

*This is the thirtieth
in Nature Magazine's
series of educational
inserts*

Some Common Amphibians

By E. LAURENCE PALMER

Illustrated by M. Hope Sawyer

IN THESE days of amphibious warfare, it is appropriate that we gain some understanding and appreciation of the worth of the group of animals that are, because of the amphibious nature of most of them, called the amphibia. Many of us have been conditioned adversely against these animals. Possibly this dates from the day we read of them in Sunday School, in Exodus. There, we were told that they were classed with lice and flies as plagues upon the earth. Some of us who had spent many days of the week hunting frogs for their legs, with a bit of flannel tied to a hook, wished we could have witnessed the Egyptian magicians turning dust into lice and could have been present when "the river shall bring forth frogs abundantly, which shall go up and come into thine house, and into thy bed-chamber, and upon thy bed, and into the house of thy servants, and upon thy people, and into thy ovens and into thy kneading troughs." However, after eleven similar verses, ending in the statement that "the land stank" when the frogs were destroyed, most of us had a well-established aversion toward frogs.

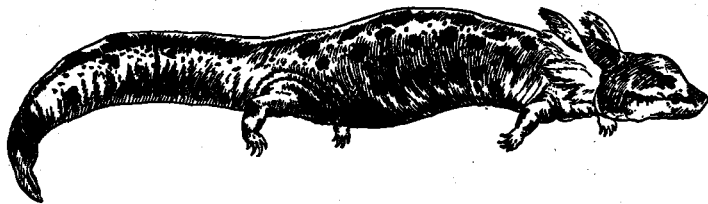
Then, after we had been well convinced that these animals were to be despised, we stumbled on Shakespeare in *As You Like It*, telling us,

"Sweet are the uses of adversity,
Which like the toad, ugly and venomous,
Wears yet a precious jewel in his head."

To be sure, the toad is not exactly a frog. And, to be sure, it is not complimentary to be considered ugly and venomous when you are not. Still, there was something fine about the critter, or it would not bear a precious jewel in his head. Or, was the jewel-in-the-head idea a bit off color? I know that in my own case I wondered for years about the jewel in the head, and although I had pulled frogs to pieces in high school and college laboratories after taking them out of formalin, I still could see nothing in them that was really intriguing. Then one day when I was about twenty I had occasion to watch a live frog closely as he sat on a log under which was a trout that I wanted. I never got the trout, but then and there I discovered that



HELLBENDER



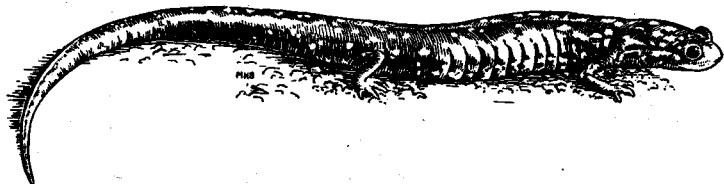
MUD PUPPY



VERMILION-SPOTTED NEWT. RED EFT



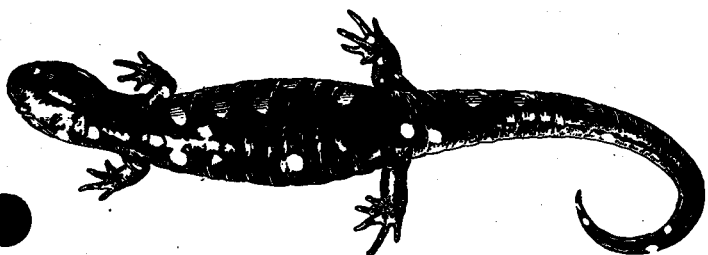
TWO-LINED SALAMANDER



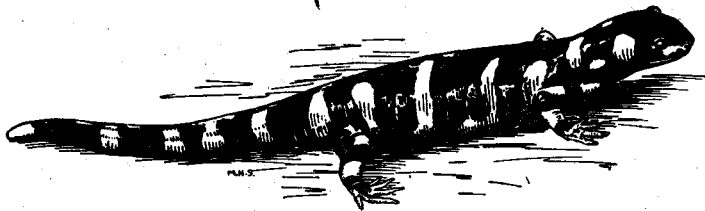
SLIMY SALAMANDER



DUSKY SALAMANDER



SPOTTED SALAMANDER



TIGER SALAMANDER

the live frog had not one but two jewels in his head—namely his eyes. About the same time I got acquainted with a college professor who was a crank on frogs—live frogs, not dead ones. He took me on a peeper hunt. There, I saw for the first time a peeper making the sounds I had enjoyed for years each spring. He showed me how to find frogs, not in the marshes, but up in trees. He had me watching their love life without a blush, identifying them even in the tadpole stage and genuinely considering the advisability of abandoning weed seeds and fishes and whirligig beetles in favor of making the study of frogs my life's work. Fortunately, I abandoned all of these specialities for a more general interest, but I never really got over my enthusiasm for living frogs. Since that time, I have always awaited each season for the sequence of frog sounds and for the date when I first could find the eggs of some frog or related salamander.

Not one of us would ever want to miss the thrill of seeing Shakespeare's witches in *Macbeth* brewing their venomous stew. Add to that famous mixture, which is fed to all high school students in their English classes, the experience of dissecting a formalin-soaked carcass in a biology laboratory and what do you have?—certainly, not a true appreciation of a frog or of a newt. The eye of a newt staring at you from the depths of the witches' pot cannot match, negatively, the positive thrill one gets from seeing many little red efts or newts prowling some early wet morning through the leaves and undergrowth of a favorite woodland. Shakespeare's *Macbeth* has probably not intrigued many to wish to know more about the amphibia. He went out of his way in the witches scene to malign them and to attribute to them qualities they do not possess. While this is fundamentally dishonest and unfair to the amphibia, I am sure

that none of us would want to delete this gem from his writings, any more than most of us would vote to outlaw Santa Claus.

