trees that bear their seeds inside cones. These salamanders do especially well in areas with Douglas firs and redwoods. Adult Pacific giant salamanders live under rocks or logs. The larvae usually live in small, trout-free streams, but larger larvae may live in rivers and small lakes.

DIET

The larvae of Pacific giant salamanders eat the larvae of any bottom-dwelling insects they find, but they also eat other stream-dwelling animals. Because they grow to a large size, the salamander larvae feed on larger prey as well, including small fish and the larvae of mole salamanders. Small adult Pacific giant salamanders eat land-dwelling invertebrates (in-VER-teh-brehts), or animals without backbones, which they catch with their long, fast tongue. As they grow larger, Pacific giant salamanders prey on vertebrates, or animals with backbones, such as slender salamanders, lizards, shrews, mice, and even snakes, which they seize with their strong jaws. Pacific giant salamanders travel to find food and can climb as high as 6.6 feet (2 meters) on tree trunks.

BEHAVIOR AND REPRODUCTION

Adult Pacific giant salamanders are active at night, but sometimes they are found walking by day in dark, moist forests.

Large Pacific giant salamanders can be aggressive, head butting and tail-lashing one another and inflicting severe bites to defend themselves from predators. Adult Pacific giant salamanders bark sharply, but scientists do not know why they make this sound.

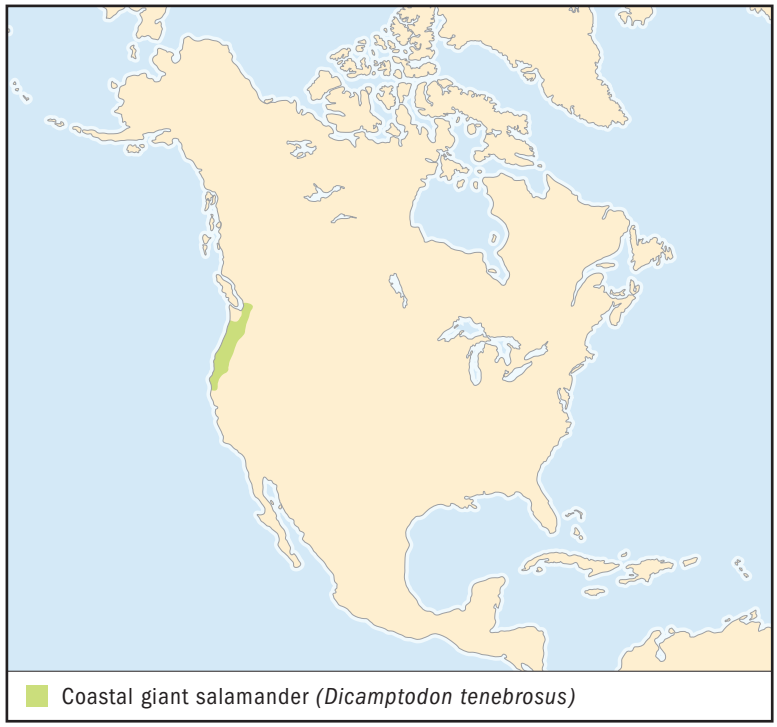
Scientists are not sure how Pacific giant salamanders mate. They do know that the males place sacs of sperm on land and that fertilization (FUR-teh-lih-ZAY-shun), the joining of egg and sperm to start development, takes place inside the female's body. The females lay eggs one at a time in groups of eighty or more under large rocks and logs. The fertilized (FUR-teh-lyzed) eggs develop slowly, and hatching does not occur for many weeks. Newly hatched larvae probably do not feed for several weeks. Metamorphosis takes at least two years and sometimes as long as four years. Some Pacific giant salamanders do not go through metamorphosis; they keep the body forms they have as larvae. However, their reproductive organs mature, and they can breed.

PACIFIC GIANT SALAMANDERS AND PEOPLE

Pacific giant salamanders are rarely seen by humans, but the rare encounters are remarkable because the animals are impressively large and do not try to escape unless someone pokes them or tries to pick them up. Sometimes people find adult Pacific giant salamanders on the floors of dense coniferous forests during light rains. At other times the larvae are caught on hook and line by people who are fishing.

CONSERVATION STATUS

The World Conservation Union (IUCN) lists one species of Pacific giant salamanders as Low Risk/Near Threatened, or at risk of becoming threatened with extinction in the future. These salamanders depend on forests and clear, unpolluted streams. This habitat is being harmed by excessive logging, road building and other construction, and the spreading of cities. Salamanders are most abundant in old-growth forests, but they survive after logging as long as the streams remain relatively free of silt.



SPECIES ACCOUNT

COASTAL GIANT SALAMANDER
Dicamptodon tenebrosus

Physical characteristics: Adult coastal giant salamanders may be the largest land-dwelling salamanders. The head plus body length is more than 7.5 inches (19 centimeters), and the total length is at least 13 inches (34 centimeters). The largest coastal giant salamanders on record were larvae found in large rivers. These larvae were about 8 inches (20 centimeters) in head plus body length and nearly 14 inches (35 centimeters) in overall length. The color of coastal giant salamanders varies. The background color of larvae usually is dark brown to black. As metamorphosis approaches, a silvery or dull golden color appears over the dark base and produces a marbling effect of light on dark. The marbling varies from fine to coarse. In some cases the marbling is so coarse that the underlying color cannot be seen.

Geographic range: Coastal giant salamanders live in an area that extends from southwestern British Columbia, Canada, southward



A pacific giant salamander is eating a large banana slug. (Photograph by Karl H. Switak. Photo Researchers, Inc.)

west of the crest of the Cascade Mountains to northern California, United States. Some of these salamanders live in isolated areas in north central Oregon, east of the Cascade crest.

Habitat: Coastal giant salamanders live in and near clear, cold, rocky streams.

Diet: Coastal giant salamanders mainly eat frogs and small mammals, but they also eat worms, insects, and spiders.

Behavior and reproduction: Adult coastal giant salamanders are active at night and are secretive, but they sometimes are seen walking through leaves on rainy days in densely forested regions. When approached, these salamanders bark. They are one of the few salamanders that make a sound. Coastal giant salamanders also can be found on rainy nights as they try to cross roads in areas near breeding sites.

Scientists know little about the breeding habits of coastal giant salamanders. Eggs are fertilized inside the female's body, so scientists believe males make a sperm sac that the females pick up. Females lay large numbers of large eggs under large rocks that are at least partially underwater in streams. The eggs take several months to hatch, and scientists believe the females guard their nests while the eggs are developing. After hatching, metamorphosis takes about two years.

Some coastal giant salamanders do not go through metamorphosis, but even though they look like larvae, they can reproduce.

Coastal giant salamanders and people: Coastal giant salamanders are rarely found and are little known to people.

Conservation status: Coastal giant salamanders are not considered threatened or endangered. The greatest risk to these salamanders is destruction of forests and the buildup of silt in streams. ■

FOR MORE INFORMATION

Books:

Bernhard, Emery. *Salamanders.* New York: Holiday House, 1995.

Duellman, William E., and Linda Trueb. *Biology of Amphibians.* Baltimore: Johns Hopkins University Press, 1994.

Gunzi, Christiane. *Amphibians and Reptiles of North America.* San Diego, CA: Thunder Bay, 1995.

Lawlor, Elizabeth P. *Discover Nature in Water and Wetlands.* Mechanicsburg, PA: Stackpole, 2000.

Llamas Ruiz, Andres. *Reptiles and Amphibians: Birth and Growth.* New York: Sterling, 1996.

Petranka, J. W. *Salamanders of the United States and Canada.* Washington, DC: Smithsonian Institution Press, 1998.

Web sites:

"Coastal (Pacific) Giant Salamander, *Dicamptodon tenebrosus*." *Northern Prairie Wildlife Research Center.* http://www.npwrc.usgs.gov/narcam/idguide/diteneb.htm (accessed on April 21, 2005).

"*Dicamptodon* (Strauch, 1870) Giant Salamanders." *Livingunderworld.org.* http://www.livingunderworld.org/caudata/database/dicamptodontidae/dicamptodon (accessed on April 21, 2005).

Guillermo, G.L. "Pacific Giant Salamander." Colegio Franklin Delano Roosevelt, American School of Lima. http://www.amersol.edu.pe/ms/7th/7block/jungle_research/new_cards/11c/report11c_G.html (accessed on April 21, 2005).

MOLE SALAMANDERS
Ambystomatidae

Class: Amphibia
Order: Caudata
Family: Ambystomatidae
Number of species: 33 species

family CHAPTER

PHYSICAL CHARACTERISTICS

Mole salamanders are small to large, stocky salamanders that live in water as larvae and on land as adults. Larvae (LAR-vee) are animals in an early stage that change form in a process called metamorphosis (MEH-tuh-MORE-feh-sis) before becoming adults. Mole salamanders are 3.5 to 14 inches (9 to 35 centimeters) long from the tip of the snout to the tip of the tail. They have a broad head, small eyes that stick out from the head, deep grooves along the sides of the body, and a long tail that is flat from side to side. Mole salamanders often have bold patterns as adults. Many species are brightly colored with yellow, orange, or silver spots, bars, and frosted patterns on a black background. Some mole salamanders have large poison glands on the head and along the body. All mole salamanders have lungs after metamorphosis.

Mole salamander larvae live in the water and have filmy gills that stick out behind their heads. Gills are organs for obtaining oxygen from water.

The larvae have a large tail fin that extends onto the body. Their small eyes do not have moveable eyelids. Many species of mole salamanders in Mexico and the United States do not go through metamorphosis; as adults they keep the body form they have as larvae. However, their reproductive organs mature, and they can breed.

GEOGRAPHIC RANGE

Mole salamanders live in North America from southern Canada to just south of Mexico City, Mexico.

AXOLOTLS

Axolotls (ACK-suh-lah-tehls) are a species of mole salamanders that never go through metamorphosis and never leave the water. According to Aztec legend a god named Xolotl escaped from his enemies by diving deep into a lake and changing himself into a salamander. Mexico City was later built on that lake.

HABITAT

Mole salamanders live in woodlands and grasslands, including partially dry pine and juniper woodland with vernal pools, ponds, or streams for breeding. A vernal (VUHR-nehl) pool is one that forms in the spring but then dries up for the rest of the year. Species that do not go through metamorphosis live in large lakes, as long as there are no predatory fish around.

DIET

Mole salamanders are predators as both larvae and adults. They eat insects, earthworms, crustaceans, frog tadpoles, and even baby rodents. Crustaceans (krus-TAY-shuns), such as crayfish, are water-dwelling animals that have jointed legs and a hard shell but no backbone.

BEHAVIOR AND REPRODUCTION

Mole salamanders spend most of the year in underground burrows and tunnels made by small mammals and come out only on rainy nights to feed or to travel to breeding sites, where they stay for several weeks. This behavior gives these salamanders their name. Moles are small mammals that spend almost all their time in tunnels searching for insects to eat.

Two key types of behavior of mole salamanders are their defenses from predators and their traveling. Many mole salamanders that have gone through metamorphosis take a head-down position and lash their tails when threatened. Both behaviors show predators parts of the salamander's body that are full of poison glands. Mole salamanders are famous for their travels to breeding ponds. In some species hundreds of salamanders may travel on a single rainy night to a breeding site, giving a spectacular display of salamanders crossing the landscape, including roads. In other species the travels take as long as many weeks rather than one night. In general, males travel before females do and stay for a longer time in the breeding pond.

Most mole salamanders breed in the winter or spring, although mountain salamanders breed in the summer. Land-dwelling adults move into vernal pools, ponds, or, more rarely, streams to breed. Two species mate and lay eggs on land. Males

often compete for females. The males deposit bags of sperm on the ground, and females take the bags into their bodies, where sperm and egg unite. One male may deposit more than thirty sperm bags in a single night. Females lay the eggs either one at a time or in large clusters. The eggs attach to the pond bottom or to plants. After hatching, larvae spend several months to several years in the water before going through metamorphosis and starting a land-dwelling lifestyle.

SOME SALAMANDER!

In 2004 the eastern tiger salamander was chosen by schoolchildren to be the official state amphibian of Illinois.

MOLE SALAMANDERS AND PEOPLE

People in Mexico eat mole salamanders. Everywhere they live, mole salamanders give important clues about the health of the environment.

CONSERVATION STATUS

The World Conservation Union (IUCN) lists eight species of mole salamanders as Critically Endangered, two as Endangered, three as Vulnerable, and one as Low Risk/Near Threatened. Critically Endangered means facing extremely high risk of extinction in the wild. Endangered means facing very high risk of extinction in the wild. Vulnerable means facing high risk of extinction in the wild. Low Risk/Near Threatened means at risk of becoming threatened with extinction in the future.

The U.S. Fish and Wildlife Service lists two species of mole salamanders as Endangered and two species as Threatened. Endangered means in danger of extinction throughout all or a significant portion of its range. Threatened means likely to become endangered in the near future.

Large numbers of mole salamanders crossing roads to and from their breeding ponds sometimes are killed by cars. In New York State an underpass was built to help these salamanders. The main dangers to mole salamanders are loss of their land and water habitats, the introduction of predatory fish that eat the salamander larvae, and, possibly, a fungus disease. Mole salamander species that do not go through metamorphosis are especially at risk because they spend their entire lives in a single lake, where introduced fish, pollution, and draining can endanger an entire species.



SPECIES ACCOUNT

TIGER SALAMANDER
Ambystoma tigrinum

Physical characteristics: Tiger salamanders are about 14 inches (35 centimeters) long from the tip of the snout to the tip of the tail, making them the largest land-dwelling salamanders. Tiger salamanders are large, strong salamanders. Adults have many color patterns depending on where they live. The most common pattern is the one that gives them their name: black with bright yellow stripes, spots, or bars. Some tiger salamanders have blurry gold blotches or yellow flecks on a black background. Others are solid olive green, brown, or black. In the central part of the United States and in the Rocky Mountains, some tiger salamanders do not go through metamorphosis.

Geographic range: Tiger salamanders have the widest geographic range of any other salamander in North America. The range extends



A Barred tiger salamander is eating an earthworm. (Photograph by Ken Highfill. Photo Researchers, Inc.)

from southern Canada south roughly to the border between Mexico and the United States.

Habitat: Tiger salamanders live mainly in grasslands in prairie and open, dry woodland, from sea level to a height of more than 11,000 feet (3,350 meters).

Diet: Fearsome predators, tiger salamanders eat just about any animal. As larvae, they eat prey ranging from microscopic plants and animals drifting in the water to tadpoles and even one another. As adults on land, tiger salamanders eat all kinds of invertebrate and small vertebrate prey, including animals almost as large as they are. Invertebrates (in-VER-teh-brehts) are animals without backbones, and vertebrates are animals with backbones.

Behavior and reproduction: Adult tiger salamanders spend almost all of their lives in underground rodent burrows. They come out and travel to breeding ponds during spring rains and sometimes can be found on the surface at night during heavy rains. Tiger salamander larvae are often the top predators in the vernal pools and ponds where

they live. To reproduce, male salamanders deposit sperm sacs, and female salamanders take them up into their bodies, where sperm and egg unite. The female then lays the eggs. After hatching, some of the larvae go through metamorphosis, and some do not.

Tiger salamanders and people: In many parts of the United States, tiger salamander larvae are sold as fish bait. Throughout their range tiger salamanders cannot live in the same bodies of water as predatory fish. When people stock these waters with bass, catfish, and other species, tiger salamanders are at risk.

Conservation status: Tiger salamanders are not considered threatened or endangered. ■

FOR MORE INFORMATION

Books:

Bernhard, Emery. *Salamanders.* New York: Holiday House, 1995.

Bishop, Sherman C. *Handbook of Salamanders: The Salamanders of the United States, of Canada, and of Lower California.* Ithaca, NY: Comstock, 1994.

Duellman, William E., and Linda Trueb. *Biology of Amphibians.* Baltimore: Johns Hopkins University Press, 1994.

Gunzi, Christiane. *Amphibians and Reptiles of North America.* San Diego, CA: Thunder Bay, 1995.

Lawlor, Elizabeth P. *Discover Nature in Water and Wetlands.* Mechanicsburg, PA: Stackpole, 2000.

Llamas Ruiz, Andres. *Reptiles and Amphibians: Birth and Growth.* New York: Sterling, 1996.

Petranka, James W. *Salamanders of the United States and Canada.* Washington, DC: Smithsonian Institution Press, 1998.

Periodicals:

Breisch, Alvin, and Peter K. Ducey. "Woodland and Vernal Pool Salamanders of New York." *New York State Conservationist* (June 2003): 15–18.

Fellman, Bruce. "To Eat or Not to Eat." *National Wildlife* (February-March 1995): 42–45.

Pennisi, Elizabeth. "Kinship Ties Influence Behavior, Morphology." *Science News* (May 1, 1993): 278.

Travis, John. "Starting Over: Some Animals Can Regenerate Limbs or Even Most of Their Bodies." *Science News* (November 1, 1997): 280–282.

Web sites:

"Ambystomatidae (Mole Salamanders)." U. S. Forest Service. http://www.fs.fed.us/r4/amphibians/family_ambystomatidae.htm (accessed on April 22, 2005).

Erelli, Mark. "Mole Salamanders." *The Vernal Pool.* http://www.vernalpool.org/inf_mol.htm (accessed on April 22, 2005).

Heying, H. "Ambystomatidae." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Ambystomatidae.html (accessed on April 22, 2005).

"Tiger Salamander." *BioKIDS.* http://www.biokids.umich.edu/critters/information/Ambystoma_tigrinum.html (accessed on April 22, 2005).

"Tiger Salamander: *Ambystoma tigrinum*." *Northern Prairie Wildlife Research Center.* http://www.npwrc.usgs.gov/narcam/idguide/atigrin.htm (accessed on April 22, 2005).

NEWTS AND EUROPEAN SALAMANDERS

Salamandridae

Class: Amphibia
Order: Caudata
Family: Salamandridae
Number of species: 59 species

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

Newts and European salamanders have long, slender bodies, long tails, sturdy legs, and poisonous skin. Some species have large skin glands that stick out from the head. Newts that have just gone through metamorphosis and begun their life on land are called efts. Metamorphosis (MEH-tuh-MORE-feh-sis) is the process by which some animals change body form before becoming adults. Newts and European salamanders are 3 to 14 inches (7 to 35 centimeters) long. They have four toes on their front legs and four or five toes on their hind legs. These salamanders do not have the grooves on the sides of their body that many other salamanders have. Efts and adults have lungs; larvae have external gills that stick up behind their heads. Larvae (LAR-vee) are animals in an early stage that change body form in metamorphosis. Gills are organs for obtaining oxygen from water. Many newts and European salamanders develop back body and tail fins when they enter the water in the breeding season.

All newts and European salamanders release substances from their skin that are poisonous or bad-tasting to predators. Many of the salamanders that make these poisons are brightly colored. The skin of most species of newts and European salamanders is rough, except during the water-dwelling phase. In the water, the skin becomes smooth, thin, and slimy. In the water, salamanders breathe through their skin, meaning they absorb oxygen directly from the water. In the water-dwelling phase, newts and European salamanders shed their skin frequently. Some newts eat the shed skin.

Because they look for food underwater, newts and European salamanders have eyes that are shaped for seeing prey, and their mouth is shaped for sucking in prey. In the water-dwelling phase, newts have organs in the skin that make up a system called the lateral (LAT-uhr-uhl) line. With these organs the newt feels tiny water currents and thus can detect moving prey, even in the dark and in muddy water.

Some keep the body form of larvae even though they become adults and can reproduce. These adults do not make the move to land and remain in water throughout life.

GEOGRAPHIC RANGE

Newts and European salamanders live in scattered areas across the Northern Hemisphere, including western and eastern North America, Europe, Japan and other areas in Asia, and the northern part of Africa.

HABITAT

Newts and European salamanders live in damp places close to ponds and streams, where breeding takes place. In the land-dwelling phase, newts and European salamanders need damp conditions and live in dense plant cover or in crack in rocks and under logs, where conditions stay moist at the drier times of year. Because the larvae live in water, all newts and European salamanders need water for reproduction. Many of these animals breed in ponds, but some breed in larger lakes and others in mountain streams. Many newts and European salamanders do well in ponds that dry up during the summer, because these ponds cannot support fish, dragonfly larvae, and other water-dwelling animals that prey on newt and salamander larvae.

DIET

Newts and European salamanders eat small invertebrate prey, including insects, earthworms, slugs, and snails. Invertebrates (in-VER-teh-brehts) are animals without backbones. In the water-dwelling phase, newts eat water insects and are fierce predators of frog tadpoles. The larvae of newts and European salamanders eat small invertebrates, such as water fleas.

BEHAVIOR AND REPRODUCTION

Most newts and European salamanders live on land as adults but move to water to breed. Some of these animals stay in the

WHAT'S THE DIFFERENCE?

There is no simple way to tell newts and salamanders apart. Species that spend a long period each year living in water and becoming temporarily adapted to life in water are called newts.

water for several months around breeding time, but the amount of time spent in the water varies greatly among species and even sometimes within one population of the same species. Newts that lay eggs one at a time have longer breeding seasons and, thus, spend more time in the water, because it takes many weeks for a female to lay all her eggs. Species that lay their eggs in clusters spend little time in the water.

Scientists know little about the behavior of newts and European salamanders during the land-dwelling, because these animals are rarely seen. At least some species, especially eastern newts, have highly developed sensing powers that help them to return to the same breeding ponds each spring. These newts can detect at least one thing in the environment that gives them directional information, such as a smell, the position of the Sun, the pattern of light in the sky, or the direction of the magnetic field of the Earth.

When bothered by predators, some newts raise their heads, chests, and tails to show the bright colors on their bellies. These newts often rock back and forth and release a strong-smelling poison through their skin. The poison of some newts is one of the most powerful natural toxins.

During mating, a male places a sperm bag close to a female and then pushes her over it or uses displays to lure her over it, so that she takes the sperm up into her cloaca, and it is united with eggs inside her body. The cloaca (kloh-AY-kuh) is the chamber in some animals that holds waste from the kidneys and intestines, holds eggs and sperm that are about to be released to the outside, holds sperm entering a female's body, and is the passage through which young are born. The female stores the sperm in special organs in her body until she is ready to lay her eggs. Some females lay single eggs on the leaves of water plants and then wrap the eggs in leaves to hide them from predators such as fish.

