Reptiles AND Amphibians OF MINNESOTA

by W. J. Breckenridge

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Preface

An increasing interest in the reptiles and amphibians of the United States is indicated by the many popular and semipopular books on the subject appearing in recent years. These books have been of two types, one attempting to cover the entire United States or North America, and necessarily dealing briefly with a great many species, and the other restricting itself to a limited area, usually a state, and dealing in detail with the forms found in that area. The first kind of book meets the need of the person who wishes to learn something of the herpetology of a considerable area, but for scouts and scout leaders, school teachers and pupils, and other amateur naturalists interested in local wild life the second type of book is by far the more satisfactory source of information. The present book is an attempt to meet this latter need in Minnesota and adjacent areas.

For the past nine years the author has been collecting specimens, notes, and photographs of the amphibians and reptiles of Minnesota. His primary work in the Minnesota Museum of Natural History has been collecting materials, constructing habitat exhibits, photographing wild life, and lecturing on the natural history of the state. These activities have offered excellent opportunities for herpetological collecting. The materials and data thus assembled are here presented in the form of a handbook appropriate for use by the amateur as well as the more advanced student of the herpetology of this region.

The maps in the text show what is known of the range of each species. The distribution marks do not signify individual specimens but merely the fact that the species has been found in the county indicated. A black spot indicates that the record is based on a specimen preserved in a collection; a circle, that a record has been examined and is believed to be correct, though no specimen is available. Most such circles indicate specimens that the author has found on highways and has identified but not preserved. Specific records are listed only in the case of the rarer species. Most of the specimens so listed are preserved in the collection of the Minnesota Museum of Natural History and are simply indicated by number. Those in other collections are so designated. With one exception the illustrations are by the author.

In general the nomenclature, arrangement of species, and, to a great extent, the North American ranges, follow the fifth edition (1943) of the *Check List of North American Amphibians and Reptiles,* by Stejneger and Barbour.

Many published accounts have been drawn upon to complete the discussion of various species. Credit is given in the text to the many workers represented. Though these citations may encumber the text, they will be of value to the student who wishes to pursue the subject further.

The author wishes to thank the many persons, both in Minnesota and elsewhere, who have given him assistance in the preparation of this volume. First and foremost, he is indebted to Dr. Thomas S. Roberts, Director of the Minnesota Museum of Natural History, for his criticism and suggestions on innumerable details in the preparation of the work; for the use of the Museum's collections, on which the work is largely based, and for the Museum's financial support in the preparation and publication of the book. He appreciates the extensive criticisms received from Samuel Eddy of the Department of Zoology of the University of Minnesota and from Karl P. Schmidt, Chief Curator of Zoology of the Chicago Natural History Museum. On specific problems he has conferred with many persons, including Reeve Bailey, Department of Zoology and Entomology, Iowa State College; Sherman C. Bishop, Department of Zoology, University of Rochester; William M. Clay, University of Louisville; Doris Cochran, Associate Curator of Reptiles and Amphibians, United States National Museum; E. R. Dunn, Curator of Herpetology, Philadelphia Academy of Natural Sciences; Helen T. Gaige, Curator of Amphibians, Museum of Zoology, University of Michigan; H. K. Gloyd, Director, Chicago Academy of Sciences; V. W. Jackson, University of Manitoba; E. B. S. Logier and L. L. Snyder, Royal Ontario Museum of Zoology; M. Graham Netting, Curator of Herpetology, Carnegie Museum, Pittsburgh; William Over, University of South Dakota; E. H. Taylor, Department of Zoology, University of Kansas; George Wagner, Department of Zoology, University of Wisconsin; Charles F. Walker, Franz Theodore Stone Laboratory, The Ohio State University; and A. H. Wright, Department of Zoology, Cornell University. For their opinions and suggestions he is much indebted to them.

In collecting specimens throughout the state several persons have been particularly helpful. Grace Olive Wiley, formerly Curator of the Public Library Museum in Minneapolis, assembled a collection of reptiles that was later donated to the Minnesota Museum of Natural History; Rene B. Stiles turned in numerous specimens from her collection of live reptiles; Milton Thompson contributed specimens as well as the pages on "Care of Reptiles and Amphibians in Captivity"; Gustav Swanson donated a small collection of specimens, together with notes and correspondence on Minnesota reptiles and amphibians; George Friedrich, of St. Cloud Teachers College, allowed the author to examine and

use the herpetological material in the collections of that institution; Russell Berthel not only contributed numerous specimens, but also accompanied the author, often at his own expense, on extensive collecting trips throughout the state; and James Harley of Lincoln, Nebraska, allowed the writer to examine and cite records from a collection of material from Crow Wing County. The author wishes to thank these persons for their material and assistance. He wishes to thank also the following persons, who have contributed pertinent materials from throughout the state: Richard Anderson, Maurice Brooks, John C. Brown, Kenneth Carlander, M. H. Doner, Joe Eheim, Arnold Erickson, R. R. Ferguson, Casimer Hero, L. E. Hiner, Ove Hoegh, Gustav Kilner, Olga Lakela, Goodman Larson, I. A. Laudenslager, Emil Liers, John B. Moyle, Martin Nelson, Rolf Pederson, Jack Pemberton, Mrs. C. E. Peterson, Mrs. R. F. Skarnes, Ray Steele, H. S. Telford, and Howard Westman.

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The writer's thanks are also due William Kilgore of the Minnesota Museum of Natural History, for hours of patient proofreading as well as numerous suggestions throughout the preparation of this work, and Dorothy Olsvick for her careful typing of the manuscript.

Finally, the author wishes to thank the editorial staff of the University of Minnesota Press for their criticism and careful handling of the details involved in the editing and production of the book.

W. J. B.

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Introduction

History of Minnesota Herpetology

A report on the natural history of an inhabited region consists necessarily of a critical review of specimens and data collected by others plus new material assembled by the author. Owing to the small amount of work done to date on the herpetology of Minnesota, there are comparatively few published records in the field covered by this handbook.

Probably the earliest mention of the amphibians and reptiles of Minnesota is found in Father Hennepin's *A New Discovery,* first published in Paris in 1683, an account of his travels in 1679–80 in the territory to the southwest of New France. Hennepin merely mentioned the wild life that impressed him most, and his names are difficult to identify. That he was least of all a herpetologist is graphically shown by his terror at seeing near the mouth of the Minnesota River "a huge Serpent as big as a Man's leg, and seven or eight Foot long," which later caused him to dream terrible dreams. This "huge Serpent" may well have been a large specimen of the harmless bull snake, *Pituophis sayi,* which is still common near Fort Snelling. Hennepin refers also to rattlesnakes, one presumably at Lake Pepin (Lake of Tears) and another at the mouth of the St. Croix, and to unidentified "tortoises."

Jonathan Carver seems to have been the only explorer in Minnesota during the eighteenth century to mention the herpetology of the region. His references to ten snakes, two lizards, a tortoise, and a toad in the appendix of his book (1796) do not include localities, and one is left in doubt whether or not these animals were seen in Minnesota.

Numerous explorers visited Minnesota during the first half of the nineteenth century, but their writings contain little more than casual mention of the amphibians and reptiles. Keating (1825) noted many spiny soft-shelled and map turtles just above Lake Pepin in the Mississippi, and there his men encountered rattlesnakes, "of which they killed four or five." He also reported rumors of the occurrence of rattlesnakes near Swan Lake in Nicollet County. A few other snakes were seen along the Minnesota River, and turtles were encountered in Lake of the Woods and Rainy Lake.

Beltrami (1828) was a romantic adventurer who wrote a fascinating account of an exploratory trip through Minnesota in 1823, in the form of letters to a countess in Italy. He seldom mentioned wild life other than game. In one letter he wrote that "Lake Pepin is the headquarters

of rattlesnakes," and added a fantastic account of the virulence of their venom.

Schoolcraft (1834) encountered "copperhead snakes" in his search for the source of the Mississippi. In this region the name "copperhead" must have been applied to either the harmless little red-bellied snake, *Storeria occipitomaculata*, or the fox snake, *Elaphe vulpina*. He gives an easily recognizable description of the black-banded skink, *Eumeces septentrionalis*, which was not named until twenty-four years later.

Featherstonhaugh (1847) mentions "a large snake of the moccasin kind," probably the common water snake, *Natrix sipedon*, at St. Anthony Falls, and, like Keating, refers to rumors of rattlesnakes near the present site of Mankato.

Surveys made during the 1850's were described later in the *Report of Explorations and Surveys to Ascertain the most Practical and Economic Route for a Railroad from the Mississippi River to the Pacific Ocean*, in which appeared some excellent reports and many fine plates on the vertebrate fauna of the middle and western states by such men as Spencer Fullerton Baird and Charles Girard. With this work began an era of much more thorough and accurate study of the western vertebrates. However, only a few records of Minnesota material appear in these reports, and no comprehensive lists were compiled for any specific regions. The material collected on the surveys was deposited largely in the United States National Museum. During the next thirty or forty years a few specimens from Minnesota were added to these collections from Fort Snelling and from Fort Ripley in Morrison County. Cope's *Batrachia of North America* (1889) and his later *Crocodilians, Lizards, and Snakes of North America* (1900) include all United States National Museum records, but comparatively few Minnesota references appear.

Between 1900 and 1930 a few small collections of amphibians and reptiles found their way to the United States National Museum, the Museum of Zoology of the University of Michigan, and the Field Museum. During this period a few specimens were preserved in the collections of the Zoology Department of the University of Minnesota. They have been added recently to the Minnesota Museum of Natural History collections and are included in the present report.

In 1922 A. C. Weed described two color phases of the leopard frog, found largely in Minnesota, giving them the specific names of *Rana burnsi* and *R. kandiyohi*. (See discussion of *Rana pipiens*.)

Since 1930 a number of persons have been actively interested in the herpetology of Minnesota, but little has appeared in print. Grace Olive Wiley did much to popularize the study of reptiles in the state. Her interest was largely in the care and rearing of snakes in captivity, rather

than in distribution and life history studies. She made a collection of several hundred specimens, and part of her collection was eventually turned over to the Minnesota Museum of Natural History. Unfortunately, much of her material was preserved after considerable periods in captivity, leaving the data open to question. Rene B. Stiles, who was associated with Mrs. Wiley and had much the same interests, wrote an article on the "Milk Snakes of Minnesota" (*Copeia*, 1938). George W. Friedrich, head of the Department of Biology of the State Teachers College at St. Cloud, has done some work on the amphibians and reptiles of the state, the St. Cloud area in particular, and has compiled local lists and keys for use in his classes. Milton Thompson, Curator of the Minneapolis Public Library Museum, has prepared numerous notes on herpetology in that Museum's *Nature Notes*, and has also published a key to the snakes of Minnesota (1939). Gustav Swanson accumulated a small collection of specimens and field records, which served as a basis for his *Preliminary List of Minnesota Amphibians* (1935).

The author of the present book became actively interested in the herpetology of Minnesota in 1935, and since that time has collected material in almost every county in the state, both in conjunction with other field work carried on for the Minnesota Museum of Natural History and on personal field trips. Thirteen papers, principally in *Copeia* and the *Minnesota Conservation Volunteer*, have appeared as a result of this work.

Tales about Reptiles and Amphibians

Man's traditional fear of serpents has given rise to many far-fetched tales, but it really has a substantial basis in the fact that some species are dangerously poisonous to man. When little was known about snakes the safe rule to follow was to avoid them all. A newcomer in the woods was once told not to be disturbed by bears, since, as the reassuring friend put it, "Nine out of ten bears will run when they see you." The not too reassured newcomer's pertinent retort was, "Just how do I recognize the tenth bear before he starts tearing me apart?" Today we are able to recognize the "tenth bear" among the snakes and, furthermore, we know that many of the "first nine bears" are not only harmless but beneficial to man and that we are only harming ourselves in destroying them. The fact is, however, that there are few animals about which people are more eager and willing to believe the preposterous than the snakes, lizards, turtles, frogs, toads, and salamanders. When we search ancient writings and listen to barber shop naturalists we find the study much more filled with thrills and shivers than if we restrict ourselves to facts.

One of the most fantastic of these folklore creatures is the hoop snake, a reptilian terror that grasps its tail in its mouth and rolls in hoop-fashion at alarming speed to overtake its prey, usually a man, and having overtaken it, suddenly releases its tail, hurtles through the air like a javelin, and impales its quarry with its venomous, spine-tipped tail. The best defense against this creature, we are told, is to step quickly behind a tree just as it strikes, thus causing it to pin itself to the tree. As for the tree, the virulent poison soon causes it to wither and die. The hoop snake seems to exist only in the minds of those whose imaginations are stimulated by an uncontrollable fear of snakes. A few snakes have fairly sharp, horny-tipped tails, but none is known to use its tail as a weapon or to have venom in its tail.

The milk snake is so named because of a belief that it sucks milk from the udders of cows. The writer has talked with persons who claimed to have seen the milk snake in the act. One mentioned knowing about a rattlesnake that had developed the same habit. These eyewitness tales are usually "recollections" from years back. Such talebearers overlook the fact that the mouth of a snake contains rows of tiny, very sharp, recurved teeth, which would be anything but soothing to the cow's teats, and also that the lips and muscles of a snake's mouth are not at all adapted to sucking movements. Aside from these facts, the amount of milk that even a large milk snake could consume would hardly be missed at milking time. Pope (1937) points out that the total body volume of a 37-inch milk snake is only about half a pint. The milk snake does often occur about farms, but its presence there is due to its liking for mice and rats rather than milk. The water snake commonly found in and near streams in Minnesota is often erroneously supposed to be the venomous "water moccasin." Actually, it is the common water snake, *Natrix sipedon*, which, though it may exhibit a rather vicious disposition, is entirely without fangs. The true water moccasin, *Agkistrodon piscivorus*, is not known to occur north of southern Illinois.

The darting tongue of snakes is feared by many people. This fear has no basis in fact. Even the rattlesnake's tongue is soft and harmless. The tongue of the snake is an exploring organ and not an injector of venoms, a function performed by specially adapted teeth called fangs. The forked tongue of the snake collects microscopic particles from the air and is then withdrawn into the mouth. Here the two points are thrust into two small, pocketlike depressions in the roof of the mouth, where they contact the nerve endings of the sense organ called Jacobson's organ, which apparently records sensations closely allied to the sense of smell.

Snakes, lizards, and salamanders, including the mud puppy, are widely considered to be venomous. As a matter of fact, there are no venomous salamanders, and only one lizard, the Gila monster of the southwestern United States, is known to possess venom glands. In Minnesota only two of our sixteen species of snakes are venomous—the timber rattlesnake, *Crotalus horridus,* and the small, very rare, swamp rattler, or massasauga, *Sistrurus catenatus.* In Minnesota the timber rattler seems to be restricted to the bluffs of the Mississippi and its larger tributaries from the mouth of the St. Croix southward. This statement is based on our present authentic records and is made somewhat in the spirit of a challenge, since this rattlesnake may rarely occur elsewhere in the state. Actual specimens must be had to establish its occurrence, since so many errors are made in reporting rattlesnakes. We have only two authentic records of the occurrence of the swamp rattlesnake in Minnesota. It may be expected to occur in the Mississippi bottoms from about Red Wing southward. Thus, except in the rugged southeastern corner of the state, there is almost no danger of encountering venomous reptiles in Minnesota.

The snake that has more tales told about it than any other local species, except perhaps the rattlesnake, is that short, stocky, sand-inhabiting snake variously known as the blow snake, blowing adder, puffing adder, spreading adder, or hog-nosed snake; actually these names apply to two species, *Heterodon nasicus* and *H. contortrix.* It is said to be able to spit venom or even fire and is almost universally considered very venomous. As a matter of fact, it is one of the best bluffers in the animal world, perhaps even excelling the opossum itself in this art. It is not venomous and after its display of bluff has subsided is exceedingly docile. Its terror-inspiring exhibition is described in the sections dealing with the two species of hog-nosed snakes.

The tale about young snakes seeking shelter in the mouth of their mother is one snake story that still seems not to have been thoroughly disproved, though no herpetologist accepts it as true. There is no record of such an occurrence in any of the large zoos, where hundreds of families of snakes have been kept under close observation, nor has any recognized herpetologist reported such an event. Many snakes give birth to living young, and gravid females of these species, when killed and opened just before giving birth to their young, would serve to prove the truth of this old story to many uncritical observers. Again, many snakes are known to eat other snakes, and this fact could easily give rise to the belief that the young seek shelter in the mother's mouth. In spite of all this negative evidence, however, there exist many "eyewitness" accounts of this strange happening. One in particular, by Dr.

E. D. Ball (1916), a well-known entomologist, is quite convincing in its vivid detail, though it should be noted that Dr. Ball's account is a report of a childhood recollection. So it seems that this story must still be viewed with an open mind by the skeptics, since there is a remote possibility that it may have some basis in fact.

Probably everyone has heard of the glass snake, which is reputed to have the ability to break into pieces in times of danger and to reassemble when the danger has passed. Actually, the glass snake is not a snake but a legless lizard, and it does not occur in Minnesota. Its tail does break off easily, with little bleeding, but it cannot reclaim the fragments, though it does have the remarkable ability of regenerating its tail. In fact, the whole group of lizards, including the black-banded skink common in Minnesota, has this ability, and although snakes' tails are often broken off, they are never regenerated. After it is severed the tail of the lizard squirms and twists actively for some time and serves as a lure to occupy the attention of enemies while the animal escapes.

The ancients were frequently amazed to see little salamanders, very much alive, squirming about in their log fires or even scurrying out across the hearths. Their interpretation of this phenomenon was that these fragile creatures were endowed with some supernatural protection against the flames. The name "salamander" came to apply to mythical genii appearing in heraldry who could exist unperturbed among the flames. Then the name was extended to more substantial articles used about fires and not damaged by the heat, for example, the poker. A heated metal plate used to brown meats or pastries became a "salamander," and the metal industry applied the name to the slag left in cooling furnaces. Even the soldier displaying unusual bravery in the face of enemy fire became a "salamander." Actually, this tiny creature is entirely incapable of withstanding fire for more than a few moments. True, its moist skin does afford momentary protection, in that it will not ignite instantly, as would the hair of a mammal or the feathers of a bird. The explanation of its appearing so often in fire is that its favored habitat is the hollow spaces often found just beneath the bark of moist, rotting logs. The bark, especially if damp, is rather resistant to fire, and the little salamander may not be heated out of its retreat until some minutes after the log is rolled on the flames.

Toads are widely believed to produce warts on the skin of those who handle them. Probably the warty skin of the toad accounts for this belief, for which there seems to be no basis in fact. However, the skin of the toad does contain a mild poison that renders this otherwise defenseless animal distasteful to most of its potential enemies.

There are many fantastic stories regarding the toad's ability to sur-

vive many years while solidly encased in stone or growing trees. Henry R. Schoolcraft (1855) quotes a number of apparently authenticated cases of this kind, such as the following: "In a trunk of an elm, about the size of a man's body, three or four feet above the root, and precisely in the centre, was found, in 1719, a live toad, of a moderate size, thin, and which occupied but a very small space. As soon as the wood was cut, it came out and slipped away very alertly. No tree could be more sound. No place could be discovered through which it was possible for the animal to have penetrated, which led the recorder of the fact to suppose that the spawn from which it originated must, from some unaccountable accident, have been in the tree from the very moment of its first vegetation. The toad had lived in the tree without air, and, what is still more surprising, had subsisted on the substance of the wood, and had grown in proportion as the tree had grown. This fact was attested by M. Hebert, Ancient Professor (*sic*) of Philosophy at Caen." In 1731 M. Leigne wrote the Academy of Sciences at Paris an account of a similar phenomenon. In this instance the tree was larger and was an oak instead of an elm. From the size of the oak M. Leigne judged that the toad must have existed in it without air or any external nourishment for the space of eighty or a hundred years.

Such cases undoubtedly were examined and reported by persons anxious to believe in these phenomenal occurrences and consequently not overcritical in their investigations. Since the toad is known to possess rather remarkable abilities of surviving long periods of drought and cold, it is not surprising that such exaggerated accounts are readily believed.

The collector of such tales might go on and on reciting accounts of the remarkable behavior of these despised animals. (See Schmidt, K. P., 1929; Curran, C. H., and Kauffeld, Carl, 1937.) Many will stoutly stand by their guns in maintaining the authenticity of their stories when it is suggested that a tricky memory plus an active imagination is responsible for their remarkable accounts. A great many of these stories continue to be retold as facts in the fantastic "nature lore" of that large group of persons who lack the first great quality of a fact finder, skepticism.

The Distribution of Amphibians and Reptiles in Minnesota

One of the most challenging questions that the person studying the plants or animals of an area can ask is, "Just what is it that limits the ranges of various species?" A complete answer to this question has not been found. The best partial answer is that a delicate balance seems to

exist between the habits and physical make-up of the plant or animal and the topography, soils, rainfall, and temperature of the area. This balance seems to determine the limits of its range. Consequently anyone who wishes to understand the distributions of the various species must have a knowledge of the physical features of the area under consideration.

In topography Minnesota is comparatively level, ranging in elevation from about 600 feet to 2230 feet above sea level. The highest point in the state lies in northern St. Louis and Lake counties. The second highest point, about 2000 feet, is in Becker County. The east-central part of the state is low, the area of several counties about the Twin Cities being below 1000 feet. The Red River Valley in the northwest has an elevation of only 700 to 800 feet. Lake Superior, with an altitude of 602 feet, is the lowest point in the state. The Mississippi River as it leaves the state in Houston County has an altitude of 620 feet and the Red River at Pembina only a little over 700 feet. Minnesota is so situated that 34 per cent of its area drains into Hudson Bay via the Red and Rainy rivers, 9 per cent into the Atlantic Ocean via the Great Lakes, and 57 per cent into the Gulf of Mexico via the Mississippi drainage system.

The whole of the state, except for the extreme southeastern tip, has been profoundly affected by glaciation. In the driftless southeastern area the high land has been exposed to erosion for hundreds of thousands of years and the Mississippi River has cut a deep valley, leaving bluffs rising 500 to 600 feet above the valley floor. The tributary streams also have eroded deep, rugged valleys, and the area is a succession of deep, almost gorgelike valleys and high wooded hills, entirely unaffected by the planing action of the glaciers.

Over the remainder of the state depositions from at least three glacial invasions are exposed at the surface. In the southwest the well-developed water courses and lack of lakes mark the well-matured drainage area of the Kansan drift. Much of the central and northern parts of the state was later overridden by the Middle Wisconsin ice sheet, which left a red drift from the granite exposures to the north and east. Then came the last or Late Wisconsin ice advance from the north and northwest, bringing down a basic gray drift from the limestone area in Manitoba.

The terminal and recessional moraines of this last ice sheet remain as rough, hilly zones conspicuous at several points in southern and western Minnesota. During the recession of this ice sheet northward, drainage was stopped and the enormous Lake Agassiz was formed in northern and northwestern Minnesota, extending also over much of North

Dakota and Manitoba. The outlet of Lake Agassiz was the River Warren, which flowed in the present course of the Minnesota River, and it was this large flow of water that carved out the present wide valley of the Minnesota River. With the disappearance of the ice this lake drained northward, and the present comparatively small Minnesota River flows in an enormous valley. The Red River Valley today, with its surface almost as level as a floor, was so formed by the bottom deposits laid down in this great glacial lake. In the eastern part of the counties from Traverse and Ottertail to Red Lake and east through Beltrami and Koochiching counties are the long gravel ridges indicating several of the former shore lines of this same lake. The early Pembina Trail followed by the famous Red River carts ran for miles along these ridges.

In the pockets among the morainic hills and in the hollows in the ground moraine laid down by the last two Wisconsin drifts are found the majority of Minnesota's ten thousand lakes. Here the drainage is still in a very immature state, for the water courses have not as yet cut deep enough to drain all the depressions.

The soils of the state vary greatly in quality and thus profoundly affect the vegetation. On the old Kansan drift areas in the southeast and southwest, extensive, fertile, wind-blown loess deposits occur, and in these older deposits the drift pebbles have largely weathered into tillable clay soils. The red drift of the Middle Wisconsin glaciation, exposed in east-central and northeastern Minnesota, has only partially weathered into a red clay soil, and most of it is rocky and difficult or impossible to till. The younger gray Late Wisconsin drift is weathering into a very fertile alkaline clay.

In Minnesota the minimum average annual rainfall of about 20 inches occurs in the extreme northwestern corner of the state. From there it increases eastward and southward to a maximum of 32 inches in the southeastern corner. The southwestern corner receives about 26 inches and the northeastern angle about 30 inches. June is the month of greatest precipitation, and the least occurs in December and January.

The annual temperature range, as in all midcontinental areas, is very great. Until very recently, at least, the coldest recorded temperature was −59° F., in Itasca County, and the hottest, 107° F., in several southern counties. The coldest month is January, with a mean temperature of 10.5° F., and the warmest, July, with 69.1° F. Frosts have been recorded in northern Minnesota in every month of the year, but are rare from mid-May to mid-September. The longest growing season, 160 days, is found from the Twin Cities south along the Mississippi, and the shortest, 100 days, in Itasca, St. Louis, and Lake counties.

The varied physical features and climate of Minnesota have produced a correspondingly marked variation in the vegetation. To the north and east coniferous forests form the dominant cover, to the south and east hardwoods predominate, and along the southern and western edges the forests give way to prairies. The general extent of these areas is shown on the distribution maps. These cover types do not have sharply defined boundaries. A great deal of intermingling of types occurs along the line of junction, with many fingerlike projections or isolated islands of one intruding into another. To the botanist these areas are fairly distinct. Certain species characteristic of each of these regions do not occur in the others. To a lesser extent the zoologists have found the animal life conforming to these limits, as though the same physical and climatic conditions, strongly influenced by the vegetation present, also limited the distribution of certain animals.

In the present study only a few instances are found in which the amphibian and reptile ranges seem to correlate with these three principal floral regions. Where a study of the complete range of an animal may show a marked correlation between certain vegetation types and the occurrence of the animal, often little or no such correlation is evident in studies carried on near the outer limits of the range of the species. Such is the case in Minnesota amphibian and reptile studies. Here we are dealing with the northern limits of the ranges of most of the species concerned, and here many may be living in habitats that are far from ideal for the species. Furthermore, almost no population density studies have been made of amphibians or reptiles in Minnesota, and a few random collections should not be depended upon as bases for habitat designations. Consequently it is thought ill advised at this time to attempt any critical analyses of the correlation between floral regions and amphibian and reptile distributions, and many of the statements about Minnesota ranges and habitats are made with a full realization that they may need to be revised after later studies.

Attention is called to certain factors disturbing amphibian and reptile distributions in the state. The extensive changes in the distribution of birds and the larger mammals due to cultivation of the land are well known. The amphibians and reptiles are less mobile than these groups, and as a result intensive tilling has virtually destroyed much of this fauna, particularly the reptiles, over large areas, leaving remnants distributed in a much interrupted pattern over the state. This destruction has left many of these animals in the agriculturally marginal areas. Thus to a great extent certain amphibians and reptiles may persist only in rocky, undesirable lands, whereas their original habitat may have included also the moist prairies. Further selective destruction has oc-

curred on the highways. In the sections of this book dealing with the tiger salamander, leopard frog, fox snake, bull snake, plains garter snake, Blanding's turtle, and ornate box turtle, these reductions in populations are discussed. Beyond a doubt the present distributions of several species within the state are materially affected by this highway destruction. Since no distribution studies of these animals were made in Minnesota before the advent of these disturbing factors, the distribution and habitat studies are necessarily based upon relatively recent data. Thus conclusions regarding their original distributions in the state are not completely reliable.

On the distribution maps a black dot indicates that one or more specimens have been taken in the county represented. This symbol does not necessarily mean that the species is found throughout the county. Some amphibians and reptiles require a very special type of habitat. Attempts to locate one of these species in the field involve careful consideration of the chosen habitat and it should be looked for only where its preferred habitat occurs.The map markings thus mean that *within certain habitats* the species is known to occur in the county. The plains garter snake, for example, seems limited rather sharply to the grasslands. Numerous records are indicated within the hardwood region and the edges of the coniferous regions. These records do not mean that the species is living in the woods in these regions, but rather that prairie necks and islands are here intermingled with other types of cover, and that the plains garter snake occurs in these prairie patches. Furthermore, cultivation has created many favorable grassland habitats for this snake within the area originally covered by forests.

A glance at the distribution maps brings out the fact that the southeastern deciduous forest area has the most varied herpetological fauna, eighteen amphibians and twenty-three reptiles having been recorded from this region. A distinct reduction in the numbers of species occurs to the northward, till in the coniferous forest region only twelve amphibians and eight reptiles occur. The numbers to the westward also fall off; only eight amphibians and seven reptiles are found on the prairies.

A few especially interesting problems in the distribution of similar species have become evident in this study. For example, the size, color, habitat choice, and habits of the black-banded and blue-tailed skinks are very similar, and their distributions also might be expected to be similar. However, so far only a single colony of the blue-tailed species has been found in Minnesota, whereas the black-banded species occurs commonly almost throughout the state. Taylor, the author of a monograph on the skinks (1935), commenting in a letter on the scarcity of

records for the blue-tailed skink, stated: "I have suspected strongly that the apparent absence in northern Missouri, Iowa, eastern Nebraska, eastern Dakota, and Minnesota was probably due to lack of collecting in those localities." However, the scarcity of records is clearly not the result of insufficient collecting. Perhaps the explanation will be found in the difference in the resistance of these two lizards to reduced moisture and temperature conditions.

A similar situation exists with DeKay's snake and the red-bellied snake. These two snakes very closely resemble each other, yet DeKay's snake occurs only along the Mississippi, north to about St. Cloud, whereas the red-bellied snake is state-wide and is even found well up into Manitoba.

Again, why should the painted and snapping turtles survive northern Minnesota conditions, whereas all the other turtles are confined to strikingly smaller ranges in southern Minnesota?

Aside from being a source of information on Minnesota amphibians and reptiles, this book, in attempting to present reliable data on their distributions within Minnesota, is setting the stage for later experimental work which may furnish the answers to these and perhaps many other such problems in animal distribution. Since Minnesota is located on the northern limit of the ranges of so many species, it is especially advantageously situated as a field laboratory for attacking just such problems. The writer therefore strongly urges those interested throughout the state to cooperate in this work by preserving for later examination all materials that seem to extend the ranges of any species here discussed or might prove the presence of any species not now known to occur in the state.

Field Methods

The widespread ignorance regarding amphibians and reptiles is not at all hard to explain, for few animals are more secretive than these. Even the person who has acquired an interest in them and makes a definite effort to study them finds it difficult to locate more than a few leopard frogs, a toad, and a garter snake, and soon begins to wonder whether all the species referred to in books actually exist in his territory. The answer is that special methods of finding them must be followed and habitats not usually visited must be investigated. Techniques employed in collecting the different animals vary with the habits of the groups, and the haunts of even closely allied species often differ sufficiently to require entirely different methods in securing specimens. Among the salamanders, for instance, the two small species, Jefferson's

and red-backed, are very similar in many of their habits. The former, however, may be successfully collected in early spring in the forest ponds where it goes to breed, but the latter, one of the few salamanders that breed on land, is never found in ponds at any season. It is evident, then, that even a little knowledge of the habits of each species will save the collector much valuable time in the field.

At the outset one must always keep in mind that most amphibians and reptiles spend the greater part of their lives under cover. Turning over all movable objects that might provide such cover is one of the most successful collecting methods. For this purpose a strong hook is essential. It can be made by sharpening and bending a foot-long metal rod, one-fourth or three-eighths of an inch in diameter, and inserting it in a hole drilled in the end of a broomstick. It is held in place by drilling and inserting a steel pin at right angles through both rod and stick. Such a hook enables one to turn over or tear apart boards, logs, pieces of sheet metal, stumps, stones, and the like, without the necessity of stooping over or running the risk of cutting one's hands on these rough materials.