What Are the Amphibia?

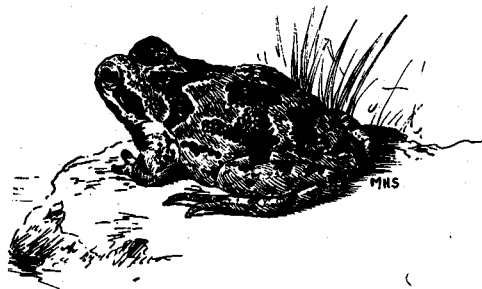
A college graduate who had had work in biology once stood beside a beaver dam with me and remarked: "Beavers live on land and water, don't they? Therefore, they must be amphibia. Therefore, they must have gills and must lay eggs. Where does a beaver lay its eggs?" Of course, he had not made an adequate distinction between amphibious and amphibia. The beaver is amphibious but not an amphibian. The amphibia are a group of cold-blooded animals placed in the evolutionary scale by zoologists between the fishes and the reptiles. For the most part, they have smooth, moist, or slimy skins, without scales, and for the most part they lay their eggs in water or in moist places. There are three main groups of living amphibia, of which one, the Apoda, are legless and wormlike, and tropical or subtropical in range. The other two are represented in this discussion; one, the tailed amphibia or Caudata, includes the mud-puppies, sirens and salamanders and the other, the usually tailless amphibia or Salientia, includes the frogs and toads. For the most part, they must live in a moist or wet environment, and for this reason the commonest places on land to find many of them are in the moist microclimates to be found under stones and logs, usually in damp woods. There are at least 2000 living species of amphibia, of which about 200 are in the salamander group, and about 1740 in the frog-toad group. There are probably more species and individuals of the amphibia to be found in the United States than in most similar areas in the world. There are 126 species and subspecies of salamanders in the United States, Canada and lower California.



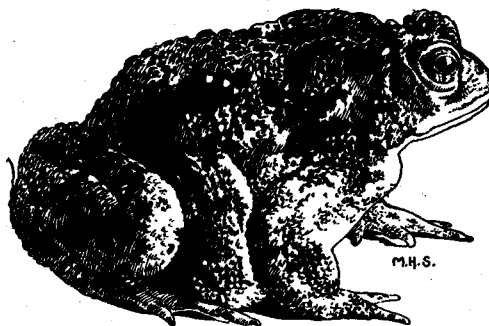
TREE FROG



SPRING PEEPER



CRICKET FROG



COMMON TOAD

The Salamanders

In body form, many of the salamanders resemble some of the lizards, which are reptiles. It is not surprising then, that to many people they "lizards." Even John Burroughs in one of his writings describes them as being

reptilian, although he does not do this with any attempt at disparagement. Most salamanders avoid the light and are therefore commonly nocturnal in their habits. In the breeding or migration seasons, however, many that normally avoid light may be found in it. While the chief food of salamanders is small living animals, some of them will feed

on carrion and others will eat plants. While some can withstand a freezing temperature, most of them avoid the severe weather of winter by burrowing into the warmer parts of their environment. Similarly, in the dry summer months, they may burrow into the moister, cooler parts of their surroundings. The salamanders lack the vocal cords found in the frogs and toads. The few sounds some of them utter have not been satisfactorily explained.

Not a few salamanders excrete slimy material that is obviously distasteful to their enemies. This material may also serve to prevent undue drying of the animal when it is living in dry air. The flesh is probably not poisonous, but the animals have been known to serve as reservoirs that in a period of 122 days excreted enough colon bacteria dangerously to contaminate 237 gallons of water a day. Both purple and dusky salamanders have been known to do this. Undoubtedly, such animals had eaten insects that had fed on contaminated wastes of mammals. Because of this, these animals should not be tolerated in springs supplying drinking water in the vicinity of human settlements.

On the other hand, salamanders are known to be efficient destroyers of the larvae of mosquitoes that may carry disease, and so salamanders, like the newts that can go overland from one small temporary pool to another, may contribute to the healthful conditions of an area. Put a newt in an aquarium with mosquito wrigglers if you wish to see a demonstration of what happens here. An adult newt in an aquarium with a mass of hatching frog eggs will also show you conclusively how these animals may be in part responsible for the small number of adults that may develop from the great masses of eggs to be seen. I have seen a newt at rest on a mass of these eggs picking off the little tadpoles almost as quickly as they freed themselves from their protective egg jelly. In a fish hatchery, a newt may be a



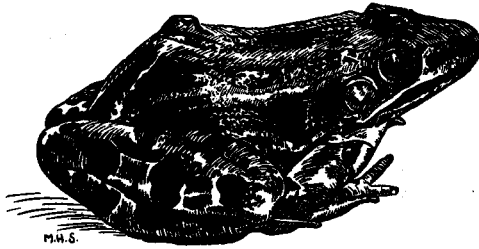
RED-BACKED SALAMANDER

real pest as it eats young fish and fish eggs.

The life history of the salamanders is highly varied and invariably interesting. In some, like the red-backed salamander, and some of the salamanders found in trees in the West, the larval stage is spent in the eggs, which are often kept moist by the mother, who may remain coiled about them. In others, like the hellbender, the egg mass is protected by the male, who eats a few before he fertilizes them, and who apparently does not again get hungry until his young have departed in safety from the mass he protects.

The courtship of many salamanders is most amusing to watch, and the actual fertilization of the eggs may be so different from what happens in most other animals as to be almost unique. Where a breeding migration takes place, the males usually precede the females to the breeding ground. There the males of some species may put on a sort of dance, or in some cases may engage in an elaborate series of caresses of the female. Following this, the male may deposit on the bottom of the pool a gelatinous cone or spermatophore on the top of which are the sperms. If the female has been sufficiently stimulated, she settles down on this and takes the sperms into her body where they fertilize the eggs. In other salamanders, including the mud puppy, the eggs are fertilized externally when the parents free the sperms and eggs into the water at about the same time.

