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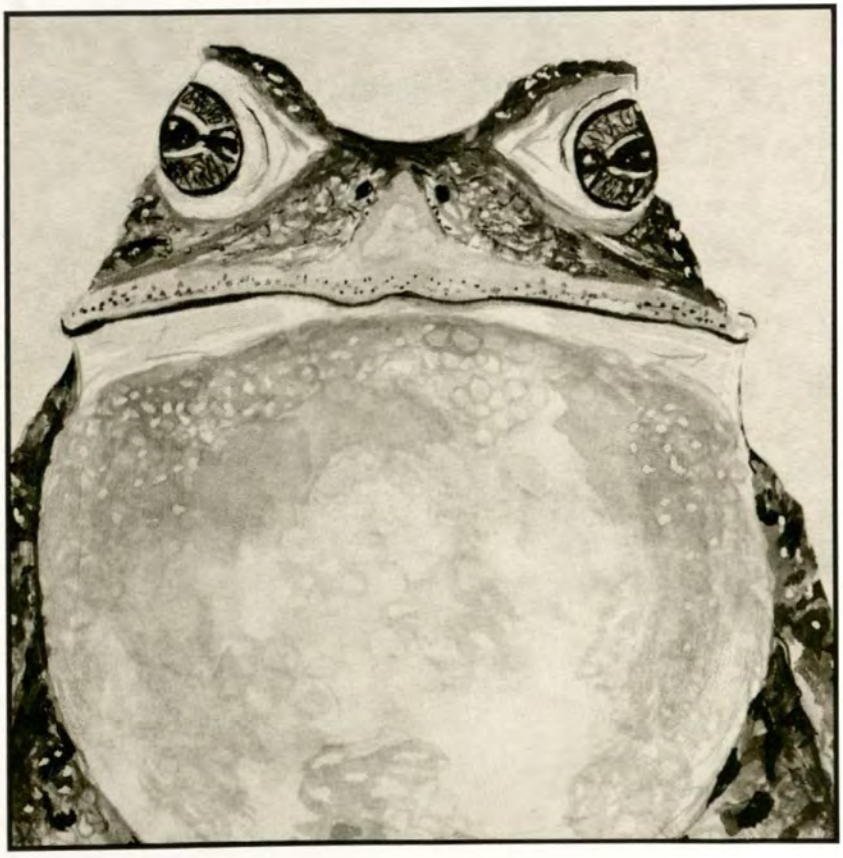
Bulletin No. 36: Amphibians and Reptiles of the Connecticut College Arboretum

Jill Devito

Joseph Markow

AMPHIBIANS AND REPTILES

OF THE CONNECTICUT COLLEGE ARBORETUM



THE CONNECTICUT COLLEGE ARBORETUM
Bulletin No. 36 ◆ December 1998

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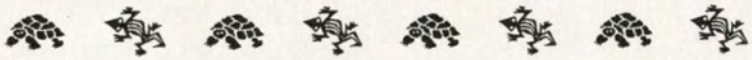
AMPHIBIANS



AND REPTILES

OF THE

CONNECTICUT COLLEGE

ARBORETUM

JILL DEVITO and JOSEPH MARKOW
illustrations by AMY DUNHAM
Edited by Glenn Dreyer

THE CONNECTICUT COLLEGE ARBORETUM
Bulletin No. 36 ◆ December 1998

Front cover illustration: Bullfrog *(Rana catesbeiana)*
Back cover illustration: Northern Ringneck Snake *(Diadophis punctatus edwardsii)*

NOTICE TO LIBRARIANS

This is the 36th volume of a series of bulletins published by the Connecticut College Arboretum, formerly named the Connecticut Arboretum. Numbers 1-30 were published as Connecticut Arboretum Bulletins.

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FOREWORD

The rich diversity of habitats in the Arboretum has helped attract numerous faculty and students to the biology and environmental studies programs at Connecticut College. The opportunity to walk a few minutes across campus to a protected natural area, and to work in a site where there is comprehensive information on both the vegetation and animal life, makes the college an ideal place to teach and study field biology. Three undergraduate students who already had a deep interest in field biology when they came to the college wrote this bulletin. They all took full advantage of the opportunity to participate in independent research and to explore the natural areas near the campus. All have gone on to graduate school in ecology or animal behavior. Both Joseph Markow '95 and Jill DeVito '95 studied amphibians for their thesis projects at the University of Connecticut and Oregon State University, respectively, while Amy Dunham is studying lemurs in a new national park in Madagascar for her thesis at SUNY Stony Brook.

While they were undergraduates, they worked together to plan this bulletin and put it together. Jill DeVito and Joe Markow had extensive field experience with reptiles and amphibians in the Arboretum, where they had completed projects for courses, independent studies, and honors theses. Amy Dunham's undergraduate thesis (like her graduate work) was on lemurs in Madagascar, but she contributed her considerable artistic skill to illustrate this bulletin.

Like an earlier Arboretum Bulletin on birds, this work combines a description of species reported from the Arboretum with a summary of the results of research projects that have been completed there. It will be an invaluable guide not only for visitors who want to learn about the natural history of the Arboretum and surrounding areas, but also for students and faculty who are planning research projects. They can quickly learn about particular localities or habitats where they can find different species of reptiles and amphibians. They can also learn about the methods and results of earlier research projects.

In addition, this summary provides a guide to baseline data on the abundance and distribution of particular species. With recent reports of steep declines in frog and toad populations in many parts of the world, this information will become increasingly important for detecting and understanding environmental changes. For example, since the first draft of this bulletin was completed, there already has been a noticeable drop in the abundance of bullfrogs and green frogs in the Arboretum Pond, perhaps because of the recent introduction of predatory pike.

This publication contributes to an impressive set of Connecticut College Arboretum bulletins on birds, upland and wetland plants, and invertebrates that are a rich source of

information for naturalists. The Arboretum not only carefully protects its natural areas, but also sponsors long-term ecological research programs, and encourages students and faculty to publish their results for a diverse audience. These efforts contribute to the training future biologists and environmental scientists while educating the public about biological diversity and the preservation of natural ecosystems.

Robert A. Askins
Professor of Zoology
Arboretum Research Associate

ACKNOWLEDGEMENTS

We would like to thank Amy Dunham for the donation of her time and artistic talents to the bulletin, Robert Askins for his guidance throughout the duration of the project, Benjamin Pierce for lending us his field notes and his expertise, Wendy Dreyer for sharing her extensive knowledge of Arboretum herpetofauna, and Glenn Dreyer for editing the manuscripts and for giving us the opportunity to write the bulletin. Thanks also to the biology students, faculty members and members of the Arboretum staff who helped us by describing their experiences with the reptiles and amphibians of the Arboretum.

Jill DeVito and Joseph Markow

FIELD GUIDE TO AMPHIBIANS AND REPTILES OF THE CONNECTICUT COLLEGE ARBORETUM

BY JILL DEVITO

INTRODUCTION

For more than sixty years, the Connecticut College Arboretum has been used as a research facility by professors and students of biology. Both botanists and zoologists have studied the Arboretum ecosystems; some of this research has been published in scientific journals, and Arboretum bulletins have been used to document the changing environment and biological diversity of the area. Relatively few students and professors have studied the reptiles and amphibians of the Arboretum, however, and no comprehensive account of the herpetology of the Arboretum existed before 1995, when I was given the opportunity to conduct a general survey of reptiles and amphibians. The results of my efforts are presented here in field guide format, with nomenclature and the order of species following Klemens (1993).

The Arboretum is home to at least seven frog species, six salamander species, four turtle species, and eight snake species. This includes the majority of the reptiles and amphibians found in southeastern Connecticut, and all the region's species are listed in the checklist at the end of this bulletin. Several distinct ecosystems in the Arboretum provide habitats for this diversity of reptiles and amphibians. The mixed deciduous forest that comprises most of the Arboretum supports many woodland reptiles and amphibians. Snakes find plenty of small animal species to prey upon, and they find shelter in rock walls, and under leaf litter and fallen logs. Turtles take advantage of the few open water habitats, and amphibians are provided with adequate breeding areas in these and other wetlands such as red maple swamps, bogs, ephemeral pools and quarry ponds, which are found throughout the natural areas of the Arboretum. A map of the Arboretum inside the back cover of this publication shows the locations mentioned in the text.

MAJOR HABITATS

The Arboretum Pond is the only permanent open body of freshwater in the Arboretum. It was created by the clearing and damming of a red maple swamp in 1928, and since 1982 it has been occasionally drained and once dredged in an attempt to keep portions of the shallow Pond as open water (Goodwin 1991, G. Dreyer, pers. comm.). The Pond provides an ideal habitat for permanent-water species that are not particularly sensitive to wetland disturbance. Species that appear to have benefited from the creation of the Pond include the Bullfrog, Green Frog, Red-spotted Newt, Snapping Turtle, Eastern Painted Turtle, and Northern Water

Snake. Other species, such as the Gray Tree Frog, Pickerel Frog, and many terrestrial salamanders require less disturbed wetlands with abundant shoreline vegetation for breeding (Klemens 1993). Although these species continue to breed in the Pond, they may have been more successful in the original red maple swamp than in the current open water habitat.

The Bolleswood is a relatively undisturbed hemlock/mixed deciduous forest designated as a natural area for research and teaching in 1952 (Goodwin 1991). During the past ten years the hemlocks have declined, and many have died, due to an infestation of the hemlock wooly adelgid, *Adelges tsugae* (Dreyer, pers. comm.). This area includes the ravine, created by a normal fault that exposed solid walls of gneiss reaching up to 50 feet (15 m) in height. Beginning near the Arboretum's south border, the ravine runs due north past Gallows Lane. A semi-permanent, unnamed, shallow stream originates in Arboretum property to the north and forms a swamp just north of Gallows Lane. The ravine area provides a home for shade-loving species and those that prefer running water, such as the American Toad, Spring Peeper, Pickerel Frog, Wood Frog, Redback Salamander, and Two-lined Salamander.

North of Gallows Lane, the red maple swamp and the headwaters of the ravine stream provide a relatively undisturbed area that is extremely wet in spring, and almost completely dry by the end of the summer. This wetland complex serves as an important breeding area for many amphibian species including the Spring Peeper, Gray Tree Frog, Green Frog, Wood Frog, and Spotted Salamander. This abundance of amphibian species provides a food source for reptiles such as the Spotted Turtle, Eastern Garter Snake, and eastern Ribbon Snake.

The Bolles Road pond is a small, semi-permanent or vernal woodland pond east of the terminus of Bolles Road, in the northern part of the Goodwin Tract (Pierce and Shayevitz 1982). This shallow water body is surrounded by dense shoreline vegetation including mixed shrubs, greenbrier, and ferns. The Bolles Road pond is an important breeding pool for many amphibian species. Among these are the Gray Tree Frog, which is particularly sensitive to wetland disturbance, and the relatively uncommon Marbled Salamander (Pierce 1985, Klemens 1993).

The white pine plantation northwest of the former college riding stables is a locally unusual habitat with an unusual distribution of amphibian species. The Redback Salamander, which is extremely common in most parts of the Arboretum, is rarely found here. The much less common Four-toed Salamander inhabits the white pine area, but has not yet been found elsewhere in the Arboretum.

TOADS AND FROGS

EASTERN AMERICAN TOAD -- *Bufo a. americanus*

The Eastern American Toad is common in many habitats in eastern North America (DeGraaf and Rudis 1983). This adaptable species successfully maintains populations even in urban areas, taking advantage of backyards and gardens as sources of food and shelter.

Like all members of the toad family, the American Toad can be easily distinguished from a frog. The toad is often found far from water, and its bumpy skin has a dry appearance. The hind legs of a toad are much smaller and less powerful than those of a frog, and the escape attempt of a toad usually consists of a series of half-hearted leaps toward shelter. The slow-moving toad is protected from most of its natural enemies by skin secretions that are toxic when ingested, and by a camouflaged color pattern that allows a motionless toad to disappear into its surroundings.

The coloration of the Eastern American Toad varies from gray to brown, with dark spots on the back and a light-colored belly. This toad can reach a length of three inches (7.5 cm), but many individuals are much smaller. The American Toad can be distinguished from the closely related Fowler's Toad (*Bufo woodhousii fowleri*) in the following ways: The Fowler's Toad is more often found in habitats containing sandy soils (DeGraaf and Rudis 1983); the call of the American Toad is a pleasant sounding trill, while that of the Fowler's Toad is characterized as a nasal "waaahj" and the American Toad has one or two large "warts" in each pigmented area, while the Fowler's Toad has three or more smaller "warts" in each large dark spot (Conant 1975).

In the Arboretum:

In damp, shaded areas of the woods, look for the movement of a toad as it is flushed from its hiding spot in your path. Listen at night for the trill of the chorusing American Toad near open water from April to July (DeGraaf and Rudis 1983). The American Toad is known to use the Bolles Road pond as a breeding area, and it has been heard calling in the red maple bog near the pond (Pierce et al. 1984; Robert Askins, pers. comm.). Individuals of this species have been sighted in the woods both north and south of Gallows Lane, and it is probably common in the Bolleswood Natural Area and in other areas with damp soil and sufficient cover (Wendy Dreyer, pers. comm.).