Since cover is a habitat requirement for many species, providing suitable cover will make an area more inviting to them. Boards, sheet metal scraps, bricks, or heavy paper scattered about may later be turned over and found sheltering a snake, toad, or salamander. The writer carried on one of his most successful studies with a colony of black-banded skinks thriving under chunks of concrete, old milk can lids, and stones strewn about in an open oak woods.

A good flashlight, or better yet, a head lamp fastened on a headband, with batteries supported on the belt, is indispensable for night collecting of both land and water forms. Night hunting is almost the sole means of collecting series of croaking male frogs, for instance. Calls may be spotted at considerable distances, and by alternately advancing and remaining quiet one may closely approach the caller. Then, with the use of the light, the frog may be located and readily secured in the hand or with an aquatic net. Hip boots are also essential in such collecting, though some species of frogs and toads will call while on land. Examination of sandy beaches at night, with a light, has been highly productive of toads and frogs.

Snakes are most easily taken by hand, but the poisonous rattlesnake found in southeastern Minnesota must be taken by other means. The hook is useful in securing and holding them, but a stick with a loop at the end is essential in picking them up. It is best made from a stout pole with a leather thong fastened at the end to form a loop, which then passes through stout guides up along the handle. A pull on the

thong tightens the loop about the snake's neck, and the snake may then be picked up without danger to the collector or injury to itself.

It is well-nigh impossible to capture fast-moving lizards by hand, and shooting with dust shot is the best method of securing them. Either a smoothbore 22-caliber pistol or rifle, shooting shot cartridges, or a 410-caliber or 28-gauge shotgun wih light loads of dust shot may be used. The author often uses his 16-gauge shotgun fitted with an auxiliary barrel shooting dust shot loads in 32-caliber shells; this shotgun is used primarily in collecting small birds. Larger snakes as well as frogs may be taken readily in this way. The method is especially adapted to securing water snakes, which habitually glide off into the water before one can get close enough to take them by hand or with the hook.

Turtles usually defy all ordinary methods of field collecting, except for the occasional specimen encountered far enough from water to be taken by hand. Turtles are occasionally taken by ordinary hook-and-line fishing, and setlines in muddy ponds or sluggish streams are often successful. However, baited traps are by far the best (Lagler, 1943). Hoop nets made of stout cord or chicken wire are good. Rectangular wire traps with a loose flap of wire netting extending downward and inward from the top at the front allow ready admittance of foraging turtles and prevent their escape. A barrel may be weighted down in the water with stones till its rim is nearly at water level and fitted with a cover slightly smaller than the top opening, with the lid pivoted on two nails resting on the barrel rim. Bait fastened at the center brings turtles onto the tipping lid, they slip into the barrel, and the trap immediately resets itself. Probing for turtles hibernating in stream banks is described in the section on the snapping turtle. Baits of fresh fish, clams, or crayfishes are most successful with turtles.

Some beginners report discouraging losses of specimens through their escape from makeshift containers. Snakes are especially adept at forcing themselves through small openings or pushing up lids on cans, jars, or boxes in which they are kept. The cloth sack is the solution to most of these troubles. The writer carries a number of salt sacks or small flour sacks in his pockets while collecting. When a specimen is secured it is dropped into a bag, a knot is tied in the open end, and the knot is thrust under the collector's belt. This method assures the specimen's not escaping and yet allows it a good air supply. Specimens so handled can be carried in a car or even packed in perforated or screened boxes for shipment with little danger of injury, escape, or suffocation. Amphibians survive well in sacks kept moist to prevent their drying out.

Another technique that has provided perhaps the major part of the distributional data appearing in this book is highway collecting. Am-

phibians and reptiles must slowly and laboriously crawl or hop over every foot of ground they traverse, whereas insects and birds may fly and mammals far outstrip them in speed. Consequently when these animals cross highways, where thousands of rubber tires are rolling over every inch of the surface at all hours of the day and night, a tremendous number of casualties results. In fact, in the fall and spring, when the abundant leopard frogs are going to and from rivers or lakes where they winter, so many are killed that their crushed bodies often render the pavement dangerously slippery, and highway departments occasionally issue hazard warnings at such points. To a motorist most of these traffic victims appear simply as spots on the pavement, and few realize the toll of amphibians and reptiles their speeding tires are taking. A wide-awake herpetologist can soon learn to recognize these spots. However badly the specimens may be crushed there is usually enough remaining for identification, and a surprising number are found in preservable condition. Before doing much collecting of this type one will be sure to make the acquaintance of what Schmidt and Davis (1941) describe as "the stick snake," the "banana peel lizard," and, most deceptive of all, the "fan belt snake." Cruising at slow speeds naturally allows a more careful inspection of the road surface. However, one must keep in mind the fact that such slow driving and the making of unexpected stops are highly dangerous and that fellow motorists have little patience with overzealous specimen hunters using such collecting methods. This highway technique of collecting is being used so extensively today that numerous publications have adopted L. M. Klauber's suggestion that such specimens be referred to in the literature as "DOR," meaning "dead on road."

Care of Reptiles and Amphibians in Captivity

BY MILTON THOMPSON*

Many persons may be interested in keeping reptiles and amphibians in captivity, either for scientific purposes or as a hobby. A few suggestions on their care will help to make these endeavors more nearly successful.

Two methods of confining reptiles are common. One is to simulate the natural habitat, the other to create an artificial habitat suitable to

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captivity. Most attempts at simulating nature are more novel than successful, owing to the difficulty of keeping the cages clean. In nature these creatures leave body wastes and external parasites behind and move on to new territory, a privilege they do not enjoy in captivity. The artificial habitat is far the simpler and more successful method of confining these animals.

The cage should be firmly constructed and very tight, for these animals can wriggle through astonishingly small holes. The bottom is best made of wood, zinc sheeting, or concrete. The cage should be kept simple, have good drainage, and have water enough for both drinking and soaking. For arboreal species branches, cords, or sticks should be arranged on which they may climb. Most species do better if provided with a stone, a piece of bark, a board, or, with larger species, an inverted box, under which they may crawl. However, they will not tame as quickly if allowed to hide continually.

Newspapers, several layers thick, provide the most suitable floor covering, for they keep the cage dry, are cheap, and can be rolled up and disposed of easily. Crushed limestone in pieces one-eighth to three-eighths of an inch thick makes a satisfactory floor covering. Well-washed sand will also work, but some species get it in their mouths, where it may be the irritant that causes sores which often lead to the condition called "mouth rot." Above all, the cages should not be overcrowded. The principal problems with big collections result from the forced contact of many specimens in limited quarters.

Temperature and humidity are much discussed problems. None of the common species thrive on long exposure to dry conditions. Aquatic species require a constant supply of reasonably clean water in which they may submerge. I know of no species that does not at times indulge in prolonged soaking, usually to eliminate skin parasites, especially mites, or to facilitate shedding.

Temperature is the subject on which reptile keepers most often disagree. I believe that most species live longest if kept at a temperature of about 65° to 75° F. The temperature should be raised before feeding to 80° or 90° F., and kept up for one to three days, until the mass of food has been digested. The animals in question are so-called cold-blooded animals, and the chemical action of digestion goes on much more rapidly at higher temperatures. Slow digestion in cool quarters may well cause trouble. It is better to warm cages from beneath, for reptiles absorb heat more rapidly from the surface on which they rest than from the air about them. Do not forget that reptiles naturally assume the temperature of their surroundings and that blankets will not keep them warm for any length of time.

When first captured reptiles may refuse food for several days. Most species in normal, healthy condition can safely go at least two weeks without feeding, and larger species are able to survive much longer than smaller ones. However, it is easier to keep reptiles in a healthy condition than to try to build up emaciated specimens. Reptiles often harbor many internal parasites without apparent impairment to their health, but once they are run down the parasites seem to prevent their return to health.

What are the signs of good health in reptiles? First, observe the tail. If the tail bones are visible the specimen is not properly nourished. The tail should be plump and well rounded. Reptiles can inflate and deflate their bodies at will, but not their tails. The health of snakes, lizards, alligators, and most tailed amphibians may be judged in this way. In frogs and toads poor health is indicated by a shrunken condition of the lower back, just in front of the hind legs. Second, observe the gloss or tone of scales, plates, or skin. When the animal is in poor health they will appear either excessively oily and dark or dry and withered. Third, look for body sores, especially between the ventral scales of snakes and lizards and the ventral plates of alligators, on the toes or bellies of amphibians, and, in turtles, for scaling off of layers of shell. Another sign that all is not well with turtles is the progressive swelling shut of the eyes.

Food is extremely important and varies greatly with different species or even individuals of the same species. For example, most hog-nosed snakes prefer toads. However, many western hog-nosed snakes refuse toads, but eat mice with great gusto. Feeding is of two types, self-feeding and force feeding. I have seen reptiles and amphibians kept alive and healthy for several years by force feeding, but in general it should be avoided. Natural self-feeding is by far the better.

The natural foods most often used are mice, rats, frogs, toads, snakes, lizards, earthworms, fish, eggs, insect sweepings (obtained by the use of a sweep net), meal worms, the larvae of flour beetles, ants, and roaches. Certain species require some vegetable food. Lettuce, bananas, apples, and even grass are old stand-bys. Ground or diced lean beef mixed with cod-liver oil, bone meal, and beaten egg is often acceptable. I have seen garter snakes, water snakes, racers, alligators, turtles, frogs, toads, and some large lizards thrive on this diet. Never feed live adult rats or mice to snakes. Use only young animals, and never leave them alive in the cage over night or for a prolonged period, for they are likely to kill the snakes. As a rule snakes will not molest these animals unless they are hungry. Almost every zoo has had large poisonous snakes killed by rats or mice left in the cage over night as food.

Rats and mice, either alive or freshly killed, may be given to rattlesnakes, bull snakes, fox snakes, or milk snakes. Legs may be cut from freshly killed mice for the young of these species, and for the very young snakes the skin should be pulled from the legs, thus enabling the snakes to swallow the food more readily. One usually has very little trouble in getting small snakes to feed.

Water snakes, garter snakes, and racers may be fed live minnows in shallow pans of water. If there are a number of snakes in a cage they may become greatly excited and will grab anything that moves and will begin swallowing it, be it minnow, another snake, their own tails, or the fingers of the hand that feeds them. Consequently it is best to separate them into small groups while they are feeding. For winter feeding larger fishes may be ground up. Moderate sized pieces of lean meat dipped in cod-liver oil will often be accepted in place of minnows.

Garter snakes and ring-necked, red-bellied, and DeKay's snakes, as well as most frogs, toads, and salamanders will do very well on earthworms. Meal worms are useful for all northern varieties of lizards, frogs (especially tree frogs), toads, newts, and small species of salamanders.

Green snakes are one of the most difficult species to bring through a winter. They do well on insect sweepings in summer; they prefer the spiders, but require variety. In winter, when sweepings are not obtainable, meal worms may be substituted for a time. I once saw two Cecropia moth cocoons opened and their contents fed forcibly to an emaciated green snake by means of an eye dropper. Three such feedings during the winter brought the snake through until insects were again available in the spring.

Bull snakes, fox snakes, and large king snakes will sometimes feed on small pullet's eggs, raw and whole. Lizards are readily eaten by king snakes, racers, large frogs, and toads. Frogs are suitable food for garter snakes, king snakes, racers, large frogs, and large toads. Toads are the favorite food of the eastern hog-nosed snake and of some western hog-nosed snakes. Snakes are the normal food of king snakes and racers. Lizards, frogs, and toads thrive on insect sweepings.

The timber rattlesnake is one of the quietest species in captivity and as a rule refuses the foods accepted by other rattlesnakes. One group of five captured in southeastern Minnesota refused for over a year to eat voluntarily, but when a common striped ground squirrel was given them all five tried to eat it at once. Apparently the ground squirrel is a prime item of diet with the timber rattlesnakes of this region.

Turtles will eat anything that moves and many things that do not. The most important single factor in feeding all northern turtles, except

wood turtles and box turtles, is having a sufficient depth of water to allow them to submerge their heads while swallowing. Turtles should have both animal and vegetable foods. They should not be fed commercial "ant eggs." Besides food, turtles need either plenty of direct sunlight or cod-liver oil and bone meal.

I have known all our northern turtles, including the box and wood turtles, to thrive on a mixture of diced lean meat, lettuce, apple, and bone meal, with a salad dressing of beaten egg and cod-liver oil three times a week. Their eyes stayed clear and their shells firm, and their weight and size increased for over two years despite crowded conditions. Their food is best placed on a board or rock where it will not pick up dirt or get into the water.

Force feeding is laborious and unsatisfactory, but it is often necessary. The force feeding of liquids can best be done with a rubber syringe. An ordinary battery tester to which a thin rubber tube has been attached works well. The most common liquid food used is a mixture of beaten egg and cod-liver oil. Sometimes powdered milk is added to the mixture, but not whole milk. Never force feed chilled foods. The food should be at a temperature of 85° to 100° F.

In force feeding solids care should be taken not to injure the specimen. A rod stiff enough to force the food down the throat and smooth enough not to scratch the throat should be used. Small bamboo sections eight inches to two feet long and not over three-sixteenths to three-eighths of an inch wide, and scraped smooth, are best. Cut the meat into long narrow pieces of suitable size and cut a pocket in the end of the piece into which the stick is inserted. Dip the meat into a mixture of cod-liver oil, egg, and bone meal. This mixture acts as a lubricant and also makes the food more nourishing. Grasp the snake behind the head with the left hand. Hold its body quiet with your forearm and elbow, or have someone assist you. With your right hand insert the stick with the meat impaled on it into the mouth of the snake. If it refuses to open its mouth, insert the meat gently along the side of its mouth. Force the food down rather slowly, in order not to injure the snake. When the food is well down the throat, close the finger around the snake's throat to retain the meat while the feeding stick is removed. When the snake is released induce it to travel forward and it will be less likely to disgorge the food.

A frog may be force fed by simply placing meat in its mouth and holding its mouth shut until it is observed to swallow. Alligators should have the meat placed behind the "trap door" in the back of their throats. In all force feeding be careful not to injure the delicate membranes of the mouth. Mouth sores usually develop into a very serious

condition commonly known as "mouth rot," which is much easier to avoid than to cure.

Other than food, the most common problem in caring for snakes is skin parasites, particularly mites. Never place a new specimen in with others until you have observed that its mouth is free of sores and that it is not infected with mites. The symptoms of mites are: constant rubbing of the snake's sides against obstructions in the cage; presence of mites between the scales; improper shedding of skin, which should come off cleanly in one piece; shedding of skin at unusually frequent intervals; and a desire to soak constantly. The best method of treating for mites is to confine the snake in a pan of water for three or four days. Remove everything from the cage and clean it thoroughly. In a few days repeat the process—and hope that the disease will not spread through the entire collection.

Amphibians are subject to two common infections. One is sores on toes, legs, and bellies, which can usually be avoided by providing clean surfaces through frequent changes of soil and water. The second infection is an inflamed condition called "red leg," occurring commonly in frogs, which first appears on the legs, then spreads to the sides, and eventually causes death. It can be controlled by keeping the frogs at a temperature of about 45° to 50° F., and can sometimes be cured by placing them in a solution of potassium permanganate just strong enough to give the water a pink tinge. The solution should be deep enough so that they are well submerged but can get their heads above water without swimming. Let them soak for two or three days. Do not place too many together.

Many other problems will undoubtedly arise in keeping reptiles and amphibians in captivity, but following these few suggestions will at least increase the amateur's chances of reasonable success in his undertaking.

Venomous Snake Bites and Their Treatment

In Minnesota the snake bite problem is of very minor importance, since but two of the sixteen species of snakes are venomous, and the range of these two species includes probably less than 2 per cent of the area of the state.

The timber rattlesnake, *Crotalus horridus*, and the massasauga, or swamp rattlesnake, *Sistrurus catenatus*, are the two venomous Minnesota serpents. According to present records the ranges of these snakes overlap and include the land bordering the Mississippi River and its tributaries from about Hastings, in Dakota County, south and east to

the Iowa line.* Two structural characters positively distinguish these snakes from harmless species: (1) The tail ends in one or more blunt, caplike structures, the rattle. Even the newborn snake has a single cap, or "button." No native Minnesota snake having a sharply pointed tail is venomous, though farther south in the United States some such snakes are venomous. (2) A deep pit is present in the side of the head between the eye and the nostril. This pit is lacking in the harmless snakes of Minnesota.

Hikers and picnickers in the wilder places within the ranges of these snakes should make local inquiry about the abundance of rattlers. Should one want to travel afoot in the rocky bluff areas in southeastern Minnesota, one should take the precaution to wear high leather boots or leather leggings. One extensive report on snake bites (Hutchison, 1929) showed that 57.8 per cent of the bites recorded occurred on the legs. Pertinent in this connection is the fact that a rattler can strike not more than two-thirds of its length. Thus the majority of bites occur below the knee. Nearly all the remaining bites (41 per cent) occurred on the hands and arms. Extreme care should be used in picking up stones, logs, or any object that might conceal a rattler. Particularly should one take great care in placing the hands when climbing in rugged, rocky places. Rattlesnakes are fond of sunning themselves on exposed rocky ledges, especially during the warmer parts of cool spring and fall days, when they are in the vicinity of their hibernating dens in the rock ledges. (The structure and functioning of the poison fangs are discussed under the description of the timber rattlesnake.)

First-aid procedures. The following first-aid procedures have become widely recognized and have effectively reduced the fatalities from the bites of venomous snakes.

1. *Do not become excited and run for assistance. Do not take whisky or alcohol in any form.* To do so simply speeds up the blood circulation, hastens the absorption of the poison, and decreases your chances of recovery.

2. *Apply a tourniquet between the bite and the heart.* Use a necktie, a belt, a shoestring, or a strip of cloth from the clothing. Tie it loosely about the limb, then insert a stick under it and twist until circulation is much retarded but not entirely stopped. The tourniquet should be loosened for a few moments every ten or fifteen minutes to allow blood to reach the affected parts, thus preventing gangrene.

*Readers are strongly urged to send any specimens thought to be poisonous to the author at the Minnesota Museum of Natural History, University of Minnesota, Minneapolis. Rattlers may occur at a few other isolated points in the state.

3. *Make small incisions one-fourth of an inch deep crossing or connecting the fang punctures.* The knife or razor blade used should be sterilized in alcohol or other disinfectant or with a match. Apply suction. Use the mouth if there are no open cuts or sores in the mouth. A rubber bulb may be used, or a bottle heated in hot water will exert suction while cooling. Suction should be continued for a number of hours or until a doctor is reached.

4. *Call for a doctor or get to a hospital as soon as possible.* Small first-aid kits are available for those traveling in areas where snake bites are frequent. Schmidt and Davis (1941) mention the B-D Snake Bite Outfit No. 2006, Beckton-Dickinson and Company, Rutherford, New Jersey; the Dudley Kit, made by the Flack-Hendrick Company of San Antonio, Texas; and the Venex Snake Bite Outfit, made by the E. D. Bullard Company, Chicago.

Preservation of Specimens

Many persons interested in learning to recognize local species of reptiles and amphibians will want to build up a small collection of specimens, and others will find occasion to preserve specimens that are to be sent to authorities for identification. In either case the collector will find that the preservation of such specimens is comparatively simple. Immersion in preserving fluids is the method used almost universally. This method retains the structures and markings perfectly and the colors are preserved in most cases, though certain of the more brilliant ones are lost.

The most commonly used method of killing amphibians—salamanders, frogs, and toads—is by drowning. They should be tied in a cloth sack weighted with a stone and submerged for about twelve hours. Ether may be administered as a quick, humane method of killing them, but it has the disadvantage of causing sticky, whitish secretions to appear on the skin, particularly that of salamanders and toads. Some collectors get good results by simply immersing the live specimens in the preservative. Bishop (1943) suggests that salamanders may best be killed by immersing them in a solution made as follows: to one quart of water add an ounce of saturated solution of chloretone, which is sold in crystal form. Dead specimens should be injected with a 4 per cent solution of formaldehyde (1 part formalin to 10 parts water) with a hypodermic syringe. If a syringe is not available the abdomen should be slit to allow the preservative to penetrate the viscera. The specimens are then immersed in the solution for a week or so. Immersion in this solution hardens the tissues, which remain permanently in the position

assumed at the time of immersion. Consequently specimens should not be crowded so closely as to cause distortion. After this period of immersion the specimens should be washed and transferred to 60 per cent alcohol for permanent preservation. If alcohol is not available the specimens may be allowed to remain permanently in the formalin solution.

Snakes and turtles, especially turtles, are very tenacious of life and will survive long periods in ether or chloroform. They may be killed quickly by injecting concentrated formalin into the heart region with a hypodermic syringe. Ethylene dichloride, a liquid fumigant, quickly kills even large turtles. Schmidt and Davis (1941) suggest that crystals of the commonly used moth repellent known commercially as dichloricide (chemical name, paradichlorobenzene) promptly kills snakes, and this substance may prove to offer the best method of killing other herpetological specimens as well. The dead snakes should be injected with 4 per cent formalin at a number of points along the body to insure proper preservation. Cutting numerous inch-long slits in the abdomen will also serve. Lumps found in the body of a snake indicate recently swallowed food. They should be removed before preserving the specimen, by working them through a slit or forward through the mouth. A careful record of the identity of such food should be kept. Turtles are slit or injected behind the forelegs and in front of the hind legs. Reptiles are then immersed in 4 per cent formalin for a week or so, then washed and transferred to 75 per cent alcohol for permanent preservation. They may be left in the formalin solution, but better preservation results from the use of alcohol.

Labels for materials in preserving solutions should be carefully tested for permanence in liquids. The Dennison Manufacturing Company of Chicago makes a suitable waterproof tag. Many museums use sheepskin labels for this purpose. Higgins Eternal ink should be used in writing the data on the label, but soft pencil may be used for temporary labels. The essential data on each label consist of the locality, date of capture, and collector's name. If a collection of any size is anticipated each specimen should bear a number, recorded in a catalogue along with the scientific name, sex, habitat where specimen was taken, method of capture, food taken, and any other pertinent facts that may prove valuable.

The most satisfactory containers for the smaller specimens are wide-mouthed fruit jars with snap-on covers of suitable size. Wide-mouthed gallon glass containers now used extensively for commercial products serve well for larger specimens. Covered earthen crocks of still larger capacity serve best for large turtles.

Classification

The careful student of animals and plants is often criticized by the layman for using difficult Latin names for species that have readily understood and easily pronounced English names. In answering this criticism the student is quick to point out that the same animal may have many such common names applied to it in different parts of its range, making it difficult for workers to recognize the species concerned. The ruddy duck, for instance, has at least ninety-two common names. On the other hand, the same common name may be applied to different animals in different regions. For instance, the name "gopher" in Minnesota refers to the ground squirrel, *Citellus tridecemlineatus*, whereas in the South the name is applied to the turtle, *Gopherus polyphemus*. Such confusion created a demand for the standardization of names, so that students and scientists all over the world could accurately designate species. Latin, a widely known but dead language in which changes were no longer occurring, was chosen for this purpose. As a result a Russian, a Brazilian, and an English scientist can now refer to *Heterodon contortrix* (Linnaeus) and each will know exactly what animal is meant.

Ordinarily two names plus a person's name designate an animal. Thus in *Heterodon contortrix* (Linnaeus) the first name, *Heterodon*, which is capitalized, refers to the genus (plural, *genera*), to which the form belongs; the second, *contortrix*, which is not capitalized, indicates the species; the person's name, Linnaeus, refers to the man who first described the animal. Parentheses around this name indicate that the species has since been relocated in a different genus from the one in which this person originally placed it. If three Latin names appear the species has been divided further into subspecies, the third name designating the subspecies of the animal. Such a name is considered sufficient to identify a specimen, though it does not complete its classification. Similar genera are grouped together as families, similar families into orders, and similar orders into classes. A more complete designation of the hog-nosed snake mentioned above would thus be:

Class Reptilia
Order Serpentes
Family Colubridae
Genus *Heterodon*
Species *contortrix*
First described by Linnaeus

In the systematic classification of animals the amphibians (Class Amphibia) and the reptiles (Class Reptilia) each occupy a rank equiv-

alent to that of the birds (Class Aves) and the mammals (Class Mammalia). The study of amphibians and reptiles is referred to as the science of herpetology (*herpeton*, reptile, from *herpein*, to creep; *logy*, science). The specific characters distinguishing the major group are described at the head of the section giving a systematic account of the species.

Use of Keys

To the amateur keys often look forbiddingly technical and are consequently avoided, but, as a matter of fact, well-constructed keys supply the quickest, surest method of identifying unknown material, for they include only those characters pertinent to the identification of species. When the specimen has been identified in the key, the determination should be verified by reference to the more detailed description of the species.

An actual case will best demonstrate the use of the present handbook in identifying a specimen. Suppose that you are cleaning out the leaves from your window well some fall day, and you come across a small brown snake with a bright reddish belly. A friend immediately pronounces it a "copperhead," but you are skeptical and turn to the keys in this handbook. These keys are constructed in such a way that you are required to place your specimen in *one* of *two* groups at each step. Read carefully the characters described in *both* groups and decide which fits your specimen, then proceed to the next choice. The characters mentioned will often be strange to you, so turn to the glossary and find out exactly what is being described.

First you read the description of characters distinguishing the major groups, or classes, and find that the little snake is a reptile. So much you were sure of, but it is always well to start at the beginning of the keys. Then turn to the reptile key and read over 1 and 1a. Here the decision is not difficult, and you pass on as directed in 1a to the section on lizards and snakes. Here 2a applies to your specimen and sends you to the key to the snakes, where you must choose between 5 and 5a. Your little snake does not have a pit between the eye and the nostril, so you turn to 6 and 6a. Fine, sharp ridges or keels are prominent on the scales of your specimen, so you proceed to 7 and 7a. The anal plate of the snake is divided diagonally into two parts, so you pass on to 8 and 8a. The glossary tells you that the "rostral plate" is the one on the snout, and, since this plate is smooth and not turned up, you skip over 9 to 10 and 10a. Again referring to the glossary and a drawing of the head scales, you decide that the "loreal scale" is absent, and since the belly is reddish you find the snake belongs to the group that

is separated into species in 11 and 11a. The method of counting scale rows about the body is carefully noted in the illustration in the glossary, and your specimen has fifteen. Since the second character of color of belly also agrees with 11a, you conclude that your specimen is not the copperhead but the harmless little red-bellied snake, *Storeria occipitomaculata.* For a complete discussion of the species, refer to the body of the text.

Keys

For Use with Minnesota Amphibians and Reptiles

The species included in these keys do not constitute a check list for Minnesota. Numerous species that occur in neighboring states have been included since they may eventually be reported in Minnesota.

1. Skeleton cartilaginous; body covered with smooth, moist skin (fairly dry and warty, not scaled, in the toads); lungs well developed only in adult; digits without claws (sometimes horny tipped) . . . Amphibians (Class Amphibia)

1a. Skeleton bony; body covered with plates or scales; lungs present in both young and adult; digits with claws . . . . . Reptiles (Class Reptilia)

Key to Amphibians

1. Adults with tails; tadpoles without beaked mouth and rows of comblike teeth above and below . . . . . 2 . . . . . Salamanders (Order CAUDATA)

1a. Adults without tails; tadpoles with beaked mouth and rows of comblike teeth above and below . . . . . Frogs and Toads (Order SALIENTIA) 8

2. External gills present in adults; aquatic throughout life; toes and fingers 4–4, round and stubby, eyelids absent . . . . . Mud Puppy, *Necturus maculosus*

2a. External gills absent in adults; adults at least partially terrestrial; toes not 4–4 (some rudimentary); eyelids present . . . 3

3. Costal grooves indistinct; inner finger and inner and outer toes rudimentary . . Common Newt, *Triturus viridescens*

3a. Costal grooves present; inner finger and outer toe small but distinct 4

4. Costal grooves 17–21; a nasolabial groove; inner toe rudimentary . . . Red-backed Salamander, *Plethodon cinereus*

4a. Costal grooves 10–12; no nasolabial groove; digits 4–5, all well developed 5

5. Two plantar tubercles; variable pattern of black and yellow 6

5a. Plantar tubercle 1 or absent; black with yellow or bluish-white spots 7

6. Black ground color with variable yellow spots on back, sides, and often on belly . . . . . Tiger Salamander, *Ambystoma tigrinum tigrinum*

6a. Yellow ground color with irregular, rounded black spots . . . . Yellow Tiger Salamander, *Ambystoma tigrinum diaboli*

7. Plantar tubercle 1; black with yellow spots in 2 rows on back, none on lower sides; costal grooves 11 . . . (Ontario and Wisconsin) Spotted Salamander, *Ambystoma maculatum*

7a. Plantar tubercle absent or very faint; black, with or without bluish-white spots; costal grooves 12 . . . . . Jefferson's Salamander, *Ambystoma jeffersonianum*

8. Parotoid glands and cranial crests present; skin definitely warty and often quite dry 9

8a. Parotoid glands and cranial crests absent; skin smooth or only slightly warty 12

9. Warts in 2 series, large and small, intermingled; dark blotches small, each including but 1 to 4 large warts; length of parotoids as great or greater than distance between their anterior ends; outer metatarsal tubercle without cutting edge 10

9a. Warts of nearly uniform size; dark blotches large and including numerous small warts; length of parotoids less than distance between their anterior ends; outer metatarsal tubercle with cutting edge . . Plains Toad, *Bufo cognatus*

10. Cranial crests narrow and distinct, the postorbital crests complete 11

10a. Interorbital crests swollen and fused into one wide, rounded elevation, with or without a central groove; postorbital crests interrupted or absent . .Manitoba Toad, *Bufo hemiophrys*

11. Under parts usually mottled with dark; warts on body and tibia strongly developed, often spiny; cranial crests slightly diverging backward; outermost subarticular tubercle on longest toe nearly always divided; song a high-pitched musical trill of more than 10 seconds . . . . . .American Toad, *Bufo americanus*

11a. Under parts immaculate, usually with pectoral spot; warts on body and tibia less well developed and not spiny; cranial crests nearly parallel; subarticular tubercle of longest toe single or divided; song a low-pitched, nasal, waa-a-a of less than 5 seconds . . . . . (Iowa) Rocky Mountain Toad, *Bufo woodhousii*

12. Pupil a vertical slit when contracted; general build very short and stout; horny cutting edge on inner sole tubercle (Dakotas) Western Spadefoot Toad, *Scaphiopus bombifrons*

12a. Pupil round; build slender and elongate; no horny cutting edge on inner sole tubercle 13

13. Digits with terminal, adhesive discs (these may be very small, especially in preserved specimens); bellies and under thighs granular in texture . . . . Tree Frogs (Family HYLIDAE) 14

13a. Digits without terminal adhesive discs; under thighs only of a granular texture . . . . . Frogs (Family RANIDAE) 17

14. Finger discs small, no wider than fingers 15

14a. Finger discs distinctly wider than fingers 16

15. Skin somewhat warty and toadlike; toes almost fully webbed; a dark triangle between eyes (often indistinct) . . . . . Cricket Frog, *Acris crepitans*

15a. Skin smooth or finely granular; toes webbed only at base; 3 dark longitudinal stripes on back (sometimes interrupted) . . . . . Swamp Tree Frog, *Pseudacris nigrita*

16. Color cream to brown; a more or less distinct X mark on back; fingers without webs; back of thighs not orange; adhesive discs moderately large . Spring Peeper, *Hyla crucifer*

16a. Color usually gray to bright green, sometimes brown; dark back pattern not forming X; fingers partially webbed; adhesive discs large; posterior surface of thighs orange in life . . . . . Common Tree Frog, *Hyla versicolor*

17. Distinct dorsolateral folds present 19

17a. Dorsolateral folds indistinct or lacking 18

18. Size medium (2–3 inches); one joint of 4th toe free of web; usually broadly spotted or blotched with black on back and legs; immaculate beneath; a distinct musky odor in life . . . . . Mink Frog, *Rana septentrionalis*

18a. Size large (4–8 inches); 4th toe webbed to tip; plain dull greenish-drab above, indistinctly spotted if at all; below mottled with gray; no musky odor in life . . . . . Bull Frog, *Rana catesbeiana*