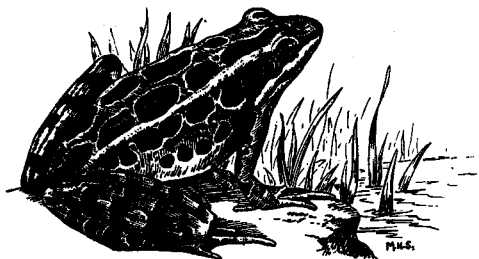
It is not possible here to relate much of the details regarding the development of the stages following fertilization. In most of them, the larval stage is spent in the water, the animals breathing by gills, which appear as fringes in the throat region. In the mud puppy, the whole life history is spent in the water. In the dusky salamander, the egg may be laid on land, the young larvae living at first at the water's (Continued on page 312)



PICKEREL FROG



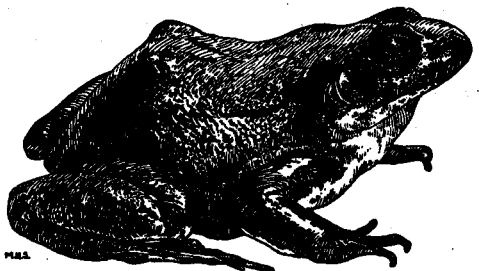
GREEN FROG



MEADOW FROG



WOOD FROG



BULL FROG

COMMON NAME SCIENTIFIC NAME	HELLBENDER <i>Cryptobranchus alleganiensis</i>	MUD PUPPY WATER DOG <i>Necturus maculosus</i>	VERMILION- SPOTTED NEWT. RED EFT <i>Triturus viridescens</i>	TWO-LINED SALAMANDER <i>Eurycea bislineata</i>
DESCRIPTION	Length: to 2 feet. Head: broad and greatly flattened. Legs and feet: larger than in the Mud Puppy, but useful primarily in the water. Skin, looks as though it were greatly wrinkled, and much too large for the animal. External gills such as are found on the Mud Puppy, are absent. Gills are internal. Dark-brown to black.	Length: to 2 feet; may mature at 8 inches. Tail: flattened, powerful. Legs: 4, weak. Feet: 4-toed. Head: short, but with fairly pointed nose. Behind head on either side, are 3 tufts of fluffy-looking, reddish gills. Dark-brown or grayish-brown or black, usually with spots or mottlings, darker. Skin: slimy and difficult to cling to.	Average length: 3 to 4 inches. Adult: brown, with red and black spots. Tail: fin-like, most conspicuous in male. Male: with black swellings on thighs and feet; lacks foldings conspicuous near vent of female. Red land form is immature, lacks fin on tail, is red all over except for fine spots, and has rougher skin than adult.	Length: to 4 inches. Tongue: free at front margin, but attached at the center, beneath. No line from eye to the nostril as in Purple Salamander. Pale straw color, with a narrow, dark line on each side running from eye onto the tail. Belly: yellow. Sides: dotted. Tail: flattened, thus differing from the Dusky Salamander.
RELATIONSHIPS AND RANGE	Two genera of Giant Salamanders, <i>Megalobatrachus</i> , of China and Japan, and <i>Cryptobranchus</i> found in rivers and lakes in eastern United States, particularly in the Lake Erie, Ohio valley region and the rivers that flow from the Allegheny highlands, south to Louisiana and Georgia.	In rivers or quiet freshwater, usually at depths of 4 to 8 feet, and commonly among water plants. Commonest in eastern United States, north and west of Alleghenies, particularly in Great Lakes, Mississippi and Hudson river systems and south to Georgia and Alabama. Two species and a related <i>Proteus</i> of Austrian caves.	Genus includes: Giant Newt, <i>N. torosus</i> , of humid California, Oregon and Washington, and Common Newt, <i>N. viridescens</i> , of eastern North America from Hudson Bay to Texas, west to western Illinois, Michigan, Missouri and Oklahoma. Found in fresh water or on land through the year.	Range: from northern New England to Florida and west through southern Canada to Lake Superior and south to Louisiana. Found almost exclusively at water's edge, in cool streams, under stones and logs, usually in shallow water. Nine related species within essentially the same range.
REPRODUCTION	Male courts female as she lays a tangled string of some 400 eggs, under a rock in August or September. Male adds milt and eats a few eggs and then protects them by curling around them. In 10 weeks, before he gets hungry again, eggs produce young much like the parents. Male really protects food, not young.	Eggs: about 66, each with 3 jelly coats and attached by gelatinous stalk to underside of stone or log or, in sand nest, in about 4 feet of sunlit water; hatch into .75-inch larvae which resemble parents, and by 10 weeks reach length of 1.4 inches. Yolk sac: still attached sometimes until larvae 1.5 inch long, then absorbed.	After courtship embrace, male deposits mucous sperm holder. On this, female settles; then lays to 90, .06-inch eggs, singly on water plants. Eggs hatch to gilled larvae. These, in 3 months, are one inch long, then lose gills and leave water as red land form which may develop 2 years before adult water form is assumed.	Eggs: laid singly but near each other, under submerged rock, April to August, diameter, 2-inch; with 3 jelly coats; to 68 per female, hatch into .5-inch honey-yellow, slender larvae which in 2 years reach 2-inch length and transformation into adulthood, when gills are lost.
FOOD	Food: mostly crayfish, insects, worms and other aquatic animals found usually at night when the Hellbender prowls about over the stony bottom of waterway. Fishes, turtles, and other large water animals eat Hellbenders readily and they are sometimes used as bait. Related Giant Salamander, <i>Megalobatrachus</i> , known to live at least 52 years.	Food: includes fish eggs, crayfish, worms, insect larvae, and other aquatic animals captured by prowling about the bottom. Movements may be slow but bite may be vigorous. Usually, remains hidden during day, begins to roam when darkness approaches. May be active throughout year. Slime protects from enemies.	Food: almost any small aquatic animal captured by slow approach and sudden snap of jaws. May hunt mass of hatching frog eggs and snap up young tadpoles as they hatch. May also destroy great numbers of mosquito wrigglers, young fishes, and similar life. May assume adult form in fall or spring.	Food: small aquatic animals such as insects, worms, crustacea, spiders and millipedes, caught by foraging in daylight more commonly than is customary with most salamanders. The slender shape, yellow belly, active nature, and two dark lines should be ample for identification.
ECONOMIC IMPORTANCE	Flesh: good for food for man, but rarely eaten because of animal's disgusting appearance. Not poisonous in any way, to man. Japanese eat and enjoy the Giant Salamander, which reaches a length of 5 feet, and its eggs, which are grape size. There are fossils of Giant Salamanders that roamed the earth 250,000,000 years ago.	Reported to be good to eat. Generally, recognized as enemy of fish nests and feared by some as being poisonous. Slime is probably distasteful to many enemies. Useful as specimens to students of animal anatomy, and therefore has a sale value to biological supply houses, one firm buying 2,000 or more in year.	Eft, land form, believed once to have mysterious qualities of fairies and pyxies. More realistic as mosquito, frog and fish enemies. In aquarium, may be fed ground beef on tooth-pick or from a dangling thread but will quickly depopulate aquaria of smaller forms of animals. Blood of some bears microscopic trypanosomes.	May serve as a check on some small animals of its environment and may also serve as food for larger creatures of the same regions. May have same relation to disease as discussed for Dusky Salamander but this has not been demonstrated and need not be implied necessarily.