The Fowler's Toad might also be found in the Arboretum, but there are no definite records. This species potentially could inhabit the sandy environment of the woods adjacent to the Thames River in the Matthies Tract and near the Mamacoke Natural Area.

GRAY TREE FROG -- *Hyla versicolor*

The Gray Tree Frog inhabits forested regions throughout the eastern United States and southern Canada. According to Klemens (1993), the species is much less successful in disturbed areas where natural wetlands have been converted into more aesthetically pleasing ponds surrounded by manicured lawns.

For breeding (which takes place from early May through July), the Gray Tree Frog requires open water surrounded by shrubby vegetation, which provides these highly arboreal frogs with adequate hiding places during the breeding process (DeGraaf and Rudis 1983). Such protection is provided in red maple swamps, which are among the favorite breeding sites of the species (Klemens 1993). Because of its dependence on breeding sites with nearby vegetation, the Gray Tree Frog is particularly vulnerable to the effects of wetland alteration.

Adults are typically 2 inches (5 cm) long, and light gray with dark spots and slightly bumpy skin. The underside of the frog is white, and the hind legs are marked with yellow. The juvenile Gray Tree Frog is bright green above and white below.

IN THE ARBORETUM:

Throughout most of the year, the Gray Tree Frog is the most elusive frog in the Arboretum. The species is almost exclusively nocturnal; during the day the frog remains motionless against the bark of a tree, protected from predators by its inconspicuous coloration (Klemens 1993). The only members of the species that are likely to be encountered during the day are the bright green newly metamorphosed juveniles as they find their way from the wetlands to the forest.

The melodic trill produced by the male Gray Tree Frog during the breeding season can be heard from the Pond, the Bolles Road pond, and the ravine stream in late spring and early summer (Pierce and Harvey 1987, DeVito 1994). Calls may also be heard outside the breeding season, especially before summer rainstorms (DeGraaf and Rudis 1983).

NORTHERN SPRING PEEPER -- *Pseudacris c. crucifer*

The Spring Peeper (formerly *Hyla c. crucifer*) inhabits eastern North America from the Florida Panhandle to the Hudson Bay (Tyning 1990). This diminutive tree frog is much more often heard than seen; the sound of its voice at dusk is known to many as an early sign of spring. At this time the clear, short, high-pitched breeding call of the male is its most distinctive field mark. In the northern part of its range, choruses begin near open water in early March, and continue throughout the spring (DeGraaf and Rudis 1983).

Individual Spring Peepers are nearly invisible at dusk, but their inflated vocal sacs can be spotted after dark with the aid of a flashlight.

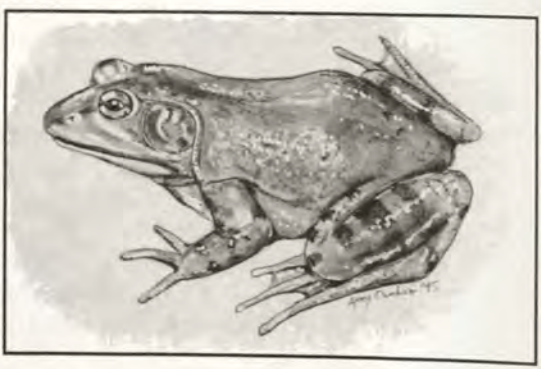
Up close the peeper is a delicate tree frog one inch (2.5 cm) in length. Its back is marked with a brown or reddish brown X pattern on a light background of tan or beige. Its long toes are tipped with suction pads. The Spring Peeper can be distinguished from the Wood Frog by the difference in size (the Wood Frog is roughly twice as large), by the dorsal X marking, and by the absence of the black eye mask that is diagnostic of the Wood Frog.

IN THE ARBORETUM:

The Spring Peeper breeds in every body of freshwater that will exist for the duration of the development of its tadpoles. In the spring, chorusing adult males can be heard at night throughout the wetlands of the Arboretum. At the peak of the breeding season in March, the choruses surrounding the Pond are loud enough to be heard across the street on the Connecticut College campus. To appreciate a chorus at close range, sit quietly beside the Pond shortly before dusk on an evening in late March or early April. If the nearest members of the chorus have become silent during your approach, remain motionless for several minutes and wait for them to resume singing. You will soon be surrounded by the enormous voices of these tiny frogs.

From late spring to early summer, individual adult Spring Peepers can be sighted occasionally in the woods (especially in the ravine area) during the day. They are perfectly camouflaged against the forest floor, however, and as a rule will be spotted only when they are flushed from underfoot. By the beginning of July, when the adults have taken refuge from the dry weather, tiny transforming peepers can be found in abundance near the drying bed of the ravine stream, among the grasses surrounding the rapidly shrinking Bolles Road pond, and near the edges of permanent bodies of water like the Pond (DeVito 1994).

BULLFROG -- *Rana catesbeiana*



The Bullfrog is native to permanent bodies of water in most of eastern North America, and has been relatively successful in developed areas (Klemens 1993). The Bullfrog is "an indiscriminate and aggressive predator" known to prey upon small vertebrates including fish, reptiles, amphibians and small

birds in addition to its usual fare of insects, spiders, crayfish, and snails (DeGraaf and Rudis 1983, Tyning 1990).

The Bullfrog is the largest frog found in the Arboretum. Individuals of this species can reach a body length of seven inches (17.5 cm), (Tyning 1990, Klemens 1993). The coloration of a typical Bullfrog is medium to dark green or olive. The legs are mottled with dark spots. At close range, the Bullfrog can be distinguished from the Green Frog by the ridges of flesh which start behind the eye, circle around the ear, and disappear at the shoulder joint. In the Green Frog, which otherwise closely resembles the Bullfrog, these ridges continue directly down either side of the back, ending near the hind legs.

The sexes are relatively easy to distinguish in large frogs such as the Bullfrog and Green Frog. In either of these species, the eardrum of the male is almost twice as large as that of the female (Behler and King 1979). In the absence of specimens of each sex for comparison, note that the eye and eardrum of the female are approximately the same diameter (Tyning 1990).

IN THE ARBORETUM:

The Pond provides an ideal habitat for the Bullfrog, one of the most easily spotted amphibians in the Arboretum. The highly adaptable Bullfrog is better suited to developed areas than many other frogs, but it is found only in permanent bodies of open water because its young spend several years as aquatic larvae (DeGraaf & Rudis 1983, Klemens 1993).

During a walk around the Pond, look closely at the surface of the water for the telltale pair of eyes that betray a frog as it sits motionless in the water. Listen for the distinctive call of the male Bullfrog from May to July, especially in the morning (DeGraaf and Rudis 1983). The call is characterized as a low-pitched "jug-o-rum" (Tyning 1990). The tadpoles of the Bullfrog are quite conspicuous and easily identifiable during their later stages of development, as they can reach a total length of more than five inches (14 cm) (Tyning 1990).

GREEN FROG -- *Rana clamitans melanota*

The Green Frog is a common, medium-sized aquatic frog found in eastern North America from the Florida Panhandle to extreme southern Canada (Tyning 1990). The tadpoles of the Green Frog sometimes transform during the year in which they hatch, so this species (unlike the Bullfrog) is able to breed in semi-permanent bodies of water (DeGraaf and Rudis 1983). The Green Frog, which is seldom found far from water, prefers running streams but is known to inhabit a wide variety of freshwater wetlands, from temporary woodland pools and streams to

large lakes and reservoirs (Tyning 1990). The species is highly adaptable, and has adjusted well to the alteration of wetlands in suburban areas (Klemens 1993).

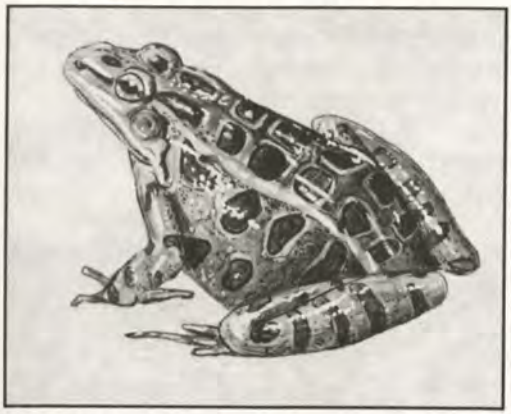
The typical adult Green Frog is six inches (15 cm) long, with a ground color of medium to olive green marked with brown or black spots on the sides and back, and dark stripes on the legs. The belly and throat are off-white or light gray. The Green Frog can be distinguished from the Bullfrog by the ridges of skin that extend from the ear of the Green Frog to the hind legs. In the Bullfrog, these ridges encircle the ear and do not extend along the back. As in Bullfrogs, the eardrum of the male is approximately twice the size of his eye, while the eardrum of the female is approximately the same size as her eye (Tyning 1990).

IN THE ARBORETUM:

The Green Frog is commonly encountered along the edge of the Pond, where it hides in very shallow water along the shoreline, with only its eyes and the tip of its snout protruding above the surface of the water. Listen for chorusing males from late April to August; the call of the Green Frog sounds distinctly like the plucking of a banjo string.

A walk along the ravine stream during the summer will often flush several Green Frogs from their resting places along the bank. In early July, look for an abundance of newly transformed Green Frogs along the drying ravine streambed, especially in the section of the stream just north of Gallows Lane. The Green Frog has also been seen in the stream flowing through the wildflower garden, and it is known to breed in the Bolles Road Pond (Pierce et al. 1984, DeVito 1994).

PICKEREL FROG -- *Rana palustris*



The Pickerel Frog is found in riparian habitats across eastern North America and southern Canada except in the extreme southeastern U.S. and most of Illinois (Conant 1975, Klemens 1993). The species inhabits cold lakes and ponds, streams and quarry pools (DeGraaf and Rudis 1993). The Pickerel Frog is sensitive to pollution and does not do well in disturbed wetlands where shoreline vegetation has been removed (Klemens 1993).

The Pickerel Frog is a medium-sized frog up to three inches (7.5 cm) long. The coloring of the species is characterized by symmetrical rows of dark brown square spots on a tan or grayish background. The underside is white, and the inner surface of the thigh is marked with bright yellow-orange pigment.

IN THE ARBORETUM:

The Pickerel Frog is common in the ravine, where it hides in shaded areas along the stream and in cool, damp crevices in the granite of the ravine wall. It breeds in the ravine stream, in the Pond, and probably in temporary pools and quarries throughout the Bolleswood Natural Area and the Goodwin Tract (DeVito 1994, 1995). Pierce et al. (1984) listed the Pickerel Frog among the species known to breed in the Bolles Road Pond, but no calling males were heard at this pond during a survey conducted during the 1995 breeding season (DeVito 1995).

The low-pitched snoring call of the male Pickerel Frog can be heard in breeding areas from late April through the end of May (Klemens 1993). This call is made while the frog is completely submerged, so calling males usually cannot be seen (Behler and King 1979). Throughout the summer, adult Pickerel Frogs can be found within several meters of the ravine stream. Look carefully along the shoreline of the Pond in the middle of July, when the tiny, newly metamorphosed young are emerging from the water.

Note: The Pickerel Frog is protected from most of its potential predators by a toxic skin secretion. While the secretion is not harmful to human skin, it can be deadly to other amphibian species (DeGraaf and Rudis 1983). When collecting in the field or caring for laboratory specimens, do not allow other amphibians to come in contact with Pickerel Frogs.

WOOD FROG -- *Rana sylvatica*

The Wood Frog inhabits both pristine and disturbed moist woodlands and tundra from the northeast quarter of the United States to northern Canada and Alaska; the range of this hardy species even extends above the Arctic Circle (Tyning 1990). The Wood Frog is often found far from water in late summer after vernal pools have dried (DeGraaf and Rudis 1983).

The Wood Frog breeds in ponds, temporary and semi-permanent pools, and slow-moving streams (DeGraaf and Rudis 1983). The breeding season consists of a brief period of approximately a week in mid-March (DeGraaf and Rudis 1983, Klemens 1993). Outside the breeding season, the Wood Frog is found on the forest floor, usually in the leaf litter.

The typical adult Wood Frog is two inches (5 cm) long, with an upper body color ranging from light tan to reddish brown, and with a light-colored belly and dark bands on its hind legs. The distinguishing fieldmark of the species is the dark mask around its eyes. With its cryptic coloring, a Wood Frog sitting upon leaf litter is nearly invisible until flushed from its hiding place.

IN THE ARBORETUM:

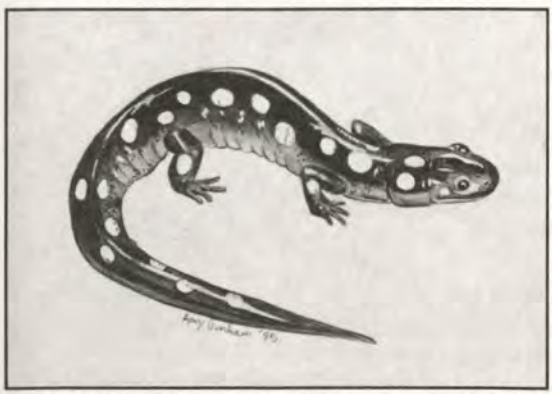
The breeding season of the Wood Frog in the Arboretum often occurs during the second two weeks in March, corresponding with the Connecticut College spring break. During this time, the distinctive hoarse "quack" of the male can be heard in breeding pools throughout the Arboretum and large, intensively active aggregations of calling males can be seen (Robert Askins, pers. comm.). The Wood Frog breeds in the Pond, the Bolles Road Pond, the Caroline Black Garden Pond, the ravine stream, the bog, and in temporary pools and quarry ponds throughout the Goodwin and the Bolleswood Natural Areas (Pierce et al. 1984, Pierce and Harvey 1987, DeVito 1994).