19. Secondary ridges on back between dorsolateral folds; black spot on back of elbow 20

19a. Without secondary ridges on back between dorsolateral folds; no black spot on back of elbow 23

20. Spots squarish on back; concealed surfaces of thighs bright orange in life . . . . . Pickerel Frog, *Rana palustris*

20a. Spots when present, rounded; concealed surfaces of thighs not orange in life 21

21. Body above unspotted . . . . . Leopard Frog, form burnsi, *Rana pipiens*

21a. Body above spotted or heavily mottled 22

22. Body above with distinct, light margined, black spots on a lighter ground color . . . . . Leopard Frog, *Rana pipiens*

22a. Body above with the dark spots nearly merging with the greatly darkened interspaces, particularly on hind legs . . . . . Leopard Frog, form kandiyohi, *Rana pipiens*

23. Color gray or brown; black ear patch; small outer sole tubercle present; upper jaw not green . . . . . Wood Frog, *Rana sylvatica*

23a. Color yellowish to greenish or blackish; no black ear patch; no outer sole tubercle; upper jaw bright green . . . . . Green Frog, *Rana clamitans*

Key to Reptiles

1. Body enclosed between upper (carapace) and lower (plastron) shields; anus a circular opening or longitudinal slit; jaws without teeth . . . . . Turtles (Subclass SYNAPSIDA; Order TESTUDINATA) 28

1a. Body without such shields; anus a cross slit; jaws toothed . . . Lizards and Snakes (Subclass DIAPSIDA; Order SQUAMATA) 2

2. Limbs present; eyelids movable; external ear openings present . . . . . Lizards (Suborder SAURIA) 3

2a. Without limbs; no external ear openings or movable eyelids . . . . . Snakes (Suborder SERPENTES) 5

3. Scales on back minute and granular, not shiny; scales on tail larger, in rings, and strongly keeled; femoral pores present . . . . . Six-lined Racer, *Cnemidophorus sexlineatus*

3a. Scales on tail shiny and similar to those on back, neither in rings nor keeled 4

4. Postnasal scale usually present; 5 narrow, light, longitudinal stripes on body, the median one bifurcating and continuing on top of head . . . Blue-Tailed Skink, *Eumeces fasciatus*

4a. Without postnasal scale; 7 narrow, light, longitudinal stripes, the median stripe not bifurcating but merging into light color on top of head . . . . . Black-Banded Skink, *Eumeces septentrionalis*

5. No deep pit between eye and nostril; tail terminating in a sharp tip (this character does not hold as an indicator of a harmless snake farther south and east in the United States) . . . . . Harmless Snakes (Family COLUBRIDAE) 6

5a. A deep pit between eye and nostril; tail with 1 or more blunt, horny caps at tip . Pit Vipers (Family CROTALIDAE) 26

6. Some or all of dorsal scales keeled 7

6a. Dorsal scales unkeeled 20

7. Anal plate divided 8

7a. Anal plate undivided 15

8. Rostral plate turned up in front and keeled above 9

8a. Rostral plate not turned up in front or keeled above 10

9. Upper line of rostral distinctly concave in lateral view; prefrontals separated by series of small scales; under side of tail as dark as abdomen . . . . . .Western Hog-Nosed Snake, *Heterodon nasicus*

9a. Upper line of rostral straight in lateral view; no small scales separating prefrontals; underside of tail lighter than abdomen . . . . Eastern Hog-Nosed Snake, *Heterodon contortrix*

10. Loreal scale absent; belly pale to deep reddish; size small . . 11

10a. Loreal scale present; belly not reddish 12

11. Dorsal scale rows 17; belly pale salmon in life . . . . . .DeKay's Snake, *Storeria dekayi*

11a. Dorsal scale rows 15; belly rich orange-red in life . . . . . .Red-Bellied Snake, *Storeria occipitomaculata*

12. First 3 to 5 scale rows smooth, remaining rows weakly keeled; 2 postoculars 13

12a. All dorsal scale rows, except often the first, strongly keeled; 3 postoculars . . . Common Water Snake, *Natrix sipedon*

13. Pattern of dark-bordered, brown blotches above 14

13a. Uniform bluish black, or only a suggestion of blotched pattern; a reddish tinge anteriorly between scales . . . . . .Pilot Black Snake (adult) *Elaphe obsoleta*

14. Ventral scales more than 220 . . . . . .Pilot Black Snake (young), *Elaphe obsoleta*

14a. Ventral scales less than 220 . . . Fox Snake, *Elaphe vulpina*

15. Scale rows 29 to 35 . . . . . Bull Snake, *Pituophis sayi*

15a. Scale rows 23 or less; pattern of longitudinal stripes 16

16. Tail less than 0.15 of total length; lower labials 5 to 7; double row of black spots on middle of belly . . . . . (Iowa and South Dakota) Striped Swamp Snake, *Tropidoclonium lineatum*

16a. Tail more than 0.15 of total length; lower labials 8 or more; ventral black spots, if present, near lateral tips of ventrals . . 17

17. Lateral stripe on 2d and 3d scale rows anteriorly 18

17a. Lateral stripe on 3d and 4th rows anteriorly 19

18. Upper of the 2 rows of spots, outlined on skin between scales, usually fused; interspaces more or less extensively red . . Red-sided Garter Snake, *Thamnophis sirtalis parietalis*

18a. Upper row of spots usually distinct; interspaces not red or very slightly touched with red . . . . . Common Garter Snake, *Thamnophis s. sirtalis*

19. Tail more than 0.25 of total length; subcaudal scales 75 to 125; upper labials without black margins . . . . . (Iowa) Western Ribbon Snake, *Thamnophis sauritus*

19a. Tail less than 0.25 of total length, subcaudal scales 63 to 86; upper labials with black posterior margins . . . . . Plains Garter Snake, *Thamnophis radix*

20. Anal plate not divided 21

20a. Anal plate divided 22

21. Dorsal saddle blotches 35 to 60 to anus, extending down to 5th to 3d scale rows; 2 series of alternating spots on sides below saddles; a Y-shaped light mark on back of head . . . . . Milk Snake, *Lampropeltis triangulum triangulum*

21a. Dorsal saddles 23 to 35 to anus, extending down to 3d scale row or lower; 1 series of alternating spots on sides below saddles; the Y-shaped light mark on head usually expanded laterally to appear as a collar from above . . . . . (Iowa) Red Milk Snake, *Lampropeltis t. syspila*

22. Color usually bright green, sometimes brownish; a single nasal plate pierced by the nostril . . . . . Smooth Green Snake, *Opheodrys vernalis*

22a. Color not bright green or brown; two nasal plates with nostril between them 23

23. Uniform blackish above; yellow collar 24

23a. Uniform greenish or bluish black above or with a spotted pattern; yellow collar absent 25

24. Scale rows usually 17; complete double row of black spots on belly . . . . . Prairie Ring-Necked Snake, *Diadophis punctatus arnyi*

24a. Scale rows 15; belly immaculate or with irregular, scattered black spots . . . . . Eastern Ring-Necked Snake, *Diadophis p. edwardsii*

25. Uniform greenish or bluish black above . . . . . Blue Racer (adult), *Coluber constrictor*

25a. Pattern of prominent dark blotches on lighter ground color . . . . . Blue Racer (young), *Coluber constrictor*

26. Top of head with about 9 large plates symmetrically arranged . . . . . Massasauga, *Sistrurus catenatus*

26a. Top of head with small scales, mostly unsymmetrically arranged 27

27. Dorsal blotches less than 33; tail usually black, rarely with rings . . . . . Timber Rattlesnake, *Crotalus horridus*

27a. Dorsal blotches more than 33; tail with a ringed pattern . . . . . (Dakotas) Prairie Rattlesnake, *Crotalus viridis*

28. Carapace and plastron covered by leathery skin 29

28a. Carapace and plastron covered by horny plates 30

29. Spines along anterior edge of carapace; a low, obtuse keel along middle of back; nostrils each with a papilla projecting into it from the separating septum . . . . . Spiny Soft-Shelled Turtle, *Amyda spinifera*

29a. No spines on anterior edge of carapace; no keel on back; no papillae projecting into nostrils . . . . . Brown Soft-Shelled Turtle, *Amyda mutica*

30. Tail nearly as long or longer than carapace, and with a dorsal row of horny tubercles . . . . . Snapping Turtle, *Chelydra serpentina*

30a. Tail definitely shorter than carapace and without a dorsal row of horny tubercles 31

31. Plastron with transverse hinge and movably attached to carapace 32

31a. Plastron without transverse hinge and immovably attached to carapace 33

32. Carapace very high domed; upper jaw with down curved hook in front . . . . . (Iowa) Western Box Turtle, *Terrapene ornata*

32a. Carapace deep but flattened above; upper jaw with a sharp notch in front . . . . . Blanding's Turtle, *Emys blandingii*

33. Upper jaw notched in front 34

33a. Upper jaw a flat inverted U-shape in front 35

34. A small, sharp tooth on either side of notch in front of upper jaw; carapace nearly smooth; plastron yellow with large central dark blotch . . . Painted Turtle, *Chrysemys bellii*

34a. A large, heavy tooth on either side of notch in front of upper jaw; carapace with strong concentric grooves on plates; plastron yellow with a large black blotch on each plate . . . . . Wood Turtle, *Clemmys insculpta*

35. Rounded yellow mark behind eye; keels on 2d or 3d dorsal plates straight or convex in lateral view before tubercles . . . . . Map Turtle, *Graptemys geographica*

35a. A boomerang-shaped yellow mark behind eye; keels of 2d and 3d dorsal plates concave in lateral view before tubercles . . . . False Map Turtle, *Graptemys pseudogeographica*

Hypothetical List

Under this heading are listed (1) species that have been erroneously reported as occurring in Minnesota, and (2) species that have not been reported in Minnesota, but may occur there.

Erroneous List

The following species have been reported as occurring in Minnesota. These reports have been investigated and, beyond reasonable doubt, should be considered erroneous.

DUSKY TREE FROG

Hyla versicolor phaeocrypta (Cope)

Cope (1889) described this race, and Wright and Wright (1942) include it in their handbook and report a specimen from Gull Lake, Brainerd, Minnesota. They express doubt as to its validity and state that Viosca considers it to have been described from poorly preserved material of *H. v. versicolor*. Stejneger and Barbour (1943) do not recognize the race. Under the circumstances it is here placed in the hypothetical list.

YELLOW-BELLIED KING SNAKE

Lampropeltis calligaster (Harlan)

A specimen of this snake in the Museum of the Academy of Natural Sciences of Philadelphia bears the label "Minnesota." E. R. Dunn, Curator of Herpetology at the Academy, examined this specimen and verified (correspondence) the data as "ANSP, 16330, Minnesota, H. E. Brown." Brown was head of the Philadelphia Zoo and, according to Dunn, "a good man on snakes." However, zoo specimens are always subject to considerable error in data. Only recently Bailey (1939) reported the first state record of *L. calligaster* in Iowa, stating that it is common throughout *southern* Iowa. He has no records north of the three southern tiers of Iowa counties. Blanchard (1921) states that this snake "has several times been said to occur in Wisconsin, but no definite record has been cited." Under the circumstances the occurrence of this species in Minnesota seems too doubtful to justify including it in the list of Minnesota forms.

SOUTHERN GROUND SNAKE

Haldea striatula (Linnaeus)

Stejneger and Barbour (1933) include Minnesota in the range of this species, evidently on the basis of United States National Museum specimen 4490, indicated as taken in Minnesota and referred to by Cope (1882). Guthrie (1926) includes it in his *Snakes of Iowa* on the basis of the above record. Doris Cochran, Associate Curator of Reptiles and Amphibians at the National Museum, examined this record and found that the specimen was from Fort Jackson, Mississippi, and not from Minnesota. Consequently this species must be definitely excluded from the list of Minnesota reptiles. (Breckenridge, *Copeia*, 1937.) Stejneger and Barbour do not include Minnesota in the range of this species in their 1943 *Check List*.

WESTERN RIBBON SNAKE

Thamnophis sauritus proximus (Say)

There is a single published report of this ribbon snake in Minnesota, and it is of questionable value. Ruthven (1908) states that "no definite Minnesota record has been found, the only record being a single specimen (6179) in the Academy of Natural Sciences of Philadelphia, labeled 'Minnesota.'" E. R. Dunn (correspondence) states: "The specimen ANS 6179 is present in the collection. It is certainly *T. sauritus proximus*. The datum on it is simply 'Minnesota,' no collector being on record." Reeve Bailey of Iowa State College has (MS) several central and southern Iowa records, but none for the north. It appears that the above record should be disregarded and that this species should be placed in the hypothetical list until further material becomes available.

CAROLINA BOX TURTLE

Terrapene carolina (Linnaeus)

A single specimen taken on the highway at Red Wing in Goodhue County by Donald Hatfield, on October 17, 1935, is the only Minnesota record for this box turtle. Considering the frequency with which turtles are picked up by tourists, to escape later, it seems more than probable that this specimen was so introduced.

Species That May Occur in Minnesota

The following species have not been reported from Minnesota, but there is reason to believe that they may occur in the state.

SPOTTED SALAMANDER

Ambystoma maculatum (Shaw)

It is possible that this salamander may occur in the extreme southeastern part of the state, since F. J. W. Schmidt (1926) reports it from Clark County, Wisconsin. Dymond, Snyder, and Logier (1928) report it from Lake Nipigon in Ontario, suggesting its possible occurrence in the northeastern tip of Minnesota.

EASTERN FOUR-TOED SALAMANDER

Hemidactylium scutatum (Schlegel)

This tiny salamander has been reported (Pope, T. E. B., 1930, 1931) as "common and widely spread over Vernon County" in Wisconsin, which is adjacent to Houston County, Minnesota. Thus it may possibly occur in southeastern Minnesota, though the Mississippi River may prove to be an effective barrier to the westward spread of this delicate little salamander.

ROCKY MOUNTAIN TOAD

Bufo woodhousii (Girard)

This toad may occur in the extreme southwestern part of the state, since Bailey (1941) reports it from Plymouth County in northwestern Iowa.

LINED SNAKE

Tropidoclonion lineatum (Hallowell)

The lined snake may occur in southwestern Minnesota, since Over (1923) found it in Minnehaha County in South Dakota, immediately adjacent to Rock County, Minnesota, and Reeve Bailey of Iowa State College has (MS) a record from Cherokee County in the third tier of Iowa counties south from the Minnesota line.

WESTERN DIAMOND RATTLESNAKE

Crotalus atrox (*Baird and Girard*)

Numerous records for this southern rattlesnake have been reported (Pope, T. E. B., 1930, 1931), several of them authenticated by specimens from Wood and Vernon counties in Wisconsin, which are east of Houston County, Minnesota, across the Mississippi River. There is evidence that this colony had its origin in snakes that escaped from captivity. Since the western diamond rattlesnake is a large, sturdy snake the Mississippi probably would not be a serious obstacle to its

westward movement, and it is entirely possible that the species may appear in Minnesota in the near future.

PRAIRIE RATTLESNAKE

Crotalus viridis viridis (Rafinesque)

Klauber (1938) reports specimens of the prairie rattlesnake from Plymouth County, Iowa, which is in the second tier of counties south of the Minnesota line. Klauber refers also to reports of rattlers killed near Granite Falls in Yellow Medicine County and suggests that if these reports are correct the snakes would probably prove to be *C. viridis*. These reports and several others from this area have been investigated, and no positive evidence of the presence of rattlesnakes can be obtained. The Minnesota River bluffs at Granite Falls are continuous with the Mississippi River habitat in southeastern Minnesota, where the timber rattler is common, and if specimens are secured from this area they will probably prove to be timber rattlers. In the discussion of the range of the timber rattlesnake several other references to "rattlesnakes" are considered.

ORNATE BOX TURTLE

Terrapene ornata (Agassiz)

Blanchard (1922) has a record of an ornate box turtle taken in Dickinson County, Iowa, adjacent to Jackson County, Minnesota, in the southwest, and Scott (1938) has a record from Clayton County in northeastern Iowa, which strongly suggest that this turtle does, or did in the past, occur in southern Minnesota. Reeve Bailey (correspondence) states that it is now extirpated from most of the intensively cultivated areas in Iowa where it formerly was found. If this turtle did occur in Minnesota it has probably met the same fate.

Amphibians and Reptiles of Minnesota

DESCRIPTIONS, DISTRIBUTIONS, HABITS,
AND LIFE HISTORIES

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Amphibians Class AMPHIBIA

Animals of the class Amphibia have developed structural changes enabling them to leave the water and live at least a part of their lives in the air. The word is derived from the Greek words "amphi," meaning double, and "bios," meaning life, referring to the aquatic larval stage and the air-breathing adult stage. Typically the eggs of this group are laid in the water. They hatch into gill-bearing larvae or tadpoles, which eventually lose their gills, as the lungs begin to function, acquire legs, and continue life on land. Amphibians have smooth, moist skins (fairly dry in toads) without scales, and in American forms do not have claws on the toes. They are cold-blooded (poikilothermic) and have three-chambered hearts. (Fishes have two-chambered hearts; warm-blooded mammals, four-chambered.) The skull has two occipital condyles and is composed of many fewer bones than that of the fishes.

Salamanders—Tailed Amphibians

Order CAUDATA

The salamanders have elongate bodies and tails that persist throughout life. All five Minnesota species have two pairs of well-developed legs in the adult stage. (Two genera, *Siren* and *Pseudobranchus*, found in the southern United States, have but one pair of legs.) There is no external evidence of an ear. Lungs are present in all except the red-backed salamander. The body muscles have a segmental arrangement, which in most forms produces distinct vertical grooves, called *costal grooves*, on the sides. The eggs of all Minnesota species, except the red-backed salamander, are laid in the water. The aquatic larvae have elongate, laterally compressed bodies, three pairs of external, plumelike gills, and a wide mouth similar to that of the adult. All these characters serve to distinguish these larvae from toad and frog tadpoles. In metamorphosing to the land form the principal changes are the disappearance of gills and tail fins and the development of limbs. The limbs appear fairly early in larval life.

In the Caudata there is no physical contact of the sexes during the transfer of sperm. The male deposits in the water a gelatinous spermatophore that is surmounted by a small head containing sperm cells. The female secures the sperm by picking up this head portion of the spermatophore in the lips of the cloaca.

Salamanders have no vocal apparatus.

MUD PUPPY, OR WATER DOG

Necturus maculosus (Rafinesque)

Map 1. Range of the mud puppy.

Races. S & B* (1943) recognize two subspecies of this mud puppy. *N. m. maculosus* is the common form in Minnesota. Bishop (1941a) described *N. m. stictus* from specimens taken in Wisconsin. He examined two St. Croix River specimens and states that they "certainly approach *stictus*," but that he "would regard the two specimens as intergrades." More material is being collected to determine the status of this form in Minnesota.

Description. The mud puppy (Figure 1) is the largest Minnesota salamander and the only one retaining the gilled, larval form throughout life. The largest Minnesota specimen examined was 13½ inches (342 mm.) long. Bishop (1941) reports this salamander as reaching 17 inches (432 mm.). The head is broad and flattened, with a squarish snout, the eyes small, and the mouth large. There are three pairs of red, feathery gills on the sides of the neck. The body is stout and slightly depressed and has 14 costal grooves. The limbs are short. There are four fingers and four toes, stubby, without claws and only slightly flattened. (The similar tiger salamander larva has five pointed, much flattened toes.) The vent is median ventral, just behind the hind limbs. In the female it is a smooth, simple, light-colored slit; in the male it is dark, wrinkled at the margin, and has a transverse groove behind and two nipplelike papillae. Above, the mud puppy is dark gray to brownish, speckled with light spots and usually with large black spots. The belly varies from slightly paler to much lighter than the back and is sometimes dark spotted.

The larvae are seven-eighths of an inch (22.5 mm.) long when hatched and 8 inches (200 mm.) at maturity (Bishop, 1926). The young are dark above, with a conspicuous light stripe on either side of the middorsal line from the snout well onto the tail.

Range. Viosca (1937) defines the range of this mud puppy as "Mis-

**A Check List of North American Amphibians and Reptiles,* by Leonard Stejneger and Thomas Barbour (5th ed.; Cambridge, Mass.: Museum of Comparative Zoology, Harvard College, 1943), is thus referred to throughout the text.

sissippi and its tributaries from the Arkansas River northward, Great Lakes Drainage area, and upper Hudson River system." It occurs also in southern Manitoba (United States National Museum, 8560). The few Minnesota records (Map 1) are so distributed as to indicate that this salamander probably occurs in the larger lakes and streams throughout the state.

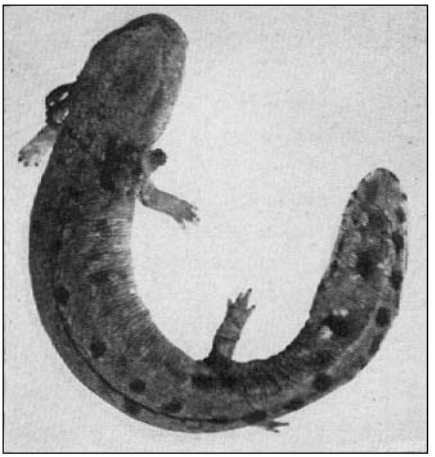


Figure 1. Mud puppy, *Necturus maculosus*. (⅓ natural size.)

Habits. The mud puppy, water dog, or water "lizard" is a strange and terrible creature to most people. Like most little-known animals, it is terrible because it is strange and not because of any known facts about it. Many fishermen will cut their lines rather than touch the "vile creatures." However, the truth is that it is not a lizard but a salamander, allied to the frogs; its bite is not venomous, and it has no poisonous spines, or skin secretions harmful to human hands. As a matter of fact, its fine, white flesh has been reported as very palatable.

All other Minnesota salamanders lose their external gills after a larval period and take up a life on land, where they breathe with lungs. The mud puppy retains its gills and remains in the water throughout life. It is most often seen when pulled in on hook and line by fishermen. Ice fishermen frequently take them, which indicates that the animal does not hibernate as other Minnesota salamanders do.

Habitat. The mud puppy is found only in the larger, permanent streams and lakes. It thrives in many different types of waters, from the clear, rocky bottoms of Lake Superior to the weed-choked bottoms and bayous of the Minnesota River. Its varied diet probably explains, in part at least, its ability to survive such diverse conditions.

Food. Nearly all the smaller forms of aquatic life fall prey to the mud puppy's voracious appetite. Hamilton (1932) reported on the stomach contents of 340 mud puppies taken throughout the year. He found crayfishes and other smaller crustaceans comprising about a third of its food, water insects making up another third, and the remainder composed of small fishes, worms, frogs, and mollusks. Fish eggs also are taken at times.

Breeding. The life history of this salamander, recorded in detail by

Bishop (1926, 1941, 1943) is here briefly summarized. The mud puppy breeds over a long period through late fall and winter. Like other salamanders, the pair engages in an elaborate courtship ceremony, during which the male deposits in the water spermatophores, or jellylike masses with saclike heads containing sperm. These are taken up in the cloaca of the female at the conclusion of the performance. The pea-sized eggs are deposited in late spring or early summer, usually at a depth of 2 to 4 feet. A cavity is excavated beneath a sunken board, log, or stone, and the eggs are attached, in groups of 50 to 100, to the under surface of such cover by gelatinous stalks. The female guards the nest during the incubation period of the eggs, which varies from one to two months, depending on the temperature of the water. The larvae grow very slowly and do not mature until their fifth year, when they are about 8 inches long.

Suggested Reading. Sherman C. Bishop, 1926, pp. 5–60; 1941, pp. 18–37; 1943, pp. 40–46. W. J. Hamilton, 1932, pp. 83–86. B. G. Smith, 1911a, pp. 181–200.

COMMON NEWT

Triturus viridescens (Rafinesque)

Map 2. Range of the newt.

Races. Three subspecies of this newt are recognized by S & B (1943). The form occurring in Minnesota is *T. v. louisianensis.*

Description. The newt (Figure 2) begins life as a tadpole, metamorphoses into a land form called the eft, then at maturity returns to the water. Each stage differs markedly from the others. Sometimes newts mature without passing through the red eft stage.

The aquatic adult newt is about 4 inches (100 mm.) long. The tail is about half the total length. The head is small, the eye conspicuous. The body is somewhat compressed. The fore limbs are very slender. There are four fingers, the inner one rudimentary. The hind limbs are heavier than the fore limbs and are enlarged in breeding male specimens. There are five toes, much flattened, the inner and outer ones small. The tail is much flattened laterally, with a fin both above and below. The upper fin extends onto the body. This fin is much widened in males during the breeding season.

The skin is smooth and the costal grooves indistinct. The color above varies from yellowish or brownish to green; below, from pale to bright yellow, with a sharp line of demarcation between the colors along the side. There are small, black dots scattered over the whole animal. These dots are larger below and on the tail. There are usually some small red dots, sometimes narrowly bordered with black on the sides of the back. (In the eastern subspecies, *T. v. viridescens*, these red dots are larger and more heavily circled with black.) A black line runs through the eye to the foreleg.

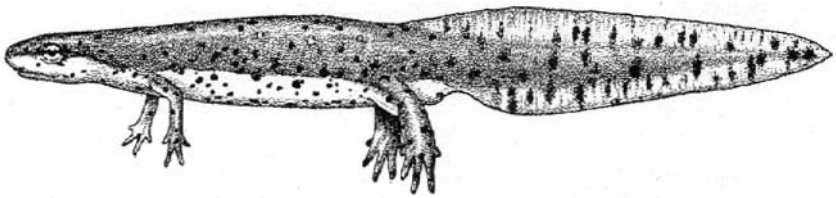


Figure 2. Newt, *Triturus viridescens.* (Natural size.)

The immature terrestrial red efts differ in having the tail only slightly compressed and the fins lacking, the skin rough and pebbled (it is smooth in newly transformed individuals), the head wider, and the toes less flattened. Over most of its range this form is bright red. The few Minnesota specimens seen by the author have ranged from a dull reddish brown to nearly black. Gustav Swanson of the University of Minnesota describes efts found at Itasca Park as bright reddish brown. This form usually, but not always, has black and red spots.

The larvae are a third of an inch (7.5 mm.) long on hatching. They have three pairs of external gills and are uniformly greenish gray faintly stippled with dark, with light spots along the sides. The larvae mature when they are about 1½ inches (40 mm.) long. The tail is dark and light mottled. The belly is speckled with dark.

Range. The range of the newt, including its three races, extends from northern Ontario and Quebec to Florida, west to Texas and Minnesota. The subspecies, *T. v. louisianensis*, occupies the portion of that territory from Texas eastward to Florida and South Carolina northwestward to northern Minnesota. It is apparently widespread in the wooded parts of Minnesota, although specimens are preserved from only five stations (Map 2): Clearwater County, Itasca Park (400, 1234–5); Cook County, Poplar Lake (401–8); Hennepin County, Lake Minnetonka (University of Michigan Museum of Zoology 51112–5); Hubbard County, Itasca Park (1072); St. Louis County, Eagle Nest Lake (959).

Habits. In early summer the tiny larval newt appears. It greatly resembles a mosquito wriggler, both in size and form. At maturity (1½

inches) it might pass as a small frog tadpole, but the wide mouth structure and narrower body differentiate it from that form. In fall the tiny larva metamorphoses into the red eft stage. At this time the newt loses its gills, acquires functional lungs, and begins life as a land animal. It burrows beneath logs and debris of the forest floor to hibernate, then feeds and lives entirely on land for three to four years. During this period it may be found by turning over such cover as logs, bark, and rocks in dense forest lands. It may travel to the surprising distance of a mile or more from ponds or lakes. It matures at the end of this period and returns to the water to breed, and normally remains a water animal for the rest of its life. In the water the newt apparently does not hibernate but remains active beneath the ice.

Breeding. The breeding period, which occurs both in fall and spring, finds the males stimulated to strut about the females in the water in remarkable courtship antics, preceding the depositing in the water of gelatinous spermatophores containing the sperm. The sperm sac is then taken up in the cloaca of the female. As with all salamanders, there is no contact of the sexes at the time of sperm transfer. The tiny eggs laid in the spring are cemented singly, or in clusters of a few, to leaves, stalks, or other supports in the water, and hatch in two to four weeks, depending upon the water temperature.

Habitat. As the life habits of the newt require, the habitat consists of permanent or semipermanent ponds or lakes bordered by undisturbed forest lands with heavy leaf mold and fallen logs. Samuel Eddy of the University of Minnesota found newts abundant in coniferous habitats at Poplar and Moosehorn lakes in Cook County, but the Michigan Museum specimens from Lake Minnetonka are from the deciduous region.

One of the remarkable characters of this salamander is its apparent adaptability to environmental changes. Workers in different regions have found the animal passing through the terrestrial stage in varying periods of time, and it has been shown experimentally (Noble, 1929) that it will mature without passing through a terrestrial stage at all. Furthermore, if the animal finds its home pond drying up it transforms into terrestrial form and lives on land until its pond reappears.

Food. The food of the newt has been reported (Hamilton, 1932) to consist of mosquito and other insect larvae, fairy shrimps and other small crustaceans, and eggs of other amphibians. According to P. H. Pope (1924), the larval diet includes green algae, but he considers the larvae to be largely carnivorous.

Suggested Reading. Sherman C. Bishop, 1941, pp. 54–82; 1943, pp. 106–9. G. K. Noble, 1929, pp. 1–22. P. H. Pope, 1924, pp. 305–68.

JEFFERSON'S SALAMANDER

Ambystoma jeffersonianum (Green)

Description. Jefferson's salamander (Figure 3) has a flattened head, with a blunt, rounded snout and prominent eyes. The mouth is large and extends back beyond the eyes. There is a row of fine, sharp teeth on both jaws. There is a well-developed gular fold, with smaller lateral folds connecting it with the eyes. The tongue is large, thick, and heavily ridged. The limbs are well developed but delicate. There are four fingers and five toes. The plantar tubercles are faint or absent. The body is slender, with 12 costal grooves and a middorsal groove. The anus is a longitudinal slit just behind the hind limbs. The tail is laterally compressed and narrow and constitutes a little less than half the total length. The color is shiny bluish or brownish black, usually with pale bluish spots, and paler underneath.

Map 3. Range of Jefferson's salamander.

Minnesota specimens of this salamander are definitely smaller than those from farther east. Bishop (1941, 1943) reports New York specimens as reaching a maximum of 185 mm. (7.28 inches), with an average for breeding adults of 162 mm. (6.37 inches), but the largest Minnesota specimen is only 106 mm. long (4.17 inches). Careful examination of series of specimens has not revealed structural differences, and Minnesota salamanders are considered to be a somewhat dwarfed population of *A. jeffersonianum.* An average sized Minnesota specimen (32) measured as follows: total length 3¾ inches (91.0 mm.); body and head, 2 inches (50.0 mm.); tail, 1½ inches (41.0 mm.); foreleg, half an inch (12.0 mm.); hind leg, five-eighths of an inch (15.0 mm.); head width, a third of an inch (7.5 mm.).

Piersol (1910) in describing Jefferson's salamander larvae mentions "a massing of the dark chromatophores into 3 or 4 spots placed in a row along each side, giving the animal, when viewed from above, the appearance of being banded." The ground color varies from greenish to yellowish gray. The larvae are about half an inch (12 mm.) long at hatching and may grow to 3 inches (75 mm.) before metamorphosis.

Range. Bishop (1943) records this salamander "from Manitoba and Ontario north to 53° N. latitude; Hull, Quebec, eastward to Gaspé, New Brunswick, and southward through New England and New York to Virginia, westward to Wisconsin, Illinois, and Arkansas." Present records show it occurring in Minnesota in wooded habitats from the

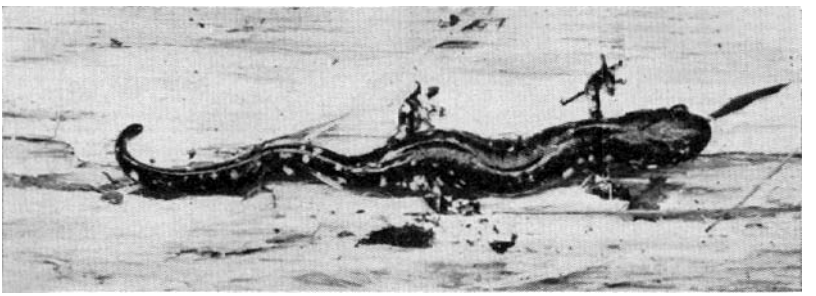


Figure 3. Jefferson's salamander, *Ambystoma jeffersonianum.* (Natural size.)