<p style="text-align: center;">SLIMY SALAMANDER <i>Plethodon glutinosus</i></p>	<p style="text-align: center;">DUSKY SALAMANDER <i>Desmognathus fuscus</i></p>	<p style="text-align: center;">RED-BACKED SALAMANDER <i>Plethodon cinereus</i></p>	<p style="text-align: center;">TIGER SALAMANDER <i>Ambystoma tigrinum</i></p>	<p style="text-align: center;">SPOTTED SALAMANDER <i>Ambystoma maculatum</i></p>
<p>Length: to 7.25 inches. Smooth, slender, shining, dark, violet-black, to gray at the tail, with gray beneath; sometimes with pin-point, ivory white spots at the front of the body. Feet: pale brown. Front feet: 4 toed; hind, 5; all without large glands beneath. Skin exudes milky mucus at touch.</p>	<p>Length: to 4 inches. With a light line running from the eye to the mouth and the tongue attached at its forward margin. Larvae: with glistening white gills. Teeth: not confined to front of the jaw. Dark brown, usually uniform, but sometimes mottled with black-edged blotches, or with a broad black-edged back band.</p>	<p>Length: to 3.5 inches. With 19 vertical grooves on sides between front and hind legs. Color: highly variable. Some, all red or wholly dark. Usually, with broad back stripe of reddish, bordered by light brown stripe and "salt and pepper" sides. Others with "red" stripe, lead colored, these being called Lead-backed Salamanders.</p>	<p>Length: to 10 inches. Rather stout. Tail: 1.25 times the body length. Body surface: all rounded and convex, but with 13 vertical grooves on sides. Head: small. Mouth: broad. Front feet: 4 toes; hind, 5. Feet: with 2 tubercles on under side. Blackish brown, with large, irregular, yellow to olive blotches.</p>	<p>Length: to 6 inches. Greenish or brownish black with bright yellow, round dots. Shining, moist, and when handled roughly, mucus-covered. Tail: 2.33 times in the length. Indistinct tubercles on hands and feet. Grooves on sides: 10 or 11. No external gills in the adult. Several clusters of enlarged pores on head.</p>
<p>Range: Eastern Canada and New England to Wisconsin and south to Florida, the Gulf States, Texas and Missouri. Related to the Red-backed Salamander (which see). Commonest, in shady ravines, being found in daytime under logs and stones or, in rains, sometimes wandering about in open.</p>	<p>Range: from southern Canada in the east, south to Georgia, and west to Illinois and Louisiana. In their range, Dusky Salamanders are often common near heads of streams or about springs where their burrows may be easily dug to water. It may swim readily in water but does not ordinarily seek open water except as larvae.</p>	<p>Range: From eastern Canada, through the United States east of the Mississippi, and also through Missouri. American species of genus, 14, through United States and northern Mexico. Red-backed or Lead-backed commonly found under logs or dry rocks, usually in rocky woodlands, rarely in open or in water.</p>	<p>See Spotted Salamander for discussion of relatives. Tiger Salamanders found widely distributed over most of the United States east of the Rockies and extending to the south over the northern part of the Mexican highlands. Some found west to California. Adults found under stones and logs in rather moist places.</p>	<p>In field, woodlands, cellars and under boards in summer and winter; in smaller pools, in early spring. Other species of <i>Ambystoma</i> include the Jefferson's, the Marbled, the Tiger and the Mole Salamanders. Spotted Salamander ranges from Nova Scotia to Wisconsin and south to Texas and Georgia.</p>
<p>Few details of life history known. Creamy-white eggs reported from Arkansas caves, late Aug.-early Sept., female coiled about eggs under rotted stump in West Va. reported by Sherman, authority respectively Noble and Marshall, and Fowler.</p>	<p>Eggs: 12 to 26, .16-inch, in 3 jelly coats, like a bunch of about 20 grapes, yellow-white, laid from June through September, in wet moss, under logs or stones, where it is wet, usually surrounded by female; develop to .5-inch length in egg in 2 months. Continues 9 months as aquatic larva before transforming.</p>	<p>Sexes mate in fall, and eggs laid late in following spring. Eggs: about 12, .2-inch, in 3 jelly coats, found commonly under wet wood encircled by mother. Larval stage spent in the egg, the young having gills only a short time after hatching. Young: 1 inch long when hatched, and soon independent of parent.</p>	<p>Following courtship, eggs, to 75, are laid in a jelly mass similar in general to those of the Spotted Salamander. The egg mass is about 4 inches across and is attached to submerged weeds or sticks. The larvae have gills and live in the water through the summer but lose them and take up life on land in 3 months.</p>	<p>Sexes migrate to pools in spring, at night, mate. Male deposits mucus sperm holder. Female visits then deposits mass of 130 to 225 eggs. Each egg, in 2 jelly coats, hatches, 2 to 4 weeks. Egg mass, attached. Larvae: .5 inch long when hatched, remain with gills in water until late summer, then assume adult form on land.</p>
<p>Food: largely insects and their larvae; also spiders, worms, millipedes and similar small creatures. The species is nocturnal and is entirely terrestrial throughout its life, apparently. Protection against some enemies is effected through excretion of abundance of distasteful mucus when annoyed. Sometimes prey of Short-tailed Shrew.</p>	<p>Food: probably exclusively small forms of animals and probably mostly, when living, caught in the crevices and wet places where the animal lives. While the slippery nature of the body may serve as some protection it is not developed to the degree found in the slimy salamander, nor can the tail be shed so readily as in the two-lined salamander.</p>	<p>Food: insects and their larvae captured by flat tongue which can be projected forward quickly and accurately. Can secrete a slime but only in small quantities. If held, may shed tail readily and tail may continue to move for some time. Regenerated tail is without vertebrae.</p>	<p>Food: essentially that of the Spotted Salamander, namely small animals caught at night by prowling around on the ground. In captivity, it may eat small frogs. In some parts of western United States and in lakes around Mexico City, Tiger Salamanders may retain their gills and their aquatic habits through life as "permanent larvae."</p>	<p>Food: largely insects, snails, slugs, worms. In aquaria, may be fed raw meat in small quantities on toothpick, or earthworms or mealworms. Larvae thrive in aquaria where temperature is about 65°F. Transformation of larvae indicated by absorption of gills in late summer or early fall. Spring appearance may be before ice leaves water.</p>
<p>Probably of little economic importance but what it does in the destruction of insects found about decaying wood may be useful in keeping such creatures in control. Makes interesting terrarium pet but usually remains deeply burrowed during the day. More details on breeding habits will reward careful study.</p>	<p>Possibly useful as a check on insects of its habitat. Unfortunately, the insects eaten may have become contaminated with colon bacteria by eating sewage and the salamander may serve as a reservoir for contaminating drinking water. In 122 days, one produced enough colon bacteria daily to contaminate 237 gallons of water.</p>	<p>Possibly useful in keeping certain insects and their larvae in check. Makes most interesting terrarium pet but should not be allowed to starve in such a situation. Every school child should have at some time opportunity to see a mother Red-backed Salamander in her nest with her eggs; better yet, find such a nest independently.</p>	<p>Economic importance about the same as that of the Spotted Salamander, though the animal may be more popular for sale as terrarium pet. To biologists, they are interesting because some retain gills through breeding adult life while others lose them at this stage of development. Larval form was known as the <i>Axolotl</i>.</p>	<p>Useful destroyer of many kinds of small animals, some of which are injurious. May eat insects infected with disease. Makes an interesting terrarium pet and the eggs are commonly brought into school rooms in spring as "frog's eggs" with the result, of course, that frogs do not hatch from them. To avoid this, watch for double film on eggs.</p>