Look carefully along the ravine stream as it begins to dry up in early July, and the newly metamorphosed Wood Frogs emerge from the water and begin to disperse. Throughout the spring and summer, watch for hopping Wood Frogs as you walk through the leaf litter along the ravine stream and in other forested areas. If a frog jumps out of your path, stand still and try to identify its landing spot, as it will sit motionless in an attempt to conceal itself until it is again pursued or disturbed.

SALAMANDERS

SPOTTED SALAMANDER -- *Ambystoma maculatum*

Like other members of the mole salamander family, the Spotted Salamander spends most of its time buried underground, emerging to travel only during the breeding season (DeGraaf and Rudis 1983). The range of the species includes most of eastern North America north of Florida. Although the Spotted Salamander is relatively common, populations appear to be declining due to several factors, including habitat destruction (and the consequent increase in adult mortality during migrations), and the susceptibility of the eggs and larvae to the effects of acid rain (DeGraaf and Rudis 1983, Tyning 1990).



Mass migrations of adult Spotted Salamanders to breeding pools occur in March or April, usually during the first steady evening rainstorm above 40° F (5° C) (DeGraaf and Rudis 1983, Tyning 1990). This salamander normally breeds in temporary pools to avoid predation of larvae by fish (DeGraaf and Rudis 1983).

At up to nine inches (25 cm) in length, the Spotted Salamander is the largest salamander found in the Arboretum. The species is easily identifiable in Connecticut, where no other salamander shares the brilliant pattern of yellow spots on a black body.

IN THE ARBORETUM:

The Spotted Salamander is known to breed in the Bolles Road pond, in the ravine stream north of Gallows Lane, in rock quarry pools throughout the Bolleswood Natural Area, in the Pond (despite the presence of fish) and in most temporary pools large enough to hold water until the larvae begin to transform in mid-July (Pierce and Shayevitz 1982, Klemens 1993, DeVito 1994). Look for the large, round, greenish egg masses of the Spotted Salamander in these areas during the spring. The plump, dark brown larvae can be found as they near the age of transformation in early summer, when they reach a length of at least two inches.

Adults are usually buried out of sight in forested areas, and are only visible during the spring migrations, when they may be seen on rainy nights crossing Gallows Lane. Occasionally, an adult can be exposed by turning over a deeply imbedded log or rock. Adults have been found in the Williams Tract, under rotten logs in the white plantation northwest of the riding stables during the spring and summer (DeVito 1994, Joseph Markow, pers. comm.).

Note: Please keep in mind that the undersides of fallen logs and rocks provide delicate microhabitats that support a variety of life forms on the forest floor. Overturned objects should always be replaced carefully after they have been examined.

MARBLED SALAMANDER -- *Ambystoma opacum*

The Marbled Salamander is native to the southeastern United States north of Florida, but the range of the species extends northward to the mid-Atlantic states and southern New England (Tyning 1990). The Marbled Salamander is one of the most elusive--and probably one of the least common--salamanders in the Arboretum. This relatively uncommon species inhabits dry, sandy soils and rocky slopes of deciduous woodlands, where it spends most of its life underground (DeGraaf and Rudis 1983, Klemens 1993).

Unlike most amphibians, the Marbled Salamander breeds in the fall. The annual migration to breeding pools takes place in September and October, and the young are left to hatch and develop throughout the winter (Tyning 1990). The Marbled Salamander breeds in the same temporary pools used by the Spotted Salamander, but the larvae of the two species avoid competition by using the pools in different seasons.

The Marbled Salamander has the stocky build that is characteristic of the mole salamander family, but the adult reaches only four inches (11 cm) in length. The distinctive dorsal color pattern of the Marbled Salamander is a series of white crossbands on a black body. The white markings of the female are not as bright as those of the male (Tyning 1990).

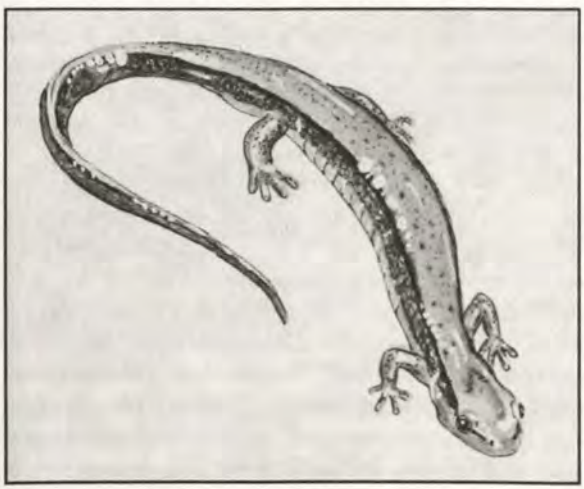
IN THE ARBORETUM:

The Marbled Salamander is known to breed in the Bolles Road Pond (Pierce et al. 1984). It probably uses many other temporary bodies of water in the Arboretum, and it may also breed in the Pond. The larvae of the Marbled Salamander can be identified by the time of year at which they are found. By the end of May, when the eggs of other amphibian species are just beginning to hatch, the Marbled Salamander larvae are ready to transform.

The adult Marbled Salamander is unlikely to be encountered except during the fall breeding season, when it can be found under leaf litter in a partially evaporated temporary pool (Tyning 1990). The female may even be discovered guarding her eggs until the pool fills with water (Klemens 1993). In the Arboretum, breeding adults and females with eggs can be found under leaf litter in the dried Bolles Road Pond in the fall, before it begins to refill with the autumn rains (Benjamin Pierce, pers. comm.). Newly transformed juveniles are abundant in the vicinity of the same pond in late May and early June (Benjamin Pierce, pers. comm.).

NORTHERN TWO-LINED SALAMANDER -- *Eurycea b. bislineata*

The northern subspecies of the Two-lined Salamander is found from Tennessee to the mouth of the Saint Lawrence River in Canada; other subspecies inhabit the southeastern U.S., with the exception of peninsular Florida (Conant 1975). The Two-lined Salamander is common along streams and springs and in seeps in moist woodlands throughout Connecticut (Klemens 1993). This species is seldom found far from water, and only ventures away from water in humid weather (DeGraaf and Rudis 1983). The Two-lined Salamander may actually benefit from development by taking over resources used by the Dusky Salamander, which is more sensitive to habitat disturbance (Klemens 1993).



In contrast to the related Redback Salamander, which prefers upland habitats, the Two-lined Salamander is normally encountered under logs and

stones imbedded in wet soil adjacent to a stream or other water source. The species deposits eggs in streams during May and June. The aquatic larvae do not transform until their second or third year (DeGraaf and Rudis 1983).

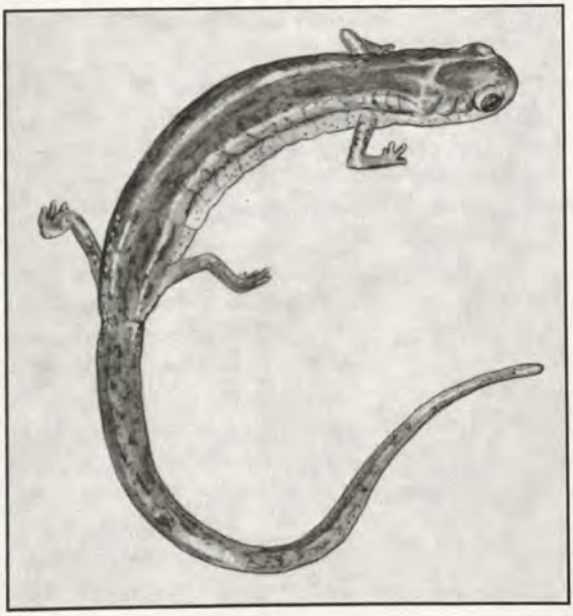
The slender, streamlined adult Two-lined Salamander is approximately three inches (7.5 cm) long. The body is yellow with a dark longitudinal stripe along each side of the back. A Two-lined Salamander, once exposed, will spring into action and wriggle quickly toward the safety of the water.

IN THE ARBORETUM:

The Two-lined Salamander is common in the Arboretum, although not as widespread as the Redback Salamander. Look for this species under wet logs along the ravine stream, especially south of Gallows Lane. Be sure to carefully replace the logs after looking under them. The two-lined has also been seen in the Matthies Tract, at the edge of a spring that empties into the Thames River (DeVito 1994). This salamander is quicker to escape than the redback, and you will find it considerably more difficult to hold on to. While both color morphs of the redback could be found under the same logs as the Two-lined Salamander, you can identify the two-lined by the speed with which it flees. If you did not get a chance to examine the color pattern of the salamander you uncovered, chances are good that it was a two-lined.

FOUR-TOED SALAMANDER -- *Hemidactylium scutatum*

The Four-toed Salamander is found from central Georgia and Alabama to southern Canada and west to Michigan and Wisconsin, with several disjunct populations outside this range (Conant 1975). This species is widespread but localized in southern New England, inhabiting low-lying forested areas with acidic soils (Klemens 1993). The nocturnal Four-toed Salamander is secretive and easily overlooked, so the species was thought to be rare in Connecticut until Klemens (1993) demonstrated that it is relatively common in many parts of the state. The Four-toed is now known to flourish on protected land and in moderately developed and semi-rural areas (Klemens 1993).



This species is found in and under moist rotted logs, under stones and among wet leaves in shaded areas with acidic soils

(DeGraaf and Rudis 1983, Markow 1993, DeVito 1994). The adult Four-toed is terrestrial, but the larva is aquatic. The species breeds in early spring and possibly in the autumn as well, depositing its eggs along the edge of a swamp, bog, or woodland pool (Klemens 1993).

The Four-toed Salamander, named for the absence of a fifth digit on its hind feet, is slower moving than the related redback, and close inspection of this species reveals several noticeable differences in physical appearance. The skin of the Four-toed Salamander is dry and granular, colored with red on the back, gray on the sides, and lighter gray on the belly. The entire body is speckled with black flecks which are particularly noticeable on the light belly. The tail of the Four-toed Salamander is constricted at the base. At a length of approximately 3 inches (7.5 cm), it is similar in size to the Redback and Two-lined Salamanders.

IN THE ARBORETUM:

A population of Four-toed Salamanders was discovered in the white pine plantation northwest of the riding stables in the Williams Tract (Markow, pers. comm., DeVito 1994). The Redback Salamander appears to be rare in this area, possibly due to the dryness or acidity of the soil. This lack of competition with the more aggressive Redback Salamander could explain the success of the Four-toed in such areas (Joseph Markow, pers. comm.). Look for the Four-toed Salamander under rotting logs in the plantation and in other habitats that appear suitable for the species. Please report any sightings of this species outside the locality noted above to the Arboretum Office.

REDBACK SALAMANDER -- *Plethodon cinereus*

The common and well-known Redback Salamander is found in eastern North America, along the coast from Virginia northward to southeastern Canada and westward to the Great Lakes states, with an additional isolated population in Missouri (Tyning 1990). This species inhabits mixed deciduous and coniferous uplands throughout this area, and it is often encountered under woodpiles and boards in wooded backyards.

The Redback Salamander is entirely terrestrial; its eggs hatch into fully developed juvenile salamanders that are tiny replicas of the adults (Klemens

1993). Individuals of this species spend most of their time under the cover of leaf litter and debris, but they emerge occasionally to forage above ground at night, especially during rain (DeGraaf and Rudis 1983). During these excursions, Redbacks have been known to climb small trees and shrubs in search of insects (Tyning 1990).

The Redback is approximately three inches (7.5 cm) long, and comes in two colors. The "redback" or striped morph is a coal-gray salamander with a brick-red longitudinal stripe along the back, and the less common "leadback" morph is entirely coal-gray above. The bellies of both morphs are light gray peppered with dark gray. Both morphs belong to the same interbreeding population, but the leadback is less cold tolerant, and is therefore usually absent from cold upland areas (Klemens 1993).

IN THE ARBORETUM:

Both Redback color morphs are common throughout the Arboretum, except in dry pine plantations, where they appear to be replaced by the Four-toed Salamander (Joseph Markow, pers. comm., DeVito 1994). The Redback can be found by overturning logs and rocks in the Bolleswood Natural Area, in the Niering Tract, in the Goodwin Tract north of Gallows Lane, and in the mixed woods of the Avery and Matthies tracts on the east side of Mohegan Avenue. Terrestrial salamanders are more difficult to locate when the ground and fallen logs are saturated after heavy rain, (when they have emerged to hunt in the leaf litter), and when the ground is extremely dry in midsummer (when they have taken cover by burrowing farther underground).

RED-SPOTTED NEWT -- *Notophthalmus v. viridescens*

Throughout most of its range, which includes the eastern U.S. and southeastern Canada, the Red-spotted Newt has an unusual three-stage life cycle (Tyning 1990). The newt spends its first summer as an aquatic larva. The larva then transforms into a terrestrial Red Eft, which wanders far from water for several years. This allows the species to take advantage of aquatic environments in other areas (Tyning 1990). The Eft returns to the water when it is ready to enter the final stage of its life as an aquatic adult.