Transfer of sperm in a sperm bag has two interesting consequences. First, it is unreliable: In some species, many sperm bags are missed by females. Second, rival males can interfere. For example, in several species rival males mimic female behavior, causing the original males to release sperm bags that

are not picked up by females. To make sure this does not happen and to make sure their sperm gets into a female, some males defend females by picking them up and carrying them away if a rival male approaches.

Chemical communication is important in the mating of newts and European salamanders. Males have glands that release scented chemicals that make females receptive to them.

In most species of newts and European salamanders the females lay their fertilized (FUR-teh-lyzed) eggs. The eggs hatch into larvae that live in the water for a while and then go through metamorphosis to become adults. In four species of European salamanders, however, the females keep the fertilized eggs inside their bodies and give birth to large larvae or, in some instances, young salamanders that look like adults but are not ready to reproduce. In these four species only a small number of eggs complete development. In Caucasian salamanders only two fully developed young are born after three or four years inside the female. Fire salamanders, alpine salamanders, and Lanza's alpine salamanders also reproduce this way.

NEWTS, EUROPEAN SALAMANDERS, AND PEOPLE

Because they taste bad and can be poisonous, newts and European salamanders are not eaten by humans. Several species are popular as pets, but they are well known for their ability to escape from all but the most secure tank.

CONSERVATION STATUS

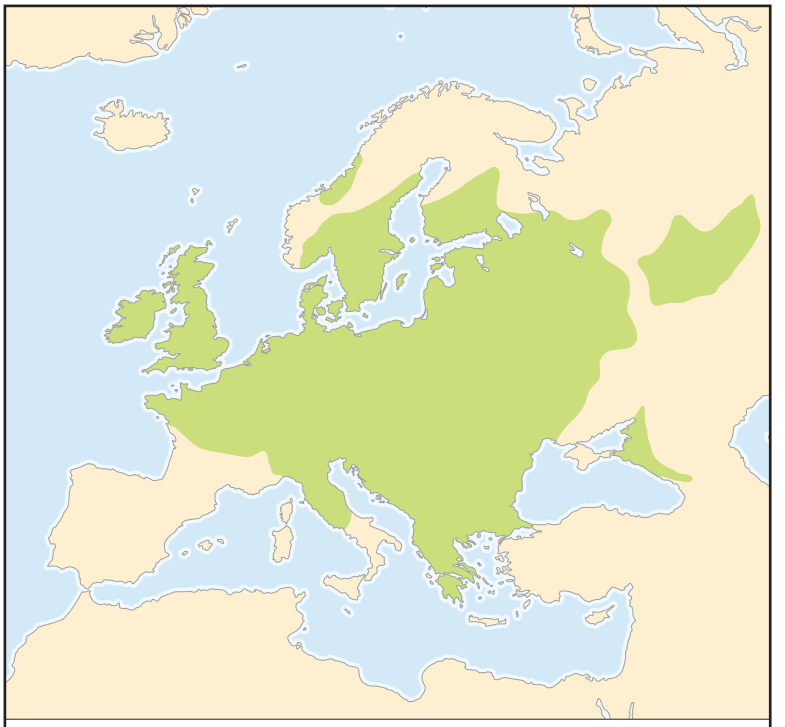
The World Conservation Union (IUCN) lists one species of newts and European salamanders as Extinct, one as Critically Endangered, nine as Endangered, ten as Vulnerable, and eleven as Low Risk/Near Threatened. Extinct means no longer in existence. Critically Endangered means facing extremely high risk of extinction in the wild. Endangered means facing very high risk of extinction in the wild. Vulnerable means facing high risk of extinction in the wild. Low Risk/Near Threatened means at risk of becoming threatened with extinction in the future.

Newts and European salamanders are threatened by loss of habitat as the result of too much cutting of trees, the spread of cities, and poor farming practices. Some of these salamanders can live together with people in areas where farmers use traditional

Across or Down?

Even if they don't know much about amphibians, people who do a lot of crossword puzzles know the word "eft." "Young newt" is a common crossword clue.

methods, such as making natural fences out of hedges and digging ponds for livestock. Modern farming methods are dangerous to salamanders. Ponds are filled in, hedges are torn up, and chemical fertilizers as well as the chemicals used to kill insects and weeds also kill salamanders.



Smooth newt *(Triturus vulgaris)*

SMOOTH NEWT
Triturus vulgaris

Physical characteristics: Smooth newts are slender and small, usually less than about 4 inches (11 centimeters) long. The tail makes up about one-half of the total length of the animal. In the land-dwelling phase, smooth newts are brown or dark gray. The skin secretions of smooth newts taste bad to predators, but they are not poisonous, so they provide little protection. Smooth newts are eaten by birds and other animals.

Geographic range: Smooth newts live in Europe.

Habitat: Smooth newts live in woodlands, grasslands, clumps of trees and shrubs, rows of hedges or trees surrounding fields, and yards and gardens. These salamanders breed in small ponds.



During breeding season male and female newts look very different from each other. Males develop a high crest that runs along the back and tail. (Photograph by Adrian Davies. Bruce Coleman, Inc.)

Diet: Smooth newts eat small invertebrates and frog tadpoles.

Behavior and reproduction: Smooth newts return to ponds to breed in early spring and stay in the water for several months. During the breeding season male and female smooth newts look very different from each other. Males develop a high crest that runs along the back and tail. The crest has a jagged edge and, like the rest of the body, is marked with large, dark spots. Stripes of red and blue decorate the lower edge of the male's tail, just behind the greatly swollen, dark cloaca. The toes on the hind limbs of the male develop flaps of skin. These flaps help the male swim fast in pursuit of females.

Female smooth newts lay several hundred eggs during the breeding season. The eggs are laid one at a time, and the female carefully wraps each egg in a folded leaf. The eggs hatch into tiny meat-eating larvae, which grow and go through metamorphosis over the summer months to leave the water in late summer at a length of approximately 0.8 inches (2 centimeters). The young newts spend the next two or three years on land before they return to water to breed as mature adults.

Smooth newts and people: Smooth newts have no known importance to people.

Conservation status: Smooth newts are not considered threatened or endangered. ■



Great crested newt *(Triturus cristatus)*

GREAT CRESTED NEWT
Triturus cristatus

Physical characteristics: Great crested newts get their name from the large, deeply notched crest that runs along the backs of breeding males. The males also have a tail that is thick from top to bottom and is decorated with a bold white stripe. Great crested newts can be as long as 6 inches (16 centimeters). Because of an abnormality in their chromosomes (KROH-muh-sohms), or the parts of a cell that hold the DNA, 50 percent of young great crested newts die before they hatch.

Geographic range: Great crested newts live in Europe.

Habitat: Great crested newts need dense cover during their land-dwelling phase and large, deep ponds for breeding.



Great crested newts live as long as sixteen years. They spend much of their lives on land, and little is known about their habits. (Photograph by Joseph T. Collins. Photo Researchers, Inc.)

Diet: Great crested newts eat small invertebrates, frog tadpoles, and the larvae of other newts.

Behavior and reproduction: Great crested newts live as long as sixteen years. They spend much of their lives on land, and little is known about their habits. When these newts are handled, glands in their skin release a bitter-smelling milky substance that humans and predators, such as water birds and hedgehogs, find highly offensive. The bright orange and black on the belly of great crested newts act as warning colors. Predators associate the color with the bad taste and do not attack the newts.

Adult great crested newts travel to ponds early in the spring. In Sweden they have been observed moving over snow and entering ponds that are still partially covered with ice. Females start the breeding season full of large eggs, but it takes males several weeks to fully develop their thick tails and their back crests. Males that come out of winter hibernation with larger fat reserves develop larger crests, and it is likely they are more attractive to females than are males with small crests.

While in breeding ponds, great crested newts are secretive by day and mate at dusk. A male takes up a position in front of a female and displays to her with rhythmic beats of his tail. The movement sends a chemical released by a large gland in the male's cloaca toward the female's snout. The male also displays his large, white-striped tail, which is bright in the dim light. If the female responds to the displays by moving toward him, the male turns and deposits a sperm

bag on the bottom of the pond. The female places herself over it and picks it up with her open cloaca.

Two or three days after mating, female great crested newts begin to lay eggs, which have united with sperm inside them. This process takes many weeks. Great crested newts lay seventy to six hundred eggs, usually 150–200, one at a time, carefully wrapping each egg in the leaf of a water plant. After two to three weeks, the eggs hatch into tiny larvae, which start to feed on water animals such as water fleas. Development and metamorphosis take two to three months, and the young leave the pond in late summer and autumn looking like miniature adults. They grow larger until they are old enough to reproduce. Female newts mate several times during the breeding season, interrupting egg-laying to replenish the supply of sperm.

Great crested newts and people: Great crested newts have no known importance to people.

Conservation status: Great crested newts are not considered threatened or endangered. Their numbers are decreasing, however, as a result of changes in their habitat caused by changes in land use and farming practices. In France, however, the great crested newt is slowly expanding its range. In central France, great crested newts overlap with marbled newts, and mating between the two species is common. In some parts of France, great crested newts seem to be handling new patterns of land use better than marbled newts and are expanding into ponds previously used only by marbled newts, whose numbers are decreasing as a result. ■



European fire salamander *(Salamandra salamandra)*

EUROPEAN FIRE SALAMANDER
Salamandra salamandra

Physical characteristics: European fire salamanders have a variety of colors and skin patterns. Some of these salamanders are black with yellow markings, and some are yellow with black or red or orange spots or stripes. They reach a length of 11 inches (28 centimeters) from tip of snout to tip of tail. Females are slightly larger than males. The legs are short and stout with broad toes, and the tail is tube-shaped and shorter than the body. European fire salamanders have two rows of poison glands along the sides of the body and a cluster of poison glands on each side of the head behind the eyes.

Geographic range: European fire salamanders live in Europe.

Habitat: European fire salamanders live in burrows in deciduous forests and, sometimes, in coniferous forests at heights of 656 to 3,280



The striking color patterns on these salamanders act as warning signs. When attacked, fire salamanders squirt toxin from their skin glands over a great distance. (Photograph by Harald Schüetz. Reproduced by permission.)

feet (200 to 1,000 meters). Coniferous (koh-NIH-fuh-russ) forests are made up of trees that bear their seeds inside cones. Deciduous (dih-SIH-juh-wuhs) forests are made up of trees that lose their leaves during cold or dry seasons.

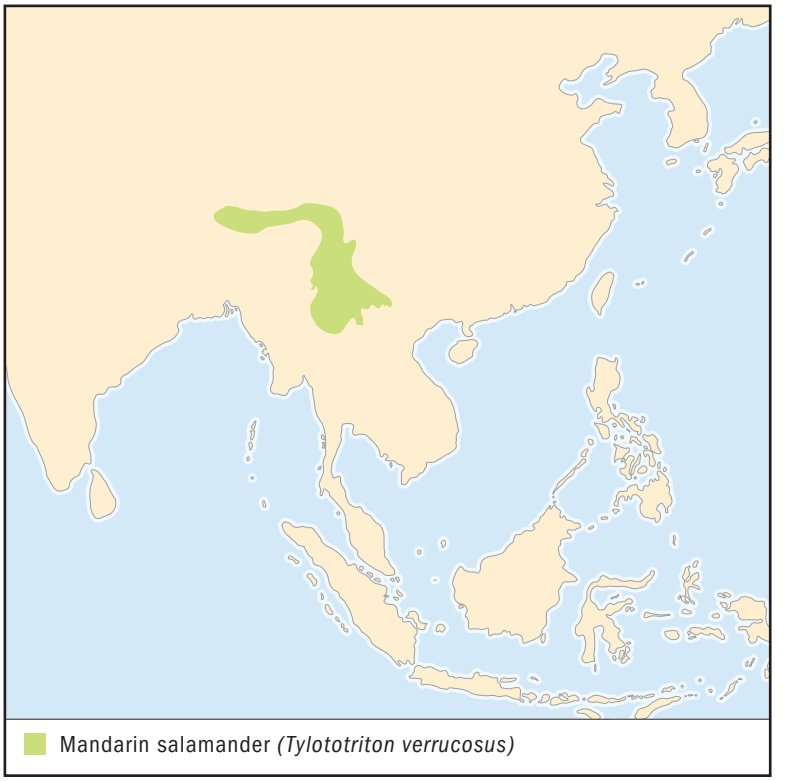
Diet: European fire salamanders eat worms, insects, insect larvae, and slugs.

Behavior and reproduction: European fire salamanders are active at night. When conditions are damp, these salamanders come out of their burrows to look for food. After metamorphosis European fire salamanders live entirely on land. They defend the ground around their burrows against intrusion by neighbors. The striking color patterns on these salamanders act as warning signs. When attacked, fire salamanders squirt toxin from their skin glands over a great distance.

During mating, which takes place on land, a male European fire salamander grasps a female from below. He stimulates the female with glands on his head, and when the female is ready he deposits a sperm bag. The male then flips his tail to one side so that the female falls onto the sperm bag. The sperm enter the female's body and unite with eggs. Larvae develop inside the eggs, and the female lays the eggs in ponds or streams in batches of twelve to fifty. In a few high-altitude populations, the larvae stay in the female throughout development and are released having the adult body form. During development in the female, larvae may eat smaller siblings. As a result, only a few salamanders in each batch of eggs complete development.

European fire salamanders and people: European fire salamanders have no known importance to people.

Conservation status: European fire salamanders are not considered threatened or endangered. ■



Mandarin salamander *(Tylototriton verrucosus)*

MANDARIN SALAMANDER
Tylototriton verrucosus

Physical characteristics: Mandarin salamanders have a sturdy build. They reach a length of 7 inches (18 centimeters) from tip of snout to tip of tail. These salamanders have a large head with large ridges of skin glands. When mandarin salamanders are in the water-dwelling phase, the tail is long, is flat from side to side, and has a fin. Mandarin salamanders are black or dark brown and are covered with two rows of large brown, orange, or red bumps. These bright colors are a warning sign to predators. Mandarin salamanders release a bad-tasting substance from their skin. The skin has a grainy texture.

Geographic range: Mandarin salamanders live in China, India, Nepal, Thailand, and Vietnam.



These salamanders live on land for most of their lives and travel to ponds and other water bodies in March or April when the monsoon rains begin. (Tom McHugh/Steinhart Aquarium/The National Audubon Society Collection/ Photo Researchers, Inc.)

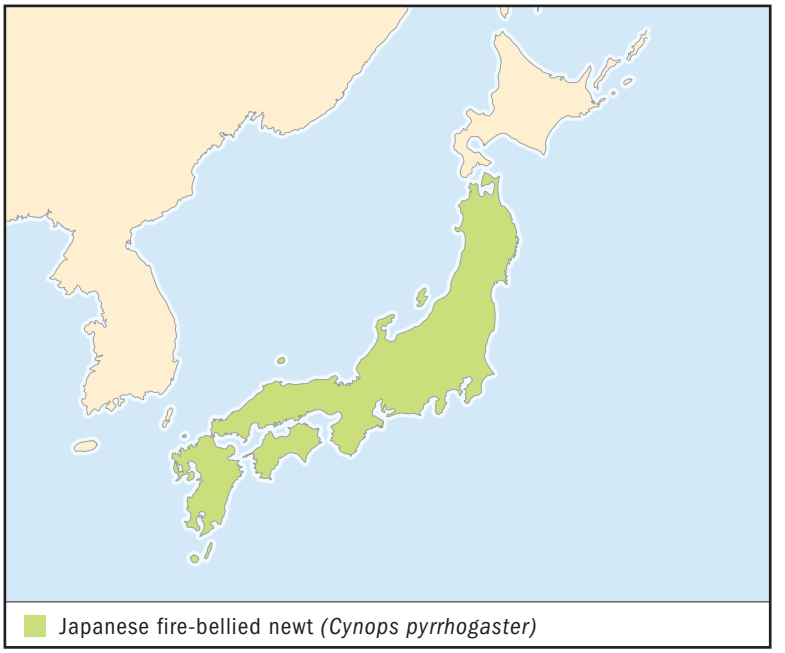
Habitat: Mandarin salamanders live in hills and mountains. The natural habitat is damp woodland and forest, but these salamanders also live in habitats made by people, such as rice fields and tea gardens.

Diet: Mandarin salamanders eat small invertebrates.

Behavior and reproduction: Scientists know little about how mandarin salamanders behave. These salamanders live on land for most of their lives and travel to ponds and other water bodies in March or April when the monsoon rains begin. Mating occurs in water. The male clasps the female before transferring his sperm bag. Fertilization takes place inside the female's body. The female lays thirty to sixty eggs in water. Some scientists believe the females guard their eggs. Mandarin salamanders can reproduce when they are three to five years old.

Mandarin salamanders and people: Mandarin salamanders are caught and sold as pets.

Conservation status: Mandarin salamanders are not considered threatened or endangered. ■



Japanese fire-bellied newt *(Cynops pyrrhogaster)*

JAPANESE FIRE-BELLIED NEWT
Cynops pyrrhogaster

Physical characteristics: Japanese fire-bellied newts reach a length of 5 inches (12 centimeters) from tip of snout to tip of tail. The tail is long and has a large fin that helps the salamanders swim powerfully. The tail of males has a thin string at the tip. Japanese fire-bellied newts have a black back and a bright red, spotted belly that acts as warning. When attacked, these salamanders release poison from their skin, especially from large glands on the head.

Geographic range: Japanese fire-bellied newts live on Honshu, Shikoku, and Kyushu, Japan.

Habitat: Japanese fire-bellied newts live in ponds and pools, their numbers often becoming quite large.

Diet: Japanese fire-bellied newts eat small invertebrates.

Behavior and reproduction: Except for mating practices, scientists do not know how Japanese fire-bellied newts behave. Mating takes



Their bright color makes Japanese fire-bellied newts very popular as pets. (© David M. Schleser; Nature's Images, Inc./Photo Researchers, Inc.)

place in water. The males do not grasp the females' bodies but stand in front of the females, sometimes restraining them with one hind foot. In this position a male beats the tip of his tail, producing a current in the water that carries a scented chemical from glands in his swollen cloaca to the female's snout. Fertilization takes place inside the female's body. She lays the eggs in water, and the eggs attach to underwater plants.

Japanese fire-bellied newts and people: Their bright color makes Japanese fire-bellied newts very popular as pets.

Conservation status: Japanese fire-bellied newts are not considered threatened or endangered. ■



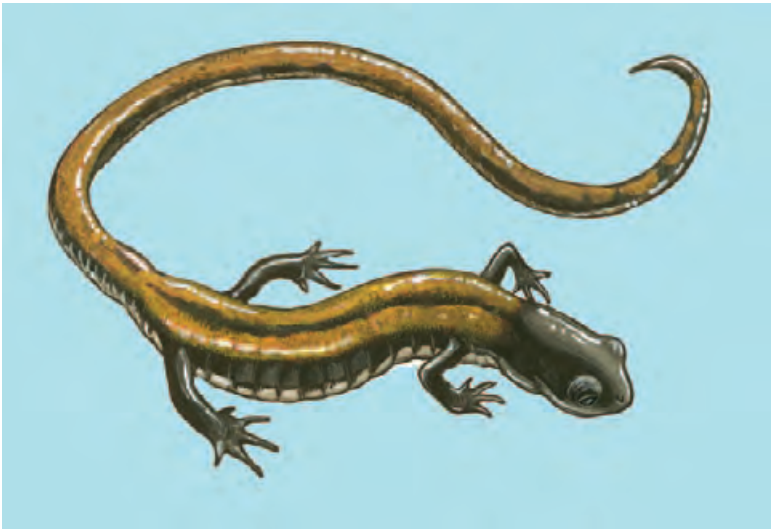
Golden-striped salamander *(Chioglossa lusitanica)*

GOLDEN-STRIPED SALAMANDER
Chioglossa lusitanica

Physical characteristics: Golden-striped salamanders reach a length of 6 inches (16 centimeters) from tip of snout to tip of tail. The body and tail are long and thin. The tail makes up about two-thirds of the total length of the animal. Golden-striped salamanders are dark brown and have two golden brown stripes on the back that join to form one stripe on the tail. On some salamanders, the stripes are broken into lines of spots. Golden-striped salamanders have a long, narrow head, large eyes, and a long, sticky tongue for catching prey.

Geographic range: Golden-striped salamanders live in Europe in northern Portugal and the northwestern part of Spain.

Habitat: Golden-striped salamanders live in wet, mountainous areas.



Golden-striped salamanders release a milky poison from their skin when attacked. (Illustration by Gillian Harris. Reproduced by permission.)

Diet: Golden-striped salamanders eat flies and other insects.

Behavior and reproduction: Golden-striped salamanders are active at night only when it is damp and thus only in areas where there is heavy rainfall. They are dormant underground or in caves during the winter and also are dormant during dry periods in the summer. If attacked, golden-striped salamanders can run quickly. If caught, they can break off their tails. The tail regrows but never reaches its original length. When they are attacked, golden-striped salamanders release a milky poison from their skin.

Golden-striped salamanders spend most of their lives on land but breed in water. Males develop swellings on the upper parts of their front legs during the breeding season. The females lay clumps of as many as twenty eggs in summer or autumn under rocks in springs and streams. The larvae spend the winter in the water.

Golden-striped salamanders and people: Golden-striped salamanders have no known importance to people.

Conservation status: The World Conservation Union (IUCN) lists golden-striped salamanders as Low Risk/Near Threatened because of habitat loss due to land drainage, replacement of natural forest by farms, and pollution from farming chemicals. This means they are at risk of becoming threatened with extinction in the future. ■

FOR MORE INFORMATION

Books:

Bernhard, Emery. *Salamanders.* New York: Holiday House, 1995.

Duellman, William E., and Linda Trueb. *Biology of Amphibians.* Baltimore: Johns Hopkins University Press, 1994.

Griffiths, R. A. *Newts and Salamanders of Europe.* London: T. & A. D. Poyser, 1996.

Gunzi, Christiane. *Amphibians and Reptiles of North America.* San Diego, CA: Thunder Bay, 1995.