COMMON NAME	SPRING PEEPER	TREE FROG	CRICKET FROG	TOAD
SCIENTIFIC NAME	<i>Hyla crucifer</i>	<i>Hyla versicolor</i>	<i>Acris gryllus</i>	<i>Bufo americanus</i>
DESCRIPTION	Length: male, to 1.15 inches; female, to 1.3 inches. Long-legged, broad, and flattened. Toes: with sticky discs at the tips. Male, yellow on groin; throat, brown or yellow. Female, with white throat. Back: with irregular dark X and dark spots. Legs: with dark cross-bands. Female, in general, lighter in color.	Length: male, to 2 inches; female, to 2.4 inches. Ashy gray, to pale brown, varying with environment. Skin: finely pimpled. Legs: slender, and toes ending in discs which stick to surface. Back and legs: marked with dark areas which are commonly black-bordered. Often orange under hind-parts.	Length: male, to 1.16 inches; female, to 1.3 inches. Looks like a true frog instead of like a tree frog, being more slender, with smoother skin and with more normal toes. A dark triangle between eyes, with a white border behind. There is an oblique, white stripe from eye to arm. Color varies, brown, reddish, gray, green.	Length: to 4.25 inches long. Male: rarely over 3.5 inches long; female, longer. Fat. Skin, roughened by pairs of dark spots on the back, each surrounding a wart. Undersides: finely roughened, with some dark spots there also. Eyes: prominent. Some males have yellow throats and yellow on under side. Two large glands back of eyes and neck.
RELATIONSHIPS AND RANGE	Range, from New Brunswick to Manitoba, and south to South Carolina, Louisiana, Arkansas and Kansas. In spring, found about shallow pools where breeding takes place, but during summer, may be in tree tops for most of the time and, in winter, hidden in forest floor. May be heard from woodlands any month of year.	Maine, through southern Canada, to Minnesota, south to Gulf States, including parts of Texas and Arkansas. Related American species, 11, cover United States and into Mexico and southern British Columbia. Included in related species, are the Peeper, Pacific tree frog and others. Lives in tree tops in summer.	Ranges from Florida to New York and Connecticut, west to Texas and northward through the most of the upper Mississippi valley states. It lives on the ground, lacking sticky toes, and haunts meadows, waterway margins or woodland margins where there is moisture.	Eastern North America, from Great Bear Lake to Mexico and east from the Rockies, with 13 other species extending range from northern Mexico and Lower California to British Columbia. Common in gardens, about lawns, in cultivated fields and in waste places where loose soil is suitable for self and for favored food.
REPRODUCTION	Male precedes female to breeding pond in spring. After the mating, 800 to 1,000 black and white, one-coated, .08-inch eggs are laid, under water, on vegetation, singly. These hatch in 5 to 15 days, and in 75 to 90 days, develop into 1.3-inch tadpoles, with many purple-black blotches, and iridescent creamy bellies. See below.	Eggs: .04-inch, brown and yellow, in one, thin, and one, loose, jelly coat, laid free, or attached, at water surface, in films of 4 to 25, though individual lays 1,500 to 2,000; hatch in 4 to 5 days, into red- or orange-tailed, creamy-white bellied tadpoles, which in 40 to 60 days, are 1.8-inch long, and transform into .6-inch frogs.	Breeds from February through October. Eggs: to 250, .04-inch, with single, jelly coat, attached to submerged vegetation; hatch in 5 to 15 days, into tadpoles which, in 60 to 75 days, are 1.7 inches long, with black-tipped tails, long breathing tubes on left side; transform into .5-inch adults which take to land.	Breeds in mid-spring to midsummer. Eggs: .08-inch, black and white, in two-coated strings of jelly, laid beneath water surface, among weeds, 4,000 to 7,000, hatch in 3 to 12 days, into black tadpoles, with looped, external gills. In 40 to 60 days, when tadpoles are .4-inch long, they transform and come onto land as little toads which mature in 2-3 years.
FOOD	Food: of adults, essentially insects caught by quick thrust of the tongue. The 1.3-inch tadpole transforms, in July, into .6-inch, tree frog which leaves the water and probably spends to 3 to 4 years before reaching sexual maturity. Has many enemies including birds, fishes, salamanders, squirrels and other animals.	Food: essentially insects, caught by lightning dart of tongue. In North, a tree frog which transforms at .6 inch is 1 inch at 1 year; 1.4 inches at 2 years; 1.8 inches at 3 years when it reaches breeding maturity. Can cling securely to clean, vertical glass. Song: a short melodious trill.	Food: insects, and other small animals of their environment, caught by quick thrust of sticky tongue. Males may jump 3 feet at a time, or leap to 1 foot high into bushes after food. Time to reach sexual maturity after transforming not known to author. Song: like a metal rattle giving rapidly repeated "clicks."	Food: cutworms, potato beetles, chinch bugs, earthworms, ants, slugs, or almost any animal moving in vicinity, all caught by quick thrust of tongue. Can exude slime which is distasteful to many enemies, but not poisonous to man, though giant toad of the tropics may cause great suffering or blindness to dogs or man. Song: a prolonged musical trill.
ECONOMIC IMPORTANCE	Essentially, useful as check on insects of the environment and a delightful animal for life in terrarium, but, more particularly, free in the open. May be fed chopped earthworm if kept through winter in terrarium when it does not hibernate as in nature. Peeping done by the male only.	Entirely useful animal of thickets, orchards and shade trees, some having been caught 60 feet up in a tulip tree. Most active at dusk and, since it sings during damp weather or before rain, many people consider it reliable weather prophet. Throat inflated conspicuously when in song.	Use to man, probably negligible, except that it serves to check multiplication of insects of its region and serves as food and as bait for fish. Sounds are difficult to trace and often come from surprising quarters, with startling suddenness and most interesting results.	One of the most useful animals associated with man and his crops. One of the best residents of any garden. In China, skin is used as a medicine, not unwisely, since it contains adrenalin which increases man's blood pressure. May live to 36 years. Can not live for ages, confined in a rock, as many believe. Does not cause warts on man.