The upper half of an aquatic adult Red-spotted Newt is light olive green, with a few small red spots. The underside is yellow, and the entire body is covered with tiny black spots. The newt can attain a length of four inches (10 cm), half of which consists of the partly transparent, tadpole-like tail. The male Red-spotted Newt is larger than the female. His hind legs and the base of his tail are thicker, and his hind legs and toes are edged with small black growths (Tyning 1990).

The juvenile Red Eft ranges in color from pale orange to bright red-orange, and its underside is tinged with yellow. As in the adult, the body is covered with black spots, and the sides are spotted with red ringed in black. The shape of the body bears some resemblance to that of the aquatic adult, but the Eft is somewhat smaller. The conspicuous coloring of the Red Eft is a warning sign; it is protected from most predators by toxic skin secretions that are lethal when ingested (DeGraaf and Rudis 1983).

IN THE ARBORETUM:

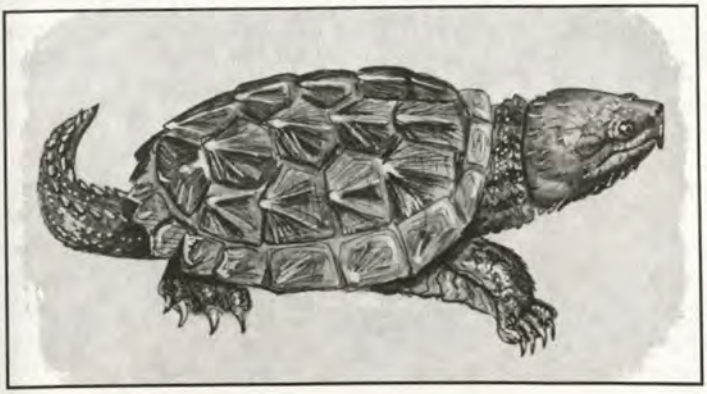
Look for Red-spotted Newts in the Pond, in shallow areas where the glare on the Pond surface is reduced and you can see straight through the water to the bottom of the Pond. At first glance, a newt will appear to be a leaf or stick resting on the mud. Be suspicious of any newt-sized object and examine it carefully. Your search will end in success when the outline of the animal becomes clear or when the "object" wriggles away to safety.

Red Efts can be found hiding in and under damp logs or leaf litter in all wooded parts of the Arboretum. They have been seen under cover in the hemlock and deciduous forest of the ravine area, in the red maple swamp, in the white pine plantation northwest of the riding stables, in the vicinity of the ravine stream north of Gallows Lane, and near the Bolles Road Pond. Efts have also been seen walking on leaf litter in the ravine area during the morning, after heavy rains in early summer (Robert Askins, pers. comm.).

TURTLES

COMMON SNAPPING TURTLE -- *Chelydra s. serpentina*

The adaptable Snapping Turtle has managed to survive among humans in urban wetlands in North America east of the Rocky Mountains, even maintaining a population in a site as highly disturbed as Central Park (Klemens 1993). The Snapping Turtle spends most of its life underwater, camouflaged and mostly buried in the muddy bottom, where the turtle is protected from humans and disguised from its prey. The diet of the species consists mainly of fish, crayfish, other small animals, and plant matter (DeGraaf and Rudis 1983).



The Snapping Turtle is the largest freshwater turtle in Connecticut; the shell

alone normally reaches a length of 10 inches (25 cm). One Common Snapping Turtle from Minnesota had a carapace length of 19.5 inches (49.5 cm) and weighed 67 pounds (30.4 kg) (Gerholdt 1986). The species is also considerably long lived; it has been known to attain to an age of at least 47 years (Tyning 1990). The adult Snapping Turtle is readily identifiable by its large size, enormous head, long legs and tail, and the jagged rear edge of its shell. The flesh on the underside of the turtle is largely exposed; this can be a key factor in identifying a juvenile of the species. While the carapace of the adult is relatively smooth, the upper shell of the juvenile Snapping Turtle is roughly textured, with a series of raised ridges and a jagged edge.

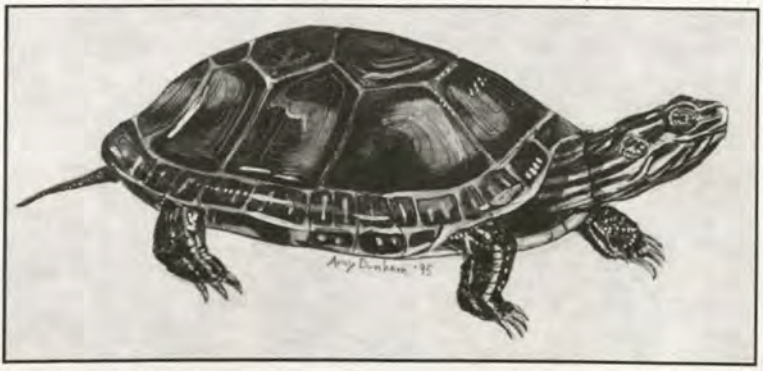
IN THE ARBORETUM:

In the middle of the Pond, a suspicious piece of driftwood moves slowly and deliberately through the emergent vegetation. It submerges, then reappears at the surface of the water in a new location. Careful observation may confirm that the driftwood appears to have a head and body, and that it moves more like a carefully guided submarine than a floating log. When the driftwood finally disappears for good, you might decide that you have just watched a full-grown Snapping Turtle explore its surroundings. Your eyes, however, may never be convinced that you saw anything but a log.

Another trip to the Pond may reveal a more conspicuous adult Snapping Turtle basking on a large rock in the middle of the water. Adult females have been seen on the trails around the Pond in May, and laying eggs in the conifer collection in June (Robert Askins, pers. comm.; Wendy Dreyer, pers. comm.). Hatchlings and young snappers should therefore also be present in the Pond, spending most of their time buried in the mud in shallow water.

PAINTED TURTLE -- *Chrysemys p. picta*

The Painted Turtle inhabits a wide belt across the northern half of the United States; its range extends southward to the Gulf of Mexico in the Mississippi River Valley (Tyning 1990). The eastern subspecies, which is found in the Arboretum, ranges from extreme southeastern Canada to Alabama in a narrow margin along the Atlantic coast (Conant 1975). The Painted Turtle is almost exclusively aquatic; it feeds and sleeps underwater, normally emerging only to bask on partly submerged rocks, logs, or debris, from which it immediately dives to take cover underwater when threatened. A Painted Turtle will only



spend a significant amount of time on land to lay eggs or to migrate to another body of water. The species prefers permanent bodies of water, and it thrives even in disturbed wetlands as long as there are cleared areas to use as nesting sites nearby (Klemens 1993).

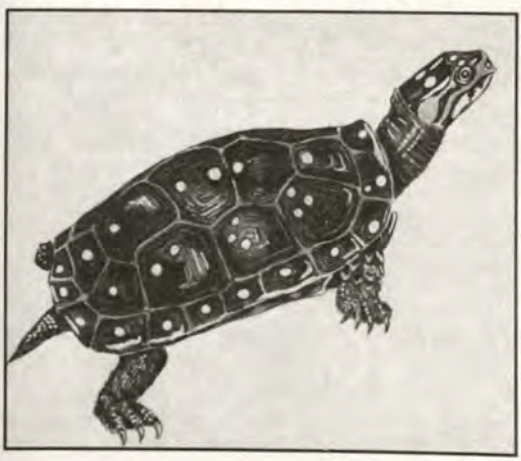
The adult Painted Turtle is eight inches (20 cm) long, with an olive colored upper shell marked with brightly colored patterns of red and yellow. The head, legs, and tail are dark green with longitudinal red and yellow stripes. The underside is yellow with a reddish tinge. The body shape of the male is oval, while that of the female is more rounded. The male has claws that are considerably longer, and the underside of his shell is concave, while that of the female is flat.

IN THE ARBORETUM:

The Painted Turtle is a well-established resident of the Pond. Rolland (1977) estimated that the population numbered 42 individuals in the mid-1970s. I suspect that there were considerably more than 42 Painted Turtles in 1995, as I saw as many as 30 turtles basking simultaneously. Painted Turtles, along with other animals of the Pond, are more easily observed in April and May, after the temperature has become favorable for basking and before the emergent vegetation obscures visibility in many areas of the Pond.

Approach basking turtles slowly and silently. They are easily startled and are especially wary when basking near the shoreline. Bring binoculars to observe turtles that are exposed on rocks in the middle of the Pond, where they do not feel threatened by the presence of humans on the shore. When a turtle dives into the water, watch patiently for its return to the surface. Almost invariably, a moment later its head will break the surface of the water several yards away. It will survey its surroundings, dive again, and resurface nearby. Only after several of these attempts will it leave the area. If you can manage to conceal yourself while keeping an eye on the turtle's position, it may re-emerge to bask while you are still at close range.

SPOTTED TURTLE -- *Clemmys guttata*



The Spotted Turtle inhabits a wide variety of shallow water environments in lowland areas around the Great Lakes and along the Atlantic coast from northern Florida to southern Maine (Ernst et al. 1994). This species is found in streams with muddy bottoms, red maple swamps, bogs, temporary and permanent ponds, quarry pools, and the marshy areas of lakes. Unfortunately, wetlands such as these are often drained and fragmented by development, leaving many Spotted Turtle populations without suitable habitat (Klemens 1993).

Like most small semi-aquatic turtles, the Spotted Turtle is omnivorous. This species mainly feeds on crustaceans, mollusks, insects, earthworms, and other invertebrates; small amphibians and vegetable matter are taken occasionally (DeGraaf and Rudis 1983). Spotted Turtles are active during cool weather, especially in the spring (Ernst et al. 1994). They nest in June in open sand or gravel areas, in pastures and on tussocks in bogs (Tyning 1990, Klemens 1993). The Spotted Turtle spends the hottest part of the summer under water, buried in mud and vegetation (Ernst et al. 1994).

This small turtle is five inches (12.5 cm) long, with a color pattern of yellow spots scattered on a dark olive-colored shell. The female Spotted Turtle has a light-colored lower jaw and reddish eyes, while the male has a dark lower jaw and brown eyes (Tyning 1990).

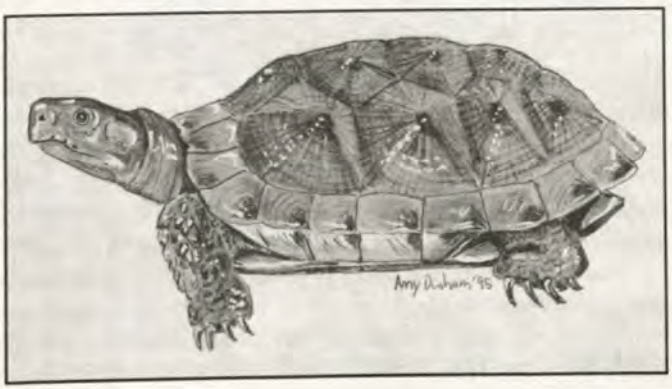
IN THE ARBORETUM:

The Spotted Turtle has been found in the vicinity of the Bolles Road Pond (Benjamin Pierce, pers. comm.). This species also inhabits the red maple swamp adjacent to the ravine stream north of Gallows Lane; adults have been seen migrating across Gallows Lane in June, and young have been killed crossing the same road (Wendy Dreyer, pers. comm.). The Spotted Turtle was also seen in the Pond until several years ago (Robert Askins, pers. comm.). It is possible that the 1992 draining and dredging of the Pond disturbed the population in that location.

Spotted Turtles can be seen basking on sunny days in spring, but they are particularly wary and will probably have to be identified at long range. Spotted Turtles and small Painted Turtles are not distinguishable from a distance, so always bring binoculars to watch turtles in the Pond. If Spotted Turtles are seen in this area, please report sightings to the Arboretum Office.

WOOD TURTLE -- *Clemmys insculpta*

The Wood Turtle is found in woodlands and meadows along the floodplains of rivers and streams (Klemens 1993). Its range includes the east coast from northern Virginia to southern Canada, and the Great Lakes region (Tyning 1990). This species is usually found near water, but in the summer it wanders away from wetlands to forage in pastures, old fields, and woodlands (Klemens 1993).



This long-lived turtle is not sexually mature until its 14th year, and natural mortality of young is high, so the conservation of adult Wood Turtles is essential to the success of the species (Ernst et al. 1994). This requires the protection of extensive

tracts of land, as the home range of each turtle is relatively large, covering up to a mile (0.6 km) of river shoreline (Tyning 1990, Klemens 1993). The Wood Turtle mates in the spring and sometimes in the late fall, and nests in areas with soft loam or sandy soils (Tyning 1990).

The omnivorous Wood Turtle consumes a variety of terrestrial and aquatic organisms including vegetation, berries, invertebrates, tadpoles, and fish (Tyning 1990). This turtle is known for its intelligence, which is comparable to that of the laboratory rat (Tyning 1990).