Lawlor, Elizabeth P. *Discover Nature in Water and Wetlands.* Mechanicsburg, PA: Stackpole, 2000.

Llamas Ruiz, Andres. *Reptiles and Amphibians: Birth and Growth.* New York: Sterling, 1996.

Petranka, J. W. *Salamanders of the United States and Canada.* Washington, DC: Smithsonian Institution Press, 1998.

Periodicals:

Breisch, Alvin, and Peter K. Ducey. "Salamanders of New York State." *New York State Conservationist* (April 2003): 15-18.

Horgan, John. "A Nasty Little Squirt: Europe's Fire Salamander Lives Up to Its Legend." *Scientific American* (July 1990): 28.

Nickens, T. Edward. "Herpin' Around: Thought It Just Took a Little Water to Make These Critters Happy?" *American Forests* (Spring 2002): 26–31.

Web sites:

"*Cynops* (Tschudi, 1839) Fire Belly Newts." *Livingunderworld.org.* http://www.livingunderworld.org/caudata/database/salamandridae/cynops (accessed on April 7, 2005).

"Great crested newt (*Triturus cristatus*)." *ARKive.* http://www.arkive.org/species/ARK/amphibians/Triturus_cristatus/more_info.html (accessed on April 7, 2005).

Heying, H. "Salamandridae." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Salamandridae.html (accessed on April 7, 2005).

"Newts." *Kids Ark.* http://web.ukonline.co.uk/conker/newts.htm#morenewts (accessed on April 7, 2005).

"Salamandridae (Goldfuss, 1820) Newts and True Salamanders." *Livingunderworld.org.* http://www.livingunderworld.org/caudata/families/#salamandridae (accessed on April 7, 2005).

"Smooth Newt (*Triturus vulgaris*)." *ARKive.* http://www.arkive.org/species/ARK/amphibians/Triturus_vulgaris/more_info.html (accessed on April 7, 2005).

Sydlowski, R. "*Salamandra salamandra*." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Salamandra_salamandra.html (accessed on April 7, 2005).

"*Triturus* (Rafinesque, 1815), *Mesotriton* (Bolkay, 1927), and *Lissotriton* (Bell, 1839)." *Livingunderworld.org.* http://www.livingunderworld.org/caudata/database/salamandridae/triturus (accessed on April 7, 2005).

OLMS AND MUDPUPPIES
Proteidae

Class: Amphibia
Order: Caudata
Family: Proteidae
Number of species: 6 species

family CHAPTER

PHYSICAL CHARACTERISTICS

Olms and mudpuppies are medium-sized to large salamanders with a long, squared-off snout, small legs, and large, bushy, red gills. Gills are organs for obtaining oxygen from water. Most olms are pale and nearly eyeless. Mudpuppies are dark with large spots and have small eyes. Olms and mudpuppies are large for salamanders, more than 16 inches (40 centimeters) from the tip of the snout to the tip of the tail.

Olms and mudpuppies spend their entire lives in water, never making the move to land the way many amphibians do. Amphibians (am-FIB-ee-uhns) are vertebrates (VER-teh-brehts), or animals with a backbone, that have moist, smooth skin; are cold-blooded, meaning their body temperature is the same as the temperature of their surroundings; and, in most instances, have a two-stage life cycle. Olms and mudpuppies have the same body features as adults that they do as larvae. Larvae (LAR-vee) are animals in an early stage that change body form in a process called metamorphosis (MEH-tuh-MORE-feh-sis) before becoming adults. These features include three pairs of large, bushy, red gills; a short tail that is flat from side to side, like an eel's tail; a tail fin; and small eyes.

GEOGRAPHIC RANGE

Olms live in southeastern Europe, and mudpuppies live in eastern North America. The Appalachian Mountains form a wedge separating the coastal waterdogs from the inland mudpuppies. Olms live in the limestone cave systems along the Adriatic Sea from western Slovenia and northeastern Italy in

The Mudpuppy Goes to College

Mudpuppies are the most commonly used amphibians in college comparative anatomy and physiology classes.

the north to Montenegro in the south. Most of them live in western Slovenia.

HABITAT

Olms and mudpuppies live in freshwater. Olms live in underground streams and lakes in limestone caves, where it is always dark and where the water is cold year-round, usually about 46°F (8°C). These salamanders are thought to group together in deep cracks in the stone. Most sightings and captures of olms have been in places where they either have been flushed out by heavy rains or have been hunting for food. Mudpuppies live in muddy canals; ditches; large, rocky, fast-flowing streams; reservoirs; and large, cool lakes. Mudpuppies can be found at all seasons of the year and are even active beneath the ice in mid-winter.

DIET

Mudpuppies eat fish, fish eggs, crayfish, worms, small mollusks, and water insects, in short, almost anything that moves and will fit into their mouths. They are especially fond of fish called sculpins and sometimes can be found gorged with these fish. Little is known about what olms eat in the wild, except that they seem to feed on tiny crustaceans, insect larvae, and other small invertebrates. Olms use chemical sensors to find prey in total darkness. Mollusks (MAH-lusks) are animals with a soft, unsegmented body that may or may not have a shell, such as slugs and snails. Crustaceans (krus-TAY-shuns), such as crayfish, are water-dwelling animals that have jointed legs and a hard shell but no backbone.

BEHAVIOR AND REPRODUCTION

Mudpuppies crawl slowly over the bottoms of streams and lakes, but they can swim rapidly when frightened. In captivity, mudpuppies are secretive and hide under any available object, including one another. They appear to be repelled by light. In water with a low amount of oxygen, mudpuppies constantly fan their gills, which can become large, bushy, and bright red. Under such conditions, the mudpuppies often rise to the surface to take gulps of air. In water with plenty of oxygen the gills tend to be held motionless against the sides of the neck and eventually shrink. There is some evidence that mudpuppies are capable of homing behavior. Olms are friendly to one another, at least when they are not breeding, and tend to group

together in deep cracks in the cave walls. Scientists believe olms use chemical sensors to mark and find their home shelters.

Scientists know little about how olms and mudpuppies reproduce. The breeding season for mudpuppies is in the fall or winter, depending on the species and where the animals live. Males that are ready to mate have a swollen cloaca and a pair of enlarged finger-like structures that stick out toward the rear of the body. The cloaca (kloh-AY-kuh) is the chamber in some animals that holds waste from the kidneys and intestines, holds eggs or sperm about to be released to the outside, holds sperm entering a female's body, and is the passage through which young are born.

Breeding in olms does not appear to be related to the seasons, reflecting the stability of their underground habitat. Olms seem to be much more territorial than mudpuppies during breeding. All species for which information is known use some kind of mating ritual in which the males and females stimulate each others' cloacas. The male then releases a bag of sperm, which the female picks up with her cloaca. The female may store sperm in special structures inside her cloaca for six months or more. Fertilization (FUR-teh-lih-ZAY-shun), or the joining of egg and sperm to start development, takes place inside the female's body. When the female lays them, the eggs usually attach to the bottom of an object such as a rock or a log, and the female guards them.

The eggs of olms and mudpuppies hatch two to six months after they are laid, depending on the species and the temperature. The larvae develop gradually into adults without going through metamorphosis. Scientists do not know when mudpuppies are old enough to reproduce, but olms can reproduce when they are seven years old. Scientists believe olms and mudpuppies live nine to sixty years.

OLMS, MUDPUPPIES, AND PEOPLE

Olms and mudpuppies have long been used for scientific studies. Mudpuppies are caught and sold as pets. Olms are a tourist attraction, particularly in Slovenia. Because of their thin skin and dependence on clean water with plenty of oxygen, olms and mudpuppies may be good indicators of water quality.

CONSERVATION STATUS

The World Conservation Union (IUCN) lists one species of olms and mudpuppies as Endangered, one as Vulnerable, and

one as Low Risk/Near Threatened. Endangered means facing very high risk of extinction in the wild. Vulnerable means facing high risk of extinction in the wild. Low Risk/Near Threatened means at risk of becoming threatened with extinction in the future.

Olms have been protected in Slovenia since 1949. The main threats to olms are economic development, industrial pollution, and over-collecting. Mudpuppies are threatened by chemical pollution, changes in habitat, and over-collecting.



OLM
Proteus anguinus

Physical characteristics: Olms are long and thin and have pale, pinkish white skin. The head is flat and narrow, and the eyes are tiny. Three pink gills stick out from each side of the head. The legs are small, and there are only three toes on the front feet and two toes on the rear feet. These features are thought to be adaptations to living in underground waterways. Some olms turn darker when exposed to light. These olms have larger eyes than do olms that never leave their caves. Olms have a squared-off snout and a short tail that is flat from side to side. They reach a length of about 12 inches (30 centimeters) from tip of snout to tip of tail.

Geographic range: Olms live in Europe from the Dinaric Alps of Slovenia and Italy in the north to Montenegro in the south.



Olms live in underground lakes and rivers in limestone caves. (Illustration by Joseph E. Trumpey. Reproduced by permission.)

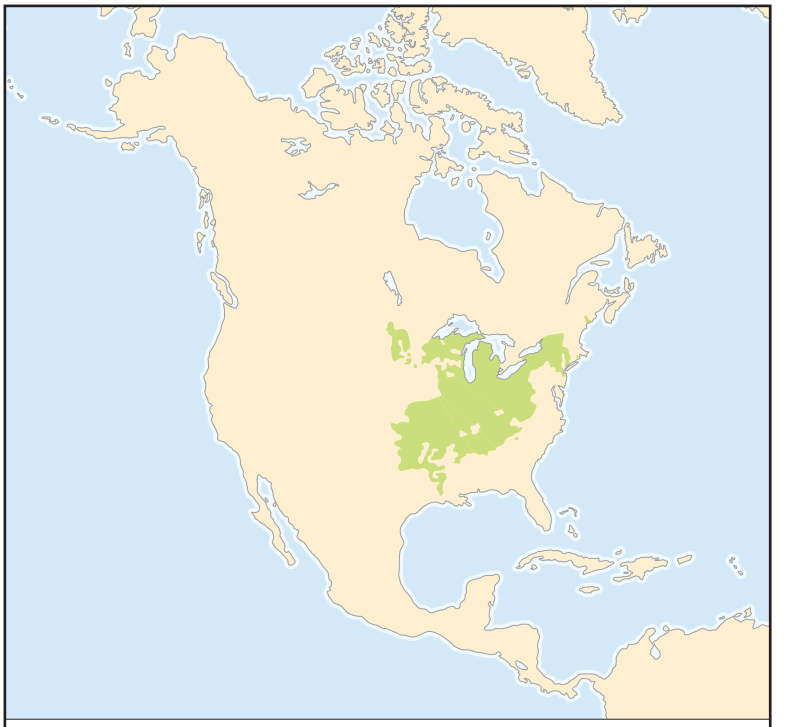
Habitat: Olms live in underground lakes and rivers in limestone caves.

Diet: Olms feed at night, using chemical sensors to find small crustaceans and insects and other invertebrates.

Behavior and reproduction: Olms are friendly to one another except during the breeding season, when they defend their territory. Olms are secretive and rarely seen, except when they leave their caves either to feed or because of flooding. Breeding is not related to the seasons. Fertilization takes place inside the female's body after she picks up a sperm bag that has been released by a male. The fertilized (FUR-teh-lyzed) eggs are large and yellowish and are laid under rocks and other cover and guarded by the female. The eggs hatch in about six months. Larvae develop directly into adults without going through metamorphosis. Scientists believe some olms give birth to a pair of well-developed young rather than laying a batch of eggs.

Olms and people: Olms are a tourist attraction. They are popular in the pet trade and are used in scientific research.

Conservation status: The World Conservation Union (IUCN) lists olms as Vulnerable, or facing high risk of extinction in the wild. ■



Mudpuppy *(Necturus maculosus)*

MUDPUPPY
Necturus maculosus

Physical characteristics: Mudpuppies reach a length of 8 to 19 inches (20 to 48 centimeters) from tip of snout to tip of tail. They have small eyes, a short tail, small legs, and a squared-off snout. Mudpuppies have camouflage coloring against the dark bottom of lakes, rivers, and streams. The colors vary from deep rusty brown to gray or even black with scattered black or bluish black spots and blotches. The spots sometimes form two rows along the back. A dark bar extends through the eye to the gills. The belly is paler than the back and may or may not have dark spots. The edges of the tail often are tinged with reddish orange. The colors of mudpuppy larvae can be strikingly different from that of adults.

Mudpuppies have different shapes of gills, depending on their environment. Mudpuppies that live in the fast-moving waters of rivers



Mudpuppies have different shapes of gills, depending on their environment. Mudpuppies that live in the fast-moving waters of rivers and streams have small gills that stay close to the sides of the animal's head. In warm or slow-moving rivers and lakes, the gills are big and bushy. (Photograph by Jack Dermid. Bruce Coleman Inc.)

and streams have small gills that stay close to the sides of the animal's head. In warm or slow-moving rivers and lakes, the gills are big and bushy.

Geographic range: Mudpuppies live in North America in a range that covers essentially the entire Mississippi River drainage system. The range extends from southern Manitoba and Quebec, Canada, in the north to Georgia, Alabama, Mississippi, and Louisiana, United States, in the south.

Habitat: Mudpuppies live in a variety of water habitats, including rivers, streams, canals, and lakes.

Diet: Mudpuppies eat water-dwelling invertebrates and vertebrates, including crayfish and other crustaceans, mollusks, worms, insect larvae, fish, and other amphibians.

Behavior and reproduction: Mudpuppies are active all year and have been seen moving around beneath the ice in mid-winter. Adults are mostly active at night, when they look for food. Mudpuppies hide under rocks and other objects or in burrows during the day. The mating season for mudpuppies is in the autumn or winter, possibly extending into spring, depending on where they live. The fertilized eggs are laid in May or June and attach to the bottoms of large rocks. The female takes care of the eggs and defends them against predators. Hatching takes place in one or two months, depending on the temperature of the water. The newly hatched larvae are approximately

1 inch (2.5 centimeters) long and have two yellow stripes on a dark background. Mudpuppies grow into adults without going through metamorphosis.

Mudpuppies and people: Mudpuppies are collected in large numbers by biological supply companies for use in classrooms and laboratories around the world. They also are caught and sold as pets.

Conservation status: Mudpuppies are not considered threatened or endangered. ■

FOR MORE INFORMATION

Books:

Arnold, E. N., and J. A. Burton. *Field Guide to the Reptiles and Amphibians of Britain and Europe.* 2nd ed. London: HarperCollins Publishers, 1998.

Bernhard, Emery. *Salamanders.* New York: Holiday House, 1995.

Bishop, S. C. *Handbook of Salamanders.* Reprint. Ithaca, NY: Cornell University Press, 1994.

Conant, Roger, and Joseph T. Collins. *A Field Guide to Reptiles and Amphibians, Eastern and Central North America.* New York: Houghton Mifflin, 1991.

Duellman, William E., and Linda Trueb. *Biology of Amphibians.* Baltimore, MD: Johns Hopkins University Press, 1994.

Lawlor, Elizabeth P. *Discover Nature in Water and Wetlands.* Mechanicsburg, PA: Stackpole, 2000.

Llamas Ruiz, Andres. *Reptiles and Amphibians: Birth and Growth.* New York: Sterling, 1996.

Petranka, J. W. *Salamanders of the United States and Canada.* Washington, DC: Smithsonian Institution Press, 1998.

Web sites:

Hawes, Alex. "On Waterdogs, Mudpuppies, and the Occasional Hellbender." *Zoogoer.* http://nationalzoo.si.edu/Publications/ZooGoer/2000/2/waterdogsmudpuppieshellbender.cfm (accessed on April 8, 2005).

Heying, H. "Proteidae." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Proteidae.html (accessed on April 8, 2005).

"Mudpuppy and Waterdog." *BioKIDS.* http://www.biokids.umich.edu/critters/information/Necturus_maculosus.html (accessed on April 8, 2005).

"Proteidae (Gray, 1825) Mudpuppies, Waterdogs, and Olms." *Livingunderworld.org.* http://www.livingunderworld.org/caudata/database/proteidae (accessed on April 8, 2005).

Siebert, E. "*Necturus maculosus*." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Necturus_maculosus.html (accessed on April 8, 2005).

family CHAPTER

TORRENT SALAMANDERS
Rhyacotritonidae

Class: Amphibia
Order: Caudata
Family: Rhyacotritonidae
Number of species: 4 species

PHYSICAL CHARACTERISTICS

Torrent salamanders are small, short-tailed, greenish yellow, large-eyed salamanders. They are 3 to 4.5 inches (8 to 11 centimeters) long with a stocky body, a broad head, eyes that stick out, and a short snout. The legs are small but sturdy. The tail is short, is flat from side to side, and has a small ridge along the top. These salamanders have lungs that do not function.

GEOGRAPHIC RANGE

Torrent salamanders live in the northwestern part of the United States from the Olympic Peninsula in northwestern Washington in the coast ranges to southern Mendocino County in northern California. They live in the Cascade range from the vicinity of Mount Saint Helens, Washington, south to central Oregon.

HABITAT

Torrent salamanders live in densely forested areas near cool water in small, clear, rapidly flowing streams, in rocky areas where water has seeped to the surface, and in cracks in large rocks with thin layers of water cascading over the surface. These habitats almost always are in closed-canopy forests often dominated by coniferous (koh-NIH-fuh-russ) trees, or those that have cones, but some are in river areas dominated by maples and alders, which are deciduous (dih-SIH-juh-wuhs) trees, or those that lose their leaves during cold or dry seasons.

WHAT'S IN A NAME?

The scientific name for the torrent salamander family, Rhyacotritonidae, comes from the Greek *rhyakos,* meaning "stream," and Triton, the Greek god of the sea. Despite the common name, a torrent being a violent, rushing stream, these salamanders rarely live in such water, although they may be found nearby.

DIET

Scientists believe torrent salamanders eat insects, especially larvae, and other invertebrates (in-VER-teh-brehts), or animals without backbones. Larvae (LAR-vee) are animals in an early stage that change body form in a process called metamorphosis (MEH-tuh-MORE-feh-sis) before becoming adults.

BEHAVIOR AND REPRODUCTION

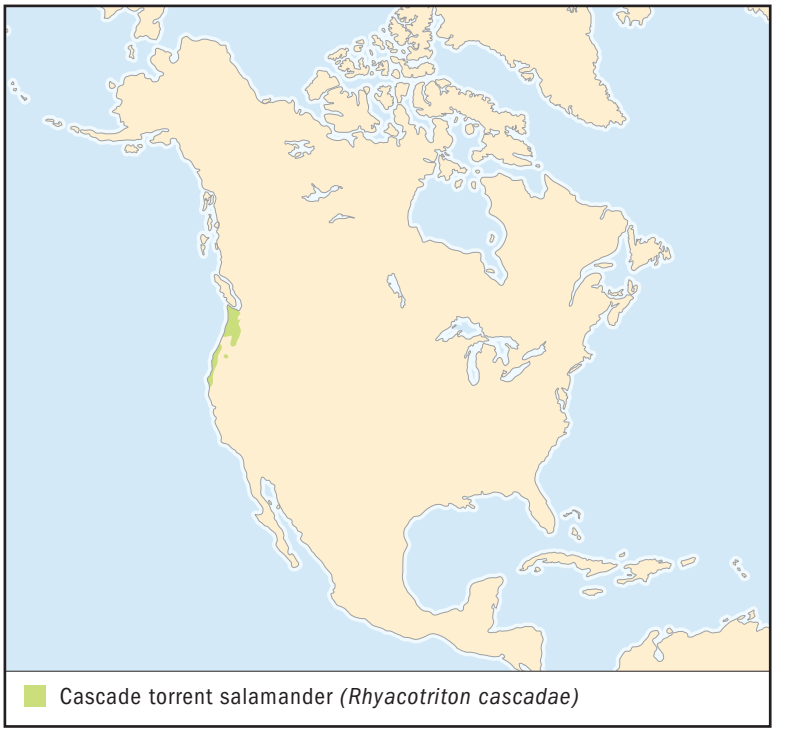
Scientists do not know how torrent salamanders behave. These salamanders are secretive and are seldom seen. Fertilization (FUR-teh-lih-ZAY-shun), the joining of egg and sperm to start development, takes place inside the female's body. Large, colorless eggs are laid in cold, clear water under rocks or in cracks. The embryos (EHM-bree-ohs), or young animals in the eggs, develop slowly, as do the larvae, which live for three or four years in the water. The larvae go through metamorphosis when they are close to adult size, but scientists do not know how long it takes the transformed salamanders to mature.

TORRENT SALAMANDERS AND PEOPLE

Torrent salamanders help scientists understand the biological characteristics of the Pacific Northwest region.

CONSERVATION STATUS

The World Conservation Union (IUCN) lists one species of torrent salamanders as Vulnerable and two species as Low Risk/Near Threatened. Vulnerable means facing high risk of extinction in the wild. Low Risk/Near Threatened means at risk of becoming threatened with extinction in the future. Clearing of forests is the greatest risk to torrent salamanders, because it damages their habitat.



CASCADE TORRENT SALAMANDER
Rhyacotriton cascadae

SPECIES ACCOUNT

Physical characteristics: Cascade torrent salamanders are 3 to 4.5 inches (7.5 to 11 centimeters) long from tip of snout to tip of tail. The body is stout with a broad head, eyes that stick out, and a relatively short snout. The tail is flat from side to side, has a ridge along the top, and is shorter than the head plus the body. Cascade torrent salamanders usually are rich brown on top and yellowish and sometimes greenish yellow on the belly. The back is marked with darker blotches and speckles. There is a sharp difference between the brown of the back and sides and the yellow of the belly. There are white flecks on the sides above the beginning of the yellow belly. The belly has dark spots, but there are fewer spots than on the back. There are fine gray flecks on the throat and chest. Male Cascade torrent salamanders have swellings on the edges of the belly.



Adult Cascade torrent salamanders go onto land but rarely travel more than a few feet from water. The larvae live in the same habitat as adults but stay in the water. (Illustration by Bruce Worden. Reproduced by permission.)