BULLFROG <i>Rana catesbeiana</i>	GREEN FROG SPRING FROG <i>Rana clamitans</i>	PICKEREL FROG SPRING FROG <i>Rana palustris</i>	LEOPARD FROG MEADOW FROG <i>Rana pipiens</i>	WOOD FROG <i>Rana sylvatica</i>
<p>Length: male, to 7.5 inches; female, to 8 inches. Hind legs may be over 10 inches long. "Ear" larger than eye. Throat: sometimes yellow in male, while ear is as large as eye, and throat is white in female. In both sexes there is a conspicuous wrinkle or fold running down behind "ear," but not down the back.</p>	<p>Length: to 4 inches, with sexes about equal. Male: with "ear" larger than eye; and throat, usually orange. Female: with ear and eye equal, and throat white. Both with a prominent fold extending from each eye, almost to base of hind leg, with a branch at right angles behind the "ear."</p>	<p>Length: male, to 2.6 inches; female, to 3.2 inches. Male croaks, has swollen thumb at breeding season, and has small swellings between "ear" and arm. Much like Meadow Frog, but yellow or orange under hindparts and dark spots are squarish, black-bordered, and regularly arranged in 2 rows, sometimes with a third incomplete row.</p>	<p>Length: male, to 3.2 inches; female, to 4.1 inches. Male, with fold of skin over arms. Female, without such fold. Male, sometimes with swollen thumb. Skin, smooth, generally moist. Green, with whitish-edged, dark, irregular blotches. White beneath. Toes: not webbed to their tips.</p>	<p>Length: male, to 2.2 inches; female, to 2.6 inches. Conspicuous, because of black mask across lower part of eyes and side of head. Skin: smooth, moist and highly variable in color, from light tan, through green, to almost black. Legs: long and slender. Male, with convex webs on hind feet in breeding season; croaks.</p>
<p>Ranges through most of North America, east of the Rocky Mountains. It lives in the water through its life, not roaming far into fields or into tree-tops as do many other kinds of smaller frogs. It favors small lakes and ponds where there is little wave action, a mud bottom, and good depth, as in mill ponds and reservoirs.</p>	<p>Ranges through eastern North America from Canada to Florida. This frog lives in or within jumping distance of water through its entire life. It haunts small pools, ponds, streams, swamps and lakes. It hibernates in the water, sometimes in burrow. In some places protected by law in breeding season.</p>	<p>From Hudson Bay to Arkansas and Louisiana and through all the Eastern States, with related species to the west. Common, in marl ponds, rocky streams, small ponds and marshes but rarely wandering far from water, as do the Meadow Frogs. Winters in marshes, ponds and springs. Does not climb into trees as do the Tree Frogs.</p>	<p>Through North America, east of the Sierras, from southern Canada into northern Mexico. Common, in spring in the marshes, ponds and shallow pools of the country, but in summer takes to swamplands, meadows, grassy woods, cultivated fields. In winter, hibernates in marshes and pools.</p>	<p>Ranges from Quebec and Nova Scotia to South Carolina, west to Great Plains, with related species on to the west and far north. Lives mostly in wooded areas, breeding in spring, in woodland ponds, spending summer and fall on forest floor, and winter under stones, stumps and logs in woodlands, not in the water.</p>
<p>Mates from February (South) to July (North). Eggs: .02- to .04-inch, in several, 3-5-foot, surface films, usually attached, total to 20,000, black and white, in one, thick coat of loose jelly; hatch in 4 days and develop (North) in 2 years into 5.8-inch tadpoles, with irregularly spotted tails and yellow, not iridescent bellies. See below.</p>	<p>Mates (North) through summer. Eggs: .06-inch, black and white, in a thin-oval and thick, spherical, loose jelly coat, in disc-like 1-foot surface films, totalling 4,000 in several films; hatch in 3 to 6 days and develop in 1 year into 3.4-inch tadpoles, with green tails, with brown spots, and creamy, not iridescent, bellies. See below.