Twin Cities north to Lake of the Woods (Map 3). Records to the northeast (Dymond, Snyder, and Logier, 1928) suggest that it is present north of Lake Superior. The disturbed condition of the forests is undoubtedly responsible for its reduction or possible elimination from the southeastern part of the state.

Habitat. Unlike the larger tiger salamander, this little salamander is seldom if ever found in the open, but may be found by turning over such cover as rotting logs or bark slabs, under which it hides. It has been found only in heavy, undisturbed hardwood or mixed hardwood and coniferous forests, where many rotting logs remain and depressions afford the semipermanent ponds required for breeding. Adults have been taken in Itasca Park still hiding beneath logs in late September, after the first frosts. It seems safe to assume that they hibernate in these situations.

Breeding. These surprising little animals, with their entire lack of protection against the cold, emerge from hibernation at the first suggestion of spring and move to ponds, still ice-choked, to breed. Here they carry on their equally surprising courtship performance, in which the male struts about the chosen female with the tail held high and swaying back and forth in a vibratory waving motion. This procedure, including the depositing of the gelatinous spermatophores and the taking up of the sperm sac in the cloaca of the female, has been described in detail by Kumpf and Yeaton (1932).

The tiny, jelly-coated dark eggs are reported (Smith, 1911) to be laid in small, grapelike clusters up to 35 in number, and are attached

to submerged leaves, stems, or twigs. They hatch in four to six weeks. The time required for the maturing of the larvae has been reported (Bishop, 1941) as eight to eighteen weeks, and they are thought to require a little less than two years to mature after metamorphosis.

Food. The larvae of this salamander feed extensively on the tiny, aquatic crustaceans Daphnia and Cyclops (Smith, 1911). The terrestrial adults prey on a wide range of adult insects, insect larvae, and pupae, earthworms, sowbugs, and spiders, which they secure while foraging in the debris of the forest floor.

Suggested Reading. Sherman C. Bishop, 1941, pp. 82–168; 1943, pp. 133–36. B. G. Smith, 1911, pp. 14–27. K. F. Kumpf and S. C. Yeaton, Jr., 1932, pp. 1–6.

TIGER SALAMANDER

Ambystoma tigrinum (Green)

Races. Dunn (1940) divides this widespread species into seven subspecies. Bishop (1943) lists only five races. The two races *A. t. tigrinum* and *A. t. diaboli,* found in Minnesota, are acceptable to both authors. Dunn's *A. t. slateri,* referred to as *A. t. melanostictum* by Bishop, occurs in the Dakotas adjacent to Minnesota, but no specimens referable to this subspecies have been taken in Minnesota.

Map 4. Range of the tiger salamander. Circles with D indicate yellow tiger salamander.

Description. With the exception of the aquatic mud puppy, the tiger salamander (Figure 4) is the largest of the salamanders found in Minnesota. It attains a length of 8 inches or slightly more. The head is flattened, the snout rounded, and the eyes are prominent. There is a heavy gular fold. Both pairs of limbs are thick and strong. There are four fingers and five toes, both flattened and pointed, and two plantar tubercles. The body is heavy. There are 12 costal grooves and a strong dorsal groove extending halfway onto the tail. The tail is strong and laterally compressed. The skin is smooth and moist.

The color above is brownish black to shiny black, grading toward flesh color beneath. There are many yellow spots or blotches over the entire animal, varying greatly in extent. In the subspecies *A. t. diaboli,*

which may be called the yellow tiger salamander, this yellow color expands until it becomes the ground color, and the black is left as blotches. In *A. t. melanostictum*, which may occur in western Minnesota, the dark ground color is reduced to a network.

The larvae at hatching are about five-eighths of an inch long. The head is much widened. There are three pairs of gills. The body is much compressed laterally. There are well-developed upper and lower tail fins. The color is yellowish green, with series of dark spots and a

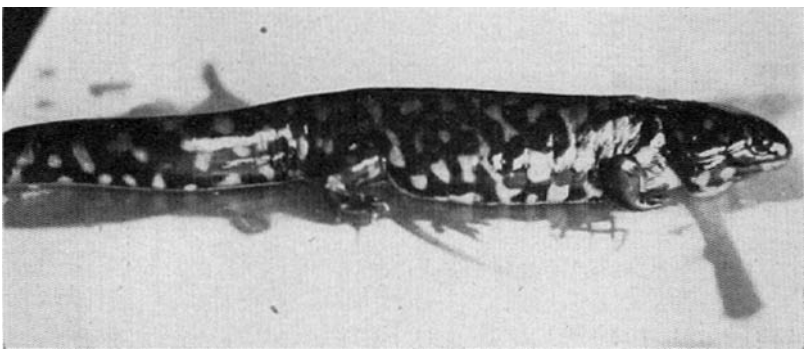


Figure 4. Tiger salamander, *Ambystoma tigrinum*. (½ natural size.)

light lateral stripe. The larger larvae have very wide, flat, catfish-like heads, three pairs of feathery-margined gills, laterally compressed bodies, two pairs of well-developed legs, and wide-finned tails. In color the larvae are a pale, dingy yellow, finely peppered with dark. The spots tend to clump into blotches. The belly is pale and unspotted. These larvae are often confused with the mud puppy, but the tiger salamander larva has five pointed toes on the hind feet, the mud puppy four relatively blunt toes.

Range. As a species the tiger salamander ranges over most of the United States and northern Mexico, extending northward into the west central and southwestern provinces of Canada (Map 4). *A. t. tigrinum*, the eastern subspecies common over most of Minnesota, occurs throughout the hardwood and prairie sections of Minnesota and into the margin of the predominantly coniferous regions. The form *A. t. diaboli* ranges (Dunn, 1940) over "North Dakota (north and east of Altamount Moraine) into Alberta and Saskatchewan." Minnesota records of this race are as follows: Lac Qui Parle County (United States National Museum 3984); Lyon County, Island Lake (British Museum); Swift County, Long Lake (996); Traverse County, Wheaton (181).

Habits. The tiger salamander is by all odds the best known Minne-

sota salamander. It is widely but erroneously called a "lizard." It comes to popular attention when it crosses highways in mass migrations, when the numbers killed are sometimes so great as to warrant comment in the newspapers. The author once counted 142 dead salamanders on one quarter mile of pavement on Highway 61 near Rosemount in Dakota County. The explanation is that these salamanders cannot long withstand dry conditions and find warm, foggy or rainy nights ideal for moving about. Such nights in late fall bring out large numbers in search of hibernating quarters, and again in early spring such conditions bring them forth seeking temporary ponds in which to breed.

An astonishing thing about these animals is the manner in which an abundant spring population can so suddenly and completely disappear and an apparently salamanderless area can be literally overrun by the animals in the fall. The explanation is found in their remarkable ability to take advantage of cover. Tiger salamanders have been taken in summer under boards in sand dunes, under beach logs, in pocket gopher holes, in basements, in well pits, about deserted foundations, in rock ledges, and, in fact, in almost any place where they can find a moist, undisturbed situation. They spend the winters in similar places where sufficient protection against the cold is found. One farmer reported digging up more than a score of these salamanders from a grass-lined burrow (probably a deserted ground squirrel den) about four feet down in a road cut.

The natural enemies of this salamander include several species of snakes, especially the garter snakes and water snakes, several of the hawks, and the great horned owl. The animal is one of its own worst enemies, for the larger larvae are voracious and will eat large numbers of smaller ones. Such water conditions as pollution, lack of oxygen, or the actual drying up of ponds destroy many of the larvae.

Breeding. Before the ice has disappeared on the ponds the first tiger salamanders arrive to breed and lay their eggs. Their strange strutting courtship has been described by Kumpf (1934). As with most other salamanders, the males deposit gelatinous spermatophores in the water. The portion containing the sperm is then taken up in the cloaca of the females and within a very few days the fertilized eggs are laid. Groups of 25 to 75 eggs are deposited with gelatinous coatings that expand in the water to protect the eggs. Water temperatures cause great variation in the incubation period, and temperatures plus the food available govern the maturing rate. The larvae usually mature and metamorphose sometime during the summer, but at times they remain over the following winter as larvae, as attested by the nearly

10-inch (250-mm.) larva taken May 25, 1940 in Wright County. Their size at metamorphosing, usually from 5 to 6 inches, varies according to the water depth and food supply.

Suggested Reading. Sherman C. Bishop, 1941, pp. 155–74; 1943, 159–74. E. R. Dunn, 1940, pp. 154–62. K. F. Kumpf, 1934, pp. 7–10. B. G. Smith, 1911, pp. 14–27.

RED-BACKED SALAMANDER

Plethodon cinereus (Green)

Map 5. Range of the red-backed salamander.

Races. S & B (1943) recognize two subspecies of this salamander, only one of which, *P. c. cinereus*, occurs in Minnesota.

Description. The head of the red-backed salamander (Figure 5) is much flattened, the eye conspicuous, the snout blunt, and there is a tiny groove downward from the nostril to the mouth. There is a prominent gular fold. The limbs are small and fragile. There are four fingers and five toes. The first digits are very small. There is very little webbing on the feet. The body is nearly cylindrical and has 17 to 21 costal grooves. The tail is round in cross section and constitutes slightly more than half the total length. The measurements of an adult specimen (389) are as follows: total length, 3.67 inches (93 mm.); body and head, 1.76 inches (44 mm.); head width, 0.23 inches (6 mm.); hind limb, 0.35 inches (9 mm.); fore limb, 0.27 inches (7 mm.).

Red and gray color phases of this animal are known, but as far as the author is aware only the red phase occurs in Minnesota. There is a broad stripe on the back, varying, in the red phase, from bright yellowish brown to bright reddish brown. This stripe starts at the neck and merges into dark color beyond the middle of the tail. This stripe is darkened along the center by fine dark mottlings. The part of the back adjacent to the stripe is nearly black, grading into finely mottled sides and becoming still lighter on the belly, which is also finely mottled. The head is dark brown above, but below is somewhat lighter than the belly. The tail is dark brown to black and is paler beneath. The limbs are dark finely mottled with light. In the gray phase the bright red is largely replaced by gray.

The larvae are terrestrial and pass most of the gill-bearing stage in the egg. At hatching they are described (Cochran, 1911) as about 20 mm. long. The gills, already decreasing in size at the time of hatching, shrivel up to mere stubs in twenty-four hours.

Range. The most recent check list (S & B, 1943) gives the range of the red-backed salamander as "Gaspesia and Cape Breton Island

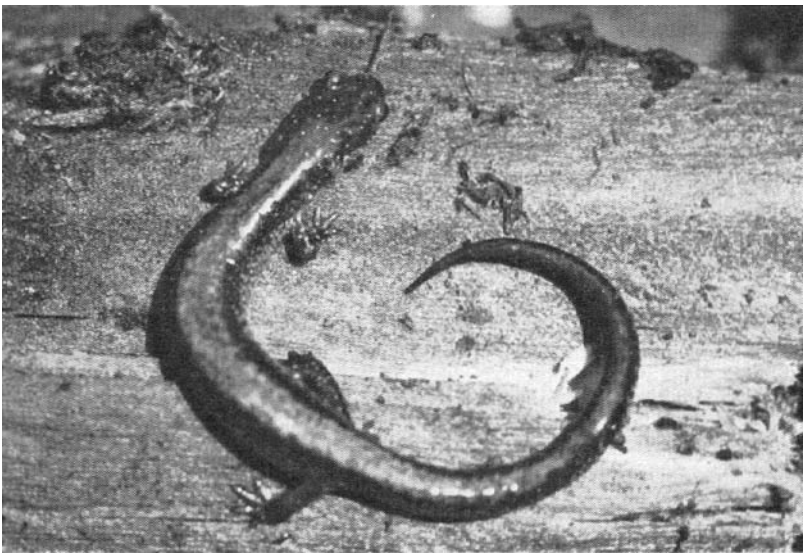


Figure 5. Red-backed salamander, *Plethodon cinereus.* (1½ natural size.)

west to Fort William, Ontario, south to Dallas, Georgia, Missouri, and Arkansas." In Minnesota this salamander has been taken in suitable habitats at widely scattered points (Map 5). It would be expected to occur throughout the heavily wooded parts of the state. The Chippewa County specimen listed below appears to be from the prairies, but was actually taken in the heavy flood plain forests along the Minnesota River. Such forests were once continuous along the river with the heavy hardwoods to the southeast. Minnesota records are as follows: Chippewa County, Montevideo (1091–92); Cook County, Grand Portage (1360); Lake County, Stewart River (1223); Mille Lacs County, Vineland (479, 1075); Pine County, Sturgeon Lake (361–62).

Breeding. The red-backed salamander differs from all other Minnesota salamanders in being entirely terrestrial. It does not resort to the water even for breeding. This circumstance is particularly noteworthy in view of the fact that this species, in common with other members of the family Plethodontidae, lacks even the vestiges of lungs. It seems

well established that the breeding activities of this species begin in the fall and continue through early spring (Blanchard, 1928; Hood, 1934; Bishop, 1943). At this time spermatophores are deposited and are taken up in the cloaca of the female. In June and July from three to thirteen yellowish eggs are laid in cavities in rotting logs. They are attached by gelatinous stalks to the upper surface of the cavities and hang like tiny bunches of grapes. The female guards the eggs until they hatch in the later part of the summer. Within a few days after hatching the young appear to be miniature adults. About two years are required for them to reach maturity (Blanchard, 1928).

Habitat. Although this species has completely adapted itself to a terrestrial existence, it still requires much the same type of moist woodland habitat as Jefferson's salamander. The only red-backs found by the author were in rotten logs easily torn apart. Reports of the type of forest preferred by this salamander differ, but all investigators seem to agree that it is seldom or never found in pure coniferous stands. Several Minnesota specimens from coniferous regions were actually found in mixed stands of spruce, poplar, and birch in these regions. Heavy maple-basswood forests are favored habitats in Minnesota.

Food. The red-backed salamander feeds on a great variety of smaller animals that thrive in rotting wood, under dead leaves, and in the loose leaf mold of the forest floor. Cochran (1911) found in fifteen stomachs of red-backed salamanders a variety of small insects, centipedes, earthworms, snails, spiders, and sowbugs.

Suggested Reading. Sherman C. Bishop, 1941, pp. 196–219; 1943, pp. 232–36. F. N. Blanchard, 1928, pp. 156–64. M. E. Cochran, 1911, pp. 332–49. G. K. Noble and M. K. Brady, 1930, pp. 52–54. E. R. Dunn, 1926, pp. 163–80.

Toads and Frogs

Order SALIENTIA

The toads and frogs are amphibians with short, compact bodies, four well-developed legs, the hind pair larger, and without tails in the adult stage. There is a prominent tympanum or external eardrum just behind the eye in all Minnesota forms. The eggs are deposited in the water. In the aquatic larvae there is a tail with finlike edges, the head and body are united in an oval, bulbous form, and the small mouth is bordered by a horny beak and comblike scraping lips. Gills are present but are concealed beneath an opercular membrane. The water passes into the mouth and nostrils, over the gills, and out through an opening on the left side called the spiracle. These characters distinguish the larvae of toads and frogs from those of the salamanders.

Transformation or metamorphosis from larva to adult involves a much greater change in the toads and frogs than in the salamanders. The fore and hind limbs begin to grow at about the same time, though the hind legs are evident sooner because the fore limbs are concealed under the opercular membrane. The left foreleg appears first through the spiracle, and later the right breaks through the ruptured membrane opposite. The beak and comblike structures about the tadpole's mouth disappear and the mouth widens greatly. The tail is absorbed and disappears. The eyes enlarge, protrude, and develop lids. The intestine shortens from the long, coiled form of a vegetarian animal to the short type of the carnivore. These changes occur at different times in different species, but the same changes occur throughout the order. The Minnesota representatives of this order are divided into three families: Bufonidae, the toads; Hylidae, the tree frogs; and Ranidae, the frogs.

In the Salientia, except for a few exotic forms, there is no internal fertilization of the eggs as in the salamanders or in higher animals. The male clasps the female tightly and deposits sperm over the eggs immediately after they are laid and before the gelatinous coating around the eggs has expanded in the water.

All male toads and frogs have vocal mechanisms that produce calls audible for considerable distances.

Toads

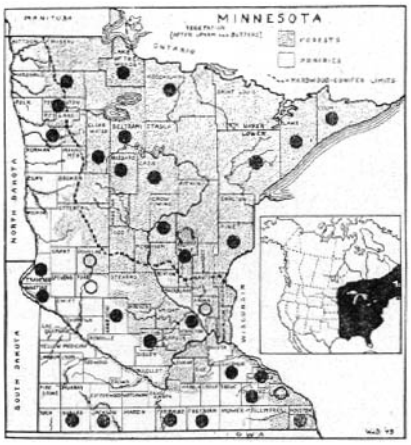
Family Bufonidae

Of the family Bufonidae only the genus *Bufo* occurs in North America. Toads have a comparatively dry, warty skin, a wide waist, cranial ridges or crests, raised parotoid glands on the neck, and darkened cutting tubercles on the soles of the hind feet. They have no teeth. The tadpoles of toads differ from those of frogs (Ranidae) and tree frogs (Hylidae) in having the vent in a median position instead of on the right side. The tadpoles of toads metamorphose at a much smaller size and in a shorter time than those of frogs. Thus toads are adapted to drier conditions than are suitable to the development of frogs.

AMERICAN TOAD

Bufo americanus Holbrook

Races. Two subspecies of this toad have been described. Of these only *B. a. americanus* occurs in Minnesota.



Map 6. Range of the American toad.

Description. When newly metamorphosed the American toad (Figure 6) has a body length of only half an inch (13 mm.). Adults may attain a body length of nearly four inches (100 mm.). The head is triangular and flattened. The width between the angles of the jaws is less than the distance from the nostril to the posterior margin of the parotoids. The length of the paratoids is as great or greater than the distance between their anterior ends. The cranial crests are nearly parallel. They meet at right angles the postorbital ridges, which extend outward behind the eyes to the tympana. The tongue is thick and fleshy and is attached anteriorly. The jaws are without teeth. There are two prominent plantar tubercles on the hind feet. They are horny, and usually dark brown or black. The inner one is small, the outer one large and oval, with a curved cutting edge. The toes are flattened and have horny, usually darkened tips. The back, upper surfaces of the head and legs, and upper eyelids are covered with warts of two sizes.

The ground color is variable and is often correlated with the soil on which the toads occur. It varies from gray to brown, yellowish, or reddish, and is often fairly bright. Usually there is a light middorsal stripe, with irregular small dark blotches on either side, each with one large wart, and sometimes two or three. The belly is lightly to heavily spotted with dark. At least during the breeding season, the lower portion of the throat of the male is dark.

The larvae are nearly black. They are only an eighth of an inch long on hatching. The tail is rounded at the tip. The dorsal crest extends only slightly onto the body. The larvae attain a length of only slightly over an inch before they metamorphose. The anus is median, and the spiracle is on the left side of the body.

Range. S & B (1943) give the range of this toad as "eastern North America from Hudson Bay to Alberta and Labrador. Also eastern Oklahoma." It occurs throughout Minnesota (Map 6). To what extent it is displaced by the plains toad along the western edge of the state and the Dakota toad in the northwest has not been determined.

Habits. The gardener has long recognized as a friend the clodlike

Figure 6. American toad, *Bufo americanus*, calling. (½ natural size.)

toad that lives on the insects in his garden. Many have been known to inhabit the same garden year after year. The warty skin of the toad suggests great age. Dickerson (1931) reports one as living thirty-six years before it was killed by accident. However, the toad's growth is not slow. Hamilton (1934), who recorded the growth of individual toads, found that with a normal food supply they reached maturity in two to three years. There are many tales about the toad's prodigious ability to survive long periods in cavities in stones and trees. (See Introduction.) Today these stories are regarded as not sufficiently authenticated, though unquestionably the toad has remarkable abilities of this kind. (See discussion of the plains toad.)

Hibernation is accomplished by burrowing in the ground to depths below the frost line with the aid of the sharp-cutting tubercles on the hind feet. The same burrowing habit serves the toad equally well in surviving dry periods in summer. This ability, together with the short larval period of the toad, enables it to extend its range over much territory where other species of amphibians cannot exist.

The warty skin of toads gave rise to the erroneous belief that handling them produced warts. The toad's skin does secrete a mild poison, which is very distasteful to many potential enemies. It appears as a milky secretion on the skin, particularly in the region of the parotoid gland, when the animal is irritated or injured. Dogs and many

other animals refuse to eat toads because of this secretion. Lemon (1942) reports unsuccessful attempts to induce a great horned owl to take a toad. Though this secretion is irritating to the membranes of the mouth and eyes of human beings, it is not dangerous. Among the enemies of the toad may be listed several of the snakes, especially the hog-nosed snakes; red-tailed, broad-winged, marsh, and Cooper's hawks; and, rarely, skunks and raccoons. The greatest mortality among toads comes during the tadpole stage, when they are preyed upon by almost all the carnivorous water forms, from giant water beetles and several aquatic insect larvae to the huge northern pike. The drying up of temporary ponds destroys enormous numbers of tadpoles. At times highway traffic also takes a huge toll.

Food. The surprising action of the tongue of the toad has attracted much popular attention. The fleshy tongue is attached only near the front of the lower jaw. The toad sits motionless until some unsuspecting insect crawls within range—then suddenly it lunges forward, the mouth opens, the tongue arches over, the sticky tip loops around the prey, and the tongue is withdrawn into the mouth—all with a startling rapidity. The food taken in this way includes moth and butterfly larvae, aphids, cutworms, ants, beetles of many kinds, sowbugs, spiders, slugs, and earthworms. Most of these creatures are injurious to crops, and thus the presence of toads in fields and gardens is highly beneficial. However, the amount of food taken by individual toads has been greatly exaggerated in many published articles, and consequently their calculated money value to farmers has been greatly overstated. Miller (1909) showed that a medium-sized toad (36.6 grams) consumed an average of 1.12 grams of food a day, which is the equivalent of two medium-sized grasshoppers.

Breeding. Soon after emerging from winter quarters male toads move to grassy, temporary ponds for breeding. When they reach the ponds about the first of May they begin their mating trills. While uttering these trills the toad sits half submerged, and the throat swells up like an enormous, translucent bubble. The trill, of a high-pitched, whistling quality, continues on the same notes and is maintained uninterrupted for twenty seconds or even longer.

The females arrive at the breeding ponds a few days after the males. Within a few hours after entering the water the female is clasped by a male in readiness for fertilization of the eggs. Miller (1909) points out that, while clasping, toads form a basketlike arrangement of the hind legs and feet. In this space the eggs are laid and held while the male deposits sperm on them, thus assuring fertilization.

The eggs, about 1 mm. in diameter, are laid in from one to four

strands, like strings of beads. They are surrounded by a very thin, gelatinous coating, which quickly absorbs water to make the strands appear like long cords of jelly. Miller (1909) reports a single female as laying 15,835 eggs. These eggs, after absorbing water, weighed 394 grams, or five times the weight of the female, and would constitute 134 feet of single egg strand.

Toad eggs hatch in two to twelve days, depending on the temperature. The period of development varies according to temperature and available food. Newly metamorphosed toads have been taken near Minneapolis as early as June 19, indicating that they can develop to this point in six to seven weeks.

Suggested Reading. Mary C. Dickerson, 1931, pp. 63–89. Newton Miller, 1909, pp. 730–45.

PLAINS TOAD

Bufo cognatus Say

Description. The head of the plains toad (Figure 7) is triangular and flattened. The width between the angles of the jaws is greater than the distance from the nostril to the posterior margin of the parotoid. The length of the parotoids is distinctly less than the distance between their anterior ends. The interorbital crests diverge widely posteriorly; the postorbital ridges extend to the tympana. There is a raised horny boss above the nostrils, connecting the anterior ends of the interorbital crests. There are two prominent, horny, usually dark brown to black, plantar tubercles on the hind feet; the inner one is small, the outer one large and with an almost straight cutting edge. The toes of both feet are somewhat flattened and have horny, usually darkened tips. The upper eyelids, the back, and the upper surfaces of the legs are warty. These warts often have horny tips and vary in size, but are without the distinct series of large tubercles found in the American and Manitoba toads. The belly is granular throughout.

Map 7. Range of the plains toad.

The ground color of the plains toad is usually some shade of gray or brown, often with a definite green tinge. Normally there is a light vertebral stripe with large dark blotches diverging from the middor-

sal line posteriorly. Each blotch includes a considerable number of tubercles. The tibia has one or two dark bars, the hind feet are faintly blotched, and the forelegs are plain or blotched. The belly is unspotted. The lower throat of males is dark, at least in the breeding season. The maximum body length is 4 inches (100 mm.).

The very young larvae, 0.20 inches or 5 mm. long, are nearly black. Bragg (1936) describes one-inch tadpoles as mottled brown and gray

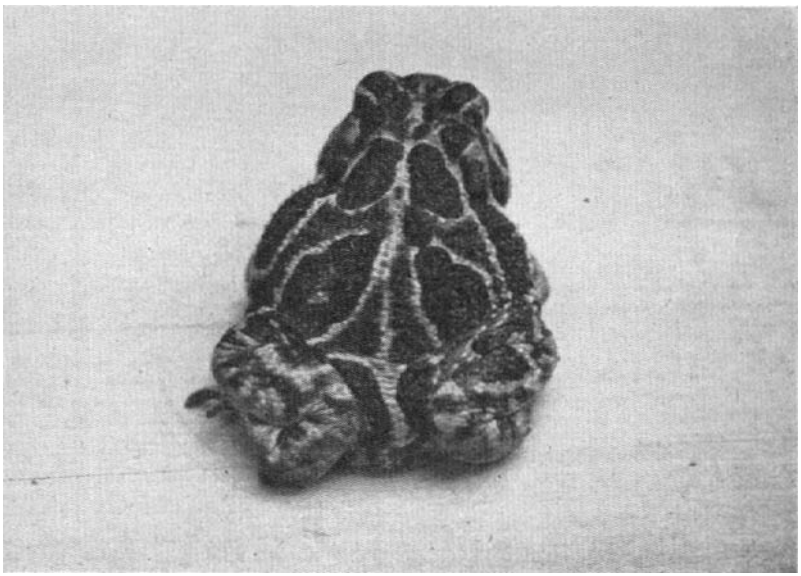


Figure 7. Plains toad, *Bufo cognatus*. (¾ natural size.)

dorsally, with greenish-yellow and reddish iridescence below. The tail fin is highly arched, with the dark pigment in a branching pattern.

Range. Wright and Wright (1942) give the range of the plains toad as "Alberta (Logier), North Dakota and eastern Montana, southwest across Colorado, Wyoming, Kansas, Utah, Oklahoma, the Panhandle of Texas into Mexico and west into eastern California." This toad is found also in most of the prairie portion of western Minnesota, from the Iowa line northward probably to Manitoba (Map 7). The author heard calls thought to be those of the plains toad in Kittson County, but was unable to secure specimens of them there.

Habits. The plains toad seems even better adapted than the American toad to dry conditions, since it is more abundant than that species in the drier western counties of Minnesota. Like most toads, it seeks shelter from either dry or cold conditions by burrowing, which it accomplishes by a sidewise shifting motion of the body, with the sharp cutting

tubercles on the hind feet loosening and pushing aside the soil, allowing the body to settle deeper and deeper into the ground. During a cycle of drought years the only periods favorable for the activity of toads are the few weeks in spring when moisture is present. If ponds persist for six to eight weeks the period is sufficient for young plains toads to metamorphose. Soon afterward they burrow into the ground and thus are able to survive the dry summer months. Apparently in extremely dry fall seasons their aestivation, or summer sleep, continues on into their winter hibernation. Thus in a dry year they have only one short active period. Many persons living in the prairie sections of Minnesota during the drought of the 1930's had never seen a toad in those regions. Then with the heavy rains in 1937 great numbers of toads suddenly emerged from their burrows, much to the surprise of the populace. Such situations give rise to the widely credited stories of "rains of toads."

There was another surprising outburst of the plains toad in the Red River Valley in the summer of 1941. Maurice Brooks, who reported extensively (correspondence) to the author on this phenomenon, noted the remarkable fact that the toads throughout an area over 100 miles long were all moving northward. The abundance of the animals was shown by a count of 256 dead toads at one highway intersection, and many live toads were still crossing the road. Such eruptive migrations of other animals have been reported, but there are no other reports of so concerted a directional movement of toads. A careful study of rainfall, together with other circumstances favoring toad reproduction (Breckenridge, 1938), usually explains the abundance of the animals, but the directional movement in this case has not been accounted for.

Breeding. As with all toads and frogs, the breeding season is the croaking season for the males. The various calls of the different species, together with those of the birds and insects, make up the welcoming chorus that announces the spring awakening of wild life. The plains toad has a call that makes up in volume what it lacks in quality. When one is near by it is almost earsplitting. On one trip made by the author these toads were located by their calls at a distance of over three quarters of a mile, over a slight rise, and with a cross breeze blowing. The call has a harsh, rather grating, mechanical quality, and differs from that of the American toad in having a rapid throbbing or pulsating rhythm of about the maximum rate one can count. Smaller males have a higher pitched, more birdlike quality in their call, but it is distinctly not the unvarying, whistlelike trill of the American toad.

While calling, the males sit half submerged and exhibit a most surprising expansion of the throat membranes. A tiny "rubber balloon" appears under the chin and swells downward and forward until the fully expanded sac extends well out beyond the animal's snout. The membrane is lightly pigmented and covered with many tiny, translucent dots. The sac vibrates with the trilling call and only partially deflates between calls.

The males clasp the females at egg-laying time and fertilize the newly laid eggs immediately after they are laid. The breeding of this toad has been described in detail by Bragg (1936, 1937, 1937a), from whom the following notes are taken. This toad breeds exclusively in shallow, temporary ponds. The eggs are laid in long, jellylike strings. One female lays as many as 20,000 eggs. The eggs may hatch in 53 hours. The newly hatched tadpoles are about a fifth of an inch (5 mm.) long. Under laboratory conditions they metamorphose in about six weeks.

Suggested Reading. A. N. Bragg, 1936, 1937, 1937a. W. J. Breckenridge, 1938.

MANITOBA TOAD

Bufo hemiophrys Cope

Map 8. Range of the Manitoba toad.

Description. The Manitoba toad so closely resembles the American toad, *B. americanus,* that a description of it may well take the form of a comparison with that species. The principal differences are in the head structures. In the Manitoba toad the interorbital ridges are so swollen that they nearly coalesce in large adults, forming a single heavy ridge with a central, groovelike depression. In younger specimens these ridges appear more distinct, with a tendency to join at their anterior and posterior ends. These ridges are nearly parallel, whereas in the American species they diverge slightly posteriorly. The distinct postorbital ridges that pass back of the eyes in the American toad are broken or absent in the Manitoba species. In very young toads no cranial crests are evident. These crests develop as the toad grows and do not attain their typical structure until the toad reaches adult size. Consequently the smaller specimens of these two species are difficult if not impos-

sible to distinguish. No constant differences can be detected between these species in the coloration, or skin character. The parotoid tends to be more irregular in outline and less distinct than in the American toad. The Manitoba toad is of slightly smaller size than the American species.

Range. The recognized range of the Manitoba toad includes (Wright and Wright, 1942) "North Dakota, Manitoba, Alberta. In country tributary to Lake Winnipeg in Canada." In Minnesota the species was not recognized until 1940, when R. M. Berthel and the author collected specimens in Kittson County (1221). Since then the species has been taken in Polk (1433), Norman (1402–3), and Mahnomen (1432) counties (Map 8). Specimens taken on islands in Lake of the Woods at the mouth of the Rainy River (9–11) in 1932 by Gustav Swanson have recently been identified as of this species. More extensive collecting of toads in northwestern Minnesota is needed to determine the extent of the range of this species and its relative abundance as compared to that of the plains toad and the American toad, which also occur in this region. The difficulty of distinguishing young specimens of the Manitoba and American toads complicates this task. Just as this book was going to press this toad was found to be common in Grant County (1555–72).