Geographic range: Cascade torrent salamanders live in the United States in the Cascade Mountains. The range extends from near Mount Saint Helens in Washington to central Oregon. These salamanders usually live at a height of less than 2,000 feet (610 meters) above sea level.

Habitat: Cascade torrent salamanders live in streams, usually in heavily forested areas. These salamanders avoid large streams but may be found near them in small, rapidly flowing arms of the streams, where they live under moss-covered rocks, in coarse gravel, in piles of rocks, and in cracks in rocks in areas that are very moist. Water often is flowing through the rocks in thin sheets. Adult Cascade torrent salamanders go onto land but rarely travel more than a few feet (1 meter) from water. The larvae live in the same habitat as adults but stay in the water.

Diet: Scientists believe that Cascade torrent salamanders eat small invertebrates, especially insect larvae and mollusks. Mollusks (MAH-lusks) are animals with a soft, unsegmented body that may or may not have a shell, such as slugs and snails.

Behavior and reproduction: Scientists do not know how Cascade torrent salamanders behave. These salamanders are extremely secretive. They are not seen unless people actively look for them by turning over rocks. Scientists also are not sure how Cascade torrent salamanders reproduce. A related species lays about eight colorless eggs one at a time in cold water flowing through rocks and rock cracks. The eggs probably are slow to hatch in the cold water. Larvae grow

slowly, taking three or four years to go through metamorphosis, which they do when they are 1.5 to 1.8 inches (4 to 4.5 centimeters) long.

Cascade torrent salamanders and people: Cascade torrent salamanders have no known importance to people.

Conservation status: The World Conservation Union (IUCN) lists Cascade torrent salamanders as Low Risk/Near Threatened, or at risk of becoming threatened with extinction in the future. The greatest risk to these salamanders is the cutting of forests, which causes the small streams used by these animals to become too hot and to dry up. ■

FOR MORE INFORMATION

Books:

Bernhard, Emery. *Salamanders.* New York: Holiday House, 1995.

Duellman, William E., and Linda Trueb. *Biology of Amphibians.* Baltimore, MD: Johns Hopkins University Press, 1994.

Gunzi, Christiane. *Amphibians and Reptiles of North America.* San Diego, CA: Thunder Bay, 1995.

Lawlor, Elizabeth P. *Discover Nature in Water and Wetlands.* Mechanicsburg, PA: Stackpole, 2000.

Llamas Ruiz, Andres. *Reptiles and Amphibians: Birth and Growth.* New York: Sterling, 1996.

Petranka, J. W. *Salamanders of the United States and Canada.* Washington, DC: Smithsonian Institution Press, 1998.

Web sites:

Heying, H. "Rhyacotritonidae." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Rhyacotritonidae.html (accessed on April 8, 2005).

"*Rhyacotriton* (Dunn, 1920) Torrent Salamanders." *Livingunderworld.org.* http://www.livingunderworld.org/caudata/database/rhyacotritonidae/rhyacotriton (accessed on April 8, 2005).

Wallays, Henk. "Observations on Torrent Salamanders (*Rhyacotriton*) in Oregon and California." *Caudata.org.* http://www.caudata.org/cc/articles/Rhyacotriton.shtml (accessed on April 26, 2005).

LUNGLESS SALAMANDERS
Plethodontidae

Class: Amphibia
Order: Caudata
Family: Plethodontidae
Number of species: 346 species

family
CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

The family of lungless salamanders includes the smallest and nearly the largest land-dwelling salamanders. These salamanders have no lungs and breathe through their skin. They have four toes on their front legs and four or five toes on their rear legs. They have a medium to long tail. Lungless salamanders are 1 to 14 inches (2.5 to 35 centimeters) long. The head is specialized for burrowing and for wedging under rocks and in stream beds. Some lungless salamanders have a long tongue that they can flick rapidly to catch prey. Lungless salamanders that live in caves never have eyes or skin coloring and may have oddly formed limbs and snouts. Other species start life as larvae, but as they go through metamorphosis their eyes disappear, the eyelids fuse together, and their skin loses its color.

Some lungless salamanders live as water-dwelling larvae for a few months to three years. Larvae (LAR-vee) are animals in an early stage that change body form in a process called metamorphosis (MEH-tuh-MORE-feh-sis) before becoming adults. Some species do not go through metamorphosis and spend their entire lives with the body form of larvae, but they can reproduce. At least three species never live as larvae and hatch from their eggs looking like small adults.

Scientists have found large numbers of miniature salamanders, mainly in the family of lungless salamanders. Most of these miniature species live on land throughout their lives, and many are secretive. New species continue to be discovered at a high

rate. Many of these species are less than 1.2 to 1.4 inches (3 to 3.5 centimeters) long from tip of snout to tip of tail.

GEOGRAPHIC RANGE

Lungless salamanders live in southern Canada, much of the United States, and Mexico except the north-central parts of these countries. They also live in Central America and central South America. Most of the species live in the eastern and central parts of the United States. Six species live in the middle western Mediterranean region of Europe.

HABITAT

Lungless salamanders live in forest, woodlands, streams, springs, and caves. They thrive in wooded mountain areas. Some species live in deserts that receive fewer than 10 inches (25 centimeters) of rainfall each year. Others live in rainforests. Many species live in trees all or part of the time.

WHERE DID THE LUNGS GO?

Lunglessness is thought to have evolved as an adaptation for life in flowing water. Larvae are small, and lungs would tend to act as air sacs that might make the salamander float in the water. This would dislodge them from their food source and threaten their survival. Water in a stream is constantly being mixed with air, and salamanders can breathe through their skin, so there is little natural selection for keeping lungs.

DIET

Lungless salamanders eat small crustaceans and insects but sometimes eat worms. Larger species sometimes eat smaller species. Lungless salamanders capture prey with an explosive flicking of their tongue. Crustaceans (krus-TAY-shuns), such as crayfish, are water-dwelling animals that have jointed legs and a hard shell but no backbone.

BEHAVIOR AND REPRODUCTION

Lungless salamanders commonly live close together in large numbers and typically are the most numerous vertebrates (VER-teh-brehts), or animals with backbones, in a region. Lungless salamanders are secretive by day and active by night. They have small home ranges. The only ones that make seasonal travels are the few species that breed in water. Lungless salamanders that live in streams are more active than land-dwelling species, but most species can move quickly when disturbed, and they are good at escaping capture. The land-dwelling species, especially the tropical species, rely more on stealth than speed to avoid detection and capture and do not move as

quickly as water-dwelling species. Some lungless salamanders are aggressive and fight to defend their territory.

All lungless salamanders have complex mating behavior, and mating can take many hours. More than half of the species are strictly land-dwelling and lay large eggs that they hide in spaces under rocks or logs, in moss mats, in balls of moss hanging in plants, in trees, and in plants that grow in trees. The eggs of these species hatch weeks after being laid, and the young look like small adults. Some species of lungless salamanders lay eggs in or near shallow water, typically moving water, and the eggs hatch into water-dwelling larvae that take a few months to three years to go through metamorphosis. A few species live their entire lives as larvae.

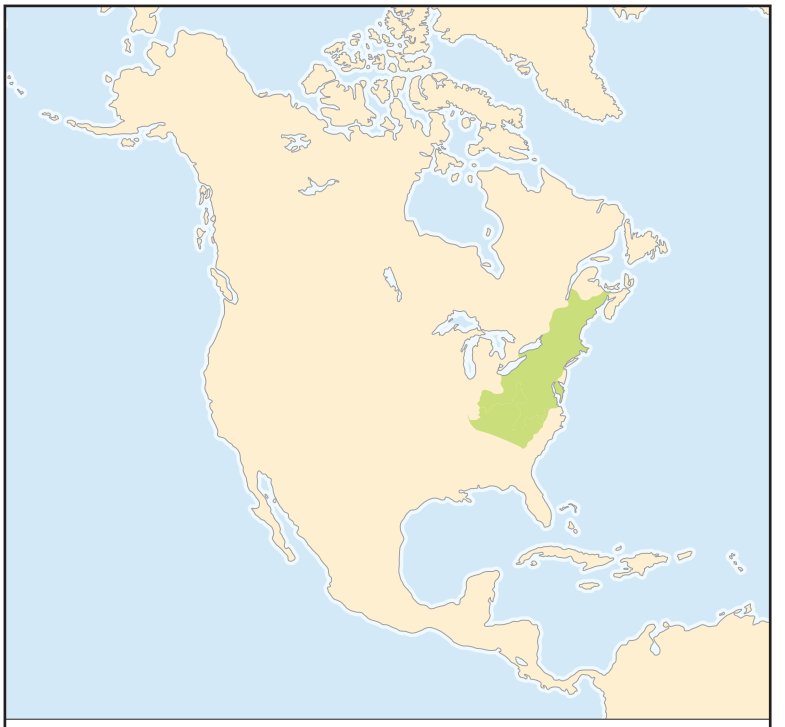
LUNGLESS SALAMANDERS AND PEOPLE

Lungless salamanders are not often seen by people.

CONSERVATION STATUS

The World Conservation Union (IUCN) lists one species of lungless salamanders as Extinct, thirty-one as Critically Endangered, eighty-three as Endangered, fifty-four as Vulnerable, and thirty-six as Low Risk/Near Threatened. Extinct means no longer in existence. Critically Endangered means facing extremely high risk of extinction in the wild. Endangered means facing very high risk of extinction in the wild. Vulnerable means facing high risk of extinction in the wild. Low Risk/Near Threatened means at risk of becoming threatened with extinction in the future.

The U.S. Fish and Wildlife Service lists four species of lungless salamanders as Endangered and three species as Threatened. Endangered means in danger of extinction throughout all or a significant portion of its range. Threatened means likely to become endangered in the near future.



Dusky salamander *(Desmognathus fuscus)*

DUSKY SALAMANDER
Desmognathus fuscus

Physical characteristics: Dusky salamanders are about 5.5 inches (14 centimeters) long from tip of snout to tip of tail. They have short legs and a stocky build. The hind legs are much larger than the front legs. The head is wedge shaped and has large eyes that bulge out. The jaw and neck muscles are thick. The tail has a low fin and ends in a sharp point. The tail grows back if it is pulled off by a predator, but it grows back with a blunt end rather than a sharp tip. Dusky salamanders usually are darker on the back than on the belly, which is cream colored. The back is mottled gray and black, striped with various shades of tan to yellowish brown to brown. A black stripe extends from the eye diagonally back to the angle of the jaw.



Dusky salamanders lay the eggs in clusters of five to thirty in moist, hidden places in seepage pools on rocks or at the edges of springs and small streams. The female guards the eggs until they hatch in about forty-five days. (© E. R. Degginger/Photo Researchers, Inc.)

Geographic range: Dusky salamanders live in Quebec and New Brunswick in eastern Canada. Their range extends south and west as far as Indiana and South Carolina in the United States.

Habitat: Dusky salamander larvae live in springs, in small streams, and in water that has seeped up through the ground and collected in a pool. Adults spend some time on land but spend most of their time in seeped-up water or on the sides of springs and small streams, where they live among rocks or under logs.

Diet: Dusky salamander larvae mainly eat small invertebrates (in-VER-teh-brehts), or animals without backbones, such as the larvae of water-dwelling insects. They also eat tiny crustaceans and clams. Adults eat land-dwelling prey, mainly small insects and crustaceans, but they feed on water-dwelling insects when in the water. Larger dusky salamanders eat larger prey, but they continue to eat small prey. These salamanders sometimes eat one another, especially the larvae of others in their species. Adults capture their prey by rapidly flicking their tongues and snapping their jaws.

Behavior and reproduction: Dusky salamanders are active animals. They move very fast and are hard to catch. Most of their normal activity takes place in the early evening, but when conditions are warm and moist, these salamanders may be active throughout the night. By day dusky salamanders typically stay under cover. Dusky salamanders defend themselves from predators by remaining motionless or by biting.

Dusky salamanders mate on land. The male lures the female by rubbing her head with his body, waving his front legs, and placing himself alongside her and snapping backward. He approaches the female and positions her head at the base of his tail. He then walks forward, moving his tail back and forth while the female follows. The male releases a sperm bag, and the female takes it into her body. The female stores the sperm inside her. The eggs are fertilized when the female is ready to lay them in middle to late summer. She lays the eggs in clusters of five to thirty in moist, hidden places in seepage pools on rocks or at the edges of springs and small streams. The female guards the eggs until they hatch in about forty-five days. When the larvae hatch, they still have plenty of nutrients from the egg and do not feed immediately. Larvae grow slowly in the fall and winter but rapidly in the spring and go through metamorphosis in about nine months.

Dusky salamanders and people: Dusky salamanders have no known importance to people.

Conservation status: Dusky salamanders are not considered threatened or endangered. They are one of the most common salamanders in eastern North America. These salamanders adapt well to changes in their habitat as long as there are enough small streams. ■



Arboreal salamander *(Aneides lugubris)*

ARBOREAL SALAMANDER
Aneides lugubris

Physical characteristics: Arboreal (ar-BOR-ee-ul) salamanders have a heavily muscled head and body; a long, grasping tail; and long, grasping toes. The toes also have widened, somewhat curved tips. Arboreal salamanders are a little longer than 7 inches (18 centimeters) from tip of snout to tip of tail. Their large eyes bulge from the head in front of large jaw muscles. The head is nearly triangular. The upper and lower jaws have large, saber-like teeth with curved tips that can cause a serious wound. These salamanders are grayish brown to brown with yellow spots and a lighter belly. The spots can be small and scattered or large and close together.

Geographic range: Arboreal salamanders live mainly in California, United States, in the coastal mountains and valleys from the north-

western part of the state to the extreme northwestern part of Baja California Norte, Mexico. Some of these salamanders live on off-shore islands in the Pacific Ocean. Scattered groups live in the foothills of the Sierra Nevada.

Habitat: Arboreal salamanders live mainly in oak woodlands, where they use holes in the trees for nesting sites and for escape from dry conditions. These salamanders also live in sycamore woodlands near creeks in the southern parts of their range. Arboreal salamanders are commonly found under the bark of fallen oak logs, under rocks, and in holes in the ground.

Diet: Despite their large jaws and teeth, arboreal salamanders mainly eat small insects and crustaceans. Sometimes they eat slender salamanders.



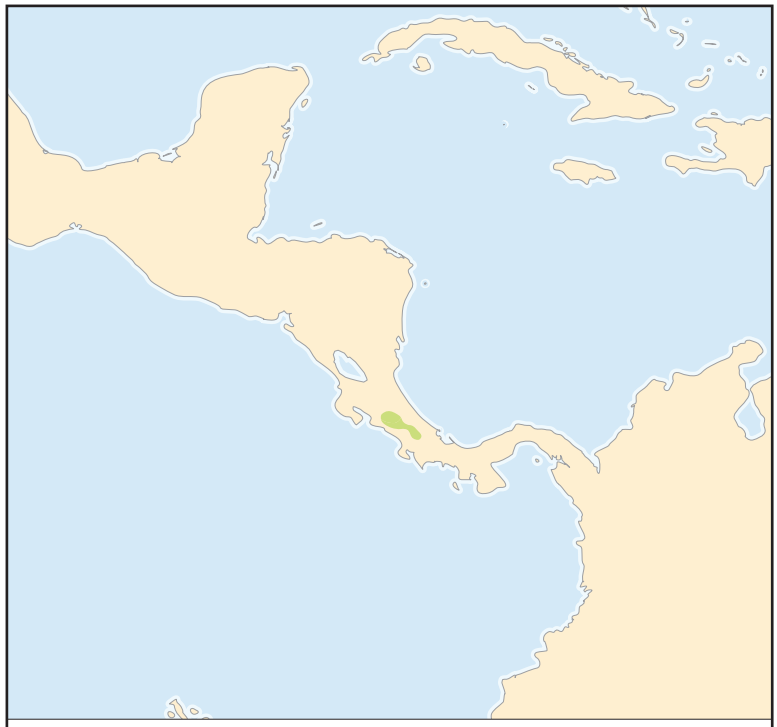
Despite their large jaws and teeth, arboreal salamanders mainly eat small insects and crustaceans. (Illustration by Gillian Harris. Reproduced by permission.)

Behavior and reproduction: Arboreal salamanders are aggressive. Both males and females have large jaw muscles and teeth that they use in fights over territory and against predators. These salamanders are good climbers, but most of their activity takes place on the ground.

Arboreal salamanders spend their entire lives on land. They do not enter water to breed. The females lay grape-like clusters of large eggs that are suspended from the roofs of underground holes, in large decaying logs, or in trees. The eggs hatch three to four months after they are laid, just before the fall rains. Young salamanders that look like small adults emerge from the eggs.

Arboreal salamanders and people: Arboreal salamanders have no known importance to people.

Conservation status: Arboreal salamanders are not considered threatened or endangered. ■



Talamancan web-footed salamander *(Bolitoglossa pesrubra)*

TALAMANCAN WEB-FOOTED SALAMANDER
Bolitoglossa pesrubra

Physical characteristics: Talamancan (tah-lah-MAHNG-kahn) web-footed salamanders are stocky salamanders that reach a length of about 4 inches (11 centimeters) from tip of snout to tip of tail. The tail is about half of the total length. The toes are webbed, meaning there is skin between them, although the tips of the toes stick out beyond the webbing. Most of these salamanders are dark brown with a gray or black blotched or marbled pattern, but some of them are solid brown. The belly is dark gray but is lighter than the back. The throat is much lighter than the back and often has a slight yellow color. The legs are usually dark red or reddish orange.

Geographic range: Talamancan web-footed salamanders live in the Cordillera de Talamanca in central and eastern Costa Rica, generally at heights of 7,500 feet (2,300 meters) above sea level.



Talamancan web-footed salamanders live under the bark of logs and under leaf litter in oak forests, but they also have survived in many areas where habitats have been destroyed. (Illustration by Gillian Harris. Reproduced by permission.)

Habitat: Talamancan web-footed salamanders live under the bark of logs and under leaf litter in oak forests, but they also have survived in many areas where habitats have been destroyed. Large numbers of these salamanders have been found in local rubbish heaps. Talamancan web-footed salamanders also live in plants that grow in trees, in moss mats on trees, and by the sides of roads. These salamanders once were common at very high elevations, about 10,000 feet (3,050 meters), even in completely open areas, where they were found under rocks, slabs of concrete, and other objects, but in more recent years few have been found.

Diet: Talamancan web-footed salamanders eat small insects, which they catch with a very fast tongue that they flick with great accuracy.

Behavior and reproduction: Talamancan web-footed salamanders hunt and mate at night. Other than that, scientists know little about their behavior. When these salamanders hatch, they look like small adults. They do not hatch as larvae that have to change form before becoming adults. The females lay eggs all year in clusters of thirteen to thirty-eight eggs. The eggs are large and take a very long time to develop, partly because of the cool temperature of their mountain habitat. Females guard the eggs until they hatch.

Talamancan web-footed salamanders and people: Talamancan web-footed salamanders are the best known of the many tropical salamanders because they have been observed by generations of students in classes organized by the Organization for Tropical Studies, a group of scientists from all over the world that has three research stations in Costa Rica. These salamanders once were thought to be extremely tolerant of human activities and thrived even along heavily used roads, but they have disappeared from much of their range. Talamancan web-footed salamanders are still found in deep forests.

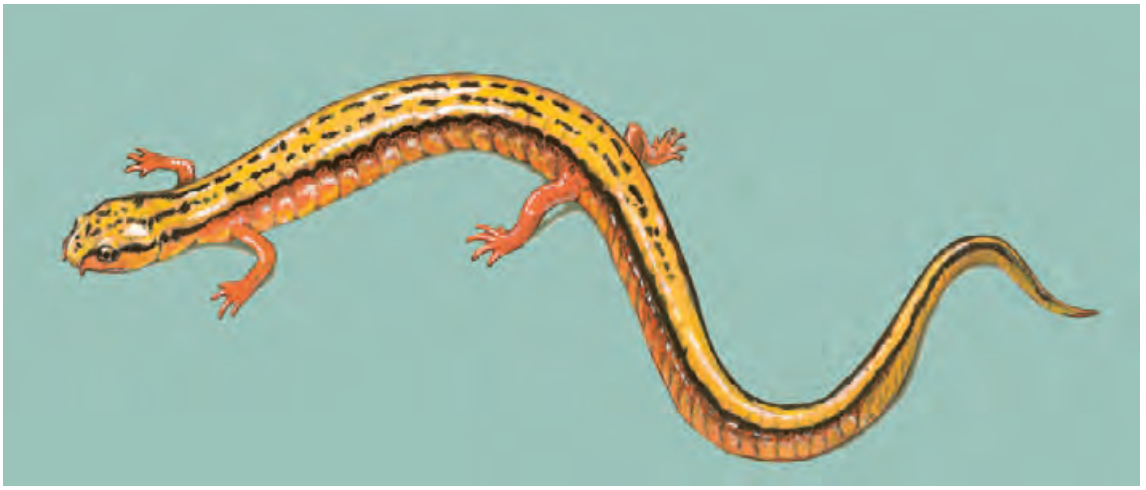
Conservation status: The IUCN lists Talamancan web-footed salamanders as Endangered, or facing very high risk of extinction in the wild. ■



Two-lined salamander *(Eurycea bislineata)*

TWO-LINED SALAMANDER
Eurycea bislineata

Physical characteristics: Two-lined salamanders are small, thin salamanders with long, tapered tails. The eyes bulge out from the head. The color of these salamanders ranges from greenish yellow to yellow or orangish brown. Broad bands extend from behind the eyes along the trunk to near the tip of the tail. This band is marked with dark brown or black spots. On each side of the dark brown band is a brown or black stripe that extends from the eye well onto the tail. The sides of the salamanders are light with dark spots, and the belly is bright yellow with scattered dark spots. These salamanders are 5 to 5.5 inches (13 to 14 centimeters) long from tip of snout to tip of tail.



These salamanders are 5 to 5.5 inches (13 to 14 centimeters) long from tip of snout to tip of tail. (Illustration by Gillian Harris. Reproduced by permission.)

Geographic range: The geographic range of two-lined salamanders extends from northeastern Canada through the northeastern part of the United States to Ohio, West Virginia, and Virginia.