</p>	<p>Breeds (North) April, in great numbers, in ponds. Eggs: brown and bright yellow, .06-inch, in a thin, and a thick, firm, jelly coat, in globular, free, or attached, underwater masses, to 3,000; hatch in 6 to 19 days and develop in 70 to 90 days into 3-inch tadpoles with dark purple opaque tail-crests and iridescent bellies. See below.</p>	<p>Breeds (North) April. Eggs: .06-inch, black and white, in a thin and a thick coat of firm jelly, attached, under water, in long masses, totalling to 4,500; hatch in 4 to 20 days, and develop, in 75 to 90 days, into 3.4-inch tadpoles, with high tail-crests, translucent, with fine markings, and bronzy, creamy iridescent bellies. See below.</p>	<p>Mates, April (North). Eggs: .1- to .06-inch black and white, in 2 thick, firm jelly coats, in several spheres, free or attached, under water, to 3,000; hatch in 4 to 24 days, and develop in 44 to 85 days into 1.8-inch tadpoles, with creamy lines along upper jaws, and pink bellies, with bronze iridescence, then transform. See below.</p>
<p>Food: of tadpoles, oozes and aquatic plants and animals; of adults, insects, fish, other frogs, birds and other animals. Tadpoles transform into 2-inch frogs which grow to 2.6 inches in 1 year; 3.25 in 2 years; 4 in 3 years; 4.75 in 4 years; and 7 in 7 years. Reaches breeding size of 5 inches in fifth year after transformation.</p>	<p>Food: almost any animal that can be swallowed by the adult. Tadpole eats oozes and slimes and waste plants and animals. Call: an explosive "Chung" or a scream. Tadpole transforms into 1.3-inch frogs, which average in 1 year 1.8 inches; in 2, 2.25; in 3, 2.85; and in 4, 3.5 inches. Breeds at about 3-inch length.</p>	<p>Food: of tadpoles, oozes and slimes and plants and animals; of the adult, insects and other small animals. The tadpoles transform into 1-inch frogs in mid-summer, which reach 1.5 inches in 1 year; 1.8 in 2 years; 2.3 in 3 years; and 2.6 in 4 years, becoming of breeding age in third year. Call: a short, grating croak.</p>	<p>Food: of tadpoles, oozes and slimes of plant or animal material; of adults, insects, worms and other small animals. Tadpoles transform in midsummer into 1-inch frogs which average 1.5 inches in 1 year; 2 at 2 years; 2.35 at 3 years; and 2.7 at 4 years; the breeding size being reached at 3 years. Call, a short clacking grunt.</p>	<p>Food: small animals of the forest floor; and, as tadpoles, the oozes and slimes of the breeding ponds. The tadpoles transform into .6-inch frogs in early summer. These become 1 inch long at 1 year; 1.3 at 2 years; 1.8 at 3 years and 2.25 at 4 years, when they reach breeding maturity. Calls: clacking croaks, by the males.</p>
<p>Excellent scavenger. Legs bring 1 cent a pair which, in North is from animal requiring 7 or 8 years from egg to egg. Advertised "frog farms" are of questionable merit unless there is a "sucker" market for breeders at advertised price of \$6.66 a pair. Call, a booming "jug-o-rum" by male. Protected by law in season in some states.</p>	<p>Legs sold on market at about 1 cent a pair for animals requiring, in North, 4 to 5 years from egg to egg. Protected by law in breeding season in some states. For information on utilizing frogs, see United States Bureau of Fisheries, Document 888, on "Frogs: Their Natural History and Utilization."</p>	<p>Skin secretes substance highly irritating to mouths of dogs. Will kill other frogs in same jar. The legs are edible in spite of the fact that, by some, they are considered poisonous. Animals are unquestionably more useful alive as insect eaters and as food for valuable food fishes than they are as food for man.</p>	<p>The legs are used as food but the animal is worth much more alive as an insect destroyer than dead at 1 cent per pair of legs. Frogs, less than breeding age, should never be killed. This species is protected by law during breeding season in some states and should have this protection generally.</p>	<p>It is questionable if this frog gets large enough to be considered of food value to man. Its value alive in the woods as an insect destroyer and as a food for larger animals, including the fur-bearers, must be more than it could possibly be worth dead to man. Important enemies include cats, rats, weasels, crows, muskrats, and so on.</p>