Habits and habitat. Specimens of this toad have been taken from pond and stream margins and in dirt-floored cellars. Swanson reported an abundance of these toads active at night on the sandy beaches of Curry Island in Lake of the Woods—just as the author found the American species on the beaches of Ten Mile Lake in Cass County. In fact, the author has found the habits of the two species to be identical in all respects.

Breeding. On the night of June 7, 1943 the author found this toad calling in rain-filled roadside ditches near Crookston in Polk County. Again on May 8, 1944, near Herman in Grant County, many male Manitoba toads were found calling in the grassy margins of recently swollen ponds. The expansion and general character of the throat sac of singing males were examined carefully and appeared to be similar to those of the American toad. The call seemed slightly lower in pitch and shorter in duration. A clasping pair was found. The egg string being laid was like a long, single string of jelly-coated black beads, each bead about 1 mm. in diameter, the distance between beads slightly less than 1 mm. The toads and eggs were collected and the eggs were placed in an aquarium. On June 12 the young had hatched and were wriggling their way from the jelly. Five series of tadpoles were preserved at intervals until July 19, when they were about 20 mm. long, with hind limbs well developed. At this stage they were com-

pared with tadpoles of the American toad. Pigmentation, width of dorsal tail crest, extent of dorsal crest onto the body, tail outline, mouth structure, and position of spiracle and eyes all seemed identical with those of the American toad.

Suggested Reading. A. A. Wright and A. H. Wright, 1942, pp. 82–83.

Tree Frogs
Family Hylidae

The tree frogs have glandular adhesive discs on the tips of the toes that aid them in climbing. There is considerable variation in the development of these discs in the different species. The vocal powers of tree frogs are highly developed. Many forms have remarkable control of their coloring, which usually closely resembles their surroundings. The skin of the belly is usually granular.

CRICKET FROG
Acris crepitans Baird

Map 9. Range of the cricket frog.

Description. The cricket frog (Figure 8C) is small; it reaches a maximum body length of about 1.25 inches (32 mm.). The head is narrow, the snout pointed. The forelegs are well developed. There are four fingers, one heavy palmar pad, and no webs. The hind legs are very long—the heel will reach the snout when the hind leg is turned forward. The hind feet are fully webbed and have five toes, with small toe pads. The dorsal surface of the body is irregularly covered with small warts, suggesting toad skin. The lower belly, the sides, and the lower and inner surfaces of the thighs are coarsely granular.

The color varies from black through dark brown, reddish brown, bronze, and light brown, to green or gray. There is a triangular dark patch between the eyes, with the apex backward; this patch is often indistinct. There is a light line from the eye to the foreleg. The dark upper lip is crossed by vertical light bars. The under parts are light. The throat is heavily mottled with dark in the male, but is much less so, or immaculate, in females, and unmarked in the young. Dark mottlings are sometimes found on the sides of the belly. Oblique bars are

sometimes evident on the back and sides. There are often prominent dark bars on the legs.

The tadpole of this species has never been distinguished from that of the very similar southeastern cricket frog, *A. gryllus*. The larva of that species has been described (Wright and Wright, 1942) as dark olive, full and deep bodied, and long-tailed, with a black accuminate tip on the tail. There are two rows of comblike teeth on both the upper and lower lips. The larva grows to 1.70 inches (42 mm.) and metamorphoses into a frog about half an inch (9–12 mm.) in body length.

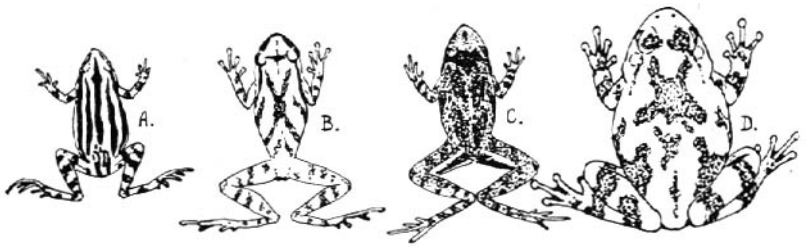


Figure 8. A, swamp tree frog, *Pseudacris nigrita; B*, spring peeper, *Hyla crucifer; C*, cricket frog, *Acris crepitans; D*, common tree frog, *Hyla versicolor* (½ natural size.)

Range. This cricket frog is known to occur from Connecticut westward through southern Michigan, southern Minnesota to Utah, and south to Georgia and western Texas, at altitudes up to 2000 feet. In the midwest it has pushed its range northward along the Mississippi and Big Sioux River valleys. In Minnesota it is found only in the extreme southeastern and southwestern parts of the state (Map 9).

Habits and habitat. In Minnesota the few records for the cricket frog are nearly all from small, meandering, gravel-bottomed streams flowing through grassy meadows; the swamp tree frogs in the same areas prefer the isolated ponds. The cricket frogs are found either in the water or in the grass or among the pebbles along the shores. When disturbed they invariably make for the water in prodigious leaps, up to three feet long, plunge in, and swim back in semicircles to the shelter of the bank, where their mottled, muddy color hides them perfectly. This remarkable leaping power, together with their small size and dull colors, makes them very difficult to capture. Their toe pads are smaller than those of any other tree frogs, and they are seldom observed to be climbing in bushes or plants, as the others so often do.

Breeding. In June 1939 the author was in Rock County, in southwestern Minnesota, during the later part of the mating season of this frog, and was able to compare its call with those of other species.

Notes taken at that time read: "About eight to ten frogs were calling in a chorus that continued for about a minute. Silence ensued for several minutes, then the calling began again. Their call sounds like a very jerky cranking of a small wooden clacking device. It is similar in rate and duration to that of the very common swamp tree frog, *Pseudacris nigrita,* but lower in tone, less musical, and more wooden and mechanical in quality. The call accompanies the inflating of a large, spherical throat sac, the membrane of which is nearly transparent, with numerous inconspicuous opaque dots. It vibrates with the interrupted, grating ticktack-like call, and is only partially deflated between calls."

Dickerson (1931), in writing of the frogs of the Eastern Seaboard, states that this species breeds late and that its chorus is loudest in late April and early May. At this season the swamp tree frogs' chorus has disbanded and the spring peepers are calling only at night. Wright and Wright (1942), in writing of the eastern cricket frog, *A. gryllus*, which is almost indistinguishable from our western one, state that each female lays about 250 eggs. The eggs are laid singly on grass or sticks, or on the bottom in shallow water. The eggs are reported to hatch in four days. The tadpole period extends from 50 to 90 days.

Suggested Reading. Mary C. Dickerson, 1931, pp. 153–56. Ruthven, Thompson, and Gaige, 1928, pp. 38–40.

SWAMP TREE FROG

Pseudacris nigrita (Le Conte)

Map 10. Range of the swamp tree frog.

Races. S & B (1943) recognize five subspecies of this frog. The common one in Minnesota is *P. n. triseriata.* Another short-legged variety, *P. n. septentrionalis,* is thought by some to occur in northwestern Minnesota.

Description. The swamp tree frog (Figures 8A, 9) has a maximum body length of about 1¼ inches. The head is triangular, the snout rather pointed. The eyes are small but prominent. The tympanum is much smaller than the eye. The body is slender, except in gravid females. The fore limbs are small but well developed, with four fingers. The hind limbs are comparatively short, with five

toes, only slightly webbed; the pads on the fingers and toes are very small. The skin is smooth or finely pebbled above. The granulations become coarser laterally. The belly is coarsely granular, but less so under the head.

The dorsal ground color varies from dingy grayish yellow to rather a bright green or, often, reddish brown. In the typical pattern there is a dark middorsal line, often interrupted, from the snout to the vent, and two longitudinal dark stripes on either side. The hind legs are sometimes plain but usually spotted or barred with dark. This pattern is variable and often quite indistinct. Beneath, the frog is dusky yellowish and unspotted.

The tiny tadpoles have wide tail crests finely and evenly dotted with dark pigment. The dorsal crest extends about halfway forward on the body. The tail is sharply pointed. The tadpoles metamorphose at a little over an inch (29–32 mm.) into frogs with a body length of about half an inch (12 mm.).

Since the recognized range of the subspecies *P. n. septentrionalis*, a short-legged form described from Great Bear Lake in Canada, touches northwestern Minnesota, its status there was investigated. Material ranging from Houston County to Manitoba was studied. The average proportionate length of the tibia was found to become progressively shorter in the northwestern material. It has been shown (Schmidt, K. P., 1938) that this variation occurs in a number of species of frogs. If this subspecies continues to be recognized and a sharp line of distinction between the two is designated, northwestern Minnesota material will be considered as intergrades between the two races.

Figure 9. Swamp tree frog, *Pseudacris nigrita*, calling. (Natural size.)

Range. As a species the swamp tree frog ranges from New York westward through Michigan and northern Minnesota to northwestern Canada, south to Arizona and Florida. Reports show it occurring throughout Minnesota, with the possible exception of the extreme northeastern corner (Map 10).

Habits and habitat. Like the American toad and the leopard frog, the little swamp tree frog seems to be able to withstand nearly all the

extremes of the Minnesota environment. Quiet pools, either temporary or permanent, seem to be the only requirement to maintain a population of these frogs. They are most numerous in marshy meadow ponds which have abundant vegetation and are situated where the first warm sunshine in spring has the best chance to melt the ice.

Although this delicate little frog is usually encountered in the ponds or very near their margins, in summer and fall they wander some distance onto the land and spend the days under boards, logs, rocks, and the like.

For some time the author considered this frog unable to climb. However, he discovered otherwise in September 1941 while camping along the east shore of Lower Red Lake, in Beltrami County, with George Rysgaard. Field notes from the trip read: "In the evening we heard what sounded like swamp tree frog calls coming from the bushes well away from the lake. On investigating with flashlights after dark we found many of these tiny frogs calling halfheartedly from several feet up in the grapevine tangles and other heavy undergrowth. In a nearby sedge swamp we searched out some calls and found that even there they were not sitting half submerged, as they habitually do during the breeding season in spring, but perched a foot or more above the water in the tangled sedge."

Little is known about the hibernation of swamp tree frogs, but it is probable that many of them pass the winter on land, for they are often encountered late in fall under logs and in similar situations, at some distance from water.

The garter snake is a common enemy of this frog. We have four records of the plains garter snake's taking it, and one of these snakes contained three of the tiny frogs. Aquatic enemies of the tadpoles and the drying up of ponds take a heavy toll of the species.

Call. The great volume of the trill produced by this tiny frog is always a source of astonishment. It is the loud, high-pitched, trilling croak that comes so commonly from roadside ponds almost anywhere in Minnesota early in spring. It is often attributed to the much larger leopard frog. The males call from among the vegetation of the plant-clogged ponds with only their tiny heads showing above the water. A field note dated April 22, 1937 reads: "Their sides were much swollen to begin with, then the bubblelike throat skin swelled to several times the size of the head as the sides deflated. The call was about one second in duration and consisted of about nine separate musical notes, in quality something like the sound of a metallic clicker. The throat vibrated markedly as the call was given and only partially deflated between calls."

Their individual calls are sustained for only about a second, but when several dozens or scores of calling males are in action at once in a small pond the combined chorus is continuous. It can be heard for several hundred yards, and when one is near by is fairly deafening. A person walking in or near the pond causes the chorus to stop short, but if he remains perfectly quiet an individual frog here and there will soon break into song again, and in a few moments the whole chorus will be in full voice. In the daytime the slightest disturbance causes them to remain quiet, and under these conditions it is almost impossible to locate them. At night, however, with the aid of hip boots, a flashlight, and plenty of caution, one may watch them with no great difficulty. The one big factor that allows them to go unnoticed is the fact that the loud call suggests a large animal, and the searcher is not looking for so tiny a creature as this mite of a frog.

Breeding. The swamp tree frog is one of the first of the amphibians to become active in the spring. The earliest calls are usually heard during the later part of March about the Twin Cities. The breeding of this species is often interrupted by early spring cold spells and is probably carried on all through April and into May. The eggs of this species are (Ruthven, Thompson, and Gaige, 1928) "laid in small masses of 5 to 20 which are attached to water plants." Tadpoles in various stages of leg growth and tail absorption were taken near Minneapolis on June 16 by C. P. Sigerfoos. These records indicate a period of eight to ten weeks for the passage of the egg and tadpole stages in this latitude. Several times during midsummer (July 25, 1937–June 20, 1939) these frogs have been heard calling in great choruses, as though a second breeding season were in progress following periods of heavy rains with the resultant refilling of the meadow ponds.

Suggested Reading. Mary C. Dickerson, 1931, pp. 157–60 (see *Chorophilus nigritus*). A. A. Wright and A. H. Wright, 1942, pp. 114–17.

SPRING PEEPER

Hyla crucifer Wied

Races. S & B (1943) recognize two subspecies of *Hyla crucifer*, of which only *H. c. crucifer* occurs in Minnesota.

Description. The spring peeper (Figure 8B) is only slightly over an inch long. The head is small and the snout blunt. The tympanum is definitely smaller than the eye. The fore limbs are small and have long fingers with prominent discs. The hind legs are long (the heel will extend forward to the eye); the toes of the hind legs have prominent discs and are webbed only at the base of the toes. The skin above is smooth; the under surface is prominently granulated. There

Map 11. Range of the spring peeper.

is a strong fold between the forelegs.

The ground color above varies from pale buff to dark brown and is often of a coppery quality; the markings vary greatly in distinctness. There is a dark V pointing backward between the eyes and a crude X on the back, often variously broken and sometimes with additional lateral extensions. There is a V pointing forward on the sacral region; it is frequently joined to the X on the back. A dark eye mask extends to the forelegs and includes the tympanum. A dark bar runs obliquely back and downward from the shoulder on the side. There are dark crossbars on both the fore and hind legs. The throats of males are more or less pigmented. Beneath, the skin is pale yellowish. The iris is golden, and the pupil is slightly elongated horizontally.

The tadpole, which grows to about 1.25 inches in length, is (Ruthven, Thompson, and Gaige, 1928) "greenish, stippled with gold; belly bronze, iridescent; the muscular part of the tail with dark spots; the crests are wide, translucent, pigmented with black on the edges toward the tip. There are two rows of teeth on the upper lip, the second interrupted; two rows . . . on the lower lip and usually a very short third row."

Range. S & B (1943) give the range of the spring peeper as extending from "Gaspé Peninsula to Manitoba, south to Georgia, Florida, Louisiana, Arkansas, and Kansas." The records for Minnesota (Map 11), though not complete, indicate that the species probably occurs throughout the wooded portions of the state.

Habits and habitat. In Minnesota the spring peeper is most commonly encountered in moist forest lands, though at times it may be found about fairly open permanent ponds. During the summer and fall spring peepers wander considerable distances from water on the moist, leafy forest floor, among the ground pines, large-leafed asters, and clintonias. No situation seems to suit them better than the soft, springy mats of sphagnum moss of the black spruce swamps. They are excellent climbers, for the adhesive discs on the toes are well developed, and they are often heard calling loudly from well up in bushes or trees. During the heat of midday they seek shelter under

rotten logs, leaves, and rocks. These delicate little creatures seem very tolerant of low temperatures and have been found active in the Cedar Creek Bog Forest in Anoka County as late as October 13.

Call. Few uninitiated persons hiking in the spring woods will recognize the clear whistling calls of this frog as anything other than those of a bird. The illusion is heightened because the calls are so often heard issuing from bushes well above the ground, rather than from the margins of nearby ponds. The call consists of a long series of single, high-pitched, whistlelike peeps, given with regular pauses of about a second between notes. A large, almost transparent, bubblelike throat sac expands explosively with the production of each flutelike note. Like the swamp tree frog, the spring peeper is almost impossible to locate while calling during the daytime, since it stops calling as soon as an intruder approaches. Even at night, when one is equipped with a flashlight and follows the call as a guide, one must move cautiously, with many long pauses, before finally getting a close-up view of one of these diminutive songsters at his singing.

Breeding. The spring peeper emerges from hibernation to breed early in spring, but not quite so early as the swamp tree frog and the wood frog. Breeding takes place through April and into May. The tiny, jelly-coated eggs of the spring peeper are laid singly or in small clusters attached to grasses or weed stalks in shallow water. Wright and Wright (1942) report the tadpoles as reaching a length of 1⅓ inches (33 mm.) and transforming, after a period of 90 to 100 days, into frogs about half an inch (9–14 mm.) in length.

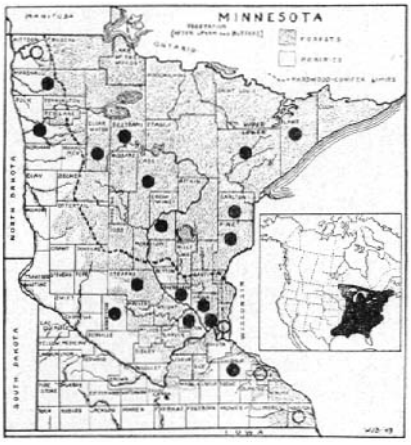
Suggested Reading. Mary C. Dickerson, 1931, pp. 138–48 (see *Hyla pickeringi*). A. A. Wright and A. H. Wright, 1942, pp. 140–41.

COMMON TREE FROG

Hyla versicolor Le Conte

Races. Two subspecies of this frog are recognized, of which only one, *H. v. versicolor,* occurs in Minnesota. Cope (1889) described another race, which he called *H. v. phaeocrypta.* (See Hypothetical List.)

Description. The common tree frog (Figures 8D, 10) is of medium size. It attains a maximum body length of about 2 inches. The head is broad and the snout blunt. The skin above and below is finely and uniformly granular in texture. There is a strong fold across the chest. The tympanum is smaller than the eye. Both the fore and hind feet are large and have very prominent discs. There are four fingers and five toes, with deeply cut webs. The heel, extended forward, will reach at least to the eye.



Map 12. Range of the common tree frog.

The general dorsal color is exceedingly variable among tones of green, gray, or brown. These colors may change within a few minutes. The markings vary greatly in prominence. The back has several dark blotches, usually elongated, black margined, and in varying configurations. There is a dark, black-margined area extending from the eye, including the tympanum, to the foreleg, and irregularly along the side. The sides below this line are variously dotted and speckled. There is a variable dark bar over each eye and a prominent light spot below the eye bordered in front and behind with dark. The throat of males is dark. The surfaces of the thigh region that are concealed when the animal is at rest are bright yellow, variously speckled and lined with black. This color is constant in spite of color changes in the dorsal region. Beneath, the skin is yellowish to pale gray, and unmarked. The small, newly metamorphosed frogs are invariably bright green, with dorsal markings indistinct or absent.

The tadpole has been described by Ruthven, Thompson, and Gaige (1928) as "greenish above, spotted with gold and black; iridescent pinkish-gold beneath; the tail crest is wide and extends on the back almost to the head; the muscular part of the tail is vermilion, spotted with black, and the crest is strongly blotched with black. Upper lip with two rows of teeth, the second interrupted; lower lip with three rows of teeth, the outermost usually wavy; entire lower lip and sides of upper lip bordered by papillae, which are not folded in at the corners of the mouth."

Range. This tree frog ranges (S & B, 1943) from Maine, southern Canada, west to Minnesota, south to eastern Texas and Florida. In Minnesota (Map 12) records show that it probably occurs throughout the wooded parts of the state. It may occur near wooded streams and ponds out onto the prairies, but is not found in isolated, typically prairie ponds or lakes.

Habits and habitat. After the spring breeding season this curious little frog wanders away from the water, often for considerable distances, and frequently surprises the gardener by appearing on the leaves or stems of plants in the garden, on the bark of trees, or in

shrubs. Invariably the color of this frog is adjusted to blend remarkably well with its immediate surroundings. In fact, it is the movement and not the color of the animal that usually calls attention to its presence. Undoubtedly this remarkable ability to change color to match its surroundings is the most interesting character of this frog. W. J. Schmidt (1919) described the structures concerned with the color changes of the European tree frog, which probably closely parallel those of our own species. These structures and their functioning may be roughly summarized as follows: This change is accomplished by unusual development and control of the chromatophores, or pigment-

Figure 10. Common tree frog, *Hyla versicolor*, calling. (Natural size.)

containing cells in the skin. These cells have a central body, with many branchlike processes extending outward from the center, and the light-reflecting materials in the cell may be lumped in the center or dispersed throughout the branches. Three different cell layers present in the skin contain materials capable of reflecting light of the three colors, blue, yellow, and black or dark brown. Varying the amounts of these materials exposed in the cells by expansion or contraction causes colors to be masked out or mingled with others in such a way as to produce the remarkable variations in color. These expansions and contractions may take place rapidly enough to cause marked color changes in periods of only a few minutes.

The large feet and remarkably developed adhesive discs of this frog enable it to climb on almost any surface. Just how high into the trees it may go is a mystery, but the following observation throws some

light on the matter. At a summer camp near Hackensack, in Cass County, Minnesota, Charles Reif had constructed a tree platform, surrounded by woven wire fencing, about 25 feet up in some pines. One night while on this platform Reif was disturbed by frequent "pinging" sounds as of small objects striking the wire. Finally something that he described as "like a raw oyster" struck him full in the face. When captured and examined it proved to be a common tree frog.

Call. The following field note on the call of the common tree frog was made at Itasca Park on May 28, 1937, apparently at about the height of the breeding season of the species in that region: "These frogs were calling persistently at night in the woods pools, where several clasping pairs were found. The males call from well out in the water from one to two feet deep, supported on sunken limbs, snags, weeds, and the like. The call is a strong trill of a much louder, more full-throated quality than that of the commoner swamp tree frog, and more musical. Each trill continues from one to two seconds and consists of from 15 to 20 separate notes. The vocal sac is partially inflated between calls and is fully expanded and vibrates visibly when calls are produced."

Breeding. The breeding ponds vary considerably in character, as might be expected from the range of the species. Old, undisturbed ponds in heavy woods or near their margins, and having a generous scattering of dead limbs or brush, seem to be the choice habitats for the breeding of this frog.

This species is not an early breeder. Breeding apparently begins soon after the first week of May in the vicinity of the Twin Cities. Wright (1932) describes the eggs as deposited in a mass in the form of a surface film. The eggs are brown above and cream or yellow below. One mass of eggs contained 1802 eggs. Hinchley (1880) in Massachusetts found egg clusters of this species hatching on May 11, and reports that the frogs metamorphosed and began leaving the water on July 4. These dates indicate that the tadpole stage must persist for about 50 days.

Suggested Reading. Mary C. Dickerson, 1931, pp. 117–22.

Frogs

Family Ranidae

The American representatives of this group of frogs lack the adhesive discs present in the tree frogs (Family Hylidae), and there is a corresponding reduction in their ability to climb. The thumbs of the males are greatly enlarged at the base. Most species of frogs give calls

of considerable volume, generally low in pitch. The skin of the belly is smooth, unlike that of the tree frogs, which is granular.

BULLFROG

Rana catesbeiana Shaw

Map 13. Range of the bullfrog.

Description. The bullfrog (Figure 11) is the largest Minnesota frog. The single Minnesota specimen on record measures 4¾ inches in body length, with a leg length of 8 inches from the vent. The bullfrog is reported (Wright and Wright, 1942) to attain a body length of 8 inches. It is similar to the large green frog, *R. clamitans,* and differs mainly in lacking the lateral fold along the back and in having more extensive foot webbing. There is a short fold over and back of the tympanum. The fourth toe is webbed to the tip. The tympanum is larger than the eye in males and equal to or smaller than the eye in females. The skin is somewhat rough.

The general color above varies from light greenish yellow to dark brownish olive. The upper lips and the skin about the eye are green. The back, sides, and belly may be obscurely mottled with dark, and the legs are often indistinctly barred. The throat is yellow in the male, whitish in the female.

Ruthven, Thompson, and Gaige (1928) describe the tadpole as "brownish green above, spotted or marbled with darker tones; yellowish beneath; tail crest not extending on back, upper part finely spotted with black, lower part usually immaculate. Upper lip with two rows of teeth, the second interrupted; lower lip with three rows of teeth, the inner interrupted; lower lip and sides of upper bordered with papillae which are folded in at corners of the mouth."

Range. The range of the bullfrog is given (S & B, 1943) as "North America east of the Rocky Mountains except extreme southeast and Gulf States coastal plain. (Introduced into many localities all over North America and Cuba.)" At present only a single specimen of this frog is on record from Minnesota (Map 13). It was taken on July 29, 1943 in the Mississippi backwaters in Houston County by R. R. Fer-

guson. Gustav Swanson (1935) includes the species in his Minnesota list on the strength of a sight record (Minnesota River bottoms, Hennepin County, 1902, Dr. T. S. Roberts).

Habits and habitat. The bullfrog, like the mink frog, is highly aquatic and seldom ventures out of the water for any distance. Most writers agree that the sluggish backwaters and oxbow ponds, with their dead trees, snags, and twisted roots, afford the favorite haunts of this frog. Bullfrogs are largely nocturnal. They are solitary as a rule. Their low, booming "jug o' rum" calls are given individually from here and there about the swamps, and there is little tendency to join in choruses.

Figure 11. Bullfrog, *Rana catesbeiana.* (½ natural size.)

The bullfrog is the major source of the frog legs used as food. Louisiana reports an increase in the value of their output of frogs from $125,661 in 1927 to $276,618 in 1933. By far the greater part of these frogs are taken from natural swamps, but some success has been attained in the artificial rearing of bullfrogs. The techniques employed are discussed in a bulletin published by the Louisiana Department of Conservation (1935) and in a United States Bureau of Fisheries bulletin by A. H. Wright (1920). The Louisiana bulletin contains notes on rearing the bullfrog in Japan. The feeding of the adult bullfrog is the major problem in its culture, for it takes only live food. It feeds on almost any form of life that moves and is not too large for it to swallow, including insects, fishes, crayfishes, birds, and other frogs. Owing

to its voracious appetite it is easily taken on hook and line with a bit of red flannel as bait. It is commonly taken by jack lighting at night.

Breeding. The bullfrog emerges from hibernation late, and its breeding season in the north does not occur till June and July. Wright and Wright (1942) state that the black and white eggs, measuring one-twentieth to one-fifteenth of an inch in diameter, are laid in large surface films up to two feet in diameter. The tadpoles pass two winters in northern waters and metamorphose sometime during their third summer. This long tadpole period is one of the drawbacks to bullfrog culture in the north. The bullfrog requires at least a year after transformation to reach mature size.

Suggested Reading. Mary C. Dickerson, 1931, pp. 227–40. A. A. Wright and A. H. Wright, 1942, pp. 190–91. Also the two bulletins cited in the section on habits and habitat.

GREEN FROG

Rana clamitans Latreille

Description. The green frog (Figure 12) is readily confused with the mink frog, *R. septentrionalis,* and this fact should be kept in mind in dealing with material from within the range of both species. Unlike the mink frog, it has no musky, minklike odor. The green frog is large. It attains a maximum body size of nearly four inches. The tympanum is larger than the eye in males and equal to or smaller than the eye in females. There are dorsolateral folds extending to a little more than half the distance from the eye to the hind limbs. The thumbs are much enlarged in males. The toes are extensively webbed; only one or two joints of the fourth toe are free. The skin is either smooth or somewhat granular and often has a slightly spiny roughness.

Map 14. Range of the green frog.

The color and markings are variable. The dorsal ground color is light yellowish green to dark olive brown. Usually, but not always, there are dark spots, seldom over a fourth of an inch in diameter. The sides are pale yellowish with dark mottlings. The upper lip is bright green, unmarked. The backs of the thighs are often mottled with dark, but are sometimes plain. The skin beneath is pale, usually with dark

mottlings under the thighs and on the sides. The throat of females and young is mottled; the throat of the male is plain yellow. The under surfaces of the young are as a rule heavily mottled.

Wright (1932) describes the mature tadpole as large, with a maximum length of 64 mm. (2.43 inches), but not deep-bodied, with tail elongate, the tip acute. The dorsal crest is not so wide as the musculature, which extends forward on the body slightly ahead of the hind legs. There is one complete row of upper labial teeth and a short lateral row on either side, and three progressively shorter sets of lower labial teeth, of which the upper or longest is usually interrupted in the middle. There are papillae extending from above the ends of the upper labial teeth completely around the lower series and folded in at the corners of the mouth. The back is olive green with numerous distinct dark spots. The belly is a deep cream color, and the throat and sides are mottled with dark green. There is a slight coppery iridescence on the belly, more marked on the sides and tail. The tail is green mottled with brown; like the back, it is covered with fine yellow spots.

Figure 12. Green frog, *Rana clamitans.* (½ natural size.)

Range. The green frog ranges (S & B, 1943) through "eastern North America, Canada to Florida and Louisiana, west to Michigan, Wisconsin, Minnesota, Illinois, Kansas, Arkansas, and Texas. Introduced into western Washington." In Minnesota this species extends westward through the wooded portions of the state to the prairies, and probably northward to the Canadian boundary waters, although records from the Rainy Lake and Lake of the Woods areas are still lacking (Map 14).

Habits and habitat. The green frog is distinctly an aquatic species, and seldom ventures more than the distance of a few vigorous leaps from the protection of a permanent pond or stream. It is undoubtedly much less abundant than the leopard frog in Minnesota, but the impression of the relative abundance of the two species gained by the observer is distorted by their habits. The leopard frog wanders farther afield and is seen and captured more frequently than the green frog, which, when disturbed, plunges into deep

water and hides in the leaves and mud at the bottom, often before it can be recognized as a frog. The enormous toll of frogs taken by traffic chiefly affects the leopard frog. Very rarely have green frogs been noted as highway victims.

In the quiet, lily-grown waters of the northern lakes and beaver flowages the green frog surveys his surroundings from some floating lily pad, or simply pokes his head up among the crowded leaves, where his bright green color makes him an integral part of his surroundings. The canoeist who spots these motionless frogs is really keen-eyed, and the average fisherman realizes their presence only when his ear catches the plunk of the diving bodies. Even then he may thrill to the thought that it might have been a "muskie" breaking water after some floundering mayfly.

Owing to the aquatic habits of the green frog it is much less preyed upon by land enemies than are some of its more terrestrial relatives. However, it is more exposed to aquatic predators. Several species of snakes, particularly the water snake, *Natrix sipedon,* have been reported as taking green frogs, and the carnivorous fishes, such as northern pike and bass, are formidable enemies. The author has a motion picture of a green heron capturing a frog in a pond where green frogs were common.

Call. The call of the green frog usually consists of a single, very deep, low-pitched, "plunking" sound, given at irregular, widely spaced intervals. Occasionally the call is repeated several times in succession. These croaks might be described as explosive grunts, and undoubtedly their character causes many persons to refer to this frog as the bullfrog. Actually, however, the bullfrog, *R. catesbeiana,* is rare in Minnesota and is known to occur only in the Mississippi bottoms in the extreme southeastern part of the state. Dickerson (1931) and Hurter (1911) credit the green frog with a high-pitched, screaming call, which Dickerson states is the call of the young frog.

Breeding. The green frog does not emerge from hibernation until late in April in southern Minnesota. Wright and Wright (1942) state that the breeding season occurs from the end of May to mid-August and that "the black and white eggs are in a surface film usually less than a foot square, and number 1000–4000." The tadpoles do not metamorphose in the season in which they hatch but winter over and transform the following year. Variations in food, temperature, and water levels result in young metamorphosing at almost any time during the summer and fall seasons.

Suggested Reading. Mary C. Dickerson, 1931, pp. 198–205.

PICKEREL FROG

Rana palustris Le Conte

Map 15. Range of the pickerel frog.