Habitat: The larvae of most two-lined salamanders live in small springs and water that has seeped up through the ground and collected in a pool. They sometimes live in ponds, where they live on the bottom. Young salamanders that have recently gone through metamorphosis and adults usually stay near streams in forested areas but move out into the forest, sometimes quite far from the water. As adults some two-lined salamanders stay on land for much of the year.

Diet: Larvae of two-lined salamanders eat the larvae of small water-dwelling insects but also eat small crustaceans. Adults feed mainly on small insects but also eat snails.

Behavior and reproduction: Two-lined salamanders look for food in the forest at night. Some scientists believe these salamanders guard their territory. Scientists believe two-lined salamanders mate on land and that females store sperm until it is time to lay the eggs. The fertilized eggs are laid one at a time under rocks in small streams. The females form nests but do not guard them. Nests can contain more than one hundred eggs, but there are usually about fifty eggs in a nest. Eggs take as long as ten weeks to hatch. After hatching, most two-lined salamanders live as larvae for about two years before metamorphosis is complete. Two-lined salamanders in the southern parts of the range are larvae for about one year.

Two-lined salamanders and people: Two-lined salamanders have no known importance to people.

Conservation status: Two-lined salamanders are not considered threatened or endangered. ■



Texas blind salamander *(Eurycea rathbuni)*

TEXAS BLIND SALAMANDER
Eurycea rathbuni

Physical characteristics: Texas blind salamanders have no eyes. They have red, feathery gills and a shiny white body with long, extremely thin legs. Gills are organs for obtaining oxygen from water. These salamanders reach a length of about 5 to 5.5 inches (13 to 14 centimeters) from tip of snout to tip of tail. The head is large and flat and has a broad, blunt snout.

Geographic range: Texas blind salamanders live only in a small area on the edge of the Edwards Plateau, near San Marcos in south-central Texas, United States.

Habitat: Texas blind salamanders live only underground in streams and pools in sinkholes and caves. A sinkhole is an area where the



Texas blind salamanders live only in a small area on the edge of the Edwards Plateau, near San Marcos in south-central Texas, United States. (© Danté Fenolio/Photo Researchers, Inc.)

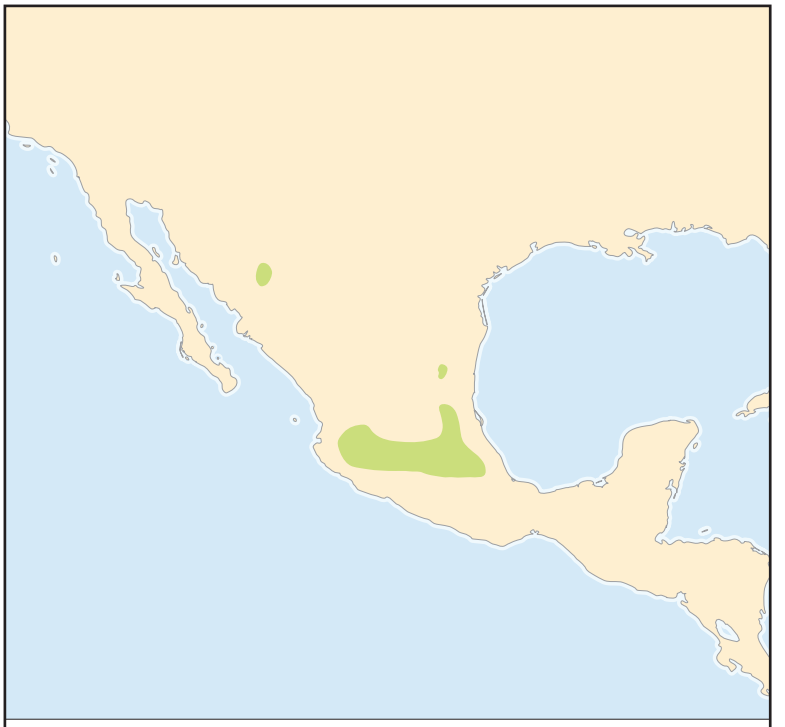
land over an underground river has collapsed and formed the entrance to a cave.

Diet: Texas blind salamanders eat snails and tiny crustaceans such as water fleas and cave shrimp.

Behavior and reproduction: Scientists know little about the behavior of Texas blind salamanders. These animals have been seen swimming in the water of caves and using their long limbs to grab and cling to the rocky cave walls. Scientists do not know how Texas blind salamanders reproduce.

Texas blind salamanders and people: Texas blind salamanders have no known importance to people.

Conservation status: The IUCN lists Texas blind salamanders as Vulnerable, or facing high risk of extinction in the wild. These salamanders were one of the first species named to the United States federal endangered species list. They become threatened when people remove the water from their habitat and by pollution from the land above the caves. ■



Bell's salamander *(Pseudoeurycea bellii)*

BELL'S SALAMANDER
Pseudoeurycea bellii

Physical characteristics: Bell's salamanders are the largest lungless salamanders and almost the largest land-dwelling salamanders. They reach a length of nearly 14 inches (36 centimeters) from tip of snout to tip of tail. Bell's salamanders are shiny dark black and have a pair of red to reddish orange spots on the back of the head and paired rows of red to reddish orange spots along the back. There is usually a V-shaped mark at the beginning of the paired rows of spots. The tail is large and long. The legs are long and sturdy.

Geographic range: Bell's salamanders live in northern and central Mexico, usually at heights greater than 4,000 feet (1,220 meters) above sea level.



Bell's salamanders are the largest lungless salamanders and almost the largest land-dwelling salamanders. (Illustration by Gillian Harris. Reproduced by permission.)

Habitat: Bell's salamanders live only on land under large surface objects such as logs and rocks in moist woods. They use burrows in the ground and can be found in holes in the sloping mounds of earth that line roadbeds in some areas.

Diet: Scientists believe Bell's salamanders eat insects, which they catch with a flick of their long, fast tongue.

Behavior and reproduction: Bell's salamanders are active at night. The females lay batches of more than twenty large eggs. Other than that scientists do not know how these salamanders behave or reproduce.

Bell's salamanders and people: Bell's salamanders have no known importance to people.

Conservation status: The IUCN lists Bell's salamanders as Vulnerable or facing high risk of extinction in the wild. ■

FOR MORE INFORMATION

Books:

Bernhard, Emery. *Salamanders.* New York: Holiday House, 1995.

Griffiths, R. A. *Newts and Salamanders of Europe.* San Diego: Academic Press, 1996.

Gunzi, Christiane. *Amphibians and Reptiles of North America.* San Diego, CA: Thunder Bay, 1995.

Lawlor, Elizabeth P. *Discover Nature in Water and Wetlands.* Mechanicsburg, PA: Stackpole, 2000.

Llamas Ruiz, Andres. *Reptiles and Amphibians: Birth and Growth.* New York: Sterling, 1996.

Petranka, J. W. *Salamanders of the United States and Canada.* Washington, DC: Smithsonian Institution Press, 1998.

Periodicals:

Cohn, Jeffrey P. "Meet the Salamander." *Americas (English Edition)* (November-December 1993): 3.

Web sites:

"*Aneides lugubris*: Arboreal Salamander." *San Diego Natural History Museum.* http://www.sdnhm.org/fieldguide/herps/anei-lug.html (accessed on April 11, 2005).

"Arboreal Salamander, *Aneides lugubris*." *Northern Prairie Wildlife Research Center.* http://www.npwrc.usgs.gov/narcam/idguide/aneidelu.htm (accessed on April 11, 2005).

Bartholomew, P. "*Aneides lugubris*." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Aneides_lugubris.html (accessed on April 11, 2005).

Heying, H. "Plethodontidae." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Plethodontidae.html (accessed on April 11, 2005).

Munger, M. "*Eurycea rathbuni*." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Eurycea_rathbuni.html (accessed on April 11, 2005).

"Northern Two-lined Salamander: *Eurycea bislineata*." *Northern Prairie Wildlife Research Center.* http://www.npwrc.usgs.gov/narcam/idguide/eurybis.htm (accessed on April 11, 2005).

Vanwormer, E. "*Eurycea bislineata*." *Animal Diversity Web.* http://animaldiversity.ummz.umich.edu/site/accounts/information/Eurycea_bislineata.html (accessed on April 11, 2005).

AMPHIUMAS
Amphiumidae

Class: Amphibia
Order: Caudata
Family: Amphiumidae
Number of species: 3 species

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

Amphiumas (AM-fee-YOO-muhs) are very long, medium-sized to very large salamanders that look like snakes with four very short legs. These animals are dark reddish brown to gray or black on top. The belly is a lighter shade than the back or almost as dark. Adult amphiumas reach a length of 13 to 46 inches (33 to 117 centimeters), depending on the species. The legs usually are less than 0.4 inch (1 centimeter) long, and there are one to three toes on each foot.

Amphiumas have a pointed head, but the snout is somewhat flattened in two species. There are teeth on the jaw bones. Amphiumas have no eyelids and have one gill slit on each side of the body. Gills are organs for obtaining oxygen from water. Unlike the bushy, outside gills of other salamanders, the gills of amphiumas are inside their bodies, just behind the head. Gill slits are openings from the gills to the outside of the body. Gill arches support the gills inside the body.

Adult amphiumas have glands in their skin that ooze out slippery mucus. An amphiuma's tail is flat from side to side and makes up 20 to 25 percent of the total body length. A lateral (LAT-uhr-uhl) line, a system of organs that help some animals sense movement in the water, is present on the body and head of amphiumas. The bodies of these animals have fifty-seven to sixty grooves along the sides, each of which indicates a vertebra (VER-teh-bruh), or one of the bones that make up the spinal column. The vertebrae (VER-teh-bree, the plural of vertebra) are curved in on each end like the inside of a bowl. A few vertebrae near the front of amphiumas have ribs connected to them.

Amphiumas are the longest and largest salamanders in the United States. Even though local people call amphiumas congo eels, lamper eels, ditch eels, lampreys, and congo snakes, these salamanders are amphibians, not fish like eels and lampreys and not reptiles like snakes. Amphibians (am-FIB-ee-uhns) are vertebrates (VER-teh-brehts), or animals with a backbone, that have moist, smooth skin; are cold-blooded, meaning their body temperature is the same as the temperature of their surroundings; and, in most instances, have a two-stage life cycle.

Amphiumas that have gone through metamorphosis keep some features of larvae: a lack of eyelids and tongue and the presence of four gill arches with a single opening to the outside between the third and fourth arches rather than a slit for each gill. Larvae (LAR-vee) are animals in an early stage that change body form in a process called metamorphosis (MEH-tuh-MORE-feh-sis) before becoming adults. Amphiumas have lungs, but they also can breath through their throat and skin. When young amphiumas hatch, they keep their gills for a few days. Hatchlings are a little more than 2 inches (5 centimeters) long. Amphiumas that have just gone through metamorphosis may be as short as 2.5 inches (6 centimeters). Adults reach a length of 46 inches (117 centimeters).

GEOGRAPHIC RANGE

Amphiumas live in an area that extends from southeastern Virginia southward along the coastal plain and throughout Florida, westward along the coastal plain and from southwestern Alabama and all of Mississippi and Louisiana to the easternmost part of Texas and most southeastern part of Oklahoma northward to the extreme southeastern portion of Missouri.

HABITAT

Amphiumas live in swamps, marshes, ditches, lakes, and sluggish streams. One species lives in watery muck. Amphiumas can be quite common in cities, where they live in waterways such as ditches and canals. Amphiumas may hide among water plants, but they prefer crayfish holes. In rainy weather amphiumas may crawl around on wet surfaces.

DIET

Amphiumas eat worms, water insects and their larvae, frogs, salamanders, fish, and any other small vertebrates. A favorite prey is crayfish.

Roommates?

In Florida, amphiuma nests have been found in the nest mounds of alligators.

BEHAVIOR AND REPRODUCTION

Amphiumas are active at night and are most active when water temperatures are higher than 41°F (5°C). These salamanders wait in holes for passing prey, or they prowl in search of prey. The strong teeth and powerful bite are used to subdue prey animals. Amphiumas are eaten by snakes and large wading birds.

If a ditch or pond goes dry, amphiumas hide in holes where they lie dormant. Amphiumas have been dug from holes as deep as 3.3 feet (1 meter). Amphiumas live about twenty-seven years and can go as long as three years without food. Amphiumas periodically shed their skin and sometimes eat it. This behavior helps them stay nourished during dry spells. Amphiumas move with a side-to-side wavy motion. They are sensitive to vibrations that they detect with their lateral line system. Amphiumas out of water sometimes make a whistling sound.

Adult male amphiumas may fight during the mating season, and many have scars to show for it. During the breeding season, the cloaca of male amphiumas swells. The cloaca (kloh-AY-kuh) is the chamber in some animals that holds waste from the kidneys and intestines, holds eggs or sperm about to be released to the outside, holds sperm entering a female's body, and is the passage through which young are born. Male amphiumas make sperm from October to May. A male amphiuma courts a female by rubbing his snout against her. The female then rubs her nose along the male's body and coils her body under his, so that his cloaca is joined to hers. The male produces a sperm sac, and the female picks it up with her cloaca.

Fertilization (FUR-teh-lih-ZAY-shun), the joining of egg and sperm to start development, takes place inside the female's body. The female makes a nest in a moist place, usually under a log, leaves, or other cover. The female lays the eggs in beady strings of fifty to two hundred eggs, but there may be as many as 354 eggs in a chain. The female coils around and guards the eggs. It may take as long as six months for the eggs to hatch. The eggs and their jelly-like outer layers are approximately 0.4 inch (1 centimeter) in diameter in large species. Female amphiumas reproduce every two years.

AMPHIUMAS AND PEOPLE

Amphiuma meat is edible and tastes much like frogs' legs, but few people eat the meat, because the skin is difficult to strip

from it. Amphiuma cells, especially the red blood cells, are the largest known cells in vertebrates, and they have long been used in physiological studies and in classrooms. The chromosomes of amphiumas also are very large and useful for study. Amphiumas are captured with dip nets, seines, minnow traps, electroshock equipment, and by hand. The skin is so slippery that cotton gloves must be used to maintain a hold on the animal long enough to place it in a container. Care in handling is recommended, because the bite can be painful.

CONSERVATION STATUS

The World Conservation Union (IUCN) lists one species of amphiumas as Low Risk/Near Threatened, or at risk of becoming threatened with extinction in the future. Although human activity has destroyed much of the habitat of amphiumas, it also has increased habitat through the building of ponds, ditches, canals, lagoons, and lakes. Amphiumas can survive in waters with fish, and they may be major predators in some waters.



SPECIES ACCOUNT

THREE-TOED AMPHIUMA
Amphiuma tridactylum

Physical characteristics: Three-toed amphiumas have three toes on each foot. Hatchlings are 1.5 to 2.5 (4 to 6 centimeters) long from tip of snout to tip of tail. Young three-toed amphiumas that have recently finished metamorphosis are about 2.5 inches (6 centimeters) long. Adults can be as long as 40 inches (103 centimeters). The back is dark brown to black, and the belly is a lighter shade of the same color. The throat has a dark patch on it.

Geographic range: Three-toed amphiumas live in an area that extends from eastern Texas to southeastern Oklahoma, southeastern Missouri, and southwestern Alabama.



Three-toed amphiumas mainly eat crayfish, but they also eat other water animals. (E. R. Degginger/Photo Researchers, Inc.)

Habitat: Three-toed amphiumas live in swamps, lakes, ditches, and sluggish streams.

Diet: Three-toed amphiumas mainly eat crayfish, but they also eat other water animals.

Behavior and reproduction: Three-toed amphiumas are active at night. Although they usually stay in a small area, some of these salamanders have been known to move as far as 1,300 feet (400 meters) from their main spot.

A male three-toed amphiuma courts a female by rubbing his snout against her. The female then rubs her nose along the male's body and coils her body under his, so that his cloaca is joined to hers. The male produces a sperm sac, and the female picks up the sperm with her cloaca for fertilization inside her body. The female every two years lays 42 to 150 eggs at a time in burrows. Larger females lay larger numbers of eggs. The eggs hatch about five months after being laid. Three-toed amphiumas reach adulthood in three to four years.

Three-toed amphiumas and people: Three-toed amphiumas are edible but are rarely eaten. These salamanders are used for classroom study. Scientists have found several new species of flatworms and tapeworms in three-toed amphiumas.

Conservation status: Three-toed amphiumas are not considered threatened or endangered. ■

FOR MORE INFORMATION

Books:

Bernhard, Emery. *Salamanders.* New York: Holiday House, 1995.

Duellman, William E., and Linda Trueb. *Biology of Amphibians.* Baltimore, MD: Johns Hopkins University Press, 1994.

Lawlor, Elizabeth P. *Discover Nature in Water and Wetlands.* Mechanicsburg, PA: Stackpole, 2000.

Llamas Ruiz, Andres. *Reptiles and Amphibians: Birth and Growth.* New York: Sterling, 1996.

Petranka, J. W. *Salamanders of the United States and Canada.* Washington, DC: Smithsonian Institution Press, 1998.

Web sites:

"Amphiumidae (Gray, 1825) Amphiuma/Congo Snakes." *Livingunderworld .org.* http://www.livingunderworld.org/caudata/database/amphiumidae (accessed on April 11, 2005).

Heying, H. "Amphiumidae." *Animal Diversity Web.* http://animaldiversity .ummz.umich.edu/site/accounts/information/Amphiumidae.html (accessed on April 11, 2005).

"Three-Toed Amphiuma." *Smithsonian National Zoological Park.* http:// nationalzoo.si.edu/Animals/ReptilesAmphibians/Facts/FacSheets/ Threetoedamphiuma.cfm (accessed on April 11, 2005).

CAECILIANS
Gymnophiona

Class: Amphibia
Order: Gymnophiona
Number of families: 5 families

order
CHAPTER

PHYSICAL CHARACTERISTICS

Caecilians (sih-SILL-yuhns) are long, legless amphibians with a dual-action jaw. Some have tails, but most do not. Amphibians (am-FIB-ee-uhns) are vertebrates (VER-teh-brehts), or animals with a backbone, that have moist, smooth skin; are cold-blooded, meaning their body temperature is the same as the temperature of their surroundings; and, in most instances, have a two-stage life cycle. Some species of caecilians are land dwellers, and some are water dwellers.

The most striking feature of caecilians is a series of rings that make these amphibians look like earthworms. The rings run the length of the body starting just behind the head. The rings are inside the body and attached to the vertebrae (VER-teh-bree), or the bones that make up the spinal column. Some caecilians have one ring per vertebra (VER-teh-bruh, the singular of vertebrae); some have two rings, especially toward the rear of the animal; and some have three. The skin is folded over the rings, making grooves between the rings. In some species the grooves go all the way around the body, and in some they only go part of the way around. The second and third sets of rings make shallower grooves than the main set. The species with three rings per vertebra have a short tail, and the tail also has rings. Some species of caecilians have scales just under their skin.

Between the nostrils and the eyes on each side of the head, caecilians have a tentacle that is pumped out and in as needed. The tentacles are sense organs that respond to chemicals and touch. Inside each tentacle is a fluid-filled channel that runs

IT'S ALL IN THE JAW

All vertebrates except caecilians have a single pair of muscles used for closing their jaws. These muscles pull up on the lower jaws. Caecilians have this mechanism of jaw closure, but they also have a second mechanism in which another pair of muscles assists in closing the jaws. The second muscle pulls down on part of the lower jaw, causing the forward, toothed portion of the lower jaw to close by rotating upward. The action is much like that of a seesaw.

from the tip of the tentacle to a chamber that opens into the part of the brain that controls the sense of smell. There is a hole in the skull through which the tentacle pumps out and in. This hole can be anywhere between the eyes and the nostrils. Scientists use the location of the hole to tell different species of caecilians apart.

The eyes of caecilians are small and covered by skin or, in some species, bone. The eyes of many species have lost some or all of their muscles, and some have lost the lens and have only a small retina and optic nerve. Even with the lack of eye parts, most caecilians can distinguish light and dark.

Caecilians have a somewhat flat head with nostrils at the tip of the snout and a large mouth. In some caecilian species the lower jaw is the same length as the upper jaw, and the mouth opens at the front of the animal's head. In other species, the lower jaw is shorter than the upper jaw, a feature that improves burrowing ability. The mouths of these species open on the bottom of the animal's head. Caecilians have two rows of teeth on the upper jaw and one or two rows on the lower jaw. The tops of the teeth have different shapes among species, but all teeth are hinged and usually curve backward, apparently to prevent the loss of prey the animals have caught.

The skin of caecilians has glands that release a substance that is poisonous to many predators. Most caecilians are dark gray to grayish brown to deep purple, often with a lighter head and belly. Some caecilians, however, are brightly colored. For example, a species on the African island of São Tomé is bright yellow. A South American species is deep bluish purple with bright white grooves between its rings. Some species are dark gray to grayish brown to brownish black with bright yellow side stripes. Most adult caecilians are 12 to 24 inches (30 to 60 centimeters) long, but some species are much smaller or larger. The smallest adult caecilians are about 4.5 inches (11 centimeters) long. The largest are more than 63 inches (160 centimeters) long.

GEOGRAPHIC RANGE

In the Western Hemisphere, caecilians live in an area that extends from central Mexico through Peru, Bolivia, Paraguay, and northern Argentina. The water-dwelling or partially water-dwelling species live mainly in the regions of the Orinoco and Amazon rivers, but some live in an area that extends from Colombia to northern Argentina and Uruguay. In the Eastern Hemisphere caecilians live in eastern and western Africa except the Sahara, in the Seychelles, India, Sri Lanka, Southern China, Cambodia, Laos, Vietnam, and much of Malaysia to the southern Philippines. Caecilians do not live in Madagascar, much of central Africa, or Australia.

LOOKS AREN'T EVERYTHING

Caecilians look like giant earthworms with a big mouth, but unlike earthworms, caecilians are vertebrates, which means they have backbones. In addition, caecilians don't just look like earthworms; they eat them!

HABITAT

Some caecilians live in moist soil that is rich in decayed plant matter. They also live in leaf litter and sometimes even in the lower parts of plants. Other caecilians live in water all or most of the time.