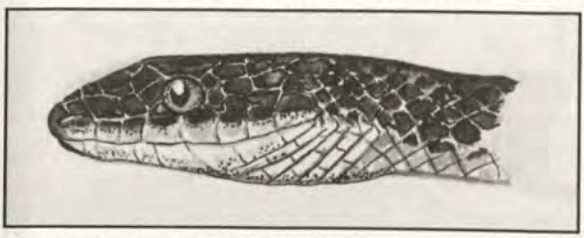
The Wood Turtle is medium sized, approximately 9 inches (22.5 cm) long. Its distinguishing characteristic is the three-dimensional texture of its shell, which is brown above and marked by raised concentric rings. The bottom shell is yellow, and the skin of the neck and legs is marked with burnt orange. As in most turtle species, the male has a longer tail, a concave bottom shell, and long, curved claws to facilitate mating.

IN THE ARBORETUM:

The Wood Turtle has been sighted along the bank of the Pond in the spring (Jennifer Lynch and Paul Fell, pers. comm.). It may inhabit other areas of the Arboretum as well; the ravine stream/red maple swamp area north of Gallows Lane appears to be a particularly suitable habitat for the species. If the Arboretum supports a reproducing Wood Turtle population, it may be a valuable refuge for this relatively rare turtle. Please report any sightings of this species to the Arboretum Office.

SNAKES

NORTHERN BLACK RACER - *Coluber c. constrictor*



The Racer, *Coluber constrictor*, is widespread throughout much of the United States, with the Northern Black Racer (*C. c. constrictor*) subspecies ranging from Maine to the deep south on the Atlantic coast (Behler and King 1979). The Racer can be found in a wide variety of habitats from grasslands to upland forests.

This active, diurnal snake preys upon insects and a variety of vertebrates including small mammals, birds, reptiles, and amphibians (DeGraaf and Rudis 1983). The Racer lays eggs under cover of loose soil, rocks or rotting logs from June through August.

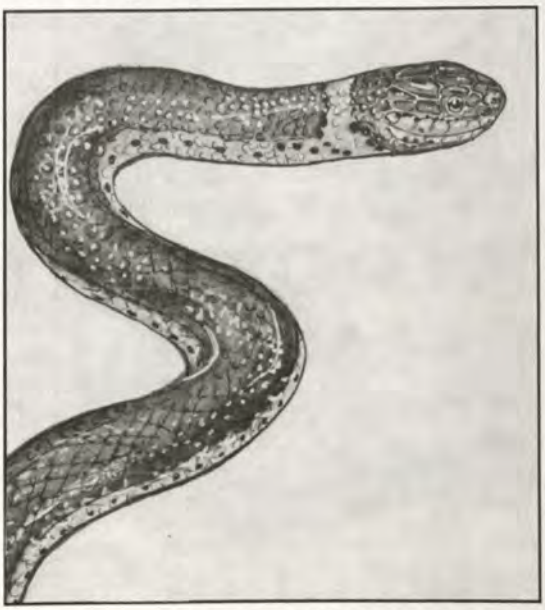
The Northern Black Racer is a smooth-scaled, slender snake up to 6 feet long (180 cm). It is completely black, except for a white patch under the chin. The Black Rat Snake, by contrast, has rough scales, is heavy bodied and has a white belly. Juvenile Northern Black Racers are gray with a pattern of red or brown blotches.

IN THE ARBORETUM:

A Northern Black Racer was spotted on the gas pipeline right-of-way east of Bolles Road on a sunny summer afternoon (Joseph Markow, pers. comm.). Black Racers travel swiftly during the heat of the day, sometimes with the head raised above the ground for better visibility. A brief chance encounter with an active Racer is a rare treat. On cool mornings, look for Black Racers under logs, boards, and other debris. Be prepared for a surprise, however, as Racers (as well as other harmless snake species) are known to sometimes rustle leaves with their tail, in imitation of the warning sound of a Rattlesnake (Behler and King 1979).

Warning: If you are lucky enough to get close to a Racer, it is best to resist the temptation to handle it, as racers are inclined to bite, sometimes repeatedly, in self defense.

NORTHERN RINGNECK SNAKE -- *Diadophis punctatus edwardsii*



The northern subspecies of the Ringneck Snake ranges from the Great Lakes states to the East Coast, and from the mid-Atlantic states north to southern Canada, and inland in the southeast to northern Georgia and Alabama (Conant 1975). This secretive snake is found in a wide variety of habitats including ravines with hemlock cover, rocky wooded hillsides and backyard gardens (Conant 1975, Klemens 1993).

The Ringneck Snake prefers to inhabit areas where hiding places such as logs, stones and debris are abundant (Conant 1975). This species is nocturnal and is seldom found exposed during the day (DeGraaf and Rudis 1993). Redback Salamanders and other amphibians comprise the bulk of the diet of this snake, but other small animals are taken occasionally (Klemens 1993). The Ringneck lays its eggs in and under rotted wood in June and July (DeGraaf and Rudis 1983).

The small, slender Northern Ringneck Snake reaches one foot (30 cm) in length, and is characterized by the complete yellow collar that rings the base of its neck. The back of the snake is slate blue or dark gray, and the belly is uniform yellow.

IN THE ARBORETUM:

The Ringneck Snake has been sighted on the laurel walk and in the vegetable garden at 61 Gallows Lane (Craig Vine, pers. comm., Wendy Dreyer, pers. comm.). It is probably

found throughout the Arboretum, where suitable habitats and food sources are abundant. You would be very lucky to experience a rare encounter with the Ringneck above ground during the day, but you could increase the chances of finding a specimen by turning over logs and debris in areas where Redback Salamanders and other potential prey are abundant.

BLACK RAT SNAKE -- *Elaphe o. obsoleta*

The Black Rat Snake ranges from the East Coast to central Kansas and Oklahoma, and from central Michigan to the middle of Georgia; locally, the species is found in the southern half of New York and in southern New England (Conant 1975). This large snake prefers rugged, forested terrain with rocky ledges, so the destruction of ledges by quarrying has had a negative effect on Rat Snake populations (Klemens 1993).

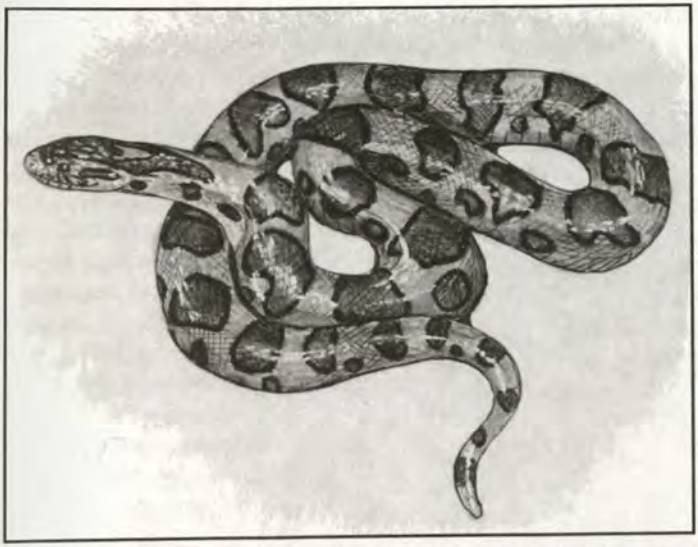
This snake mainly feeds upon rodents and birds, which it kills by constriction. The Rat Snake hunts for prey in a variety of habitats including woodlands, thickets, farmlands, and rocky hillsides (DeGraaf and Rudis 1983). The eggs of the species are laid during July and August, in loose soil, decaying wood, manure, and sawdust piles.

The heavy-bodied Black Rat Snake is up to six feet (180 cm) long. The upper half of the adult snake is shiny black and the belly is white. This species is sometimes confused with the Black Racer, which is black both above and below, except for a white patch under the chin. Young Black Rat Snakes are gray, patterned with brown or dark gray saddles along the back (Conant 1975).

IN THE ARBORETUM:

A Black Rat Snake was found in a flowerbed at 61 Gallows Lane in mid-summer, and a snakeskin belonging to this species was collected in the basement of the same house during the winter (Wendy Dreyer, pers. comm., Jeffrey Smith, pers. comm.). To increase your chances of seeing this and other snake species, look carefully along stone walls and rock ledges as you walk through the Arboretum, and peek under boards and other large pieces of debris that could provide convenient hiding places. When you walk through tall grass or pass by shrubby vegetation or leaf litter, always remember to look quickly when you hear a suspicious rustling noise. Snakes can be flushed from their hiding places, but they are always quick to disappear again.

EASTERN MILK SNAKE -- *Lampropeltis t. triangulum*



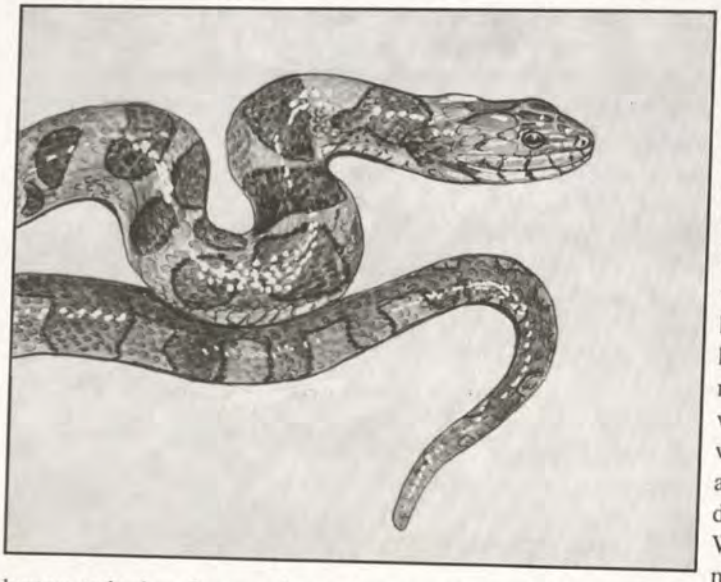
The Milk Snake is widespread in North America, ranging from the East Coast west to the Rocky Mountains and south through eastern Mexico to northern South America (Tyning 1990). The eastern subspecies is found from southeastern Canada and New England west to southern Minnesota and south to West Virginia (Conant 1975). The Milk Snake, which prefers open habitats, is not sensitive to development as long as food remains plentiful. It may be threatened, however, by the widespread reforestation of old fields (DeGraaf and Rudis 1983). The Milk Snake is common around buildings in rural areas and in suburban vacant lots, where it forages for rodents, which it kills by constriction (Klemens 1993). Birds, fish, and some invertebrates are also taken occasionally (Tyning 1990).

The Milk Snake normally hunts at night and occasionally basks during the day, although rarely in the open. In early summer, the Milk Snake deposits its eggs under boards or logs, or in wood chip piles, compost, or sand, sometimes in communal egg-laying sites (Tyning 1990). This slender snake can reach a length of three feet (90 cm). It is colored with a striking pattern of reddish saddles on a background of cream or tan. The belly is white with scattered black markings.

IN THE ARBORETUM:

The Milk Snake has been seen basking on the rock wall at the main gate of the Arboretum, and crossing the dam at the Pond in the summer (Wendy Dreyer, pers. comm.). To increase your chances of encountering a Milk Snake, look carefully along stone walls and hedgerows, and overturn boards, debris, and other potential hiding places, especially in open fields and pastures. The corral adjacent to the college riding stables north of Gallows Lane appears to be a particularly suitable habitat for this and other snake species. Power line rights-of-way are also prime areas for field-dwelling snakes.

NORTHERN WATER SNAKE -- *Nerodia s. sipedon*



The Northern Water Snake is found in open water habitat throughout most of the eastern half of the United States (Tyning 1990). While this snake is nonvenomous and will not bother humans when left alone, many harmless Water Snakes have been killed when misidentified as the venomous cottonmouth water moccasin (Behler and King 1979). The diet of the northern Water Snake consists mainly of aquatic vertebrates: tadpoles, frogs, salamanders and fish, which it seizes and swallows, sometimes underwater.

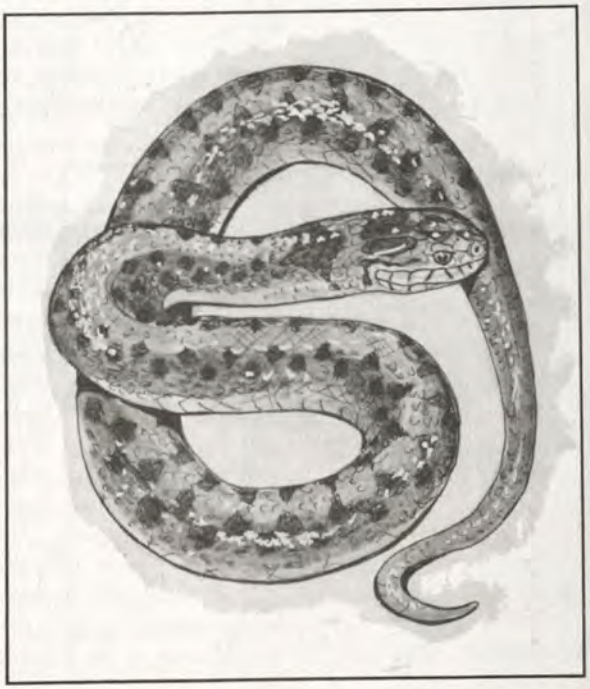
The Water Snake is a heavy-bodied snake up to five feet (150 cm) long, with a dorsal color pattern of reddish brown saddles edged with black, on a tan background. This pattern is distinctive in juveniles, but adults typically appear dull dark brown or gray between sheddings. Both adults and juveniles have belly scales of mottled white, black and bright red.