Description. The pickerel frog (Figure 13B), rare in Minnesota, closely resembles the common leopard frog, *Rana pipiens*, and a comparison of the characters of the two species may well replace a detailed description. The spots on the back, between the lateral folds, are usually in two rows in the pickerel frog, cover a greater proportion of the surface, are dark instead of light bordered, and in shape tend to be more square than in the leopard frog. The spots immediately below the lateral folds in this species are also squarish and are arranged in a more regular row. The most striking difference is the orange color inside the forelegs, under the thighs, on the lower sides, and in the groin regions in the pickerel frog. These bright-colored parts are concealed when the frog is at rest, but give an orange flash when it leaps. They make a fine field mark for the pickerel frog. This color usually disappears in preserved specimens.

The tadpole (Ruthven, Thompson, and Gaige, 1928) "is brownish green above, with dark spots; iridescent beneath; tail dark, strongly marked with black and yellow. Upper lip with two rows of teeth, the inner interrupted; lower lip with three rows of teeth, the inner interrupted; lower lip and sides of upper bordered with papillae."

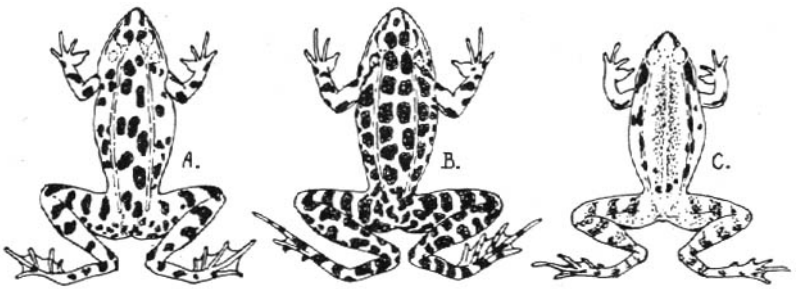


Figure 13. A, leopard frog, *Rana pipiens; B,* pickerel frog, *Rana palustris; C,* wood frog, *Rana sylvatica.* (½ natural size.)

Range. S & B (1943) give the range of this frog as "Hudson Bay south to Arkansas, Kansas, Oklahoma, and Louisiana and all of eastern North America from Gaspesia west to Wisconsin and Minnesota." Although the pickerel frog is present in Minnesota, the author's records indicate that it is not common or widespread (Map 15), but occurs only, as far as is now known, in the extreme southeastern part of the state. Records are: Fillmore County (948–50); Houston County (St. Cloud Teachers College Collection); Mower County (909); Winona County (1359). The University of Wisconsin has specimens of the pickerel frog taken in Burnett County, Wisconsin, opposite Pine County, Minnesota, a fact which suggests that the species may be more widespread in eastern Minnesota than our present records would indicate.

Habits and habitat. The very few specimens of the pickerel frog taken in Minnesota have come from the valleys of the Root and Whitewater rivers, where this frog has established itself among the rough, eroded, limestone and sandstone hills. These streams are cold and consist of series of alternately rocky bottomed stretches and muddy, meandering portions with abundant vegetation growing along the banks.

Wright and Wright (1942) give the habitat of the pickerel frog as "sphagnum bogs, marl ponds, cold streams, shallows of mill ponds, quiet waters of bayous, rocky ravines."

Most workers familiar with this species have mentioned the fact that the skin gives off a poisonous secretion very irritating to the tender mouth tissues of its enemies. This secretion seems to be strong enough to kill other frogs that are confined in small containers with the pickerel frog.

Call. Wright and Wright (1942) describe the call of the pickerel frog as "a low-pitched grating croak with little carrying power, shorter and higher than *Rana pipiens* [leopard frog], and more prolonged and lower than *Rana sylvatica* [wood frog]."

Breeding. The author has not been able to observe the breeding of this rare Minnesota species. Wright and Wright (1942) give the following data: "They breed from April 23 to May 15. . . . The brown and bright yellow eggs are submerged attached to twigs or grass stems, form a firm globular mass 3½–4 inches (87–100 mm.) in diameter and number 2000–3000. The egg is . . . a little smaller than those of *Rana pipiens.* After a tadpole period of 70–80 days, they transform in August at ¾–1½ inches (19–27 mm.)."

Suggested Reading. Mary C. Dickerson, 1931, pp. 188–92. A. A. Wright and A. H. Wright, 1942, pp. 202–3.

LEOPARD FROG

Rana pipiens Schreber

Map 16. Range of the leopard frog. Circles indicate leopard frog; squares indicate form kandiyohi and triangles indicate form burnsi.

Races. S & B (1943) recognize four subspecies of the leopard frog. The Minnesota form is *R. p. brachycephala.* However, these subspecific separations are questioned by many workers and may later be changed.

Two color phases of this species that occur in Minnesota differ so widely from normal *R. pipiens* that they must be mentioned. These color phases were originally named as separate species (Weed, 1922), *Rana burnsi* and *Rana kandiyohi.* These species were later reduced to subspecies and finally the terms were dropped entirely. Recent genetic work (Moore, 1942) has proved that the former phase is a sport or mutant of the typical form and may be recognized simply as *R. pipiens,* form *burnsi.* No similar work has been attempted with the other form, but since it is probable that the case is the same, the form is here referred to as *R. pipiens,* form *kandiyohi.* Distinctions between the two are noted in the section on color phases.

Description. The leopard frog (Figures 13A, 14, 15) is the large green frog with black spots, abundant throughout Minnesota. It reaches a maximum body size of about 4 inches. The tympanum is smaller than the eye in both sexes. Heavy skin folds extend from back of the eyes along the sides of the back to the pelvic region. Smaller, interrupted ridges lie between these large dorsolateral folds. The limbs are well developed. The thumbs of the males are much enlarged at the base. The hind feet are fully webbed. The skin is smooth, with granular areas on the hind surface of the thighs. The skin is often roughened on the sides below the lateral folds.

The dorsal ground color varies from yellowish, brownish, or grayish to vivid green. The dorsolateral folds and the folds below the tympanum are light. There are large, rounded, light margined, black spots on top of the head and on the back, sides, and upper surfaces of the legs. The hind leg spots are usually in the form of cross bars. Beneath, the skin is white and unspotted.

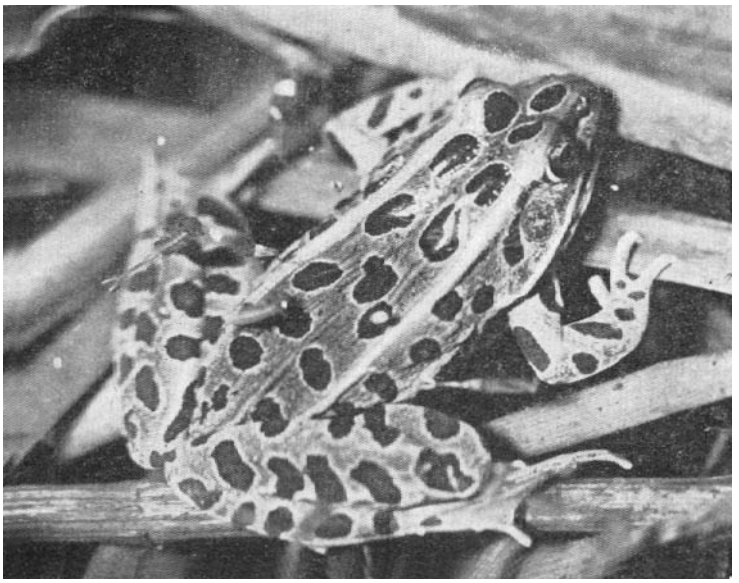


Figure 14. Leopard frog, *Rana pipiens.* (Natural size.)

Leopard frog tadpoles grow to a length of about 3¼ inches. The ovate body is dark above, lighter beneath, often with iridescent colors on the sides. The tail has wide crests and is rather translucent, spotted and speckled with dark. The mouth has the tiny beak characteristic of all frog and toad tadpoles, with two or three rows of comblike teeth above and three rows below the beak. The rows of papillae about the mouth completely encircle the teeth below and are curved in at the corners of the mouth.

Color phases. The plain-colored *burnsi* form of the leopard frog lacks the heavy black spots that characterize normal *R. pipiens.* This frog has the ground color of normal *R. pipiens,* usually a dingy yellowish finely speckled with dark, frequently quite greenish, but seldom the intense green that *R. pipiens* often assumes. The dorsolateral folds are often bronze or copper colored. In the extreme form all the black spots on the head, body, and legs are lacking except for a single small black spot that persists back of the elbow. It is common to find all variations in the reduction of the hind leg spots, including specimens with normally spotted hind legs. This same gradation seems not to occur in the body markings. With rare exceptions, individuals have either the complete spot pattern of normal *R. pipiens* or entirely lack body marks. The wide distribution of this frog throughout Minnesota in indicated on Map 16 (triangles). Counts of leopard frogs made in

six different localities within 35 miles of Minneapolis showed that the proportion of this form varied from 0.4 per cent to 10 per cent of the leopard frog population.

The dark color phase of the leopard frog, form *kandiyohi*, is characterized by a marked darkening of the interspaces between the black spots of normal *R. pipiens*. On the hind legs the black spots are often much broken into coarse fleckings of black and greenish or yellowish. The result is a very dark frog, with the black spots of the normal pattern indistinctly outlined in broken light lines. The dorsolateral ridges are often metallic in appearance. The few records of this dark, mottled form of the leopard frog are rather widely scattered over the prairie section of western Minnesota, with one isolated record in Hennepin County in the eastern part of the state (Map 16, squares). A fisherman's frog box containing 250 frogs was examined near Granite Falls and was found to contain five, or 2 per cent, of this dark form. On the basis of present data the author considers form *kandiyohi* to be much less common than form *burnsi*, and more restricted in distribution.

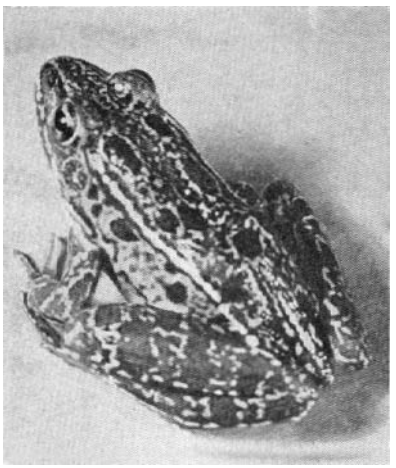


Figure 15. Leopard frog, *Rana pipiens*, form *kandiyohi*. (Natural size.)

Range. The leopard frog is probably the most widely distributed amphibian in North America. It ranges over the entire eastern part of the continent east of the western edge of the Great Basin and from the lower Arctic region into Mexico. It is common throughout Minnesota (Map 16).

Habits and habitat. The leopard frog is by all odds the most abundant and well-known amphibian in Minnesota. The fact that these frogs have the ability to travel for considerable distances away from water brings them to public attention more often than other frogs. The same habit enables them to take advantage of fluctuating water conditions both in breeding and in hibernation. During the drought years of 1931–34 they were very scarce in the prairies of western Minnesota, but even then, when ponds in stream beds were miles apart, a few could always be found in them. With the return of the rains the country in a surprisingly short time again brought forth large leopard frog populations.

Leopard frogs become active late in March in the southern half of the state and a little later in the north. Almost immediately they become conspicuous by starting out for temporary meadow ponds for breeding, and many cross highways in doing so. Warm, misty or rainy nights induce them to move most abundantly, and at such times thousands are killed by cars. Until the later part of April large numbers of leopard frogs are to be found breeding in the temporary ponds. After breeding they disperse to all sorts of wet situations in streams, marshes, lake shores, tamarack swamps, or roadside ditches. If ponds dry up in midsummer these frogs are able to start off in search of more permanent waters. While on these overland treks they spend the daytime, with its low humidity, in burrows, crevices, or any available moist places of concealment, and if none are found they work out depressions under the grass. For a time they can withstand surprisingly hot, dry conditions while they are thus partially buried in the soil. Again in the fall mass movements of frogs appear crossing highways on their way to permanent waters for winter quarters. Occasionally mass movements of very small frogs are seen in midsummer. These frogs are the newly metamorphosed young, abandoning the disappearing ponds in which they were reared, or dispersing from overpopulated areas.

Food. Drake (1914) reported the contents of the stomachs of 209 Ohio specimens of the leopard frog. He found almost 90 per cent of the food to consist of various insects and spiders. M. H. Doner of Winona reported a large leopard frog as containing a small garter snake—an interesting case of the frog's turning the tables on one of its mortal enemies. L. T. S. Norris-Elye of Winnipeg (correspondence) has three records of large leopard frogs' taking ruby-throated hummingbirds and one record of a frog's taking a yellow warbler.

Hibernation. On January 1, 1939, R. M. Berthel and the author, at the suggestion of James Kimball, investigated the outlet of Martin Lake in Anoka County. A concrete dam 12 feet wide controlled the outflow from the lake. Immediately below the dam were limestone slabs, and farther downstream the bottom was clean sand. The stream here was 18 to 24 inches deep, and the agitated water was unfrozen for some distance below the dam. The sand bottom for several yards below the dam was literally paved with hundreds of closely crowded leopard frogs. They were not entirely dormant, for every few seconds one would float up and swim slowly to a new situation.

American merganser ducks, taken in midwinter along the Mississippi River below the mouth of the St. Croix, were found by the Wisconsin Conservation Department to be living to a considerable extent on frogs.

This fact suggests that the frogs were hibernating there in a similar manner, since these ducks are not known to probe for food.

Such well-aerated waters provide optimum hibernating conditions, but the leopard frog evidently is able to winter also in the much less favorable waters of ponds and marshes.

Enemies. The greatest destruction of leopard frogs observed by the author has been caused by traffic during mass movements of the frogs. On September 14, 1939, between Anoka and Elk River, north of Minneapolis, the author counted 330 leopard frogs recently killed on 100 yards of a two-lane pavement comprising half of a boulevard highway —a traffic mortality rate of nearly 12,000 a mile. Fully as heavy a death rate has been observed over short distances in many places in the vicinity of the Twin Cities, and there is reason to believe that the same thing occurs over a large part of the state during these migrations. With some species, of course, this tremendous toll would be a very serious matter, but since leopard frogs lay large numbers of eggs it is doubtful whether such destruction materially influences their population over a period of years.

The author has recorded the following animals preying on leopard frogs: three forms of the garter snake, both western and eastern hognosed snakes, the blue racer, bull snake, water snake, pied-billed grebe, American merganser duck, green heron, great blue heron, sparrow hawk, broad-winged hawk, marsh hawk, and great horned owl. A host of other carnivorous reptiles, birds, and mammals prey on this abundant frog, and in its tadpole stage fishes and aquatic insects also take toll of them. The lowering of pond levels is a major factor in the destruction of eggs and tadpoles. Tremendous mortality is of course expected, and in fact is necessary in the case of such animals, to prevent the land from becoming overrun by their innumerable offspring.

Call. The harsh, low croaks of the male leopard frog may be heard from late March through April and into early May. The disproportionately loud trill of the tiny swamp tree frog, *Pseudacris nigrita*, is very often mistakenly attributed to this much more conspicuous leopard frog, whose size so much better fits the volume of that call. The croak of the leopard frog is described in the following field note: "I found many of these frogs giving their lazy, half-hearted, guttural, grating croak. It has a quality like the creaking of heavy harness or saddle parts. The calls usually start weak in volume and increase to the maximum, then rapidly decrease, the whole consisting of fifteen to twenty separate notes. A vocal sac swells out on either side just below and behind the tympanum above the front leg. The calls are frequently given while the frog is completely submerged, the air being forced

back from the vocal sacs into the lungs in preparation for the next sound."

Breeding. In late March the melting snows begin to form pasture ponds where these frogs congregate to breed. As with other frogs and toads, the males clasp the females in readiness to fertilize the eggs the moment they are laid in the shallow water. Often the frogs will gather in one particular part of a pond. A field note dated April 9, 1938, reads: "The croaking of the leopard frogs was concentrated in the open west end of the pond; in fact, only there were these frogs present. A disturbance was found to be caused by a number of male frogs attempting to clasp a large female. Six males were so tightly clasping her already that the whole mass was lifted from the water and a surprising amount of force had to be used to separate each male from the mass. Six other males were in the water within a radius of four feet of this cluster."

On the same night as the above notes were taken, a number of the egg masses were found. Each egg is a black and white sphere about 1 mm. in diameter, with a transparent gelatine outer coating giving each coated egg a diameter of about 5 mm. Frequently several thousands will constitute a single mass. These masses are usually placed about dead twigs, weed stalks, or similar supports, from a few inches to a foot or so beneath the surface. Temperature and weather conditions have a marked effect on the period of development of the eggs and tadpoles. Thousands of tadpoles were found just beginning to emerge from the waters of an Anoka County slough on June 30, 1938, and on July 10, 1937, Warren Nord noted large numbers of newly metamorphosed frogs (0.75 to 1.25 inches in length) leaving a lake in Ramsey County. These dates indicate that a period of approximately twelve weeks is required for the passage of the egg and tadpole stages of this species in the latitude of the Twin Cities.

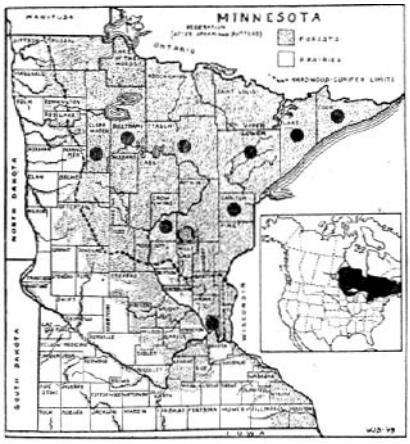
Suggested Reading. Mary C. Dickerson, 1931, pp. 171–85.

MINK FROG

Rana septentrionalis Baird

Since the mink frog often closely resembles the green frog, descriptions of both species should be checked in identifying material from the coniferous forest regions of Minnesota.

Description. The mink frog is of medium size, with a maximum body length of 3 inches. It never attains the size of the green frog or the leopard frog. It gives off a distinct musky odor, hence the name mink frog. The tympanum is larger than the eye in males and smaller



Map 17. Range of the mink frog.

in females. The dorsolateral folds are absent or much interrupted. The thumbs of males are much enlarged at the base. The feet are extensively webbed, usually with only one joint of the fourth toe free. The third and fifth toes are usually equal in length. The skin is usually smooth, with only slight granulations on the sides, but is sometimes roughened.

The color and markings are variable. Normally the mink frog is a darker appearing frog than the green frog and its dorsal black spots or blotches are larger and more numerous. These black spots are narrowly margined with light color. The mink frog has green lips like those of the green frog. The back of the thighs and the sides are usually heavily blotched or reticulated with black. The under parts are whitish or yellowish, sometimes quite yellow, and are nearly always unmarked.

The following description of the larvae is summarized from A. H. Wright (1932). The tadpoles develop to a large size (99 mm.) before metamorphosing. The tail is elongate with the tip acute. The dorsal crests are not as wide as the musculature and do not extend forward on the body much beyond the level of the buds of the hind legs. There are one complete row and one incomplete row of teeth above the horny beak and usually three complete rows below. The general coloration is yellowish olive to dark olive. There are small dark spots more or less uniformly scattered over the back. The maturing tadpoles darken, leaving the yellowish legs contrasting with the back. The belly is straw yellow to buff. The sides are mottled. The white pigment beneath obscures the viscera within. There are pinkish buff spots on the edge of the dorsal and ventral tail crests. There are very few black specks on the tails of mature tadpoles. In two-legged tadpoles there are one or more prominent black blotches with pinkish cinnamon spots at the base of the tail.

Range. S & B (1943) give the range of this frog as from "northern New England to the Gaspé Peninsula and northern New York, west through Michigan to Minnesota, Canada to Hudson Bay." The eight county records for this species (Map 17) are well distributed and strongly suggest that it is found throughout the coniferous region of

the state. One specimen (835) was taken from Lake Josephine in Ramsey County, a lake south of the coniferous belt, but with a floating sphagnum bog along one shore.

Habits and habitat. The mink frog, like the green frog, is highly aquatic. The author has encountered it in bog lakes, sluggish, vegetation-choked streams, and beaver flowages, where it pokes its head above the water among the lily pads as a canoe glides by, to disappear quietly as the canoe nears. Or it may rest near the banks, partly submerged, a position in which it is hard to detect until it hops with a splash into deeper water. Unlike the leopard frog, it is never found at any distance from water. Garnier (1883) states: "It inhabits spring creeks and rivers, but in lakes and ponds of the purest water I have never seen it, nor captured a single specimen. It is quiet and solitary in its habits."

Call. P. H. Pope (1915) quoted A. H. Norton concerning the call of this frog: "At Mud Pond, Caswell [Maine] they were heard calling. . . The call of *Rana septentrionalis* was found to be similar in nature to that of *R. clamata*, but differed strikingly in tone, being higher and slightly metallic, resembling closely the sound produced by striking a long nail on the head with a hammer in driving it into heavy timber." Pope later confirmed this description, saying that it fitted the call admirably.

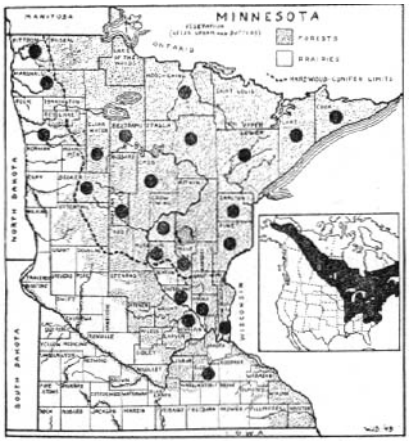
Breeding. A. H. Wright (1932) states that the period of mating begins in the later part of June and extends well into August. The actual mating of this species seems never to have been observed. Wright and his associates found water lily patches in slow-moving streams to be the preferred location for egg laying. The egg masses are brownish or yellowish and vary from two to six inches in diameter. The masses are placed anywhere from near the surface to five feet below it, and surround, or are attached to, the water lily stems. The tadpoles metamorphose in the second summer, after a tadpole life of a year or slightly more. Some may even pass a second winter in the tadpole stage.

Suggested Reading. J. H. Garnier, 1883, pp. 945–54. A. H. Wright, 1915, pp. 46–48.

WOOD FROG

Rana sylvatica Le Conte

Races. S & B (1943) recognize three subspecies of this frog. The ranges given show only one of these, *R. s. cantabrigensis*, occurring in Minnesota. However, there is some uncertainty regarding the distinction between *R. s. cantabrigensis* and *R. s. sylvatica*, and it is possible



Map 18. Range of the wood frog.

that wood frogs from eastern and southeastern Minnesota may eventually be referred to the latter race.

Description. The wood frog (Figure 13C) is a small to medium-sized frog. It sometimes attains a body length of 2 inches. The snout is rather pointed. The tympanum is smaller than the eye in both sexes. There is a heavy fold from the upper lip to the forearm, and prominent ridges (dorsolateral folds) extend down either side of the back to the hind legs. The skin is roughened between these folds, often suggesting a second pair of folds. The skin beneath is smooth, except for a granular area under the thighs.

The general dorsal color varies from gray to reddish brown and is often distinctly coppery. There is a dark mask running from the snout through the eye, including the tympanum, and terminating abruptly in a diagonal line just behind the tympanum. The upper lip and fold to the fore limb are light. The dorsolateral folds are light, often bright coppery. There are either many varied dark markings or none at all on the back between the lateral folds and on the head. Usually a light middorsal stripe runs from the top of the head to the pelvic region; this stripe may be very prominent or entirely absent. Frequently there are a few distinct, rounded, black spots on the lateral fold and below it and also on the pelvic region. There are dark bars on the legs, varying from very prominent to almost absent. Beneath, the skin is yellowish white, plain to heavily mottled with dark, especially on the throat.

Ruthven, Thompson, and Gaige (1928) describe the tadpole as "brownish gray above, finely speckled with gold; iridescent grayish bronze beneath; the tail crest does not extend on the body and is light vermiculated with dark. Upper lip with three rows of teeth, second and third interrupted; lower with four rows. Lower lip and sides of upper bordered with papillae and folded in at the corners of mouth."

The distinction between the two subspecies referred to in the paragraph on races concerns the relative length of leg. In Minnesota those to the southeast have longer legs than those to the northwest. The gradation is gradual, and authorities differ as to where the separation should be made or whether a separation should be recognized at all.

The proportions suggested by Wright and Wright (1942) would place St. Croix Valley material as well as scattered individuals from all over Minnesota as belonging to *R. s. sylvatica*. Patch (1939) has suggested dividing the species into only two forms, *R. s. sylvatica* and *R. s. cantabrigensis*, distinguishing them on the basis of whether the leg, minus the foot, is longer or shorter than the body. On this basis all Minnesota material would be referred to *R. s. cantabrigensis*.

Range. As a species the hardy wood frog ranges from Alaska to James Bay east to Labrador, south, to the east of the Rockies and the Great Plains, to Arkansas and South Carolina. In Minnesota it probably occurs throughout the wooded parts of the state, though records are still lacking for the southeastern part (Map 18).

Habits and habitat. The wood frog has always appealed to the author as one of the most attractive amphibians. Perhaps its appeal is partly due to its surroundings. So often this beautiful, sometimes coppery colored frog hops aside while one is walking beside a stream in ancient, heavy woods where the fallen logs have lain for many years undisturbed and are covered luxuriantly with a mantle of green moss, and where the undergrowth has held the stream bank cutting to a minimum. The wood frog seems not to wander very far from such situations. The grazed, brushed out woods of southeastern Minnesota seem no longer to harbor this species. The few comparatively primitive situations, such as the Nerstrand Woods in Rice County and the wooded St. Croix Valley, still have their wood frogs, but such haunts are rapidly passing, and this species almost surely goes when burning, grazing, and clearing destroy its natural haunts. In the Red River Valley this frog follows the wooded stream courses onto the prairies to the Red River itself, but never invades the strictly prairie habitat. Its occurrence under logs, bark, and stones late in fall indicates that it hibernates in such situations.

Call. The wood frog becomes active and starts calling very early in the spring, in late March or early April. The following note was written concerning the calling of the males along Coon Creek in Anoka County in April, 1938: "Five males were croaking along the shores of an oxbow pond among the grasses overhanging the water. They floated with hind legs fully extended on the water surface or sat mostly submerged while calling. The croak was a one-syllabled, harsh, grating call, sounding like a couple of black walnuts being pressed firmly together and scraped one upon the other. The explosive calls were given singly or one or two at a time at intervals of a little less than a second. The species is said to have no vocal sacs, but the throat and chest inflated markedly with the production of the sound."

Breeding. The eggs, according to Dickerson (1931), are laid in the pools of the woods or open country adjacent. They are laid in masses four or five inches in diameter and containing one to three thousand eggs each, and are attached to twigs or grasses in shallow water, or they may be free. The eggs hatch in one to three weeks. The tadpole stage may persist well along into the summer. Young, newly metamorphosed wood frogs are usually about three-fourths of an inch long.

Suggested Reading. Mary C. Dickerson, 1931, pp. 205–13. Harold Trapido and R. T. Clausen, 1938, pp. 122–24.

Reptiles Class REPTILIA

The reptiles have become adapted to a land existence throughout life, for lungs are present at all stages. The skin is covered with plates (turtles) or scales (snakes and lizards). The toes are clawed. The skull has a single occipital condyle. Reptiles are cold-blooded, or rather, variable temperatured, technically "poikilothermic." The heart is three-chambered. The embryonic membranes, the allantois and the amnion, lacking in amphibians, are present in reptiles. Eggs are laid on land or retained within the body until hatched.

Lizards

Suborder SAURIA

Lizards are elongated reptiles covered with scales. Minnesota species have two pairs of five-toed, clawed limbs. Lizards have a prominent ear opening. They have both upper and lower eyelids. The jaws are much more firmly attached to the skull than in the snakes, and the lower jaws are joined in front. The tail is brittle and if lost will grow again. The vertebrae cannot be regenerated. Lizards have no vocal apparatus. Minnesota species lay eggs.

SIX-LINED RACER

Cnemidophorus sexlineatus (Linnaeus)

Description. (Compare with the description of the common black-banded skink.) The head of the six-lined racer (Figure 16) is narrow and pointed at the snout when viewed from above. The muzzle is deep and heavy when viewed from the side. There are prominent ear openings. The top of the head is covered with large plates. There are two prominent folds across the under surface of the neck. The back, sides, throat, and under surface of the neck are covered with tiny, granular scales.

Map 19. Range of the six-lined racer.

Both jaws are armed with a row of fine, sharp teeth. The belly has rectangular plates arranged in lateral and longitudinal rows. The limbs are well developed. They are plated above and have small scales beneath. There are five fingers, strongly clawed. The hind limbs are much larger than the front ones. There is a prominent row of femoral pores. There are five toes, the fourth considerably longer than the foot; all are strongly clawed. The anus is a cross slit just behind the hind limbs. The tail is cylindrical in cross section. It is extremely long, with a perfectly uniform taper. The scales are strongly keeled above and weakly so beneath, and are arranged in rings from base to tip. The

Figure 16. Six-lined racer, *Cnemidophorus sexlineatus.* (Natural size.)

measurements of an adult specimen (981) are as follows: total length, 8.98 inches (228 mm.); head and body, 2.82 inches (70 mm.); hind limb from inner tip of femoral pore series, 1.97 inches (50 mm.); fourth toe, 0.66 inches (17 mm.); fore limb, 0.94 inches (24 mm.).

The top of the head, central dorsal stripe, and the dorsal surfaces of the legs and tail are neutral olive brown. On either side of the mid-dorsal stripe the back is black; it becomes lighter ventrally, merging into the bluish green of the lower side. The sides have three narrow longitudinal light stripes, the upper yellowish, the lower two bluish to greenish. Beneath, the head, chest, legs, and tail are glistening white. The sides of the belly are often bright blue or green, particularly in spring males.

Range. S & B (1943) give the range of the six-lined racer as "Maryland to Florida, west to northern Mexico and Arizona and up the

Mississippi Valley as far north as Lake Michigan." The collections of the University of Wisconsin and the Milwaukee Museum contain specimens from Pierce, Pepin, and Vernon counties, all of which border the Mississippi between the mouth of the St. Croix and the Iowa line.

A number of records are at hand from Houston County (139–40 and several in the St. Cloud Teachers College collection). At present the only Minnesota record outside of that county is a specimen (621) taken on Gray Cloud Island in Washington County on July 18, 1899 (Map 19). Recent searches indicate that this colony has probably disappeared. The author's record of specimens taken on the St. Croix–Pierce County line in Wisconsin, across the St. Croix River from Afton, Minnesota, appears to be the most northerly for this species throughout its entire range.

Habits and habitat. The most striking characteristic of this slender, whip-tailed lizard is its swift movement. So rapidly will it dart from cover to cover that one is left with the impression that only a shadow has been seen. Its actual running speed has been recorded (Hoyt, 1941) as 18 miles an hour, which seems disappointingly slow. But should a good-sized police dog travel as fast, in comparison to its body length, it would have to run nearly 300 miles an hour.

This southern lizard prefers hot, dry, exposed situations. Louis Moos found it in Houston County living on the hot, dry hillsides under small slabs of disintegrating limestone. R. M. Berthel and the author found these lizards active during the heat of late July days on the cinder fills along the railroads in the town of Reno, in Houston County. Just across the Mississippi from Red Wing, Minnesota, they were found on the steep, gravel sides of a ravine covered with red cedar and sandburs. Along the St. Croix, Warren Nord and the author found a thriving colony of racers living on the sand beach of the river at the foot of a steep sand and gravel bluff. This lizard has a definite tendency to live in colonies.

Apparently the six-lined racer is a very adaptable lizard throughout its entire range. Burt (1931) states: "It frequents a greater variety of habitats than all of the other Kansas species . . . it has been found on rocky hillsides, open corn and wheat fields, in upland meadows, on low sandy river banks, about chalk cliffs, railroad embankments, road beds, sand dunes, isolated sand banks, occasional outcroppings of rock, and on the upper part of wooded hillsides. These animals are often found close to dwellings, and are apparently able to adapt themselves to changes brought about by agricultural conditions."