DIET

Caecilians are meat eaters. Land-dwelling species prey on animals that they can reach on the ground, including earthworms; termites; insects, such as crickets, that have shed their outer layer; and many other invertebrates (in-VER-teh-brehts), or animals without backbones. Large caecilians have been known to eat lizards and baby rodents. The water-dwelling species nose about at the water's bottom to find food, or they scrape food from logs and rocks. They eat water insects, shrimp, and small fish.

BEHAVIOR AND REPRODUCTION

Caecilians are excellent burrowers in the ground or in leaves. They pump their tentacles in and out while they are moving in order to investigate their surroundings. Caecilians sometimes twist their bodies rapidly when subduing prey that they have grasped with their mouths. Scientists do not know how water-dwelling and partially water-dwelling caecilians behave because these animals live in dark, cloudy water and are hard to observe.

Some caecilians lay eggs that hatch into free-living larvae that have small gills and tail fins. Larvae (LAR-vee) are animals in an early stage that change body form in a process called metamorphosis (MEH-tuh-MORE-feh-sis) before becoming adults. Gills are organs for obtaining oxygen from water. Scientists believe the eggs are laid in burrows or under grass or leaf litter on land. The female guards the eggs until the newly hatched larvae wriggle into nearby streams, where they live until metamorphosis. After metamorphosis the caecilians again become land dwellers. Other caecilians go through metamorphosis while inside the eggs, so they hatch with the body form of adults.

While inside the female, some species of caecilians have fetal (FEE-tehl) teeth that are different from adult teeth. The developing young use the teeth to chew a nutrient liquid made by the inner lining of the egg tubes inside the mother and to stimulate production of this liquid. The fetal teeth are shed at or near birth.

CAECILIANS AND PEOPLE

Caecilians eat insects that are harmful to people. The burrowing movements of land-dwelling caecilians turn soil and thus keep it in good condition.

CONSERVATION STATUS

The World Conservation Union (IUCN) lists one species of caecilians as Endangered and three species as Vulnerable. Endangered means facing very high risk of extinction in the wild. Vulnerable means facing high risk of extinction in the wild.

FOR MORE INFORMATION

Books:

Duellman, William E., and Linda Trueb. *Biology of Amphibians.* Baltimore, MD: Johns Hopkins University Press, 1994.

Lamar, William W. *The World's Most Spectacular Reptiles and Amphibians.* Tampa, FL: World, 1997.

Lawlor, Elizabeth P. *Discover Nature in Water and Wetlands.* Mechanicsburg, PA: Stackpole, 2000.

Llamas Ruiz, Andres. *Reptiles and Amphibians: Birth and Growth.* New York: Sterling, 1996.

Petranka, J. W. *Salamanders of the United States and Canada.* Washington, DC: Smithsonian Institution Press, 1998.

Web sites:

"Caecilian." *Animal Bytes.* http://www.sandiegozoo.org/animalbytes/t-caecilian.html (accessed on April 11, 2005).

Hawes, Alex. "On Waterdogs, Mudpuppies, and the Occasional Hellbender." *Zoogoer.* http://nationalzoo.si.edu/Publications/ZooGoer/2000/2/waterdogsmudpuppieshellbender.cfm (accessed on April 11, 2005).

Summers, Adam. "Squeeze Play." *Natural History.* http://biomechanics.bio.uci.edu/_html/nh_biomech/caecilian/caecilian.htm (accessed on April 11, 2005).

AMERICAN TAILED CAECILIANS
Rhinatrematidae

Class: Amphibia
Order: Gymnophiona
Family: Rhinatrematidae
Number of species: 9 species

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

American tailed caecilians (sih-SILL-yuhns) are medium-sized caecilians with a true, but short, tail. There are a few vertebrae (VER-teh-bree), or the bones that make up the spinal column, behind the cloaca, and these are considered a true tail. The cloaca (kloh-AY-kuh) is the chamber in some animals that holds waste from the kidneys and intestines, holds eggs or sperm about to be released to the outside, holds sperm entering a female's body, and is the passage through which young are born.

Caecilians look like earthworms. A series of rings runs the length of the body starting just behind the head. The rings are inside the body and attached to the vertebrae. American tailed caecilians have three rings per vertebra (VER-teh-bruh, the singular of vertebrae). The skin is folded over the rings, making grooves between the rings. The second and third sets of rings make shallower grooves than the main set.

The mouth of American tailed caecilians opens at the front of the head, and the upper and lower jaws are the same length. The jaws have a dual-action mechanism, like a seesaw. The tentacle openings in these caecilians are next to their eyes. American tailed caecilians are either purplish gray or gray with yellowish stripes along the sides of the body. Adult American tailed caecilians are 8 to 13 inches (20 to 33 centimeters) long.

GEOGRAPHIC RANGE

American tailed caecilians live in northern South America, including parts of Brazil, Colombia, Ecuador, French Guiana, Guyana, Peru, Surinam, and Venezuela.

HABITAT

American tailed caecilians live in tropical rainforests in moist spots full of leaf litter, rotten logs, and burrows in the soil. The larvae live mainly in streams. Larvae (LAR-vee) are animals in an early stage that change body form in a process called metamorphosis (MEH-tuh-MORE-feh-sis) before becoming adults.

DIET

Scientists are not sure what American tailed caecilians eat. They have found large amounts of soil in the intestines of these animals, which is evidence that they eat earthworms. Undigested earthworms and the remains of insects also have been found inside caecilians.

BEHAVIOR AND REPRODUCTION

American tailed caecilians burrow in soil and leaf litter. They sometimes twist their bodies rapidly when subduing prey they have grasped in their mouths. Scientists do not know how American tailed caecilians reproduce. They believe that most species lay eggs and that the females coil around the eggs to protect them. Larvae of one species have been found.

AMERICAN TAILED CAECILIANS AND PEOPLE

American tailed caecilians have no known importance to people.

CONSERVATION STATUS

American tailed caecilians are not considered threatened or endangered. Although not threatened according to the World Conservation Union (IUCN), caecilians are rarely found. Scientists are not sure whether this is because these animals are rare or because they are highly secretive and difficult to find.



SPECIES ACCOUNT

MARBLED CAECILIAN
Epicrionops marmoratus

Physical characteristics: Marbled caecilians reach a length of about 12 inches (30 centimeters). They have a stocky build, and the tail is about 1 inch (2.5 centimeters) long. The back is dark purple with scattered yellowish blotches. The sides and belly are yellow with scattered dark purple spots.

Geographic range: Marbled caecilians live on the Pacific slope of Ecuador.

Habitat: Marbled caecilians live in rainforests. They also live along streams in areas that have been cleared of trees.



Marbled caecilians live in rainforests. They also live along streams in areas that have been cleared of trees. (Illustration by Patricia Ferrer. Reproduced by permission.)

Diet: Marbled caecilians probably eat earthworms and small insects and crustaceans. Crustaceans (krus-TAY-shuns), such as crayfish, are water-dwelling animals that have jointed legs and a hard shell but no backbone.

Behavior and reproduction: In captivity marbled caecilians dig their own burrows in moist soil. They find earthworms and crickets by scent and lunge forward to grasp them in their jaws. To eat larger earthworms, which struggle when caught, marbled caecilians grasp the worm in their mouth and then rapidly spin around to break the worm in half. The caecilian then swallows the grasped part of the worm. Crocodiles and alligators use the same method to subdue and rip apart their prey.

Scientists are not sure how marbled caecilians reproduce. Larvae of this species have been found in leaf litter and stone rubble on the bottoms of small streams. This finding is evidence that marbled caecilians are an egg-laying species.

Marbled caecilians and people: Marbled caecilians have no known importance to people.

Conservation status: Marbled caecilians are not considered threatened or endangered. ■

FOR MORE INFORMATION

Books:

Lamar, William W. *The World's Most Spectacular Reptiles and Amphibians.* Tampa, FL: World, 1997.

Lawlor, Elizabeth P. *Discover Nature in Water and Wetlands.* Mechanicsburg, PA: Stackpole, 2000.

Llamas Ruiz, Andres. *Reptiles and Amphibians: Birth and Growth.* New York: Sterling, 1996.

Petranka, J. W. *Salamanders of the United States and Canada.* Washington, DC: Smithsonian Institution Press, 1998.

Web sites:

"Caecilian." *Animal Bytes.* http://www.sandiegozoo.org/animalbytes/t-caecilian.html (accessed on April 11, 2005).

Hawes, Alex. "On Waterdogs, Mudpuppies, and the Occasional Hellbender." *Zoogoer.* http://nationalzoo.si.edu/Publications/ZooGoer/2000/2/waterdogsmudpuppieshellbender.cfm (accessed on April 11, 2005).

Summers, Adam. "Squeeze Play." *Natural History.* http://biomechanics.bio.uci.edu/_html/nh_biomech/caecilian/caecilian.htm (accessed on April 11, 2005).

ASIAN TAILED CAECILIANS
Ichthyophiidae

Class: Amphibia
Order: Gymnophiona
Family: Ichthyophiidae
Number of species: 39 species

family CHAPTER

PHYSICAL CHARACTERISTICS

Asian tailed caecilians (sih-SILL-yuhns) are medium-sized to large caecilians that have a true tail. The mouth opens at the bottom of the head because the upper jaw is longer than the lower jaw. The jaw has a dual-action mechanism like a seesaw. The tentacle openings in Asian tailed caecilians are in front of the eyes, usually no more than halfway to the nostrils.

Caecilians look like earthworms. A series of rings runs the length of the body starting just behind the head. The rings are inside the body and attached to the vertebrae (VER-teh-bree), or the bones that make up the spinal column. Asian tailed caecilians have three rings per vertebra (VER-teh-bruh, the singular of vertebrae). Some species have as many as 420 rings. The skin is folded over the rings, making grooves between the rings. In Asian tailed caecilians the grooves go all the way around the body. The second and third sets of rings make shallower grooves than the main set. Asian tailed caecilians have a large number of scales under the skin in all the ring grooves.

Asian tailed caecilians are either solid purplish gray or purplish gray with paler stripes of the same color. Adult Asian tailed caecilians are 7 to 22 inches (18 to 56 centimeters) long from tip of snout to tip of tail.

GEOGRAPHIC RANGE

Asian tailed caecilians live in India, Sri Lanka, the Philippines, southern China, Thailand, Myanmar, Laos, Vietnam, Indonesia, and the Malay Archipelago west of Wallace's line.

HABITAT

Asian tailed caecilians live in leaf litter and soil in tropical rainforests. Many species do well, however, in areas that have been cleared of trees for farming.

DIET

Little is known about the feeding habits of Asian tailed caecilians. Scientists have opened up these animals and found large amounts of soil, which is evidence that an animal eats earthworms. The scientists also have found partially digested earthworms and pieces of insects inside caecilians. In captivity Asian tailed caecilians are fed earthworms, crickets, and even strips of beef, fish, and chicken.

BEHAVIOR AND REPRODUCTION

Asian tailed caecilians are burrowers. Newly hatched larvae are attracted to light. Larvae (LAR-vee) are animals in an early stage that change body form in a process called metamorphosis (MEH-tuh-MORE-feh-sis) before becoming adults. In captivity adults leave their burrows at night and crawl on the surface. In their natural habitats Asian tailed caecilians have been found on the surface at night during heavy rains.

At mating time, male Asian tailed caecilians place sperm directly inside a female's cloaca. The cloaca (kloh-AY-kuh) is the chamber in some animals that holds waste from the kidneys and intestines, holds eggs or sperm about to be released to the outside, holds sperm entering a female's body, and is the passage through which young are born. Fertilization (FUR-teh-lih-ZAY-shun), or the joining of egg and sperm to start development, takes place inside the female's body. The female then lays large white eggs strung together by jelly strands. The female takes care of the eggs in hidden nests until hatching.

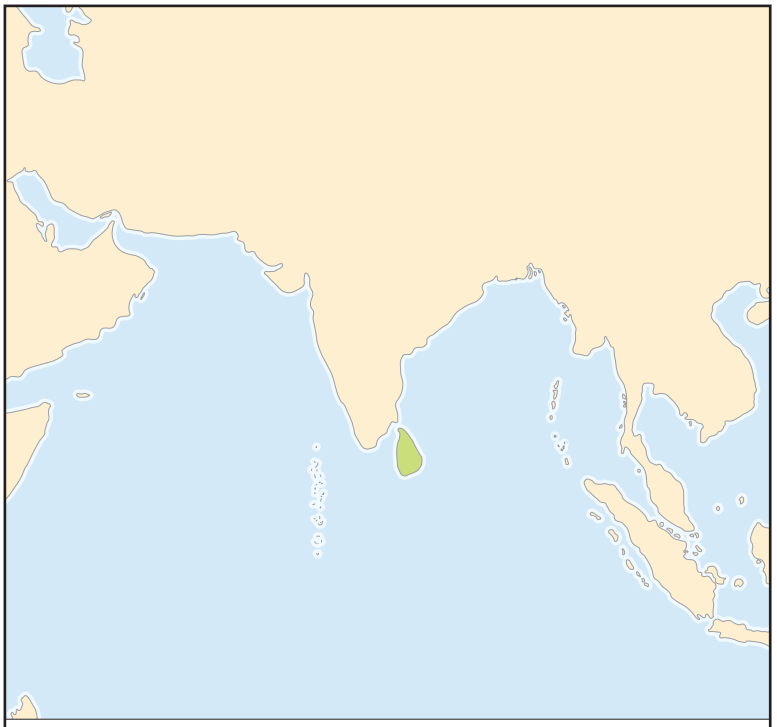
Upon hatching, the larvae of Asian tailed caecilians leave the nest and wriggle to a stream, where they spend an unknown amount of time feeding on small water animals until they transform into young that look like small adults but are not yet able to reproduce. At this point, Asian tailed caecilians leave the stream and take up a land-based, burrowing lifestyle.

ASIAN TAILED CAECILIANS AND PEOPLE

Asian tailed caecilians have no known importance to people.

CONSERVATION STATUS

The World Conservation Union (IUCN) lists two species of Asian tailed caecilians as Vulnerable, or facing high risk of extinction in the wild.



Ceylon caecilian *(Ichthyophis glutinosus)*

SPECIES ACCOUNT

CEYLON CAECILIAN
Ichthyophis glutinosus

Physical characteristics: Ceylon caecilians are medium-sized to large caecilians that reach a length of 9 to 16 inches (23 to 41 centimeters). Adults have 342 to 392 rings along the body. The tentacle openings are closer to the eyes than to the nostrils and are close to the sides of the mouth. These caecilians are purplish gray with yellowish cream stripes on the sides.

Geographic range: Ceylon caecilians live in Sri Lanka.

Habitat: Most Ceylon caecilians have been found in areas that were once rainforests but have been converted to farmland. These animals were found in piles of rotting plant matter and manure and in loose, wet soil. One caecilian was dug up from the soil of a moist meadow.



When it grasps its earthworm prey, a Ceylon caecilian moves backward into its burrow while vigorously twisting its head and neck to subdue the worm. Sometimes the caecilian spins its body to break the earthworm into smaller, more manageable pieces. (Illlustration by Marguette Dongvillo. Reproduced by permission.)

Diet: Newly transformed and adult Ceylon caecilians mainly eat earthworms but also eat other small invertebrates (in-VER-teh-brehts), or animals without backbones, that they find in the leaf litter and soil. Scientists do not know what the larvae eat in the wild, but in captivity they eat small bloodworms and earthworms.

Behavior and reproduction: When it grasps its earthworm prey, a Ceylon caecilian moves backward into its burrow while vigorously twisting its head and neck to subdue the worm. Sometimes the caecilian spins its body to break the earthworm into smaller, more manageable pieces.

Scientists know little about how Ceylon caecilians mate. The females lay twenty-five to thirty-eight large white eggs in jelly strings then place them in hidden nests in the soil. They then coil around the eggs until they hatch. The newly hatched larvae are 3 to 4.5 inches (8 to 11 centimeters) long. The larvae go through metamorphosis after about 280 days.

Ceylon caecilians and people: Ceylon caecilians have no known importance to people.

Conservation status: Ceylon caecilians are not considered threatened or endangered. ■

FOR MORE INFORMATION

Books:

Duellman, William E., and Linda Trueb. *Biology of Amphibians.* Baltimore, MD: Johns Hopkins University Press, 1994.

Lamar, William W. *The World's Most Spectacular Reptiles and Amphibians.* Tampa, FL: World, 1997.

Lawlor, Elizabeth P. *Discover Nature in Water and Wetlands.* Mechanicsburg, PA: Stackpole, 2000.

Llamas Ruiz, Andres. *Reptiles and Amphibians: Birth and Growth.* New York: Sterling, 1996.

Petranka, J. W. *Salamanders of the United States and Canada.* Washington, DC: Smithsonian Institution Press, 1998.

Web sites:

"Caecilian." *Animal Bytes.* http://www.sandiegozoo.org/animalbytes/t-caecilian.html (accessed on April 11, 2005).

Hawes, Alex. "On Waterdogs, Mudpuppies, and the Occasional Hellbender." *Zoogoer.* http://nationalzoo.si.edu/Publications/ZooGoer/2000/2/waterdogsmudpuppieshellbender.cfm (accessed on April 11, 2005).

Summers, Adam. "Squeeze Play." *Natural History.* http://biomechanics.bio.uci.edu/_html/nh_biomech/caecilian/caecilian.htm (accessed on April 11, 2005).

family CHAPTER

KERALA CAECILIANS
Uraeotyphylidae

Class: Amphibia
Order: Gymnophiona
Family: Uraeotyphylidae
Number of species: 5 species

PHYSICAL CHARACTERISTICS

Kerala caecilians (sih-SILL-yuhns) are small to medium-sized caecilians. Their upper jaw is much longer than the lower jaw, so the mouth opens on the bottom of the head. This type of jaw makes the animals good burrowers. Red caecilians have a short tail and small eyes. The tentacle openings are far forward of the eye, below the nostrils.

Caecilians look like earthworms. A series of rings runs the length of the body starting just behind the head. The rings are inside the body and attached to the vertebrae (VER-teh-bree), or the bones that make up the spinal column. Kerala caecilians have two rings per vertebra (VER-teh-bruh, the singular of vertebrae). The skin is folded over the rings, making grooves between the rings. The grooves of Kerala caecilians do not go all the way around the body. The second set of rings makes shallower grooves than the main set. Kerala caecilians have a large number of scales under the skin of the grooves.

Kerala caecilians are either nearly solid dark gray or dark gray with a whitish to yellowish cream belly. Newly transformed young Kerala caecilians and adults are 6 to 12 inches (14.5 to 30 centimeters) long.

GEOGRAPHIC RANGE

Kerala caecilians live in the Western Ghats, which are mountains in Kerala State, which is in southern India.

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

HABITAT

Kerala caecilians live in moist soil and leaf litter in rainforests and areas that have been cleared of trees within the rainforest region. These animals usually are found in moist soil near streams, marshes, and other bodies of water.

DIET

Kerala caecilians eat earthworms and insects.

BEHAVIOR AND REPRODUCTION

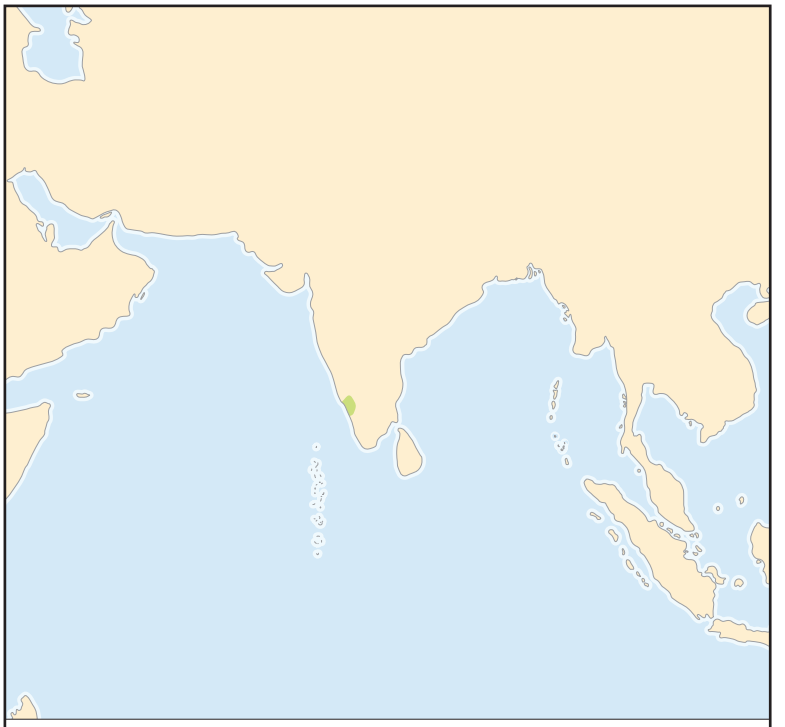
Kerala caecilians dig burrows. Other than that, scientists do not know how Kerala caecilians behave or reproduce. They believe these caecilians are egg layers and that they hatch looking like small adults rather than as larvae. Larvae (LAR-vee) are animals in an early stage that change body form in a process called metamorphosis (MEH-tuh-MORE-feh-sis) before becoming adults. However, larvae of at least one species, red caecilians, have been found, which suggests that the other species also may have larvae.

KERALA CAECILIANS AND PEOPLE

Kerala caecilians have no known importance to people.

CONSERVATION STATUS

Kerala caecilians are not considered threatened or endangered.