IN THE ARBORETUM:

The Northern Water Snake has established a successful population in the Pond. Both adults and juveniles are often found basking in warm weather, either lying motionless on the rocks adjacent to the Pond, or draped upon the branches of emergent woody vegetation. Look for a basking Water Snake camouflaged against the gray of the wall in front of the outdoor theater. You may find a cautious individual peeking through the cracks and drainage holes in the steps of the Outdoor Theater stage. On a sunny day, a careful search of the aquatic vegetation near the edge of the Pond may reveal the motionless heads of several juveniles poking out of the water, almost perfectly camouflaged in the emergent vegetation.

Warning: While a basking Water Snake may allow itself to be approached, handling of this snake is likely to induce a rather unpleasant defense mechanism. When disturbed, the Water Snake will secrete a foul-smelling liquid from its cloaca (the excretory and reproductive opening under the tail). Some individuals of this species may bite when provoked. The bite, while not dangerous, may draw blood.

NORTHERN BROWN (DEKAY'S) SNAKE -- *Storeria d. dekayi*



The northern subspecies of the Brown Snake thrives in disturbed habitats from South Carolina to southeastern Canada (Conant 1975, Klemens 1993). In rural areas this snake is found in damp woods, swamps, bogs, open fields, and clearings, and along railroad tracks; in more populated areas, it is encountered in vacant lots, trash piles, backyards, and gardens (DeGraaf and Rudis 1983).

The nocturnal Brown Snake may be active in the early morning, but it spends most of the day under the cover of brush, leaf litter, logs, or rocks (DeGraaf and Rudis 1983). The Brown Snake burrows deeper underground in midsummer to escape the heat. The diet of this species consists mainly of earthworms, slugs, and snails; insects, frogs, and fish are taken occasionally. The Brown Snake bears live young in late July and August.

The diminutive Brown Snake rarely exceeds a foot (30 cm) in length. The body is tan or grayish brown with a row of small dark diamonds along each edge of the back. The top of the head is dark. Young of this species may be confused with the Ringneck Snake, as they are gray with a light ring around the neck (Conant 1975). Keep in mind that the ring and belly of the Ringneck are yellow, while those of the young Brown Snake are white or light gray.

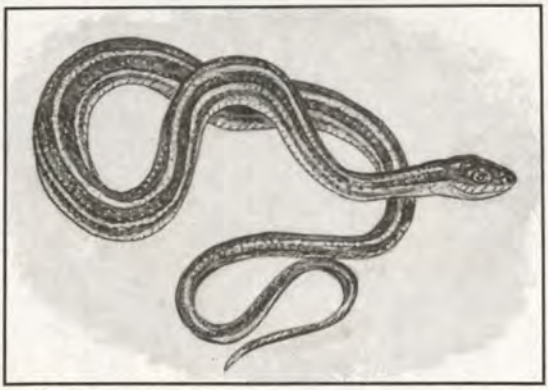
IN THE ARBORETUM:

The Brown Snake is docile and relatively slow moving, so it is a good species for examination at close range. Unfortunately for snake enthusiasts, the secretive habits of this species make it difficult to locate even in areas where it is quite abundant.

The Brown Snake is probably common throughout the Arboretum, especially in the more manicured areas. It has been sighted, for example, under lawn turf in the spring at 61 Gallows Lane (Wendy Dreyer, pers. comm.). Look for the Brown Snake under decorative logs and stones around plant collections, and watch for it in moist grassy or mossy areas, especially in the morning.

EASTERN RIBBON SNAKE -- *Thamnophis s. sauritus*

The eastern subspecies of the Ribbon Snake is found from southern Alabama and Georgia to southern Maine (Conant 1975). This semi-aquatic snake inhabits open, grassy or shrubby areas near shallow water even in disturbed areas (Klemens 1993). The Ribbon Snake is also found in damp deciduous and northern pine forest (DeGraaf and Rudis 1983).



This streamlined species is agile and quick to flee from danger, fooling predators with the motion of its yellow stripe as it heads for cover. The Ribbon Snake often hunts under the cover of vegetation during the day, feeding on small amphibians, young mice, minnows, and some invertebrates (DeGraaf and Rudis 1983). This snake bears live young from late July to September (DeGraaf and Rudis 1983).

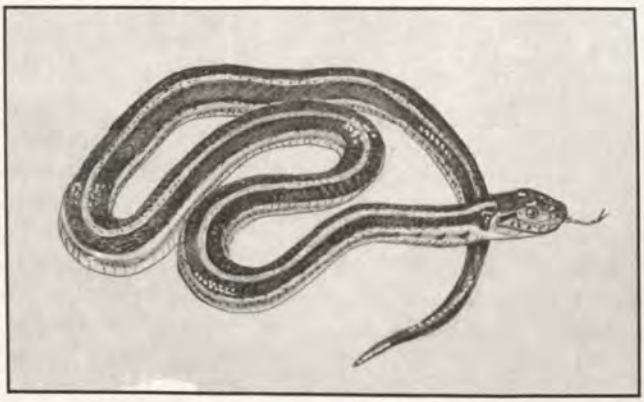
The Ribbon Snake is closely related to the Garter Snake, from which it can only be distinguished at close range. At two feet (60 cm) long, the Ribbon Snake is approximately the same length as the Garter Snake, but it is thinner than the garter, and the contrast between the solid bright yellow longitudinal stripe and the black body is more dramatic in the Ribbon Snake.

IN THE ARBORETUM:

The eastern Ribbon Snake has been seen at the edge of the yard at 61 Gallows Lane, which is surrounded by Arboretum land (Wendy Dreyer, pers. comm.). This individual had probably come from the ravine stream/red maple swamp area north of Gallows Lane. Ribbon snakes may also find suitable habitat and an adequate food supply along the ravine stream south of Gallows Lane and around the Pond.

EASTERN (COMMON) GARTER SNAKE -- *Thamnophis s. sirtalis*

The Eastern Garter Snake is the most common and widespread snake in North America; it is often discovered and recognized in neighborhood parks and backyards even in urban areas. The range of the species covers a wide variety



of habitat types across the eastern half of the United States and Canada, but the Eastern Garter Snake is most likely to be found near wetlands (Tyning 1990). This is probably due to its preference for moisture-loving prey items such as amphibians and earthworms. The Garter Snake bears live young from July to early September (DeGraaf and Rudis 1983).

The Eastern Garter is a small snake of medium build, attaining a length of approximately two feet (60 cm) (Conant 1975). The upper half of the snake is marked with a brown or olive and black checkerboard pattern with a central yellow longitudinal stripe and two smaller yellow stripes running along each side of the body. The underside is yellow or greenish with black spots along the sides of the belly scales. The female is generally larger, with a tail that is relatively short compared to that of the male (Tyning 1990).

IN THE ARBORETUM:

Watch for Garter Snakes on stone walls and listen for the rustling of their escape in tall grass almost anywhere in the Arboretum. Remember, however, that as a rule they are seen by accident. Actively hunting for Garter Snakes can be a frustrating experience, but it pays to keep your eyes open while walking or exploring in the Arboretum.

The Eastern Garter Snake can be an excellent subject for close observation, as it often chooses to freeze rather than flee in response to danger. Approach a basking garter slowly and quietly, and it will likely remain still until it knows that it has been detected. Garter snakes are more visible in early spring, when they spend much of their time in the open, basking in the sun and searching for mates (Tyning 1990). Look for sunning Garter Snakes along the rock walls adjacent to the Pond, especially in April and May. During the rest of the year, Garter Snakes are often discovered under boards, logs, and other debris.

Warning: When the common Garter Snake is captured, it will secrete a foul-smelling liquid from its cloaca (the excretory and reproductive opening under the tail). This species is also more aggressive than it looks, and may bite when handled.

INTRODUCED SPECIES

Laboratory specimens of the Leopard Frog, *Rana pipiens/Rana sphenocephala*, were once commonly released in the Pond. However, they do not appear to have established a breeding population in the area. This could be due to the fact that the Leopard Frog has a very low tolerance for acidity, with 100% mortality of embryos occurring in egg masses subject to pH 5 (Pierce 1985). It is highly unlikely that the Leopard Frog could successfully breed in the Arboretum, as the pH of the Pond was measured to be 5.1 in 1994, and nearby woodland pools are even more acidic (Pierce et al. 1984, DeVito 1994).

The Mudpuppy, *Necturus m. maculosus*, inhabited the ravine stream/red maple swamp north of Gallows Lane before the dam that prevented this area from drying in the summer was destroyed several years ago to prevent the flooding of Gallows Lane (Wendy Dreyer, pers. comm.). The completely aquatic Mudpuppy is not native to Connecticut, but university laboratory stock was introduced into the Connecticut River by the early 1920's (Klemens 1993).

An Eastern Box Turtle (*Terrapene c. carolinal*), was seen in the conifer collection on July 8, 1995 (Robert Askins, pers. comm.). This may have been a released pet. Box turtles are rare in Southeastern Connecticut and they are often kept as pets (Klemens, 1993).

The introduction of exotic species to the Arboretum is not allowed, even when the life of an animal can be "saved" by setting it free in the wild. If an introduced animal species is not adapted to an environment similar to that of the Arboretum, the released individuals will likely suffer needlessly and die. If an introduced species is capable of surviving in the Arboretum, the possible consequences are much worse. The introduction of new species to any ecosystem poses a potential threat to the resident organisms, and the possible danger to the native ecosystem far outweighs any perceived benefit to the individual or group of released animals. Newly established populations of foreign species compete with native animals for food, shelter, and breeding areas. Also, individual animals not native to the area can carry diseases to which they may be immune, but which could be deadly to the native species of the Arboretum.

RESEARCH ON AMPHIBIANS AND REPTILES IN THE CONNECTICUT COLLEGE ARBORETUM

Joseph Markow

The Connecticut College Arboretum contains coniferous and deciduous forests, scattered vernal pools, and intermittent streams that support many species of amphibians and reptiles. The variety of habitats in the Arboretum provides an ideal area for the study of wildlife and it has been used for numerous research projects on the physiology, breeding behavior, competition, distribution, and hibernation of amphibians and reptiles

Amphibians are often overlooked when considering the dynamics of forest communities despite their importance in the ecology of the forest floor. For example, in a study plot in a New Hampshire forest, the combined mass of all amphibians was greater than the mass of mammals and twice the mass of all birds in the area (Burton and Likens 1975). Reptiles are also more common in woodlands than most people realize. Their presence is often overlooked by woodland wanderers because they are silent, frequently motionless, and sometimes nocturnal; they can escape from view before we become aware of their presence. These animals, which are important predators, are sensitive to environmental change. They are worth protecting and studying.

The recent decline of amphibian populations in many parts of the world is alarming, and has focused attention on these animals. Scientists are struggling to understand what is causing so many species to decline or disappear. Possible causes of the problem include habitat loss, climate change, acid rain and other sources of pollution, regional changes in habitats, and excess solar ultraviolet radiation resulting from ozone depletion (Blaustein and Wake 1995, Phillips 1994, Pough et al. 1998, and Stebbins and Cohen 1995). In addition to the population declines, the United States has recently seen a wave of media coverage about deformities found in frogs. The majority of the reports are local newspaper articles, but Kaiser (1997) provides a scientific review of possible reasons for the apparent increase in the frequency of deformations.

This article is a summary of the results of several research projects conducted in the Connecticut College Arboretum during the past twenty-five years (1970-1995). The descriptions are arranged chronologically. Students and faculty have collaborated on these projects, some of which fulfill requirements for field biology courses, independent studies, or honors theses. These studies expand our information of the behavior and physiology of amphibians and reptiles and provide basic information on which species one can expect to find in the Arboretum and where to find them.

NAVIGATION BY MIGRATING SPOTTED SALAMANDERS

Robert Ballek, 1973

Large salamanders in the family Ambystomatidae generally migrate from year-round woodland sites to a temporary pool of water to breed. These vernal or ephemeral pools are present only in the spring following the thaw or in the late fall after heavy rains. Water collects in these depressions and may remain for a few weeks or up to a few months. These pools provide excellent conditions for reproduction of salamanders because they do not contain fish that would prey on salamander larvae. The larvae develop in the pools and transform into juvenile salamanders before the pool dries up.

Robert Ballek '73 investigated the navigational abilities of the Spotted Salamander, *Ambystoma maculatum*, in the Connecticut College Arboretum during his senior year (Hunter 1977). This salamander migrates in the spring after the first warm rain. Ballek set up a fence around the 2-acre Bolles Road pond, which is known to be a breeding site for amphibians. The 24-inch fence was buried six inches under the soil so the salamanders would not burrow under it when they intercepted the fence while migrating along the ground surface. The salamanders were forced to walk along the fence until they fell into one of the buried gallon cans (pitfall traps) next to the fence. Ballek checked these every morning and removed the salamanders, marked them, and released them on the other side of the fence. He kept a record of all individuals entering and leaving the pool and how long they remained in the vicinity of the pool.