(Continued from page 307) edge, but soon becoming thoroughly aquatic. The adult stage is spent mostly on the land. In the newt, the eggs are laid in the water and an early larval stage is spent there. By late summer or fall, the young animal comes out on land as a red eft that may live for a varied period of time. This land stage may last as long as three years, or be wholly lacking. Then, when mature, the animal assumes the brown color and the flattened tail of the adult and returns to the water. So different are these two stages of the same animal that for years they were thought to be two separate species. In the early larval stages of most salamanders, the food may probably be oozes and slimes found near the hatching place.

A most excellent book, *Handbook of Salamanders* by Sherman C. Bishop, has been published by the Comstock Publishing Company. It is unique in its field. It has excellent illustrations taken from living animals, and life-history keys.

Frogs and Toads

When spring comes, one of the first signs of the season is the calling of some frog or toad. In southern California, this may begin by Christmas time. In Jamaica, the frog chorus is at its height when Christmas gifts and firecrackers are being distributed. From then on through the year, some one or another of these animals may be heard. Peepers, or some other frog or toad, have been heard in Ithaca, New York, in every month of the year.

The sounds heard in the choruses are produced almost wholly by the males. Females of some species may produce sounds when disturbed or injured, but they do not sing to call their mates to a love tryst. The males are usually smaller than the females, have black or colored throats rather than the lily-whiteness usually reserved for the fair sex, and come to the breeding grounds in advance of the females.

Each species of frog and toad has its own distinctive song that may be recognized as such by the specialist. And since each species also has a more or less restricted range, a naturalist frequently gets a real thrill from attending a movie whose locale is supposed to be New England only to hear southern California frog sounds used to indicate "night in a swamp." It should not be difficult to learn to recognize the sounds of the relatively few species any locality has. Since few species sing over a long span of time, there is less likelihood of confusion such as comes to those who try to learn to recognize birds' songs when the spring migration is at its height.

Usually, the spring chorus is opened by the peepers or by some of their close relatives. As the season progresses, these are joined by the wood frogs, pickerel and meadow frogs, and followed by the tree frogs and the common toads. When the "Tschunk" of a green frog can be heard, spring is well advanced and summer is not far away. Neither is the bellowing "jug-o-rum" of the bull frog, which is usually the last species to appear and to breed.

While some frogs, particularly in the tropics, lay their eggs in wet trash on the ground, most species deposit them in the water. In the North, the earlier-laying species usually place the eggs in the deeper water where there is less danger of freezing, while the green frogs and bull frogs, the last to lay, deposit them in great masses that float at or near the surface. As a rule, the earlier species lay fewer eggs than the later

species, and their tadpoles mature to the transforming period in the same season. In the North, at least, the later-appearing species produce tadpoles that live through one or more winters before transforming into the hopping form.

In the larval or tadpole stage, the animals feed largely on the oozes and slimes to be found on the submerged objects about them. Some may live as scavengers. When the time for transformation comes, the tadpoles do not shed the tails as some would believe but absorb them during the time the change is being made. With the toads, at least, great numbers may transform at a given time, frequently during the time near a shower. Because of this many believe that it has "rained down" toads. It is quite probable that the incident referred to in Exodus took place in early summer when frogs and their relatives were transforming.

One cannot assume that once a tadpole has become like a frog its troubles are over and it is ready to reproduce its kind. In the North it takes a wood frog four years to reach sexual maturity; a tree frog, pickerel frog, leopard frog or green frog three years after transformation; a bull frog, five or six years. If the numbers of a species are to be maintained, the animals smaller than the breeding adults must be protected.

There are laws designed to protect frogs in their breeding territory and during their breeding season. In some states, at least, they cannot be driven into compounds and slaughtered, nor can they be prevented from reaching their breeding grounds.

There have been many "get-rich-quick" schemes built around the food value of frogs but most of them are so patently impractical that no sensible person would be caught by them. One southern firm with whom I corresponded boasted that their frogs were especially selected to be quiet and not bother the neighbors, and they guaranteed that the frogs would make no more noise than a dog or cat. When I asked permission to visit one of the farms of their customers anywhere in the Northeast, I was told that I should appreciate how annoying it would be to have every one visit my frog farm, were it successful, and therefore I could not expect others to let me see their farms. This particular firm has, I understand, gone out of business because of its abuse of the United States mails.

For my own part, I much prefer to listen to a frog chorus than to sink my teeth into the muscles of a few frog's legs and I hope that there will always be places where I can hear the sounds of these animals in season. As a college senior, who was once one of my students, wrote:

"Somewhere there is a hyla song
Piping clear, and sweet and thin.
Tonight if you knocked at the door of my heart,
Tonight, I would let you in."

She was criticised by the English department for mentioning hyla with which the instructor was unfamiliar. I doubt if he would have been better satisfied had she substituted the word "peeper."

If you are interested in knowing more about frogs and toads from a book, get *Handbook of Frogs and Toads*, by Anna Allen Wright and Albert Hazen Wright, The Comstock Publishing Company, or the U. S. Bureau of Fisheries Document, No. 888, *Frogs: Their Natural History and Utilization*.