Red caecilian *(Uraeotyphlus oxyurus)*

RED CAECILIAN
Uraeotyphlus oxyurus

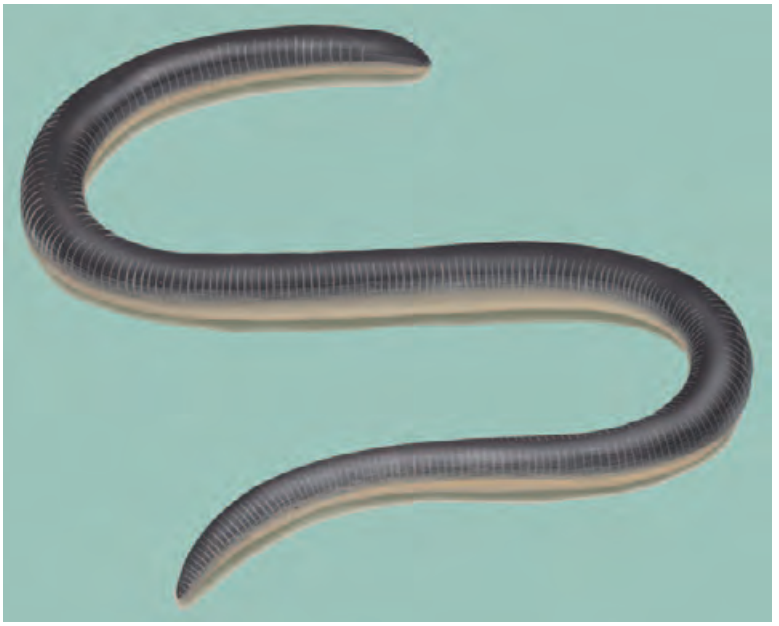
SPECIES ACCOUNT

Physical characteristics: Red caecilians have a somewhat thick body and are 7 to 12 inches (18 to 30 centimeters) long. They are solid dark bluish gray and slightly paler on the belly. Red caecilians have 98 to 107 rings in the main set and 89 to 104 rings in the second set. They have a large number of scales in the ring folds.

Geographic range: Red caecilians live in Kerala, India.

Habitat: Red caecilians live in moist soil and forest floor litter in and near rainforests.

Diet: Scientists believe red caecilians eat earthworms and insects.



Kerala caecilians live in moist soil and leaf litter in rainforests and areas that have been cleared of trees within the rainforest region. (Illustration by John Megahan. Reproduced by permission.)

Behavior and reproduction: Scientists believe red caecilians are burrowers. They are not sure how these caecilians mate. The larvae go through metamorphosis when they are about 3.5 inches (9 centimeters) long.

Red caecilians and people: Red caecilians have no known importance to people.

Conservation status: Red caecilians are not considered threatened or endangered. ■

FOR MORE INFORMATION

Books:

Duellman, William E., and Linda Trueb. *Biology of Amphibians.* Baltimore, MD: Johns Hopkins University Press, 1994.

Lamar, William W. *The World's Most Spectacular Reptiles and Amphibians.* Tampa, FL: World, 1997.

Lawlor, Elizabeth P. *Discover Nature in Water and Wetlands.* Mechanicsburg, PA: Stackpole, 2000.

Llamas Ruiz, Andres. *Reptiles and Amphibians: Birth and Growth.* New York: Sterling, 1996.

Petranka, J. W. *Salamanders of the United States and Canada.* Washington, DC: Smithsonian Institution Press, 1998.

Web sites:

"Caecilian." *Animal Bytes.* http://www.sandiegozoo.org/animalbytes/t-caecilian.html (accessed on April 11, 2005).

Hawes, Alex. "On Waterdogs, Mudpuppies, and the Occasional Hellbender." *Zoogoer.* http://nationalzoo.si.edu/Publications/ZooGoer/2000/2/waterdogsmudpuppieshellbender.cfm (accessed on April 11, 2005).

Summers, Adam. "Squeeze Play." *Natural History.* http://biomechanics.bio.uci.edu/_html/nh_biomech/caecilian/caecilian.htm (accessed on April 11, 2005).

BURIED-EYED CAECILIANS
Scolecomorphidae

Class: Amphibia
Order: Gymnophiona
Family: Scolecomorphidae
Number of species: 6 species

family CHAPTER

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

Buried-eyed caecilians (sih-SILL-yuhns) are small to medium-sized caecilians. The mouth opens on the bottom of the head because the upper jaw is longer than the lower jaw. The holes for the tentacles are on the bottom of the snout toward the sides, below the nostrils and even with, or slightly in front of, the front edge of the mouth. Buried-eyed caecilians are usually dark purplish gray on the back and sides and cream colored on the belly. Adult buried-eyed caecilians are 6 to 18 inches (15 to 46 centimeters) long.

Buried-eyed caecilians have characteristics that set them apart from other caecilians: The eyes, which are undeveloped and can only distinguish light from dark, are attached to and move with the tentacles and may be exposed when the tentacles are extended. Otherwise, they are covered with, or buried under, bone. Another distinguishing characteristic is that buried-eyed caecilians have no sound-conducting bones in their middle ears.

Caecilians look like earthworms. A series of rings runs the length of the body starting just behind the head. The rings are inside the body and attached to the vertebrae (VER-teh-bree), or the bones that make up the spinal column. Some species of buried-eyed caecilians have one ring, and some have two rings per vertebra (VER-teh-bruh, the singular of vertebrae). The skin is folded over the rings, making grooves between the rings. Some species of buried-eyed caecilians have a small number of scales, and some have no scales, under their skin folds.

Buried-eyed caecilians have no tail. Instead, they have a thick shield of skin at the end of their body. This shield is bluntly rounded and flattened on the bottom side. The opening of the cloaca lies in a shallow, oval space. The cloaca (kloh-AY-kuh) is the chamber in some animals that holds waste from the kidneys and intestines, holds eggs or sperm about to be released to the outside, holds sperm entering a female's body, and is the passage through which young are born. The males of some species have hard spines on the penis.

In some species of buried-eyed caecilians the females are longer than the males because they have many more vertebrae and rings than the males. This characteristic may help the females because the body provides more space for developing young. Male buried-eyed caecilians have larger heads than females. Scientists believe this feature may help males fight one another for mates and territory.

GEOGRAPHIC RANGE

Buried-eyed caecilians live in Cameroon in the west of Africa and Malawi and Tanzania in the east of Africa. No caecilians of any kind have been found in central Africa. This distribution pattern is odd, because the vast region of the upper Congo seems ideally suited for caecilians. Caecilians probably live in central Africa but just have not been found.

HABITAT

Buried-eyed caecilians live in tropical rainforests and areas that have been cleared of trees, usually in hilly or mountainous regions. These animals usually are found in moist areas under logs and in leaf litter on the forest floor. They sometimes are dug up from moist soil. In Tanzania and Malawi, buried-eyed caecilians have been found in turned soil and in piles of old plant matter on farms.

DIET

Scientists believe buried-eyed caecilians eat earthworms and insects. In captivity they eat earthworms and small crickets.

BEHAVIOR AND REPRODUCTION

Buried-eyed caecilians are excellent burrowers. They pump their tentacles in and out when they are moving and otherwise investigating their surroundings. Their tentacles are thought to

be sense organs for "tasting" their immediate surroundings. Because they have found bite marks on male caecilians in captivity and in nature, scientists believe the males fight one another for mates and for territory.

Some buried-eyed caecilians give birth to live young. After mating, the female keeps the fertilized (FUR-teh-lyzed) eggs, or those that have joined with sperm, inside her in egg tubes. Scientists believe the egg tubes make a nutritious liquid that the developing young eat with special teeth that are lost after they are born. These teeth are comblike, and they also may be used to stimulate the egg tube to secrete the "milk" near the mouth of the feeding young. Scientists believe the species of buried-eyed caecilians that do not give birth to fully developed young are egg layers. The young develop inside the eggs but have the adult body form when they hatch. Scientists believe the female takes care of the eggs until they hatch.

BURIED-EYED CAECILIANS AND PEOPLE

Buried-eyed caecilians have no known importance to people.

CONSERVATION STATUS

Buried-eyed caecilians are not considered threatened or endangered.



Kirk's caecilian *(Scolecomorphus kirkii)*

KIRK'S CAECILIAN
Scolecomorphus kirkii

SPECIES ACCOUNT

Physical characteristics: Kirk's caecilians reach a length of 8.5 to 18 inches (22 to 46 centimeters). They have 130 to 152 rings. The purplish gray color on the back extends down the sides of the animal almost to the center of the belly. The rest of the belly is cream colored. The top and sides of the head are dark like the rest of the upper part of the body, but there is a lighter area along the tentacle. The black retina of the eye at the base of the tentacle is visible through the skin and skull bones.

Geographic range: Kirk's caecilians live in Malawi and Tanzania.



Buried-eyed caecilians have characteristics that set them apart from other caecilians: The eyes, which are undeveloped and can only distinguish light from dark, are attached to and move with the tentacles and may be exposed when the tentacles are extended. (Illustration by Bruce Worden. Reproduced by permission.)

Habitat: Kirk's caecilians live in tropical rainforests and farming areas, usually in mountainous regions. They live under and in surface leaf litter and in the soil.

Diet: Kirk's caecilians probably eat earthworms and insects.

Behavior and reproduction: Kirk's caecilians are efficient burrowers. They stick out their tentacles to investigate their surroundings. They also can make their eyes stick out beyond their skull bones. Scientists do not know how Kirk's caecilians mate. They do know that these caecilians give birth to young that have the body form of adults.

Kirk's caecilians and people: Kirk's caecilians have no known importance to people.

Conservation status: Kirk's caecilians are not considered threatened or endangered. ■

FOR MORE INFORMATION

Books:

Duellman, William E., and Linda Trueb. *Biology of Amphibians.* Baltimore, MD: Johns Hopkins University Press, 1994.

Lamar, William W. *The World's Most Spectacular Reptiles and Amphibians.* Tampa, FL: World, 1997.

Lawlor, Elizabeth P. *Discover Nature in Water and Wetlands.* Mechanicsburg, PA: Stackpole, 2000.

Llamas Ruiz, Andres. *Reptiles and Amphibians: Birth and Growth.* New York: Sterling, 1996.

Petranka, J. W. *Salamanders of the United States and Canada.* Washington, DC: Smithsonian Institution Press, 1998.

Web sites:

"Caecilian." *Animal Bytes.* http://www.sandiegozoo.org/animalbytes/t-caecilian.html (accessed on April 11, 2005).

Hawes, Alex. "On Waterdogs, Mudpuppies, and the Occasional Hellbender." *Zoogoer.* http://nationalzoo.si.edu/Publications/ZooGoer/2000/2/waterdogsmudpuppieshellbender.cfm (accessed on April 11, 2005).

Summers, Adam. "Squeeze Play." *Natural History.* http://biomechanics.bio.uci.edu/_html/nh_biomech/caecilian/caecilian.htm (accessed on April 11, 2005).

family CHAPTER

TAILLESS CAECILIANS
Caeciliidae

Class: Amphibia
Order: Gymnophiona
Family: Caeciliidae
Number of species: 107 species

phylum
class
subclass
order
monotypic order
suborder
▲ **family**

PHYSICAL CHARACTERISTICS

Tailless caecilians (sih-SILL-yuhns) are small to very large caecilians that have a very short tail or no true tail. These caecilians are 4 to 63 inches (10 to 160 centimeters) long. Some tailless caecilians live on land, and some live only in water. Tailless caecilians have a flat head. The mouth opens on the bottom of the head because the upper jaw is longer than the lower jaw. The eyes are covered by skin or, in some species, by both skin and bone. The tentacles lie between the eyes and the nostrils.

Caecilians look like earthworms. A series of rings runs the length of the body starting just behind the head. The rings are inside the body and attached to the vertebrae (VER-teh-bree), or the bones that make up the spinal column. Tailless caecilians have one ring per vertebra (VER-teh-bruh, the singular of vertebrae). The skin is folded over the rings, making grooves between the rings.

GEOGRAPHIC RANGE

Tailless caecilians live in Central and South America; the eastern and western parts of Africa, but not the Sahara; the Seychelles; India; Sri Lanka; the Philippines; and the region that extends from southern China through the Malay Peninsula.

HABITAT

Tailless caecilians live in tropical forests and grasslands and on stream banks. Land-dwelling tailless caecilians live in loose, moist, soil rich in decayed plant matter and leaf litter. They are

often found under rocks, logs, and waste material, such as piles of coffee hulls. Many of these caecilians are found near streams. Some tailless caecilians live in grassland, and scientists find them by rolling the grass layer away from the soil. Tailless caecilians that live in water for part or all of their life cycle live on the banks of streams and rivers and sometimes travel onto nearby land or farther out into slow-moving water. Water-dwelling tailless caecilians hide under hanging branches, logs, and other floating objects.

DIET

Tailless caecilians are sit-and-wait predators, staying in their burrows or on the ground and then grabbing prey animals that wander near them. These caecilians eat earthworms, termites, other small invertebrates, and even small lizards and rodents. Invertebrates (in-VER-teh-brehts) are animals without backbones. Tailless caecilians lunge at their prey, grabbing it with their strong jaws and powerful jaw muscles. They force prey animals into their mouths and gradually swallow them. Some tailless caecilians move backward into their burrows, turning rapidly on their body in a corkscrew motion in order to break the prey into bite-sized morsels. Water-dwelling tailless caecilians hunt for their prey by poking around with their snout at the bottom of the stream.

BEHAVIOR AND REPRODUCTION

Little is known about the behavior of land-dwelling tailless caecilians because of their secretive, soil-dwelling nature. Some of these animals emerge from deep in the soil or leaf litter to look for food at dusk or dawn, often during light rain. Tailless caecilians are expert burrowers, digging head-first through moist soil that is rich in decayed plant matter. Species may differ in their ability to burrow efficiently in different kinds of soils. Tailless caecilians appear to spend most of their time in their burrows, but they also can travel quite far from their burrows. Scientists know little about the behavior of the water-dwelling and partially water-dwelling tailless caecilians because these animals typically live in slow-moving streams and rivers that have a lot of plant material that obstructs the view of the animals.

At mating time a male tailless caecilian inserts sperm directly into the female's reproductive tract. Scientists have observed tailless caecilians in aquariums coiling around each other before

the male places the sperm in the female. The eggs are fertilized (FUR-teh-lyzed), or joined with sperm, inside the female's body.

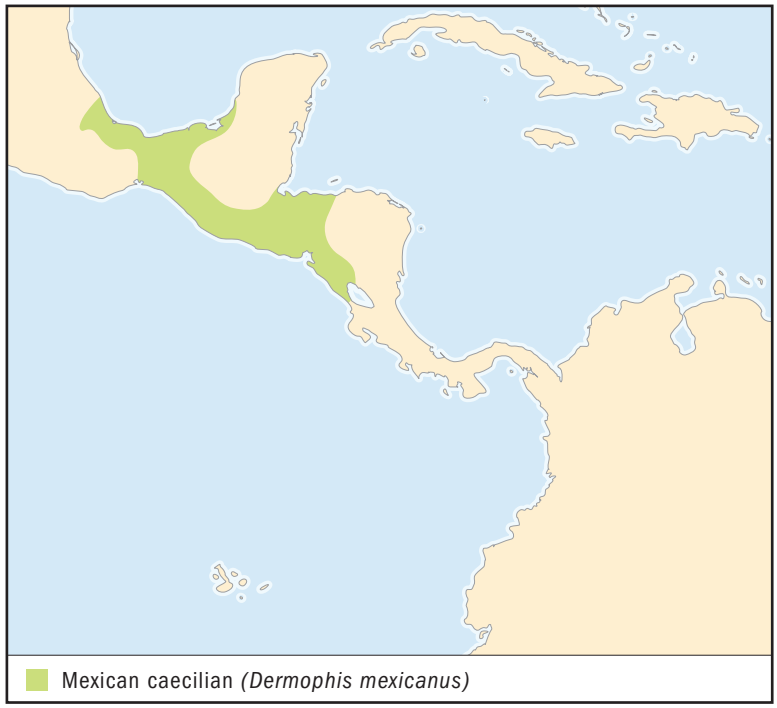
Tailless caecilians use several methods of reproduction. Some species lay eggs that hatch into free-living larvae. Larvae (LAR-vee) are animals in an early stage that change body form in a process called metamorphosis (MEH-tuh-MORE-feh-sis) before becoming adults. Some species lay eggs on land, and the larvae develop and go through metamorphosis before hatching, so that when they hatch they have the body form of adults. In some species the young develop in the egg ducts of the female, eating nutrient liquid made by the egg ducts. These young also are born with the body form of small adults. The females of some species of tailless caecilians take care of their eggs by coiling their bodies around the cluster of eggs. They also take care of newly hatched young.

TAILLESS CAECILIANS AND PEOPLE

Tailless caecilians help to control damaging insects, such as termites. Because they actively burrow, rather than following root channels or other ready-made holes in the ground, tailless caecilians aid in turning the soil and maintaining good soil condition. In some parts of the world, people think caecilians are nasty, dangerous animals. In other places, however, people eat them. Some people keep tailless caecilians as pets in aquariums.

CONSERVATION STATUS

The World Conservation Union (IUCN) lists one species of tailless caecilians as Endangered and one species as Vulnerable. Endangered means facing very high risk of extinction in the wild. Vulnerable means facing high risk of extinction in the wild. Changes in land use are restricting the geographic ranges of tailless caecilians, and some populations get a fungus disease.



SPECIES ACCOUNTS

MEXICAN CAECILIAN
Dermophis mexicanus

Physical characteristics: Mexican caecilians are 12 to 20 inches (30 to 50 centimeters) long and have a thick body. They are dark gray with paler markings on the belly, jaw, and tentacles. The grooves between the rings are darker than the main body color.

Geographic range: Mexican caecilians live in an area that extends from the lowlands and mountains of central Mexico south to northern Panama.

Habitat: Mexican caecilians live in moist soil that breaks up easily and in leaf litter.

Diet: Mexican caecilians are sit-and-wait predators. They eat invertebrates and vertebrates (VER-teh-brehts), or animals with a backbone, that live or travel in soil or leaf litter, including earthworms,



Mexican caecilians are valuable to humans. They turn soil as they make their burrows, and they eat insects. (Illustration by Brian Cressman. Reproduced by permission.)

termites, insects such as crickets that have shed their outer layer, and even small lizards and baby mice.

Behavior and reproduction: Mexican caecilians spend most of their time in burrows in loose, moist soil. They often come out at dusk in a light rain to look for food on the surface. These caecilians make their own burrows in many kinds of soil rather than using the burrows of other animals. Mexican caecilians move with an accordion-like motion and with side-to-side, wavy movements.

Mexican caecilians give birth to fully developed young. They are ready to reproduce when they are two to three years old. The male places the rear part of his cloaca into the cloaca of the female and transfers sperm directly to her reproductive tract. The cloaca (kloh-AY-kuh) is the chamber in some animals that holds waste from the kidneys and intestines, holds eggs or sperm about to be released to the outside, holds sperm entering a female's body, and is the passage through which young are born. Fertilization (FUR-teh-lih-ZAY-shun), or the joining of egg and sperm to start development, takes place inside the female.

Male Mexican caecilians make sperm eleven months of the year, but all females give birth at about the same time, in May and June when the rainy season begins. The young take eleven months to develop. Inside the female the developing young use up the yolk supply of their eggs about three months into the development period. The mother then releases a nutrient liquid from glands lining her egg ducts. The developing young move around in the egg ducts, eating the liquid. They have special teeth that they use to stimulate release of the nutrient liquid and to help take it into their mouths. These teeth are shed at birth, and the adult teeth, which are very different from those of the young inside the mother, grow out within a few

days. The developing young have gills that have three branches, and each of the three branches has many more branches. The developing young use the gills and their skin to breathe while in the egg ducts. Gills are organs for obtaining oxygen from water.

Female Mexican caecilians give birth to three to sixteen young, which are 4 to 6 inches (10 to 15 centimeters) long at birth. These young are quite large considering the mother is only 12 to 18 inches (30 to 45 centimeters) long.

Mexican caecilians and people: Mexican caecilians are valuable to humans. They turn soil as they make their burrows, and they eat insects, such as termites, that can be harmful to people or their property.

Conservation status: Mexican caecilians are not considered threatened or endangered. Their numbers are high in some areas, but their habitat is being changed as trees are cut down to make way for farming. Mexican caecilians seem to adapt to some kinds of farm use. For example, there are large numbers of tailless caecilians on coffee farms, where the coffee hulls are thrown in piles to decay, thus forming the moist organic soil that is best for Mexican caecilians and their earthworm prey. ■



Cayenne caecilian *(Typhlonectes compressicauda)*

CAYENNE CAECILIAN
Typhlonectes compressicauda

Physical characteristics: Cayenne (kye-EHN) caecilians are water dwellers. They have a fin on the back that runs the length of the body. The body is flat from side to side, making the caecilians look more like eels than earthworms. These caecilians have large passages inside the head between the nose and the roof of the mouth, and they have well-developed lungs. Cayenne caecilians have one ring per vertebra, and the grooves between the rings are deep. These caecilians are gray to dark blue or black. Adults are 12 to 22 inches (30 to 55 centimeters) long. The cloaca region is flat, forming a disk that is paler in color than the rest of the body.



Cayenne caecilians live in slow-moving, warm tropical rivers and streams. (Illustration by Brian Cressman. Reproduced by permission.)

Geographic range: Cayenne caecilians live throughout the Guianas and the Amazon region of South America.

Habitat: Cayenne caecilians live in slow-moving, warm tropical rivers and streams.

Diet: Cayenne caecilians root around in the mud of the sides and bottoms of the waterways in which they live. They eat shrimp, insect larvae, and small fish. These caecilians have a strong bite mechanism. In captivity cayenne caecilians feed on pieces of earthworms and liver. Cayenne caecilians seem to sense the presence of prey by touch or motion.

Behavior and reproduction: Cayenne caecilians share burrows with one another and leave the burrows at sunset to look for food. These animals have mucus glands all over their bodies. The mucus is poisonous and tastes bad to fish. Predators of cayenne caecilians include large fish, snakes, and birds.

Cayenne caecilians mate by nudging and coiling around each other. The male places sperm in the female, and fertilization takes place inside her body. Cayenne caecilians give birth to fully developed young, which are born seven to nine months after fertilization. A female can give birth to six to fourteen young at a time. The developing young have gills that are shed soon after birth. The developing young have teeth they use to eat a nutrient liquid made by the female's egg ducts. These teeth also are shed soon after birth, and then the adult teeth grow in.

Cayenne caecilians and people: Cayenne caecilians are sold in aquarium stores as rubber eels or black eels. Only rarely do store

owners identify them as amphibians (am-FIB-ee-uhns), which are vertebrates (VER-teh-brehts), or animals with a backbone, that have moist, smooth skin; are cold-blooded, meaning their body temperature is the same as the temperature of their surroundings; and, in many instances, but not in the case of cayenne caecilians, have a two-stage life cycle.