Breeding. Ditmars (1936) states: "All of the species [of *Cnemidophorus*] lay thin shelled eggs. The female scoops out a hollow in the

sand, and, carefully covering the eggs, leaves them to be hatched by the sun's heat." Burt (1931) states: "The eggs of *sexlineatus* are . . . about 17 to 22 mm. long by 11 to 14 mm. broad, with a smooth skin to which the dirt does not adhere . . . readily." Apparently little is known of the breeding of this widespread lizard. Burt gives but one reference to natural nests—those found during June in Georgia between the furrows in a plowed field. Four to five soft, velvety eggs were found together in holes four to twelve inches deep. Nothing is given on the incubation period or the time of hatching of the young.

Food. A specimen collected along the St. Croix contained a medium-sized grasshopper almost intact. Ditmars (1936) states: "For the most part they are insectivorous, but the adults are not averse to feasting upon the eggs of small birds that build their nests on the ground. The lizard cracks the shell with its strong jaws and laps up the contents with the flat, forked tongue." Burt (1931) comments: "After considering the size of the lizard's mouth, it appears that only extremely small eggs, if any, would be eaten; and it seems that the lizard cannot be a serious enemy to bird life in this respect." Burt further reports that the stomachs of fifteen Kansas specimens contained grasshoppers, crickets, katydids, moths, measuring worms, beetles, bugs, ants, chalcid flies, ichneumon flies, tachinid flies, spiders, and land snails.

Suggested Reading. Charles E. Burt, 1931, pp. 91–94.

BLUE-TAILED SKINK

Eumeces fasciatus (Linnaeus)

Map 20. Range of the blue-tailed skink.

Description. The blue-tailed skink, very rare in Minnesota, closely resembles the common black-banded skink, *Eumeces septentrionalis.* It differs from that species in having five instead of seven stripes on the body, the light middorsal stripe forking and continuing on the top of the head, and a postnasal scale. Otherwise the blue-tailed skink is almost identical with the black-banded. The young of both species have deep blue tails. In very old males the light lines are almost entirely lost, but the females usually retain at least an indistinct pattern of lines.

Range. Taylor (1935) outlines the range of this skink as including South Dakota, the northern peninsula of Michigan, southern Ontario to Massachusetts south to the Gulf of Mexico and from east Texas to north Florida.

At present there are only two authentic records (904, 1358) for this species from the whole of Minnesota. Both are apparently from the same colony in the Minnesota River bottoms on the Yellow Medicine–Redwood County line, in the west central part of the state. R. M. Berthel and the author collected a specimen in Wisconsin a few miles east of Taylors Falls, Minnesota. Considering the author's extensive series of the black-banded skink from Minnesota, there can be little doubt that this species is rare in the state and that it is largely replaced here by the black-banded skink. (Map 20.)

Habits and habitat. Several authors familiar with this skink in its centers of abundance to the east and south of Minnesota (Ruthven, 1911; Cagle, 1940; Ditmars, 1936; Taylor, 1935) agree that the species prefers dry, sandy situations with sparse, open tree growths, where it lives largely in and under rotting logs, brush piles, sawdust heaps, stones, and similar cover. Little mention is made of rocky habitats, from which the few records from Minnesota and western Wisconsin come. The Wisconsin record, from east of Taylors Falls, came from under an 18-inch slab of rock lying on the surface of an extensive basalt outcrop, with sparse oak cover. The two Minnesota records were from granite outcrops in the Minnesota bottomlands. These records are too few to be significant, but they suggest that here, on the western border of its range, the blue-tailed skink is pushed out from its preferred sandy habitat by the black-banded skink, a form better adapted to survive in this particular climate.

The habits of this species do not appear to differ significantly from those of the common black-banded skink.

Breeding. Notes published by workers from areas where this skink is abundant (Cagle, 1940; Noble and Mason, 1933) indicate that its breeding habits are the same as those of the black-banded skink.

Food. The food of the blue-tailed skink does not differ markedly from that of the black-banded species. McIlhenny (1937) described a large blue-tailed skink repeatedly climbing into some vines, vigorously shaking a number of wasp nests, then going to the ground and picking up the dislodged larvae. Adult wasps that alighted on the attacker were unable to penetrate its smooth scales and were snapped up and swallowed by the skink.

Suggested Reading. F. R. Cagle, 1940, pp. 227–33. G. K. Noble and E. R. Mason, 1933, pp. 1–29.

BLACK-BANDED SKINK

Eumeces septentrionalis (Baird)

Map 21. Range of the black-banded skink.

Races. Two subspecies of this skink are recognized (S & B, 1943), of which only one, *E. s. septentrionalis*, occurs in Minnesota.

Description. The black-banded skink (Figures 17, 18) has a prominent ear opening above the angle of the jaws. The top of the head is covered with large plates, the rest of the body with small, imbricated scales. The body is slender in young skinks, stouter in adults. The normal tail is circular in cross section and evenly tapering, and somewhat exceeds the body and head in length. The tail is easily broken off, but regenerates. The new tails are shorter, more abruptly tapering, and of a slightly different color, and the scale pattern near the break is irregular. The limbs are small. There are five toes on each foot, each with sharp, strongly curved claws; the fourth toe is markedly longer than the others. An average adult male (838) measures: total length, 7.25 inches (183 mm.); length from snout to vent, 2.91 inches (73 mm.); tail (normal), 4.37 inches (110 mm.); length of fore limb, 0.66 inches (17 mm.); length of hind limb, 0.74 inches (19 mm.); length of fourth toe, 0.27 inches (7 mm.).

In normal coloration the adult has three wide, ashy or brownish-gray stripes on the back, separated by two narrower black lines. No stripes are evident on the head. There are three black stripes on the upper part of the side, separated by two narrow, sharply defined, bluish-white stripes. The lower side and belly are pale bluish gray. The labials, chin, throat, soles of feet, anal border, and sometimes a chest patch are pale yellowish, except in spring males, which are bright salmon orange about the jaws, this tint remaining until early summer. The limbs are dark above and bluish gray or yellowish beneath.

The young are shiny black, with seven light longitudinal stripes of a yellowish color. The top of the head is black, with dorsal light lines disappearing on the neck. The chin and throat are yellowish. The lower sides and belly are pale bluish. The tail in newly hatched skinks (measuring 25–27 mm. from snout to vent) is brilliant blue, which be-

comes progressively duller with age and disappears after the skink reaches a length of about 50 mm. from snout to vent.

Range. Taylor (1935) reported specimens of this species from North and South Dakota, Manitoba, Minnesota, Wisconsin, Iowa, Nebraska, Kansas, Oklahoma, and Texas. In Minnesota black-banded skinks have been found in thirty-six of the eighty-seven counties (Map 21). These records indicate that the species is found over the whole of the state with the exception of the northeastern portion. It is scarce in the southeastern part of the state, but occurs there in certain local areas.

Habits and habitat. The average hiker rarely sees this elusive little lizard. On some beautiful May day you may be walking in an open sandy oak woods when suddenly a tiny rustling of the leaves attracts your attention. You get glimpses of what appears to be a rather short, striped snake squirming rapidly through the grass and leaves. You may or may not recognize that it has legs. Dropping to your knees, you clap your hand down on the little creature. Carefully lifting your hand to examine it, you either find nothing at all or merely a generous portion of its tail, which squirms and twists vigorously. Do not feel too badly about the injury, since within a few weeks the skink will grow a new tail. The wriggling member is really an effective protection to the skink, since it serves to attract an enemy's attention while the animal escapes. The brilliant blue tail of the young is particularly effective in this "rear guard action."

Figure 17. Black-banded skink, *Eumeces septentrionalis.* (½ natural size.)

The majority of those seen in the open are males taken during the breeding season in May and June. For the most part these animals appear to spend their time in hiding in small excavations beneath such objects as sticks, stones, bark, boards, and pieces of tin or paper. They are hunted most productively with the aid of a strong hook for turning over such objects that have been lying undisturbed for some time and have settled well into the surface of the sod. Often these excavations connect with small burrows in the soil. These burrows become deeper and deeper in late summer and fall, when more protection is needed.

Colonies of these skinks seem to thrive best in comparatively dry, sandy soils where there is a fair amount of vegetation to afford protec-

tion and where there are insects for food. The scattered scrub oak growths common in Anoka and Sherburne counties seem to afford ideal conditions for this skink.

Hibernation. It appears that skinks become less and less active through September and October and that during this time they are deepening their burrows to sufficient depths to afford winter protection. Skinks

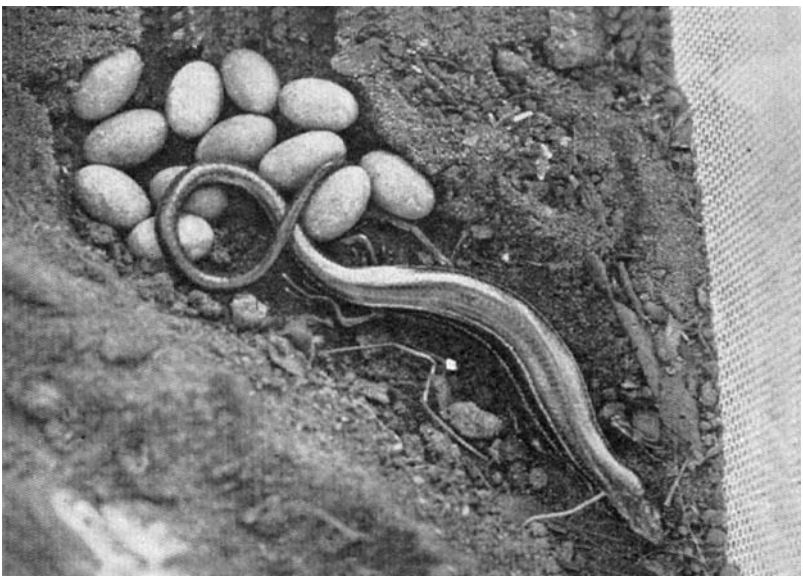


Figure 18. Black-banded skink, *Eumeces septentrionalis*, with eggs. (Natural size.)

have been dug from gravel beds at depths as great as four and a half feet, although several captive skinks survived a winter in Minneapolis in sandy soil at a depth of only a foot. Skinks may mass together like snakes during hibernation. A football-sized mass of fifty-two skinks was once found in an Iowa gravel bank (Scott and Sheldahl, 1937), but the author's records suggest that at times they may winter in small groups or singly. In a mild spring the middle of April finds some skinks emerging, but most of them emerge in early May.

Enemies. Skinks are preyed on by a variety of carnivorous animals, including the western hog-nosed snake, marsh hawk, barred owl, sparrow hawk, migrant shrike, striped ground squirrel, and raccoon. Adult skinks sometimes take the young of their own kind.

Breeding. Skinks reach the peak of their breeding season soon after emergence from hibernation in May. Six captive females laid their eggs

between June 26 and July 17, although the author has data suggesting that many eggs must be laid as early as the first part of June. The eggs are dirty white in color and elongate in shape, and have soft, leathery shells. Of thirty-six eggs the average size at the time of laying was 8.04 mm. by 13.37 mm. The eggs swell up during incubation and may measure as much as 11 mm. by 19 mm. just before hatching. Nineteen sets of eggs contained from 5 to 13 eggs each, the average set containing 8.79 eggs.

The eggs are usually laid in well-drained situations in small cavities, which the animals hollow out directly beneath stones or logs, or pieces of bark, wood, or metal. The incubation period of six sets of eggs varied from 40 to 52 days. The average period was found to be 45.5 days.

A colony of wild skinks, individually marked, afforded data indicating that the young grow rapidly during their first year (0.37 mm. a day). During their second year the rate of growth (0.31 mm. a day) decreases slightly. At the end of their second year the skinks are of mature size. They undoubtedly breed in the spring of their third season, at less than two years of age.

Food. An analysis of the stomach contents of thirty-seven wild skinks revealed a wide range of foods, with a distinct preference for grasshoppers, crickets, and spiders. Treehoppers and leafhoppers, beetles, and caterpillars ranked next in the food preferences of these lizards.

Suggested Reading. W. J. Breckenridge, 1943a, pp. 591–606.

Snakes

Suborder SERPENTES

Snakes are much elongated reptiles covered with scales. They lack limbs, external ear openings, and eyelids. The lower jaws are attached to each other and to the cranium by elastic ligaments, which permit the swallowing of remarkably large objects. The tongue is long, slender, and forked, and is concerned with touch and smell. Minnesota snakes either lay eggs or produce living young; that is, are oviparous or ovoviviparous. Snakes have no vocal apparatus but may produce loud hissing sounds. Males have paired, fingerlike, spiny copulating organs, which, when at rest, are inverted into long, tubelike pockets extending backward into the tail from either side of the vent. The presence of these organs makes the tails of males heavier at the base than those of females, and the proportionate length of the tails of males is usually greater than that of females.

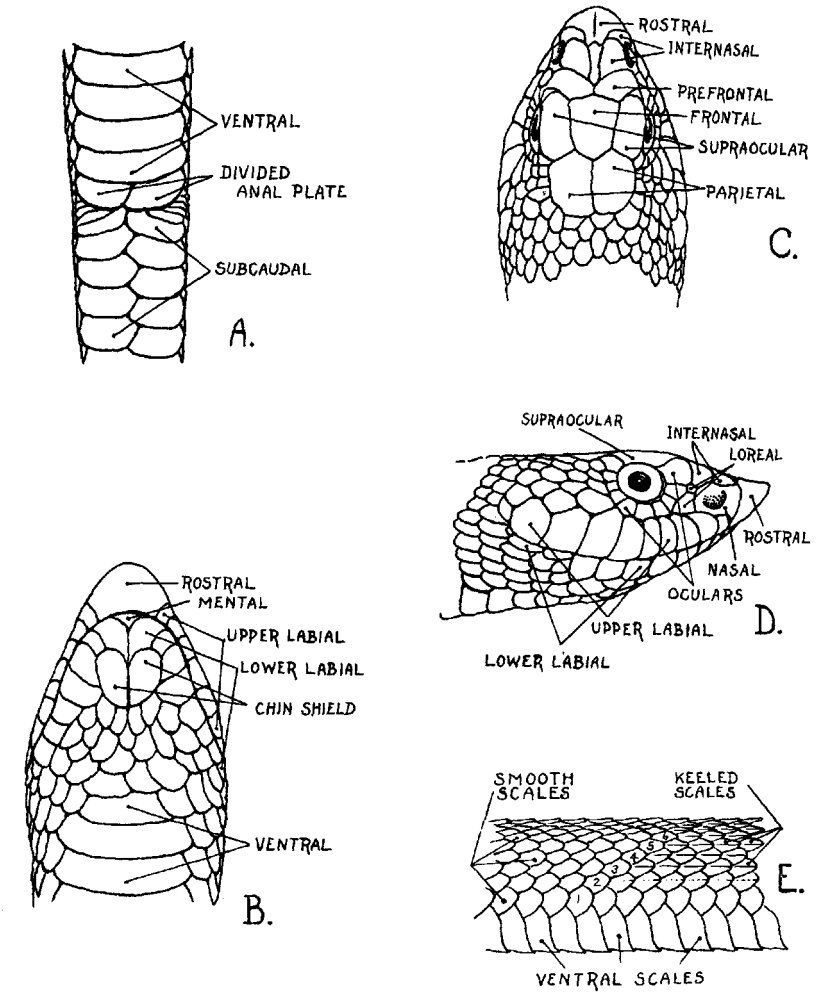


Figure 19. Nomenclature of scales in snakes. *A*, ventral aspect of anal region; *B*, ventral aspect of head; *C*, dorsal aspect of head; *D*, lateral aspect of head; *E*, lateral aspect at midbody, showing keeled and unkeeled scales and method of counting scale rows.

RING-NECKED SNAKE

Diadophis punctatus (Linnaeus)

Races. The ring-necked snake (Figure 20) has five recognized races (Blanchard, 1942), of which two, the eastern ring-necked snake, *D. p. edwardsii* (Merrem), and the prairie ring-necked snake, *D. p. arnyi* (Kennicott), occur in Minnesota.

Map 22. Range of the ring-necked snake. Circles indicate eastern ring-necked snake and squares indicate prairie ring-necked snake.

Description. The ring-necked snake is not venomous. It is small, seldom exceeding 16 inches in length. The eastern race, *D. p. edwardsii,* is dark slate color, with a yellow or orange neck ring. Beneath, it is yellow to orange. The labials are like the under parts. Most specimens are unspotted beneath, but some have a few small scattered black spots, particularly posteriorly. Very young snakes are darker above and have pinkish bellies and more brilliant yellow collars. Ruthven, Thompson, and Gaige (1928) summarize the scalation as follows: "Dorsal scale rows 15, the scales smooth. Upper labials 8 or 7; lower labials 8, less often 7. Oculars 2—2, rarely 1—2. Ventrals in males 145 to 160, average 151, in females 154 to 168, average 160; subcaudals in males 51 to 64, average 57, in females 43 to 56, average 51. Anal plate divided."

The prairie ring-necked snake, *D. p. arnyi,* differs in several characters from the eastern form. It usually has 17 instead of 15 scale rows. It has more spots on the belly. These spots are usually ranged in two rows. In the prairie form the dark color of the head extends around or across the angle of the jaw and slightly forward on the lower jaw, and the undertail color tends to be more red orange than in the eastern race. The ventral scale count averages higher than in the eastern race, and the subcaudal count is lower. Blanchard (1942) gives the following scale counts for the prairie form: ventrals in males 142–169, average 156; females 151–185, average 168; subcaudals in males 37–57, average 46; females 30–50, average 41.

The young of the red-bellied snake are dark, with the occipital spot and the spots on the sides of the neck united to form an almost complete collar around the neck, and the belly is pale pink. Thus it closely

resembles the young ring-necked snake. However, the sharply keeled scales of the red-bellied snake separate this species from the smooth-scaled ring-necked snake.

Range. As a species the ring-necked snake ranges from Maine to northeastern Minnesota south to Florida, Texas, and Colorado. The eastern race, *D. p. edwardsii*, occupies a triangular portion of this range, extending from Maine to northeastern Minnesota south in the Appalachian Mountains to northern Georgia. The prairie form, *D. p. arnyi*,

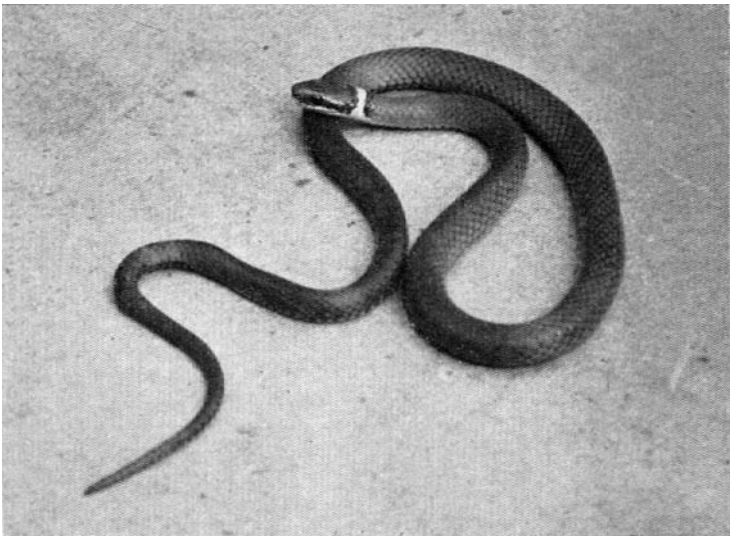


Figure 20. Ring-necked snake, *Diadophis punctatus*. (⅔ natural size.)

occurs from southeastern Minnesota and eastern Nebraska southward to Arkansas, central Texas, and southeastern Colorado. In Minnesota (Map 22) only two specimens of the eastern race have been taken, one (1065) near Lax Lake in Lake County by Harvey Gunderson on July 23, 1940, and another (1237) by Olga Lakela only a few miles from this locality on August 29, 1943. A third specimen (1134) was taken by Harvey Gunderson and the author in Pierce County, Wisconsin, on the bluffs of Lake Pepin, just across from Goodhue County, Minnesota. The only Minnesota specimen of the prairie ring-neck (1143) was taken in Winona County by George Rysgaard, Harvey Gunderson, and the author on August 16, 1941.

Habits and habitat. The author's experience with this snake is limited, but as far as it goes it corroborates published accounts of the exceedingly secretive nature of the species. The ring-necked snake is nocturnal and spends the day under rotting logs, boards, stones, bark

slabs, and similar cover. Its range coincides with the forested areas, usually hardwood, although it seems to invade the southern part of the coniferous forests. The so-called prairie form occupies the wooded parts of the prairie states. One writer (Ortenburger, 1930) states that "it is usually seen in the evening as it is getting dark, and most commonly on old unused roads or paths through the woods." These were exactly the conditions under which Gunderson found the Lax Lake specimen. The Winona County specimen was found coiled up under a small log in the elm, black ash, and soft maple forest covering the moist bottomlands of the Whitewater River.

Food. Conant (1938) reports that "the food of the ring-necked snake consists of cold-blooded animals, including snakes, lizards, salamanders, frogs, insects, and earthworms." This report agrees with the findings of numerous other workers.

Breeding. The ring-necked snake is oviparous. Blanchard (1942) states that the freshly laid eggs of the eastern race are "elongate, straight or curved, with ends blunt or slightly pointed. . . . In length the eggs vary from 20.5 to 41.6 mm. and in width from 6.0 to 10.6 mm." Blanchard states that the most common number of eggs is three, with clutches varying from one to six. Regarding the nests he observes: "Most of the natural nests discovered have been in rotten logs that lay exposed to the sun and usually in logs with a shell of unrotted wood on the outside. In such logs the eggs may be found in a cluster in the soft part just under the shell on the sunny side of the log." He mentions that several females often lay their eggs in one nest, 48 eggs having been found in one log. According to Blanchard, the prairie race lays from one to four eggs and lives under similar habitat conditions, with perhaps a tendency to occupy drier hillsides than its eastern relative.

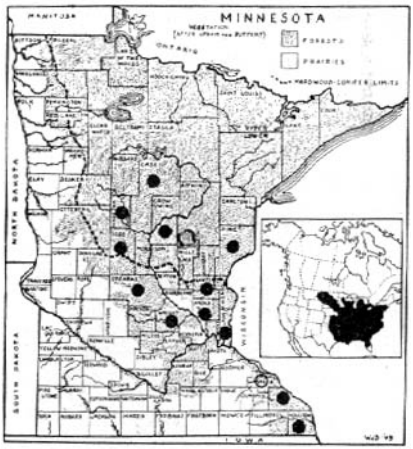
Suggested Reading. F. N. Blanchard, 1942, pp. 1–144.

EASTERN HOG-NOSED SNAKE

Heterodon contortrix (Linnaeus)

Races. S & B (1943) recognize two races of this snake, of which only *H. c. contortrix* is found in Minnesota.

Description. The eastern hog-nosed snake (Figures 21, 22, 23) is not venomous. All the scales are keeled. The rostral plate (snout) is much flattened beneath, with sharp edges, and keeled above. Viewed from the side the upper line of this keel is virtually parallel with the top of the head, or only slightly turned up. (It is definitely turned up in the western species.) The upper labials number 8, occasionally 9; the lower, 9 to 11. In contrast to *H. nasicus,* the plates on top of the head



Map 23. Range of the eastern hog-nosed snake.

are regularly formed. The scale rows number 25 or 27 at the neck and decrease to 19, or rarely 17, at the vent. The anal plate is divided. The ventral scale count in ten females ranged from 133 to 143; the subcaudal count, from 36 to 47. The ventral scale count in six males ranged from 125 to 130; the subcaudal count, from 47 to 52. The tails of males are proportionately longer than those of females. This species attains a larger maximum size than its western relative. A female from Pine County (1062) measuring 43 inches is, as far as is known, the largest specimen of this species on record. An average female (342) has the following measurements: length to vent, 23.5 inches; tail, 4.5 inches; total length, 28 inches.

The median dorsal spots are squarish and of dark brownish olive, often with darker margins, on a lighter yellowish or grayish olive ground color. These spots alternate with lateral rows of prominent spots. There are many smaller irregular black spots on the lower three or four scale rows. Blotches merge on the tail to form an irregular banded pattern. Beneath, the head is white. The belly is usually extensively marked with black, and is more heavily marked toward the vent. There is often a median pale line along the belly. The anal plate and under surface of the tail are light yellowish, contrasting with the black belly. (The under surface of the tail of *H. nasicus* is black.) On the head a dark margined bar connects the anterior corners of the eyes. There is a dark bar from the eye to the gape. The body pattern in most Minnesota specimens approaching adult size is gradually obliterated by a darkening of the ground color; this change progresses more rapidly posteriorly. Thus large specimens are plain dark posteriorly, with the pattern only faintly outlined in light dots on the anterior part of the body. In these larger specimens the two dark blotches on the sides of the neck usually remain distinct, while beneath they become light throughout. Small specimens have a very light gray ground color prominently setting off the black-bordered markings.

Range. S & B (1943) give the range of the common hog-nosed snake as "New Hampshire to peninsular Florida . . . westward to Texas and Oklahoma and northward through the states of the Mississippi basin

Figure 21. Eastern hog-nosed snake, *Heterodon contortrix*. (⅓ natural size.)

Figure 22. Eastern hog-nosed snake, *Heterodon contortrix*, playing dead. (⅓ natural size.)

into Minnesota." Over (1923) records it as widespread in South Dakota and numerous others (C. H. Pope, 1937; Conant, 1938) give its range as extending northwestward to include eastern Montana. Owing to its habitat requirements this species is local in distribution and cannot be said to occur throughout any extensive region. Minnesota records for this species are restricted to the loose fluvial sands and associated sand dune areas bordering the Mississippi and St. Croix rivers (Map 23). The gravel beaches of glacial Lake Agassiz bordering the Red River Valley seem ideal for the species, but so far all records from there are for the western species, *H. nasicus*.

Habits and habitat. The hog-nosed snakes probably have more common names applied to them than does any other Minnesota snake. Puffing adder, blowsnake, blowing adder, spreading adder, spreadhead, and hissing adder all refer to its striking defense display, while the name sand adder suggests its chosen habitat.

The shovellike structure of the rostral scale is considered to be an adaptation to burrowing in loose, sandy soil. However, even this sand-loving species may occasionally take to water, as indicated by Warren Nord's observation of August 13, 1939, when he saw a 20-inch specimen coming ashore after apparently crossing the St. Croix River.

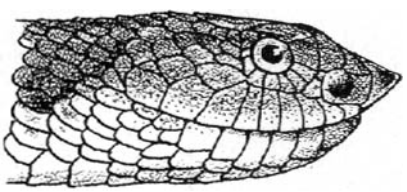


Figure 23. Head of eastern hog-nosed snake. (Natural size.)

The hog-nosed snake has two exceedingly effective defense actions. When it first encounters an enemy it attempts to bluff him into retreating with a most convincing and terror-inspiring display. It draws its stout body together in sinuous coils, and with a combination of inflation and peculiar muscular control it spreads out its head, neck, and the fore part of its body to two or three times its normal width. Often it raises its head like a cobra and warns the intruder with a loud, long-sustained hiss that can well be imagined to be a rattle. If the enemy approaches still nearer the snake strikes out vigorously and repeatedly. Ditmars (1936) wrote: "I have watched the majority of the world's most deadly snakes assume their various fighting attitudes, but will give this harmless creature credit for appearing even more hostile than the African vipers which are among the most fear-inspiring in aspect of any of the poisonous serpents."

This display may effectively repel most of the snake's natural enemies, and many human beings beat a hasty retreat from an angry hog-nose. Those who are bolder are usually convinced of its venomous

nature and immediately lay onto the snake with the nearest available stick. Even at this point, however, the snake's bag of tricks is not exhausted. At the first blow the snake quivers in convulsive muscular contractions, stiffens out, opens its mouth wide, in a perfectly genuine looking death gasp, and twists over onto its back, to remain still as death. The tongue is usually extruded. Even dirt and sand kicked into the mouth will not induce the snake to close it. The uninitiated attacker, thinking he has dispatched the reptile, puts his stick under a loop of its stiffened body and throws it off into the weeds. If he should watch, he would be surprised to find the "carcass" stealthily crawling out of the weed patch, to go on with its hunting of frogs and toads.

The one weak spot in this serpent's otherwise perfect act of playing possum is that it is thoroughly convinced that a dead snake should lie on its back. If it is turned on its belly, as in life, it immediately turns over again into its orthodox "dead" position, thus seriously damaging the illusion.

In captivity the hog-nose becomes a docile creature that can hardly be induced to strike or bite.

Over (1923) states: "We have known red-tailed hawks to feed their young on these snakes."

Food. The stomach contents of five Minnesota specimens comprised three leopard frogs, an American toad, and numerous insects, including beetles, bugs, wasps, and ants. Uhler, Cottam, and Clarke (1939) recently reported from Pennsylvania the contents of ten stomachs of this snake, as follows: "These indicated a degree of food selectivity not common among reptiles. Cold-blooded vertebrates, chiefly toads and frogs, are the favored fare, although contrary to most published accounts, warm-blooded vertebrates are at times taken. Of the ten specimens here reported upon, one had made its entire meal on a chipmunk (*Tamias striatus*) and another 87 per cent of its meal on a mouse (*Microtinae*)."

Breeding. This species is known to lay eggs, but only a single Minnesota record is at hand of eggs being taken in the wild. Marius Morse (correspondence) reported taking two eggs from a gravel deposit at a depth of about six inches in Crow Wing County, August 23, 1939. These eggs hatched on the following day, and on August 27 one of the young measured 7 inches in length. On June 1, 1942 Don L. Jacobs took in Anoka County a 28-inch female, which on July 7 laid 12 eggs, varying in length from 27 to 36.5 mm. and in width from 18 to 21 mm. The tough, leathery shells of the eggs were nearly white and tended to adhere to one another. The 43-inch Pine County specimen (1062) contained the remarkable number of 61 well-formed eggs nearly ready

to be laid, and a 36-inch female (1215) taken only a few miles to the east, in Wisconsin, contained 39 eggs. Conant (1938) reports a 33-inch Ohio specimen as laying 27 eggs on June 19, and mentions another clutch of 12 eggs laid July 1.

Gloyd (1932) states that a Kansas specimen laid 8 eggs on June 26: "The 8 eggs were placed in a metal container with a mixture of finely crumbled sphagnum and rotting wood and kept slightly moist. . . . All the eggs hatched on August 23 and 24, within 60 days after being laid." When two days old the snakes measured from 6⅝ to 8 inches.

Suggested Reading. R. L. Ditmars, 1936, pp. 290–93. K. P. Schmidt and D. D. Davis, 1941, pp. 115–18.

WESTERN HOG-NOSED SNAKE

Heterodon nasicus (Baird and Girard)

Map 24. Range of the western hog-nosed snake.

Races. S & B (1943) recognize two subspecies of the western hog-nosed snake, of which only one, *H. n. nasicus*, occurs in Minnesota.

Description. The western hog-nosed snake. (Figures 24, 25, 26) is not venomous. All the scales are keeled. The rostral plate (snout) is much flattened and keeled above. Viewed from the side the upper line of the keel is distinctly turned up at an angle with the top of the head. (In the eastern race this line is straight or nearly so.) The top of the head in front of the eyes is covered by many small, irregular scales. The parietals are small and irregular. The upper labials number 8, occasionally 7 or 9; the lower labials, 10 or 11, rarely 9 or 12. The scale rows number 25 on the neck, decreasing to 19 near the vent. The ventrals of three males numbered 130 to 137, the subcaudals 31 to 38. The ventrals of nine females numbered 139 to 150, the subcaudals 46 to 50. The anal plate is divided. The tails of males are proportionately longer than those of females.