Ballek was able to mark 55 individuals in the pitfall traps. He noticed that individual salamanders tended to exit the pool in the opposite direction from which they entered it. They may be returning to permanent shelter sites. Ballek investigated this by relocating 12 salamanders as they were leaving the pool. He spun them around and then placed them 90° to 180° off their original course and several meters away from the pool, to try to disorient them. Ten of the twelve relocated salamanders were captured after 9-42 days traveling in the direction of their year-round shelter site, suggesting that they have strong navigational ability. Some of these salamanders had encountered up to four stone walls and a few had passed through the breeding pool to continue in the direction that they had started prior to being relocated.

Olfactory cues are thought to be used for migrating to a breeding pool. Salamanders may be able to recognize scents in streamlets that lead to their particular breeding site. Although the mechanism of navigation back to the year-round site is a mystery, Ballek demonstrated the accuracy of the Spotted Salamander's directional skill and ability to overcome obstacles.

POPULATION ECOLOGY OF PAINTED TURTLES

Alma Rolland, 1975

In 1975, Alma Rolland '77 studied the population of Painted Turtles, *Chrysemys picta*, in the Connecticut College Arboretum Pond. In addition to her independent project report,

her findings were described in the Connecticut College Alumni Magazine (Rolland 1977). Rolland used basking traps and baited funnel traps to capture the turtles so they could be marked and information on each individual could be recorded. The basking trap was designed so that a turtle would climb onto a plank extending out of the water to bask and then become trapped in a cloth enclosure when sliding off the plank into the water. Four basking traps were scattered around the pond. Natural basking areas were fenced off to encourage use of the trap planks by turtles. The baited funnel traps were placed in shallow water, where turtles were lured into a cloth enclosure and then became trapped inside. The trap was only partly submerged to prevent drowning. The weight, sex, and length of each captured turtle was recorded. Notches were carved in the shell edge to mark the individual in such a way that it could be identified during that summer and possibly in future studies.

By marking individuals and then measuring the rate of capture of the marked and unmarked individuals, Rolland could estimate the number of the Painted Turtles in the pond. A total of 91 captures were made with the traps and by catching turtles with dip nets. Thirty individuals were captured and marked. Seventeen of these were recaptured, some several times, during the census. The population was estimated to be 42 individuals. There were equal numbers of males and females. The measurements of growth for marked individuals over the study period suggested that most growth occurred in the early summer at a rate of 1.5 mm/year. Most of the turtles were estimated to be older than 35 years. The size of the population was lower than expected (5 turtles per hectare), but this may be related to the shallowness of the pond, accessibility to nest sites, or human disturbance.

VARIATION IN PAINTED TURTLE IN CONNECTICUT

Michael W. Klemens, 1978

Michael Klemens studied Painted Turtles in Connecticut for his Masters dissertation at the University of Connecticut (Klemens 1978). He divided the state into 5 regions, and used the Connecticut College Arboretum Pond as one of his sampling sites for the eastern coastal region. The purpose of his study was to document the distribution of two subspecies of the painted turtle, *Chrysemys picta picta* and *Chrysemys picta marginata*, in Connecticut.

There are four subspecies of the Painted Turtle that evolved when populations were geographically isolated during the Wisconsin glacial period. Following the retreat of the glaciers, these populations spread and converged on each other. *Chrysemys p. picta* spread northward along the coastline, whereas *Chrysemys p. marginata* moved eastward through New York and Pennsylvania. The two subspecies met in New Jersey, New York, and possibly Connecticut.

The two subspecies are distinguished by the plastron (belly) color and the alignment and color of other shell segments. "Picta" has an immaculate yellow plastron, whereas the belly of "marginata" has a dark pattern over some or all of the segments. Klemens used the belly pattern and 12 measurements of the body of captured turtles to identify and study the

distribution of the two subspecies in this zone where they tend to hybridize. All the turtles were released following measurements.

Klemens identified a cline or gradual change in the characteristics of the turtle from west to east in Connecticut. The turtles in the northwestern and western portions of the state resembled the "*marginata*" subspecies, whereas the southern coast and areas east of the Connecticut River more closely resembled a "*picta*" subspecies with few or no "*marginata*" features. These observations were consistent with the hypothesis that "*marginata*" entered the state from the north and west, and "*picta*" entered from the south (Bleakney 1958). Klemens used turtles in the Arboretum Pond to provide evidence that helps us understand an event that began thousands of years ago, but happened at a very slow pace and still continues.

ACID TOLERANCE IN WOOD FROGS

Benjamin Pierce, 1984-1986

Benjamin Pierce, Professor of Zoology, and his students studied acid tolerance of Wood Frogs, *Rana sylvatica*, in the 1980s (Pierce and Harvey 1987, Pierce et al. 1984). He was concerned about the impact of increasingly acidic rainfall on Wood Frogs in New England. Acid rain is known to affect other amphibians; for example, low pH has reduced the reproductive success of Spotted Salamanders in New York (Pough and Wilson 1977).

Pierce collected eggs and water samples from the Bolles Road Pond in the Connecticut College Arboretum to use in his experiments (Pierce et al. 1984). The pH of the pond was monitored over the period of egg deposition and larval development from early March to late June. The eggs were artificially fertilized and placed in pond water solutions in which the pH had been changed. The development was monitored and considered successful if the egg hatched and a viable larva emerged. Larvae that were collected directly from the pond were also treated in different solutions with different pH. Pierce found that wood frog eggs were relatively acid tolerant and could withstand a pH as low as 4.0 without noticeable effects. Below 4.0, however, the eggs showed high mortality and many larvae that hatched were deformed. Larvae showed greater acid tolerance than the eggs, but this may have been a result of natural selection already having eliminated individuals from the pond that could not adjust to lower pH. Pierce and his students thought that this was unlikely, and hypothesized that as the embryo developed, its increased size acted as a buffer, making it more acid tolerant. They concluded that Wood Frogs were probably not in danger at that time because they tolerate low pH better than other species of frogs and salamanders (Table 1).

In another study, Pierce and Harvey (1987) investigated geographic variation in acid tolerance of Wood Frogs. Populations in New London County were compared with populations in Litchfield County. The alkaline nature of the pools in northwestern Connecticut, caused by calcareous bedrock, allowed Pierce and Harvey to compare acid tolerance of a population that rarely encounters acidic conditions with the New London population, which must deal with more acidic conditions. When eggs were artificially fertilized and

SPECIES	pH 100% MORTALITY	50% MORTALITY
WOOD FROG	3.5	3.5-3.9
AMERICAN TOAD	3.5-3.9	4.0-4.5
GREEN FROG	3.8	3.8-4.1
GRAY TREE FROG	3.8	3.9-4.3
NORTHERN SPRING PEEPER	3.8	4.0-4.2
BULLFROG	3.9	4.1-4.3
PICKEREL FROG	4.0	4.2-4.4
SPOTTED SALAMANDER	4.0-5.0	5.0-7.0

Table 1. Acid tolerance of some amphibian embryos (Pierce 1984).

placed in solutions of different pH, the developing embryos from the two locations responded similarly to the different levels of pH. There did not appear to be any variation that might be caused by genetic differences. In contrast, the response of larvae from the two regions differed. Larvae from Litchfield County were less tolerant of low pH, which is consistent with the alkaline nature of their environment. This is relevant to conservation efforts because generally a study at one location is used to form expectations about how a population in a different area will react to the same changes. Pierce showed the danger of assuming that all populations of a species will react in the same way to particular situations.

BASKING BEHAVIOR OF PAINTED TURTLES

Jill DeVito and Jennifer Lynch, 1993

The scattered boulders that break the surface of the Arboretum Pond are frequently used for basking by Painted Turtles. It is not unusual to see these rocks covered with the shiny black shells of turtles on warm, sunny days. In the fall of 1993, Jill DeVito '95 and Jennifer Lynch '95 analyzed the effect of cooling temperatures and the approach of winter on the basking behavior of these turtles for a research project for the Animal Ecology course, Zoology 301 (DeVito and Lynch 1993). The eastern painted turtle, *Chrysemys picta*, can regulate its internal temperature by moving into environments with different temperatures. DeVito and Lynch found that the temperature of the surface of the rocks was consistently about 7° C higher than the air temperature. This was measured by placing a soil thermometer on sunlit rocks on the shore. The water was usually about 1.5° C cooler than the atmosphere. Turtles are ectothermic, which means that their body temperature tends to equilibrate with its surroundings, so they can raise their body temperature considerably by basking on warm rocks.

The turtles were observed between 1 and 3 p.m. on all sunny days in September and October. Using binoculars, DeVito and Lynch counted them from a large observation rock

at the north edge of the pond. The temperature of the observation rock and the water surrounding it were used to estimate the temperature of the rocks and water near the turtles. Observations ended on October 25, when the turtles were no longer seen basking. It was assumed that they were all hibernating because no turtles were observed on subsequent days that were warm and sunny (Ernst 1972).

Turtles were observed basking at air temperatures between 11° and 27° C, or rock temperatures 17.5° to 34° C. The water and air temperatures declined gradually throughout the study. Basking time for each turtle and the number of turtles basking increased toward the end of September and then dropped sharply in the first week of October, when the air temperature dropped below 15° C (Figure 1). They began hibernating sooner than expected, probably because this behavior was triggered by the air or water temperature rather than the temperature of the basking surface. The rock surface was 17.5° C on the coolest day, although it was expected that the turtles could tolerate 8° C. Nevertheless, a late season pattern of increased basking behavior, followed by a rapid decline with decreasing temperature, was observed.

All the turtles observed in this study resembled the subspecies *Chrysemys p. picta*, which agrees with Klemens (1978) data from southeastern Connecticut (Jill DeVito, pers. com.)

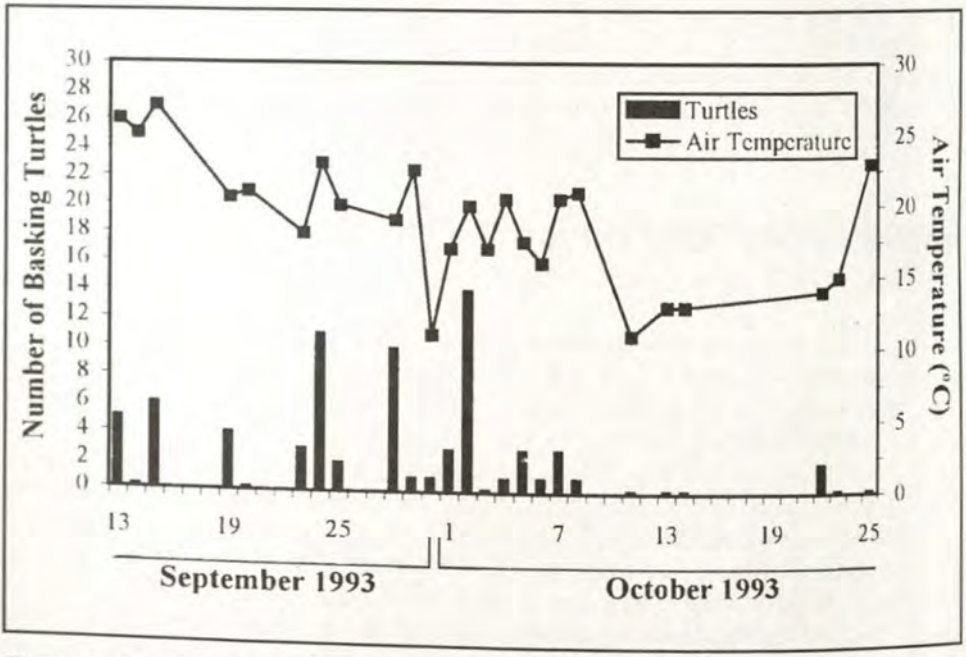


Figure 1. Number of Painted Turtles basking on rocks in the Arboretum Pond during September and October 1993 as a function of air temperature (Devito and Lynch 1993).

DISTRIBUTION OF COLOR MORPHS OF THE REDBACK SALAMANDER

Joseph Markow, Amy Dunham, and Gillian Andrews, 1993

The Redback Salamander, *Plethodon cinereus*, is probably the most common salamander in the Arboretum. It is easily found by turning over logs and rocks in the wooded areas, including recently abandoned agricultural areas (Klemens 1993). It is entirely terrestrial and tends to be found repeatedly under the same substrate, suggesting that there is little horizontal movement. Its distribution can therefore be studied by setting up study plots that are close to one another.

There are two color types, or morphs, of the Redback Salamander in southeastern Connecticut (a third, all-red variety is present in northwestern Connecticut and western Massachusetts). The unstriped "leadback" variety has a dark gray upper body, with a black and white or salt and pepper speckled pattern on the belly, while the typical "redback" or "striped" variety is identical with the exception that it has a brick red stripe down the back from head to tail. A clutch of eggs may contain both color morphs and an adult of either color type can produce young of both types (Test 1952). The leadback morph is uncommon at higher altitudes and latitudes (DeGraaf and Rudis 1983; Tyning 1990). It is possible that the leadback morph is better adapted to a warmer climate because it has a lower metabolic rate (Moreno 1989).