Conservation status: Cayenne caecilians are not considered threatened or endangered. They have been collected extensively by fishermen, scientists, and pet dealers. ■

FOR MORE INFORMATION

Books:

Duellman, William E., and Linda Trueb. *Biology of Amphibians.* Baltimore, MD: Johns Hopkins University Press, 1994.

Lamar, William W. *The World's Most Spectacular Reptiles and Amphibians.* Tampa, FL: World, 1997.

Lawlor, Elizabeth P. *Discover Nature in Water and Wetlands.* Mechanicsburg, PA: Stackpole, 2000.

Llamas Ruiz, Andres. *Reptiles and Amphibians: Birth and Growth.* New York: Sterling, 1996.

Petranka, J. W. *Salamanders of the United States and Canada.* Washington, DC: Smithsonian Institution Press, 1998.

Web sites:

"Caecilian." *Animal Bytes.* http://www.sandiegozoo.org/animalbytes/t-caecilian.html (accessed on April 11, 2005).

Hawes, Alex. "On Waterdogs, Mudpuppies, and the Occasional Hellbender." *Zoogoer.* http://nationalzoo.si.edu/Publications/ZooGoer/2000/2/waterdogsmudpuppieshellbender.cfm (accessed on April 11, 2005).

Summers, Adam. "Squeeze Play." *Natural History.* http://biomechanics.bio.uci.edu/_html/nh_biomech/caecilian/caecilian.htm (accessed on April 11, 2005).



Species List by Biome

CONIFEROUS FOREST

Ailao moustache toad
Annam broad-headed toad
Bana leaf litter frog
Brown frog
Cascade torrent salamander
Coastal giant salamander
Eastern narrow-mouthed toad
European fire salamander
Fire-bellied toad
Great crested newt
Mandarin salamander
Oriental fire-bellied toad
Schmidt's lazy toad
Smooth newt
Two-lined salamander
Yellow-bellied toad

DECIDUOUS FOREST

Arboreal salamander
Asian horned frog
Bell's salamander
Brown frog
Cascade torrent salamander
Common squeaker
Darwin's frog
Eastern narrow-mouthed toad
European fire salamander
Fire-bellied toad
Golden-striped salamander
Goliath frog
Great crested newt
Green treefrog
Hairy frog
Hamilton's frog
Harlequin frog
Kinugasa flying frog
Lynch's Cochran frog
Mandarin salamander
Marine toad
Maud Island frog
Mesoamerican burrowing toad
Mexican caecilian
Micro frog
Mocquard's rain frog
Natal ghost frog
Nilgiri tropical frog
Oriental fire-bellied toad
Pacific giant glass frog
Painted frog
Painted Indonesian treefrog
Painted reed frog
Paradox frog
Parsley frog
Phantasmal poison frog
Pumpkin toadlet
Rock River frog
Rocky Mountain tailed frog
Ruthven's frog
South American bullfrog
Smooth newt
Sumaco horned treefrog
Talamancan web-footed salamander
Tusked frog
Two-lined salamander
Yellow-bellied toad
Yucatecan shovel-headed treefrog

DESERT

Sandhill frog
Water-holding frog

GRASSLAND

Asian horned frog
Banded rubber frog
Brown frog
Bubbling kassina
Budgett's frog
Darwin's frog
Fire-bellied toad
Gray four-eyed frog
Great crested newt
Mandarin salamander
Marbled snout-burrower
Marine toad
Mesoamerican burrowing toad

Mocquard's rain frog
Natal ghost frog
Northern spadefoot toad
Oriental fire-bellied toad
Painted frog
Painted reed frog
Paradox frog
Parsley frog
Patagonia frog
Plains spadefoot toad
Pointed-tongue floating frog
Riobamba marsupial frog
Smooth newt
Tiger salamander
Tusked frog
Yellow-bellied toad
Yucatecan shovel-headed treefrog
Water-holding frog

LAKE AND POND

Amazonian skittering frog
Brown frog
Bubbling kassina
Bullfrog
Common plantanna (African clawed frog)
Eastern narrow-mouthed toad
Fire-bellied toad
Golden-striped salamander
Gray four-eyed frog
Great crested newt
Hokkaido salamander
Hourglass treefrog
Japanese fire-bellied newt
Lesser siren
Mandarin salamander
Marine toad
Midwife toad
Mudpuppy
Olm
Oriental fire-bellied toad
Painted frog
Painted reed frog
Paradox frog
Patagonia frog
Perez's snouted frog
Phantasmal poison frog
Philippine barbourula
Pointed-tongue floating frog
Pyburn's pancake frog
Riobamba marsupial frog
Smooth newt
South American bullfrog
Surinam horned frog
Surinam toad
Three-toed amphiuma
Tropical clawed frog
Two-lined salamander
Yellow-bellied toad

RAINFOREST

African wart frog
Amazonian skittering frog
Blue-toed rocket frog
Eungella torrent frog
Free Madagascar frog
Golden dart-poison frog
Golden toad
Gold-striped frog
Hip pocket frog
Hourglass treefrog
Kirk's caecilian
La Palma glass frog
Long-fingered slender toad
Marbled caecilian
Perez's snouted frog
Philippine barbourula
Pyburn's pancake frog
Red caecilian
Ruthven's frog
Seychelles frog
South American bullfrog
Surinam horned frog
Tusked frog
Wilhelm rainforest frog

RIVER AND STREAM

Ailao moustache toad
Annam broad-headed toad
Asian horned frog
Brown frog
Bullfrog
Cascade torrent salamander
Cayenne caecilian
Ceylon caecilian
Coastal giant salamander
Common plantanna (African clawed frog)
Darwin's frog
Dusky salamander
Eungella torrent frog
Fire-bellied toad
Goliath frog
Green treefrog
Hairy frog
Harlequin frog
Hellbender
Hokkaido salamander
Japanese clawed salamander
La Palma glass frog
Lesser siren
Long-fingered slender toad
Lynch's Cochran frog
Marbled caecilian
Midwife toad
Mudpuppy
Natal ghost frog
Nilgiri tropical frog
Olm
Oriental fire-bellied toad
Pacific giant glass frog
Painted frog
Painted reed frog
Paradox frog
Phantasmal poison frog
Philippine barbourula
Pyburn's pancake frog
Rock River frog
Rocky Mountain tailed frog
Ruthven's frog
Schmidt's lazy toad
Semirechensk salamander
South American bullfrog
Surinam toad
Texas blind salamander
Three-toed amphiuma

Tropical clawed frog
Two-lined salamander
Yellow-bellied toad

WETLAND

Banded rubber frog
Bubbling kassina
Budgett's frog
Brown frog
Bullfrog
Ceylon caecilian
Common plantanna (African clawed frog)
Darwin's frog
Eastern narrow-mouthed toad
Fire-bellied toad
Free Madagascar frog
Green treefrog
Kinugasa flying frog
Kirk's caecilian
Lesser siren
Malaysian painted frog
Marbled snout-burrower
Marine toad
Micro frog
Mocquard's rain frog
Northern spadefoot toad
Oriental fire-bellied toad
Painted frog
Painted reed frog
Paradox frog
Perez's snouted frog
Pointed-tongue floating frog
Riobamba marsupial frog
Ruthven's frog
Schmidt's lazy toad
Semirechensk salamander
Surinam horned frog
Surinam toad
Three-toed amphiuma
Yellow-bellied toad
Yucatecan shovel-headed treefrog
Water-holding frog



Species List by Geographic Range

ALBANIA
Brown frog
European fire salamander
Great crested newt
Smooth newt

ALGERIA
Painted frog

ANDORRA
European fire salamander
Great crested newt
Smooth newt

ANGOLA
Bubbling kassina
Common plantanna (African clawed frog)
Hairy frog
Marbled snout-burrower
Painted reed frog
Tropical clawed frog

ARGENTINA
Budgett's frog
Darwin's frog
Gray four-eyed frog
Marine toad
Patagonia frog

ARMENIA
Brown frog

AUSTRALIA
Eungella torrent frog
Green treefrog
Hip pocket frog
Marine toad
Northern spadefoot toad
Painted frog
Sandhill frog
Tusked frog
Water-holding frog

AUSTRIA
Brown frog
European fire salamander
Fire-bellied toad
Great crested newt
Smooth newt
Yellow-bellied toad

BAHAMAS
Eastern narrow-mouthed toad

BELARUS
European fire salamander
Great crested newt
Smooth newt

BELGIUM
Brown frog
European fire salamander
Great crested newt
Midwife toad
Parsley frog
Smooth newt

BELIZE
Marine toad
Mesoamerican burrowing toad
Mexican caecilian
Yucatecan shovel-headed treefrog

BENIN
Bubbling Kassina
Goliath frog
Painted reed frog

BOLIVIA
Amazonian skittering frog
Budgett's frog

Hourglass treefrog
Marine toad
Perez's snouted frog
Surinam toad

BOSNIA AND HERZEGOVINA

European fire salamander
Great crested newt
Olm
Smooth newt

BOTSWANA

Bubbling kassina
Common plantanna (African clawed frog)
Painted reed frog

BRAZIL

Amazonian skittering frog
Blue-toed rocket frog
Cayenne caecilian
Gold-striped frog
Hourglass treefrog
Marine toad
Paradox frog
Perez's snouted frog
Pumpkin toadlet
Rock River frog
Ruthven's frog
South American bullfrog
Surinam horned frog
Surinam toad

BULGARIA

European fire salamander
Great crested newt
Smooth newt

BURKINA FASO

Bubbling kassina
Painted reed frog

BURUNDI

Bubbling kassina
Common plantanna (African clawed frog)
Painted reed frog

CAMBODIA

Pointed-tongue floating frog

CAMEROON

African wart frog
Bubbling kassina
Common plantanna (African clawed frog)
Goliath frog
Hairy frog
Marbled snout-burrower
Painted reed frog
Tropical clawed frog

CANADA

Bullfrog
Coastal giant salamander
Coastal tailed frog
Dusky salamander
Mudpuppy
Plains spadefoot toad
Rocky Mountain tailed frog
Tiger salamander
Two-lined salamander

CHAD

Bubbling kassina
Painted reed frog

CHILE

Common plantanna (African clawed frog)
Darwin's frog
Gray four-eyed frog
Marine toad

CHINA

Ailao moustache toad
Malaysian painted frog
Mandarin salamander
Oriental fire-bellied toad
Pointed-tongue floating frog
Schmidt's lazy toad
Semirechensk salamander

COLOMBIA

Amazonian skittering frog
Cayenne caecilian
Golden dart-poison frog
Gold-striped frog
Hourglass treefrog
La Palma glass frog
Lynch's Cochran frog
Marine toad
Pacific giant glass frog
Perez's snouted frog
Pyburn's pancake frog
South American bullfrog
Sumaco horned treefrog
Surinam horned frog
Surinam toad

COSTA RICA

Golden toad
Harlequin frog
La Palma glass frog
Marine toad
Mesoamerican burrowing toad
Mexican caecilian
South American bullfrog
Talamancan web-footed salamander

CROATIA

European fire salamander
Great crested newt
Olm
Smooth newt

CYPRUS

Brown frog

CZECH REPUBLIC
Brown frog
European fire salamander
Great crested newt
Smooth newt

DEMOCRATIC REPUBLIC OF THE CONGO
Common plantanna (African clawed frog)
Common squeaker
Hairy frog
Marbled snout-burrower

DENMARK
Brown frog
European fire salamander
Fire-bellied toad
Great crested newt
Smooth newt

ECUADOR
Hourglass treefrog
La Palma glass frog
Marbled caecilian
Marine toad
Pacific giant glass frog
Phantasmal poison frog
Riobamba marsupial frog
South American bullfrog
Sumaco horned treefrog
Surinam toad

EL SALVADOR
Marine toad
Mesoamerican burrowing toad
Mexican caecilian

EQUATORIAL GUINEA
Common plantanna (African clawed frog)
Hairy frog
Marbled snout-burrower

ESTONIA
Brown frog
European fire salamander
Great crested newt
Smooth newt

ETHIOPIA
Bubbling kassina
Ethiopian snout-burrower (Lake Zwai snout-burrower)
Painted reed frog

FINLAND
Brown frog
European fire salamander
Great crested newt
Smooth newt

FRANCE
Brown frog
European fire salamander
Great crested newt
Midwife toad
Painted frog
Parsley frog
Smooth newt

FRENCH GUIANA
Cayenne caecilian
Gold-striped frog
Hourglass treefrog
Marine toad
Paradox frog
Pyburn's pancake frog
Ruthven's frog
South American bullfrog
Surinam toad
Surinam horned frog

GABON
African wart frog
Bubbling kassina
Common plantanna (African clawed frog)
Hairy frog
Marbled snout-burrower
Painted reed frog
Tropical clawed frog

GERMANY
Brown frog
Common plantanna (African clawed frog)
European fire salamander
Fire-bellied toad
Great crested newt
Midwife toad
Smooth newt

GHANA
Bubbling kassina
Goliath frog
Painted reed frog

GREECE
Brown frog
European fire salamander
Fire-bellied toad
Great crested newt
Smooth newt
Yellow-bellied toad

GUATEMALA
Marine toad
Mesoamerican burrowing toad
Mexican caecilian
Yucatecan shovel-headed treefrog

GUINEA
Bubbling kassina
Goliath frog
Painted reed frog

GUINEA-BISSAU
Bubbling kassina
Painted reed frog

GUYANA
Cayenne caecilian
Gold-striped frog
Hourglass treefrog
Marine toad
Paradox frog
Pyburn's pancake frog
Ruthven's frog
South American bullfrog
Surinam horned frog
Surinam toad

HONDURAS
Marine toad
Mesoamerican burrowing toad
Mexican caecilian
South American bullfrog
Yucatecan shovel-headed treefrog

HUNGARY
Brown frog
European fire salamander
Great crested newt
Smooth newt
Yellow-bellied toad

INDIA
Mandarin salamander
Nilgiri tropical frog
Pointed-tongue floating frog
Red caecilian

INDONESIA
Asian horned frog
Long-fingered slender toad
Malaysian painted frog
Painted Indonesian treefrog
Pointed-tongue floating frog

IRELAND
European fire salamander
Great crested newt
Smooth newt

ITALY
Brown frog
European fire salamander
Great crested newt
Olm
Painted frog
Parsley frog
Smooth newt
Yellow-bellied toad

IVORY COAST
Bubbling kassina
Goliath frog
Painted reed frog

JAPAN
Hokkaido salamander
Japanese clawed salamander
Japanese fire-bellied newt
Kinugasa flying frog
Marine toad
Oriental fire-bellied toad

KAZAKHSTAN
Semirechensk salamander

KENYA
Banded rubber frog
Bubbling kassina
Common plantanna (African clawed frog)
Common squeaker
Marbled snout-burrower
Painted reed frog

KOREA (NORTH AND SOUTH)
Oriental fire-bellied toad

LAOS
Bana leaf litter frog

LATVIA
European fire salamander
Great crested newt
Smooth newt

LESOTHO
Bubbling kassina
Common plantanna (African clawed frog)
Natal ghost frog
Painted reed frog
Tropical clawed frog

LIBERIA
Bubbling kassina
Goliath frog
Painted reed frog

LIECHTENSTEIN
European fire salamander
Great crested newt
Smooth newt

LITHUANIA
European fire salamander
Great crested newt
Smooth newt

LUXEMBOURG
Brown frog
European fire salamander
Great crested newt
Midwife toad
Parsley frog
Smooth newt

MACEDONIA
European fire salamander
Great crested newt
Smooth newt

MADAGASCAR
Free Madagascar frog
Mocquard's rain frog

MALAWI
Bubbling kassina
Common plantanna (African clawed frog)
Kirk's caecilian
Painted reed frog

MALAYSIA
Asian horned frog
Malaysian painted frog
Painted Indonesian treefrog
Pointed-tongue floating frog

MALI
Bubbling kassina
Painted reed frog

MALTA
Brown frog
European fire salamander
Great crested newt
Painted frog
Smooth newt

MEXICO
Arboreal salamander
Bell's salamander
Bullfrog
Lesser siren
Marine toad
Mesoamerican burrowing toad
Mexican caecilian
Plains spadefoot toad
Tiger salamander
Yucatecan shovel-headed treefrog

MOLDOVA
European fire salamander
Great crested newt
Smooth newt

MONACO
European fire salamander
Great crested newt
Smooth newt

MOROCCO
Painted frog

MOZAMBIQUE
Banded rubber frog
Bubbling kassina
Common plantanna (African clawed frog)
Common squeaker
Marbled snout-burrower
Painted reed frog

NAMIBIA
Bubbling kassina
Common plantanna (African clawed frog)
Painted reed frog
Tropical clawed frog

NEPAL
Mandarin salamander

NETHERLANDS
Brown frog
European fire salamander
Great crested newt
Midwife toad
Smooth newt

NEW ZEALAND
Green treefrog
Hamilton's frog
Maud Island frog

NICARAGUA
Marine toad
Mesoamerican burrowing toad
Mexican caecilian
South American bullfrog

NIGER
Bubbling kassina
Painted reed frog

NIGERIA
Bubbling kassina
Goliath frog
Hairy frog
Marbled snout-burrower
Painted reed frog

NORWAY
Brown frog
European fire salamander
Great crested newt
Smooth newt

PANAMA
Harlequin frog
La Palma glass frog
Marine toad
Mexican caecilian
South American bullfrog

PAPUA NEW GUINEA
Wilhelm rainforest frog

PARAGUAY
Budgett's frog
Marine toad

PERU
Amazonian skittering frog
Cayenne caecilian
Gold-striped frog
Hourglass treefrog

Marine toad
Perez's snouted frog
Phantasmal poison frog
Ruthven's frog
South American bullfrog
Sumaco horned treefrog
Surinam toad
Surinam horned frog

PHILIPPINES
Asian horned frog
Marine toad
Painted Indonesian treefrog
Philippine barbourula

POLAND
European fire salamander
Fire-bellied toad
Great crested newt
Smooth newt

PORTUGAL
Brown frog
European fire salamander
Golden-striped salamander
Great crested newt
Midwife toad
Parsley frog
Smooth newt

REPUBLIC OF THE CONGO
African wart frog
Common plantanna (African clawed frog)
Tropical clawed frog

ROMANIA
European fire salamander
Great crested newt
Smooth newt

RUSSIA
European fire salamander
Great crested newt
Oriental fire-bellied toad
Smooth newt

RWANDA
Bubbling kassina
Common plantanna (African clawed frog)
Painted reed frog

SAN MARINO
European fire salamander
Great crested newt
Smooth newt

SÃO TOMÉ AND PRÍNCIPE
Common plantanna (African clawed frog)

SENEGAL
Bubbling kassina
Painted reed frog

SERBIA-MONTENEGRO
European fire salamander
Great crested newt
Olm
Smooth newt

SEYCHELLES
Seychelles frog

SIERRA LEONE
Bubbling kassina
Goliath frog
Painted reed frog

SINGAPORE
Painted Indonesian treefrog

SLOVAKIA
European fire salamander
Great crested newt
Smooth newt

SLOVENIA
European fire salamander
Great crested newt
Olm
Smooth newt

SOMALIA
Banded rubber frog

SOUTH AFRICA
Banded rubber frog
Bubbling kassina
Common plantanna (African clawed frog)
Common squeaker
Marbled snout-burrower
Micro frog
Natal ghost frog
Painted reed frog
Tropical clawed frog

SPAIN
Brown frog
European fire salamander
Golden-striped salamander
Great crested newt
Midwife toad
Painted frog
Parsley frog
Smooth newt

SRI LANKA
Ceylon caecilian

SUDAN
Bubbling kassina
Painted reed frog

SURINAME
Cayenne caecilian
Gold-striped frog
Hourglass treefrog
Marine toad
Paradox frog
Pyburn's pancake frog
Ruthven's frog
South American bullfrog
Surinam horned frog
Surinam toad

SWAZILAND
Bubbling kassina
Common plantanna (African clawed frog)
Natal ghost frog
Painted reed frog

SWEDEN
Brown frog
European fire salamander
Fire-bellied toad
Great crested newt
Smooth newt

SWITZERLAND
Brown frog
European fire salamander
Great crested newt
Midwife toad
Smooth newt
Yellow-bellied toad

TAIWAN
Malaysian painted frog
Painted Indonesian treefrog

TANZANIA
Banded rubber frog
Bubbling kassina
Common plantanna (African clawed frog)
Kirk's caecilian
Painted reed frog

THAILAND
Asian horned frog
Mandarin salamander

TOGO
Bubbling kassina
Goliath frog
Painted reed frog

TRINIDAD AND TOBAGO
Surinam toad

TUNISIA
Painted frog

TURKEY
Brown frog
European fire salamander
Fire-bellied toad
Great crested newt
Smooth newt

UGANDA
Bubbling kassina
Common plantanna (African clawed frog)
Painted reed frog

UKRAINE
European fire salamander
Great crested newt
Smooth newt

UNITED KINGDOM
Common plantanna (African clawed frog)
European fire salamander
Fire-bellied toad
Great crested newt
Smooth newt
Yellow-bellied toad

UNITED STATES
Arboreal salamander
Bullfrog
Cascade torrent salamander
Coastal giant salamander
Coastal tailed frog
Common plantanna (African clawed frog)
Dusky salamander
Eastern narrow-mouthed toad
Hellbender
Lesser siren
Marine toad
Mesoamerican burrowing toad
Mudpuppy
Plains spadefoot toad
Rocky Mountain tailed frog
Texas blind salamander
Three-toed amphiuma
Tiger salamander
Two-lined salamander

URUGUAY
Marine toad
Paradox frog

VENEZUELA
Marine toad
Paradox frog
Pyburn's pancake frog
Ruthven's frog
Surinam toad

VIETNAM
Ailao moustache toad
Annam broad-headed toad
Bana leaf litter frog
Mandarin salamander
Pointed-tongue floating frog

ZAMBIA
Bubbling kassina

Common plantanna (African clawed frog)
Painted reed frog

ZIMBABWE

Bubbling kassina
Common plantanna (African clawed frog)
Common squeaker
Marbled snout-burrower
Painted reed frog