Joseph Markow '95, Amy Dunham '95, and Gillian Andrews '94 studied the distribution of these two color morphs at the top and bottom of the ravine in the Bolleswood Natural Area (Markow et al. 1993). They predicted that there would be fewer leadbacks at the base of the ravine along the stream because both the lower elevation and the stream would make this area cooler. They set up four transects running east and west, with the ravine bisecting each transect. Plots were located every 30 m along each transect. Salamanders were found in these plots by turning over all the logs and rocks in the plot. The color morph and length of each salamander were recorded as well as the temperature of the soil where the salamander was found. Twenty-three leadback individuals and 121 striped individuals were found. The leadback morph was about one fifth as common as the striped morph, regardless of the location of the sampling, which agrees with morph ratios for other parts of Connecticut (Lotter and Scott 1977). No differences were found in the proportion of leadback morphs at the top and the bottom of the ravine. However, the greatest elevation difference is 24 m, which is relatively small compared to elevational differences in other studies that showed differences in the morph distributions (Test 1952; Lotter and Scott 1977).

An unpublished study from the University of Connecticut mapped the distribution of the three morphs in New England (Lotter 1975). The leadback phase was restricted to the warmer areas of Connecticut, Rhode Island, eastern Massachusetts, Connecticut River Valley in Massachusetts, and southeastern New Hampshire. The frequency of leadbacks decreased northward from these areas. The Connecticut College Arboretum was in the area where leadbacks comprised more than 5% of the *Plethodon cinereus* population.

TERRITORIAL BEHAVIOR IN WOODLAND SALAMANDERS

Joseph Markow, 1994

Joseph Markow '95 studied the territorial behavior in woodland salamanders as the topic of his senior honors thesis (Markow 1995). The research was conducted at the Connecticut College Arboretum and Burnham Brook Nature Preserve in East Haddam. Markow studied the distribution of the Redback Salamander, *Plethodon cinereus*, Two-lined Salamander, *Eurycea bislineata*, and Four-toed Salamander, *Hemidactylium scutatum*, at both sites by searching under logs and rocks in 15 x 15 m plots located at different distances from streams and wetlands. The Two-lined Salamanders were concentrated around the open water areas, whereas Redback Salamanders were evenly distributed throughout woodlands right up to the edge of the water. Four-toed salamanders were found only on a pine-covered slope above a red maple swamp in the Williams Tract of the Arboretum.

During the surveys, salamanders were collected and stored in large petri dishes lined with moist paper, which they marked with chemicals secreted from glands near the chin and cloaca (the excretory and reproductive opening under the tail). The odors of these chemicals identify the species and the particular individual. These individuals were used in two types of tests to find out which species acted aggressively towards other salamanders and which species avoided contact with other salamanders. The first test, described by Jaeger and Gergits (1979), involved placing a salamander into a dish with a clean, moist paper liner on one side and a paper that had been marked by a salamander on the other side. Salamanders tended to wander freely in other salamander's territories when the territorial owner was not present. However, if an individual redback had a choice between clean paper and its own paper, it tended to remain in its own territory rather than explore unmarked areas.

The second test (Jaeger 1984) consisted of a thirty-minute observation period in which an intruder salamander was placed into another salamander's territory with the resident present. All interactions between the two salamanders were recorded. Redback salamanders were aggressive toward other Redback Salamanders more than toward other species, but tended to show some aggression toward all intruders (Table 2). Two-lined salamander residents were aggressive toward Four-toed Salamanders and other Two-lined Salamanders, but not toward Redback Salamanders. Four-toed salamanders rarely showed aggression, and performed submissive behaviors, such as assuming a flat posture and turning away from the aggressor, in the presence of other species of salamanders.

These results are important when considering the habitat needs of the salamanders. The Four-toed Salamander is restricted to certain habitats, particularly acidic woodlands uphill from sphagnum bogs where they breed. Although particular environmental requirements may be the cause of this patchy distribution of Four-toed Salamanders, the results of these experiments suggest that more aggressive salamanders located in the surrounding habitats may restrict the Four-toed Salamanders to these areas. However, field studies of behavior would be needed to confirm that the behaviors observed by Markow in the laboratory actually occur in nature and affect the distribution of the salamanders.

Exclusion of species by environmental limitations and competitive interactions has been reported in mountainous areas in other salamanders (Jaeger 1971). In such cases, the habitats in which the rare species can survive are the focus of conservation efforts for that species. If the necessary refuge habitats are maintained, the less aggressive species survives with little danger of extirpation.

		INTRUDER		
		FOUR-TOED SALAMANDER	TWO-LINED SALAMANDER	REDBACK SALAMANDER
RESIDENT	FOUR-TOED SALAMANDER	✔	—	—
	TWO-LINED SALAMANDER	✔	✔	—
	REDBACK SALAMANDER	✔	✔	✔

Table 2. Aggressive behavior of resident salamanders toward intruders. Check marks indicate when attacks occurred. Shaded areas indicate the resident and intruder were of the same species (Markow 1995).

AMPHIBIAN AND REPTILE SURVEYS

Jill DeVito, 1994

In the summer of 1994, Jill DeVito '95 completed a detailed survey of the reptiles and amphibians in the Connecticut College Arboretum (DeVito 1994). The goal of the project was to determine which species were present in the Arboretum, to identify their preferred habitats, and to locate breeding areas important to their survival. The results of this project are summarized in the field guide section of this bulletin, where DeVito describes the identification of the species with notes on their presence in the Arboretum.

Several methods were employed to accommodate the variety of habitats and behaviors of the different species of amphibians and reptiles. Transects in the ravine area and red maple swamp area provided quantitative data on the populations of salamanders and some frogs. Square plots (15 m x 15 m) were placed at regular intervals along each transect and were searched by turning over all logs and rocks that an amphibian might use as a shelter site. Transects in the ravine area ran eastward from the bottom of the ravine and crossed the stream perpendicularly. The 17 transects were placed 15 meters apart from the deciduous forest of the southern ravine north to Gallows Lane. In addition, two transects were situated on the stream north of Gallows Lane. Four plots were surveyed at the red maple

swamp south of Gallows Lane and one at the Bolles Road Pond, the pond used by Ballek (Hunter 1977) to study Spotted Salamander migrations.

DeVito also recorded all amphibians and reptiles found at the Arboretum Pond. This included both visual and auditory records. Samples of larvae were also collected to determine which species were using the pond as a breeding site. In the spring, she sampled vernal pools where eggs were deposited.

PICKEREL FROGS AND WETLAND DEVELOPMENT

Jill DeVito, 1995

Jill DeVito '95 studied individual and breeding choruses of Pickerel Frogs in the Arboretum as part of an independent study (DeVito 1995). Pickerel frogs normally breed in wetlands with abundant shoreline vegetation. DeVito wanted to compare Pickerel Frog numbers in areas that had experienced different levels of disturbance, including vegetation removal. Using information acquired from her amphibian survey in 1994 and data that Pierce et al. (1984) had collected, DeVito chose three ponds in the Arboretum to conduct her study. The Bolles Road pond, located in the northern section of the Arboretum, is home to nine amphibian species (Pierce et al. 1984), and its close proximity to the surrounding woods provides conditions suitable for breeding by Pickerel Frogs. DeVito also investigated the small, artificial pond in the Caroline Black Garden. Pierce had studied Wood Frogs here, but there were no records of Pickerel Frogs. The third study site, the Arboretum Pond, contained larvae and adult Pickerel Frogs during the 1994 amphibian survey conducted by DeVito (1994). She distinguished between the eastern and western sides of the Arboretum Pond, because they were bordered by different types of vegetation.

DeVito made four nighttime observations of each pond during the period from April 25 to May 18. This allowed her to collect information during the peak of the breeding season. She counted the number of frogs she could hear calling during a ten-minute interval at each site. DeVito expected that the number of frogs would be greatest at Bolles Road Pond and the Western side of the Arboretum Pond, where the least forest disturbance had occurred. She expected that a lower number of frogs would be heard on the eastern side of the Arboretum Pond and the Caroline Black Garden pond.

During the surveys, choruses of Pickerel Frogs were heard only at the Arboretum Pond. Two to five frogs were heard on each of the four night surveys at the Pond. The absence of Pickerel Frogs at the Bolles Road pond was surprising. There was no evidence to suggest that the accessibility of the pond was hindered in any direction by a ravine or other barriers to migration.

The pH of the Arboretum Pond was 5.1, which is considered safe for embryo development (Pierce 1985). However, the Bolles Road pond had a pH of 4.5, which may be low enough to cause egg mortality in some amphibians. Pierce 1985 reported 50% mortality of Pickerel Frog eggs at levels of 4.2-4.4 (see Table 1). The Caroline Black Garden pond had a pH of 6.1, but is a very small pond and may not be accessible from undisturbed woodland areas.

The Connecticut College Arboretum continues to provide students and faculty with opportunities for research and exploration. Behind these scientific endeavors is a fascination and pure enjoyment of the outdoors that the Arboretum stimulates and nourishes in its visitors. Watching the Painted Turtles, with their heads in the air, basking on the Arboretum Pond rocks, and listening to the wood frog choruses in the bog on a March evening brings out the curious scientist in all of us.

CHECKLIST OF AMPHIBIANS AND REPTILES NATIVE TO SOUTHEASTERN CONNECTICUT

FROGS

_____ * Eastern American Toad (*Bufo a. americanus*)
_____ Fowler's Toad (*Bufo woodhousii fowleri*)
_____ * Gray Tree Frog (*Hyla versicolor*)
_____ * Northern Spring Peeper (*Pseudacris c. crucifer*)
_____ * Bullfrog (*Rana catesbeiana*)
_____ * Green Frog (*Rana clamitans melanota*)
_____ * Pickerel Frog (*Rana palustris*)
_____ * Wood Frog (*Rana sylvatica*)
_____ Eastern Spadefoot Toad (*Scaphiopus h. holbrookii*)

SALAMANDERS

_____ Blue-spotted Salamander (*Ambystoma laterale*)
_____ * Spotted Salamander (*Ambystoma maculatum*)
_____ * Marbled Salamander (*Ambystoma opacum*)
_____ Northern Dusky Salamander (*Desmognathus f. fuscus*)
_____ * Northern Two-lined Salamander (*Eurycea b. bislineata*)
_____ * Four-toed Salamander (*Hemidactylium scutatum*)
_____ * Redback Salamander (*Plethodon cinereus*)
_____ * Red-spotted Newt (*Nophthalmus v. viridescens*)

TURTLES

_____ * Common Snapping Turtle (*Chelydra s. serpentina*)
_____ * Painted Turtle (*Chrysemys p. picta*)
_____ * Spotted Turtle (*Clemmys guttata*)
_____ * Wood Turtle (*Clemmys insculpta*)
_____ Northern Diamondback Terrapin (*Malaclemys t. terrapin*)
_____ Eastern Box Turtle (*Terrapene c. carolina*)
_____ Common Musk Turtle (*Sternotherus odoratus*)

SNAKES

_____ Eastern Worm Snake (*Carphophis a. amoenus*)
_____ * Northern Black Racer (*Coluber c. constrictor*)
_____ * Northern Ringneck Snake (*Diadophis punctatus edwardsii*)
_____ * Black Rat Snake (*Elaphe o. obsoleta*)
_____ Eastern Hognose Snake (*Heterodon platirhinos*)
_____ * Eastern Milk Snake (*Lampropeltis t. triangulum*)
_____ * Northern Water Snake (*Nerodia s. sipedon*)
_____ Smooth Green Snake (*Opheodrys vernalis*)
_____ * Northern Brown Snake (*Storeria d. dekayi*)
_____ Northern Redbelly Snake (*Storeria o. occipitomaculata*)
_____ * Eastern Ribbon Snake (*Thamnophis s. sauritus*)
_____ * Eastern Garter Snake (*Thamnophis s. sirtalis*)
_____ Northern Copperhead (*Agkistrodon contortrix mokasen*)

* indicates confirmed sighting in the Arboretum

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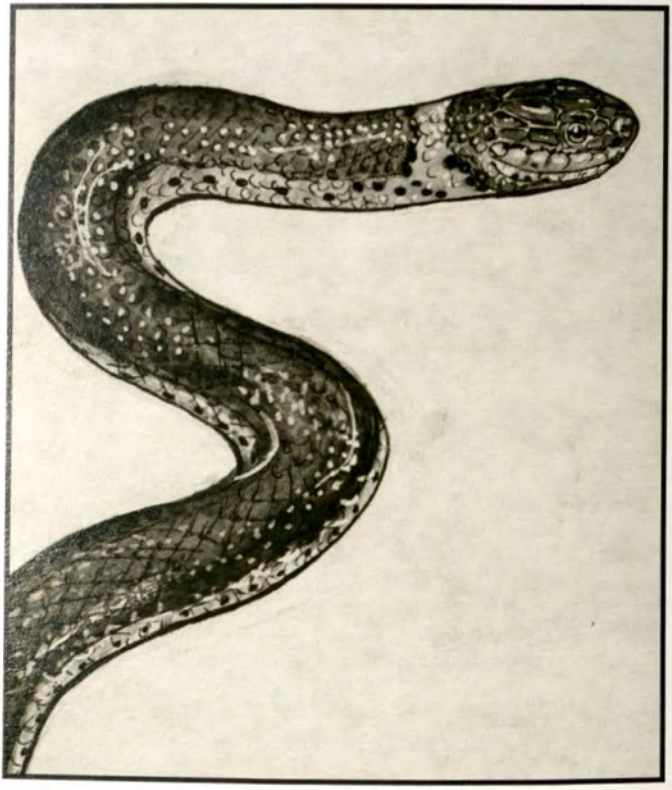

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