The body ground color is usually a light yellowish umber or grayish olive. In some specimens it tends toward a fairly rich brown. There are dark brown to black, roughly round, middorsal blotches, which are usually only slightly larger than those of the lateral rows, and vary greatly in form and number. Usually there are two rather indistinct

rows of dark lateral spots, which merge with the dorsal blotches on the tail to form a broken, ringlike pattern. The lateral five to seven rows of scales, exclusive of the first row, are frequently dark, edged with pale yellow. The first row of scales and the outer tips of the ventrals are usually light. The head has a dark blotch from the eye to the gape, and there is a wide dark blotch on either side of the neck. The under parts are whitish to yellowish, with many squarish blotches, which usually become more extensive near the vent and often cover the belly completely. The under surface of the tail is also black, and the anal plate is yellowish. In larger adults the ground color darkens

Figure 24. Western hog-nosed snake, *Heterodon nasicus.* (½ natural size.)

and the lateral markings become partly obliterated, but the major part of the pattern remains fairly definite and does not disappear as in the eastern hog-nose. In the very young the ground color is often light gray to whitish, contrasting strongly with the dark markings.

This species never attains the maximum size of the eastern hog-nose. The largest specimen in the collection (1161) measures only 30 inches. The measurements of an average specimen (male, 388) are: length to vent, 18.75 inches; tail, 4.25 inches; total length, 23 inches.

Range. S & B (1943) give the range of this species as "Illinois, southwestern Iowa, Missouri, and Kansas, west to Montana and south to northern Mexico. Common along the Mexican border of eastern

Texas." Present records show that this range should be extended in the north to include the southern and western parts of Minnesota (Map 24) wherever its restricted type of habitat occurs.

Habits and habitat. As far as present records show, this species occurs only in sandy or gravelly areas. Specimens may be encountered even in the open sand blowouts, where almost no cover is available. Probably the species more often frequents the sandy and gravelly areas of glacial or fluvial origin, with sparse vegetation, found locally in southern, cen-

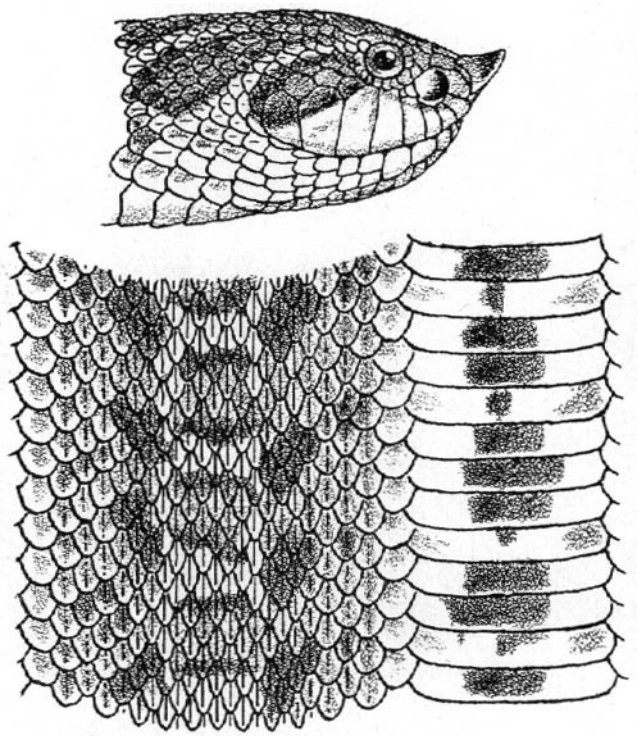


Figure 25. Head of western hog-nosed snake.
Figure 26. Pattern of western hog-nosed snake. (Natural size.)

tral, and western Minnesota. Large expanses of sparse scrub oak constitute an excellent habitat throughout much of the Minnesota range of the species.

Some of the strange habits of this snake attract considerable popular attention. The species is entirely harmless, and its inoffensive nature is typified by an encounter with one of the kind on May 30, 1937, in Anoka County. The author's field note reads: "It coiled up and put its head under the coil as though for protection. Only after repeated dis-

turbances did it finally withdraw its head." When this ruse failed it turned to other tactics, for it has the same threatening actions and habit of playing possum characteristic of the eastern hog-nosed snake.

The more extreme development of the shovellike snout in this species suggests that it is more adept at burrowing than the eastern species. A field note dated May 11, 1941 relates to this habit: "While with the ornithology class I ran across a 28-inch western hog-nosed snake in the low sandy ground adjacent to Laddie Lake in Anoka County. It tried to escape by crawling, but when surrounded it immediately started burrowing and in a couple of minutes was nearly hidden under the sand, dead grass, and weeds. We removed it and it began again and soon penetrated an old mole burrow. It then disappeared quickly from sight and we left it."

Food. This snake is credited with feeding extensively on toads (Ditmars, 1936). One Minnesota specimen contained two leopard frogs, and another contained a black-banded skink and the feathers of a grasshopper sparrow.

Breeding. The western hog-nosed snake, like the eastern, is an egg-laying species, and its breeding habits are undoubtedly very similar. One Anoka County specimen contained 9 eggs. One containing eggs was found on July 13.

Suggested Reading. R. L. Ditmars, 1936, pp. 295–96. G. E. Hudson, 1942, pp. 50–52.

SMOOTH GREEN SNAKE

Opheodrys vernalis (Harlan)

Races. Grobman (1941) has recently separated this species into two subspecies, *O. v. vernalis* and *O. v. blanchardi.* Both races and intergrades between the two occur in Minnesota.

Description. The smooth green snake (Figure 27) is not venomous. It is a small, very slender species, seldom attaining a length of more than 18 inches. The largest Minnesota specimen (169) measures 18⅜ inches, the smallest specimen (181), newly hatched, 5⅞ inches.

The scales are smooth. The dor-

Map 25. Range of the smooth green snake.

sal scale rows number 15. The ventral plates in nine males numbered 127 to 134; in twelve females, 127 to 147. The subcaudals in nine males numbered 83 to 92; in twelve females, 73 to 89. The anal plate is divided. There is one loreal, or none. The upper labials number 7, or rarely 5, 6, or 8; the lower labials, 8 or 7, rarely 5 or 6. The two races are distinguished by the number of ventral plates. *O. v. vernalis* has in males less than 131, in females less than 140; *O. v. blanchardi* has in males 131 or more, in females, 140 or more.

The color above is usually a uniform bright green, but occasionally tends toward grayish or brownish green; beneath, including the upper labials, it is glistening white, often with a greenish or yellowish tinge. The tongue is pinkish buff, with a dark tip. The iris is black, with gold above.

Range. Grobman (1941) gives the range of the smooth green snake as extending from New Brunswick to West Virginia westward through Kansas to New Mexico and northward into Manitoba. *O. v. vernalis* occupies the eastern part of this range, *O. v. blanchardi* the western. The two races meet and intergrade in Minnesota.

The twenty county records (Map 25) for this snake extend from the Manitoba line to the Iowa line, and some records are found in all three of the major vegetational formations. From these data it seems probable that this snake occurs in suitable habitats throughout Minnesota, with the possible exception of the northeastern part.

Habits and habitat. The common name "grass snake," often applied to this brilliant green snake, is a very apt one, both because of its color and long, slim form and the fact that it seems to prefer an open, grassy type of habitat.

Several specimens were taken May 24, 1937, along the Minnesota River bottoms in a marshy meadow thickly dotted with grassy hummocks. On each of three trips through northern Mahnomen County in three successive years the author found smooth green snakes on the same stretch of highway. Evidently a considerable colony of these snakes occurs at that point, where the highway passes through a rather extensive area of moist prairie land grown up to a rich cover of grasses and sedges.

Hibernation. Criddle (1937), in excavating an anthill near Treesbank, Manitoba, on October 10, 1934, found 148 smooth green snakes hibernating with 101 red-bellied snakes, *Storeria occipitomaculata*, and 8 plains garter snakes, *Thamnopis radix*. This anthill was situated in hazel brush near a willow swamp.

Food. Uhler, Cottam, and Clarke (1939) concluded from an examination of five specimens that this snake "feeds entirely on inverte-

brates. Soft-bodied larvae, including caterpillars, are apparently a favored food as three of the five individuals here discussed had fed extensively on these insects. On the average, lepidopterous [butterfly and moth] larvae made up 36.80 per cent of the total food. Grasshopper allies (Orthoptera) supplied the entire meal of one individual and contributed 20 per cent of the average diet, while ants and flies formed 40 per cent of the food. Spiders and undetermined Arachnida were taken in numbers by another individual and supplied 9.80 per cent and 19 per cent of the total food. Undetermined snails entered into the menu of one snake and average 1 per cent of the entire consumption."

Breeding. The smooth green snake normally lays eggs, but the extreme variation in the incubation period of the eggs, as reported by

Figure 27. Smooth green snake, *Opheodrys vernalis.* (¾ natural size.)

Blanchard (1930)—4 to 23 days—suggests that at times the eggs may be retained until hatched, and thus the snake would give birth to living young.

The only Minnesota record of a natural nest of this snake to come to the author's attention is from Milton Thompson, who found a set of eggs buried at the base of a clump of dead willows on a grassy hummock in a marshy pasture near Forest Lake in Washington County.

The four available records of the number of eggs laid are: 7, 6, 6, 6. M. H. Doner of Winona reported a captive specimen laying eggs about July 11, 1937. Harvey Gunderson, in eastern Pine County, reported a

set of 6 eggs laid on July 18, 1939. They were white, 25 by 10 mm., and looked like pieces of chalk with one end slightly more bulbous than the other. Blanchard (1933) reported the number of eggs as varying from 3 to 11, with 7 the most common number. He found the eggs varying from 19.5 to 34 mm. in length and 8 to 18 mm. in width. He reported females laying their eggs during the last week in July and through August, and the eggs hatching from August 5 to September 4.

Suggested Reading. A. B. Grobman, 1941, pp. 1–38.

BLUE RACER

Coluber constrictor (Linnaeus)

Map 26. Range of the blue racer.

Races. S & B (1943) divide this species into six subspecies, of which *C. c. flaviventris*, the blue racer, is the form found in Minnesota. The race found in the east, *C. c. constrictor*, is widely known as the black snake.

Description. The blue racer, *C. c. flaviventris* (Figure 28), is not venomous. It is an extremely long and slender snake. The scales are not keeled. The dorsal scale rows almost always number 15 or 17. The ventral plates in eight females numbered 164 to 183; in six males, 172 to 179. The subcaudal scales in eight females numbered 75 to 86; in six males, 83 to 92. The upper labials number 7 or 8, rarely 6; the lower labials, 8 or 9. The oculars are 2—2; the loreal is present. The anal plate is divided.

The smallest Minnesota specimen (61) measures 13¾ inches; the largest (Houston County, May 21, 1938, not preserved), 55 inches. An average male (141) has a total length of 34½ inches and a tail length of 10¾ inches.

A typical adult (female, 570) has a dorsal color of gun-metal gray with a distinct greenish cast, becoming more greenish on the lower sides approaching the ventrals. The dorsal color touches the tips of the ventral plates. The under surface of the head, including the lower and part of the upper labial scale rows, is white; the under surface of the neck and body is yellow, paling posteriorly on the body and tail.

Young blue racers are not uniformly colored, but have a spotted pattern and are often mistaken for young fox, milk, or bull snakes. A

17½-inch specimen (567) has a distinct spotted pattern of dull rufous spots on a ground of pale neutral brown near the head, the pattern becoming progressively less distinct toward the tail, until on the terminal part the color becomes a dark, uniform, neutral gray. There are 38 to 40 well-formed, black-bordered, dark rufous saddle marks, becoming much broken toward the uniformly colored tail. There are two rows of alternating black spots with rufous borders on the sides,

Figure 28. Blue racer, *Coluber constrictor.* (⅓ natural size.)

and a third including the tips of the ventrals. The ground color of the head is olive gray, with many irregular dark spots. The under surface of the head is white, changing abruptly at the neck to yellow, which pales to grayish white under the tail. The tip of every other ventral is black, with a rufous border. These black tips unite with those on the first scale row to form spots. There is a zigzag row of half-moon shaped black spots with rufous borders on each side of the belly. These markings are most prominent on the neck and become progressively paler, till they disappear on the tail. As the snake increases in length, the pattern tends to disappear farther forward until the adult color is assumed. A 28-inch specimen (897) had almost complete adult coloration.

Range. S & B (1943) give the range of this subspecies as the "central and southwestern states." Ortenburger (1928) outlines the range as "from the Mississippi and Ohio rivers west to the Rocky Mountains; north from the Gulf of Mexico and Rio Grande to the Canadian border." Present records (Map 26) show it occurring in Minnesota only south and east of the Twin City region. Since it occurs in North Dakota and Montana, one would expect it to be found in suitable habitats

in western Minnesota. However, other species have been found extending their range northward along the Mississippi and Missouri rivers much farther than in the intervening territory (see cricket frog and eastern hog-nosed snake), and it is possible therefore that this species does not occur in western Minnesota.

Habits and habitat. Blue racers are usually found in open territory. As a rule they occur on sandy plains or gravel hillsides. The Anoka and Wabasha sand plains, the steep dry sides of Gwinn's Bluff near Winona, and the crest of the dry bluff overlooking Red Wing, from which there are records, are all typical of this habitat. However, blue racers are not entirely absent from the lower lands, with their denser vegetation, for specimens are often killed on the highways in the Mississippi bottoms, particularly in Wabasha, Winona, and Houston counties.

Ruthven, Thompson, and Gaige (1928) state that the blue racer "is a good climber and is not infrequently found several feet from the ground in bushes and twenty or thirty feet up in trees." As its name suggests, the blue racer is swift and graceful in motion, and is usually able to escape capture. If taken it will fight viciously, but its teeth are small, and even the larger blue racers will inflict only small skin punctures on a human being.

Aside from traffic mortality, which is considerable, the only instance of destruction of these snakes observed was the remains of a specimen found in a pellet of a marsh hawk, *Circus hudsonius*, taken in Anoka County.

Food. Like the milk snake and rarely the fox snake, the blue racer sometimes feeds on other snakes. Four Minnesota blue racers (of ten examined, six were empty) contained the following food: one leopard frog, an 18-inch common garter snake, two moths, three crickets, and several unidentified hard pellets.

Surface (1906) found in a series of nineteen specimens (undoubtedly *C. c. constrictor*), from Pennsylvania, the following food: insects, 25 per cent; snakes, garter, green, and water, 15 per cent; meadow mice, 22 per cent; bird eggs, robin, 8 per cent; rabbits, 4 per cent; frogs, green and wood, 7½ per cent; birds, 4 per cent; unidentified mammals, 7 per cent; larvae of royal moth, 3½ per cent.

Breeding. Conant (1928) records the following of an Ohio blue racer: ". . . a clutch of 25 eggs was laid by a female 5½ feet in length, from Lucas County on June 26, 1930. These were white, non-adherent to one another, and were covered with small, salt-like particles which formed a part of the shell. They measured 32 to 38, average 34.5 mm., in length and 18 to 23, average 22 mm., in width." Ortenburger (1928)

reports a set of 19 eggs laid by a female of this species on July 1–2, 1920, and another set on June 29, 1922. No record of a natural nest of this species has been encountered in Minnesota, but it undoubtedly lays its eggs a few inches deep in moist soil or the rotten wood of fallen logs, much as does its close relative, the black snake, C. *c. constrictor*.

Suggested Reading. A. I. Ortenburger, 1928, pp. 175–92.

PILOT BLACK SNAKE

Elaphe obsoleta (Say)

Map 27. Range of the pilot black snake.

Races. S & B (1943) recognize two subspecies of this snake, of which *E. o. obsoleta* is the only one occurring in Minnesota.

Description. The pilot black snake (Figure 29) is not venomous. It is very large, often exceeding five feet in length. The dorsal scales are weakly keeled, becoming smooth on the lower sides. Conant (1938) gives the following scale counts: dorsal scale rows, 25 or 27 at neck to 17 or 19 at vent; upper labials, 8, rarely 7; lower labials, 11 to 14; preoculars, 1 [Houston County female, 2]; postoculars, 2 or 3; ventrals in males, 221 to 239; in females, 228 to 244; subcaudals, in males, 73 to 85, in females, 69 to 81 [Houston County female, 63]. The anal plate is divided.

The dorsal color is nearly solid shiny black. The anterior part of the body usually has a pattern of dorsal blotches, with alternating side blotches faintly outlined in light cream, or red dots between the scales which extend onto the basal part of the scales, the red often being prominent. The posterior part of the body and tail are entirely black. The head is black above; the lower part of the upper labials and the lower labials are white. The under surface of the head is white or yellowish. The belly is light, with square black blotches becoming more extensive toward the solidly black under surface of the tail. (The greater number of scale rows, the keels on the dorsal scales, and the black under surface of the tail distinguish the pilot black snake from the blue racer.)

The young pilot black snake has a prominent blotched pattern of brown on a gray ground color, and closely resembles the young fox

snake or blue racer. It differs from the fox snake in always having more than 220 ventral scales; the fox snake has less than this number. It differs from the blue racer in having keeled dorsal scales (these keels may be very faint) and a greater number of scale rows.

Range. S & B (1943) give the range of this snake as "southern New England westward to Wisconsin, southern Ontario, southward to Texas, Louisiana, and Florida." The first and only Minnesota specimens were secured in the fall of 1942, when a large specimen in the possession of Emil Liers, taken in September in southern Houston County

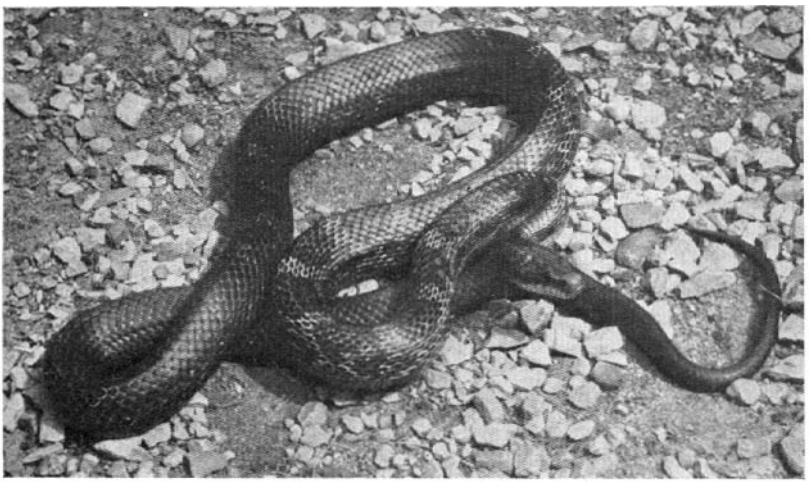


Figure 29. Pilot black snake, *Elaphe obsoleta.* (⅓ natural size.)

(Map 27), was examined, and two specimens were found by the author on the highway in the same locality on October 2. One of these (1178) was preserved.

Habits and habitat. Hardwood forested limestone and sandstone bluffs form the only Minnesota habitat that seems suited to this species, and it is usually considered a forest-loving species. Cagle (1942) in southern Illinois writes, "These snakes are excellent climbers and were collected from trees on several occasions." He reports a specimen as taken in an old woodpecker hole, more recently occupied by flying squirrels, at a height of 35 feet, in an old dead tree trunk 20 inches across at the base, devoid of bark, and with only a few limb stubs along the trunk.

Cagle reports also that "on two different occasions this species has exhibited an interesting protective instinct. A specimen observed on top of a large stump literally froze in position with the posterior part of its body coiled around a projection of the stump and the anterior end protruding outward for a distance of one foot. In this position it resembled

the broken branch of a tree and its color contributed much to this impression."

Conant (1938) remarks from Ohio on the pilot black snake's habit of remaining motionless until picked up, and further observes that "this habit and the fact that it often crosses highways or suns itself upon them makes the pilot black snake an easy target for its human enemies. The frequency with which it is run over and the many which are found killed, even in the more remote areas, would indicate that it soon may become a rare snake in the state."

Food. The single preserved Minnesota pilot black snake contained a white-footed mouse. Numerous reports on the food of this species indicate that it lives almost exclusively on warm-blooded prey, largely small mammals. Its large size enables it to take animals as large as full-grown red squirrels, and as a result of its arboreal habits small birds and their eggs enter significantly into its diet. The pilot black snake, a constrictor, swallows its smaller prey alive, but about its larger prey it throws several loops of its powerful body, crushing the animal into helplessness by suffocation before swallowing it.

Breeding. The pilot black snake, like its close relative the fox snake, lays white, elongate, leathery-shelled eggs in rotting logs, manure, or sawdust piles, or nearly any similar location affording sufficient protection, warmth, and moisture. Conant (1938) reports females as laying clutches of 12 to 22 eggs, measuring roughly 1 by 2 inches. One set was laid on July 1, 1932; another was recorded as hatching on September 11, 1932. The young measured from 13¼ to 14¼ inches in length.

Suggested Reading. Roger Conant, 1938, pp. 55–60.

FOX SNAKE

Elaphe vulpina (Baird and Girard)

Races. The fox snake has been divided into two subspecies (Conant, 1940), *E. v. vulpina* and *E. v. gloydi,* of which the former, the more westerly, occurs in Minnesota.

Description. The fox snake (Figures 30, 31) is not venomous. It is a large snake, attaining a maximum length of nearly five feet. A male (884) measures in body length 43¾ inches, tail 8¼ inches, total, 52 inches.

In 39 Minnesota and western Wisconsin specimens the pattern was a series of 36 to 56 dorsal blotches (average, 43.1) to the vent. (The eastern *E. v. gloydi* has fewer and larger dorsal blotches, averaging 34.5.) The dorsal ground color is a smoky yellowish gray, darkening posteriorly. The blotches are a dark olive brown, with only slightly

Map 28. Range of the fox snake.

darker margins. There is a row of smaller blotches, alternating with the dorsal ones, on each side, and a second lateral row alternating or joined with the first. The pattern is uniformly distinct from the head to the tip of the tail. There is a pair of elongated blotches on either side of the neck. In smaller specimens the ground color is lighter and more gray than in adults. The head pattern includes a prominent bar connecting the front corners of the eyes and a dark bar from eye to gape. In large specimens all head marks tend to merge into a plain, distinctly brownish olive or rufous color, and for this reason the fox snake is often mistakenly called a "copperhead." The under surface of the head is white. The other under parts are pale with a distinct yellowish cast. There are irregular squarish blotches on the belly, usually veiled and milky in appearance.

The scales are weakly keeled dorsally, becoming entirely smooth on the lower few rows. The number of scale rows varies from 25 or 27, rarely 23 or 29, near the head, to either 21 or 19 rows near the vent. The anal plate is divided. The upper labials number 8, rarely 7; the lower labials 11, rarely 9, 10, or 12. The subcaudal scales in nine females numbered 53 to 58; in nine males, 62 to 67. The ventral plates in nine females numbered 196 to 214; in nine males, 194 to 209. The tail is short and is terminated by a sharp, spinelike scale in both males and females.

This species is often confused with the bull snake, *Pituophis sayi*, from which it may be distinguished by the blunt snout, fewer scale rows at midbody, and the fact that the pattern is uniformly prominent from head to tail tip. The milk snake, *Lampropeltis triangulum*, is also easily confused with this species, but differs in having smooth scales throughout.

Range. Conant (1940) shows that the range of the fox snake is unusual in including two isolated populations. The eastern form, *E. v. gloydi*, occurs about Lake Erie and Lake Huron, and the western subspecies, *E. v. vulpina*, is found from northwestern Indiana to Upper Michigan west to southeastern South Dakota and eastern Nebraska. Present records (Map 28) suggest strongly that in Minnesota this

snake has followed up the Mississippi, St. Croix, and Minnesota river valleys. The isolated Rock County record may represent a Missouri River population coming up the Big Sioux Valley.

Habits and habitat. The fox snake occurs over much the same portions of Minnesota as the bull snake. Although there is a considerable overlapping of habitats, this species seems to prefer the more moist places, for it is found in the river valleys and marsh borders, whereas the bull snake occupies the rocky valley walls and drier sandy and gravelly wastelands. Specimens have been taken swimming in the

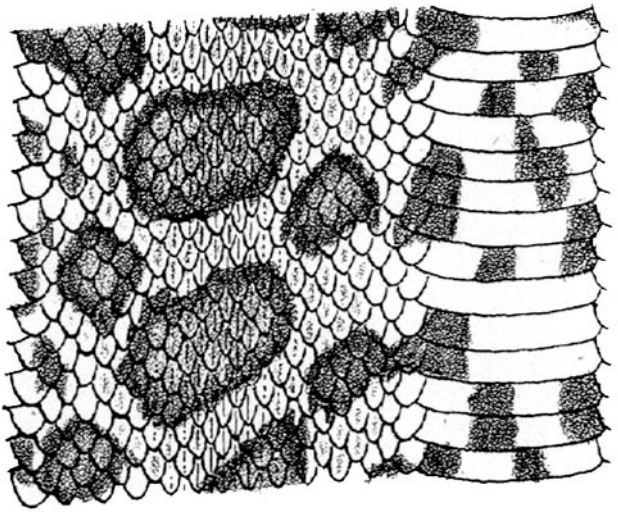


Figure 30. Head of fox snake, *Elaphe vulpina. Figure 31.* Pattern of fox snake. (Natural size.)

marshy backwaters of the Mississippi River, and Conant (1938) even records one as swimming in Lake Erie a mile from shore. The present known range follows closely the wooded rocky bluffs bordering the larger streams. The survival of the fox snake in these areas may be due to the undisturbed nature of such surroundings, so uninviting to agriculture, and also to the fact that these places afford the best possibilities for winter dens. Just how widely the fox snake ranged originally over what is now cultivated prairie land has not been determined.

In the author's experience, the fox snake is by far the most abundant of the larger snakes in southern Minnesota. Many more of this species than of any other are found as traffic victims. The success of the species may be due to its better protection from man and cultivation in its more moist, more heavily vegetated, habitat, than is experienced by

the bull snake and the blue racer, for example, in their more open haunts.

The fox snake is one of the harmless snakes that have the habit of vibrating the tail when disturbed. The resulting buzzing sound when dry leaves or grass are struck by the tail often makes even the fairly well-informed naturalist jump to the conclusion that he has encountered a rattler. This fact accounts for many erroneous reports of rattlesnakes.

When encountered in the field, the fox snake often presents a threatening appearance. It is somewhat more aggressive than the bull snake and will sometimes strike viciously. In captivity it is fairly hardy, adjusts itself readily, and becomes fairly docile.

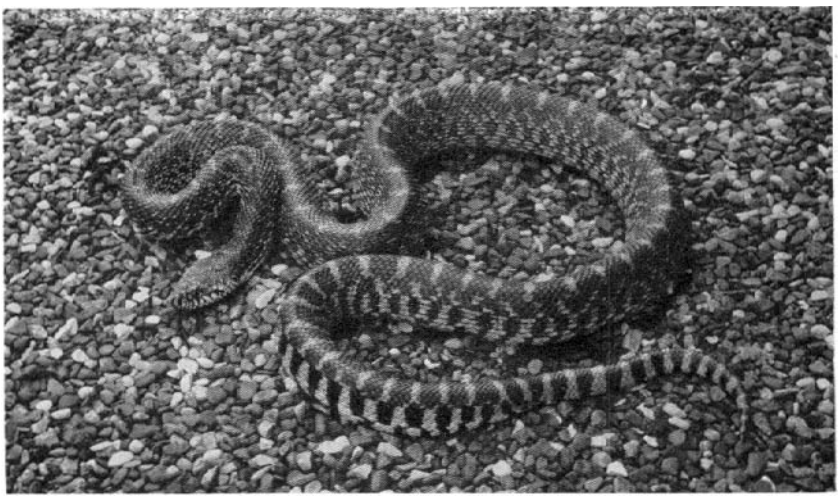


Figure 32. Bull snake, *Pituophis sayi.* (½ natural size.)

On October 2, 1942 a small, partially albino fox snake was taken crossing a gravelled road in Houston County. The ground color was very light and the blotches were pale but still prominent.

Enemies. The fox snake, which grows to be fairly large and conspicuous, is frequently seen and almost as frequently killed by man, who in his ignorance usually considers all large snakes to be rattlesnakes. Man is indirectly responsible for the death of many more fox snakes through highway traffic. Very often the last stand of this snake in a cultivated region is made in the rocky bluffs along the streams, and there are often highways along the valleys at the foot of such rocky bluffs. As the snakes leave their rock dens and scatter into the lower

lands in the summer they are forced to cross these highways, and in doing so a fair percentage of the population in such areas may be killed. It is conceivable that over a period of a few years the species may in this manner be almost eradicated in these areas.

Food. One Minnesota fox snake contained a young meadow mouse, *Microtus pennsylvanicus*, and another had eaten a smooth green snake, *Opheodrys vernalis*—apparently the only recorded instance of this species' feeding on snakes. As a rodent eater the fox snake compares favorably with the bull snake. The value of the species in this regard is extolled by a number of writers (Ditmars, 1936; Conant, 1938; Ruthven, Thompson, and Gaige, 1928; Guthrie, 1926). The fox snake takes many young rabbits and ground squirrels and often frequents barns and granaries, where it feeds extensively on rats and mice. Its limited feeding on ground-nesting birds and their eggs is to its discredit, but all investigators appear to agree that these foods make up a minor part of its diet.

Breeding. Data on a series of Minnesota specimens of the fox snake, an egg-laying species, relate to the development of the eggs. All these specimens were taken near the Twin Cities. A female taken May 12 contained 10 developing eggs about 10 mm. long. A month later, on June 10, another female was taken, containing 19 eggs, approximately 32 by 20 mm. On July 9 a female laid a clutch of 16 eggs. These eggs were nearly white, had tough, leathery shells, and tended to stick together in a cluster. Rene B. Stiles placed the eggs in a jar of moist sand covered with cotton. At room temperature, sometimes exposed to the sun, the eggs hatched on September 4, after an incubation period of 57 days.

Conant (1938) states that a set of Ohio fox snake eggs, averaging 44 by 24 mm., hatched in 78 days. He also reports sets of eggs laid on June 25, July 17, and July 29, varying in number from 11 to 29. Ditmars (1930) says that the fox snake generally deposits its eggs in the hollow of a rotting stump. It seems reasonable to suppose that fox snakes may also deposit their eggs in moist soil under logs, stones, or in similar situations where they would be assured of moist conditions over a considerable period for the hatching of the eggs.

Guthrie (1926) states that newly hatched young measure 9½ to 11 inches. The fact that one Dakota County specimen 10¾ inches long was taken on August 18, while one 11 inches long was found in Goodhue County on October 8, suggests a wide range of hatching dates in this area.

Suggested Reading. R. L. Ditmars, 1936, pp. 219–20.

BULL SNAKE

Pituophis sayi (Schlegel)

Map 29. Range of the bull snake.

Races. S & B (1943) recognize two subspecies of the bull snake, of which only *P. s. sayi* occurs in Minnesota.

Description. The bull snake (Figures 32, 33, 34, 35) is the largest Minnesota snake, and attains a maximum length of slightly over six feet. An adult male (468) measures: body, 48¾ inches; tail, 6¼ inches; total length, 55 inches.

The ground color anteriorly is usually dull straw yellow, grading posteriorly into a richer brownish buff. There is a row of roundish dark spots on the back; the number in eleven Minnesota specimens varied from 47 to 64 from head to vent. There are several series of smaller, very irregular dark spots along the sides. The spots are usually dark anteriorly. Posteriorly in large snakes they become a paler, faded appearing, yellowish brown. The blotches occasionally cover nearly all the ground color anteriorly, leaving the ground color forming little more than a dotted outline of the blotches. This ground color becomes more extensive posteriorly, leaving the blotches definitely separated on the hindmost part of the body and tail. When the tail is looped back beside the neck, the two parts appear to be from two different snakes, so different is the distinctness of the pattern in the two regions. The yellow ground color of the head is very extensive except in young specimens, making the head appear light in contrast to the very dark neck and body. The head has many irregular dark markings. The under surfaces are a grayish yellow, somewhat whiter beneath the head. There is a series of dark, often much veiled, squarish blotches covering the belly, and more abundant posteriorly.

All the scales are keeled. The ventral scale count of five Minnesota females was 216 to 225; that of six males, 211 to 215. The subcaudals of five Minnesota females numbered 50 to 57; those of six males, 51 to 60. In eleven specimens examined the upper labials numbered 8 or 9; the lower labials, 11 to 13; the preoculars 1, rarely 2; the postoculars, 3 or 4. The anal scale was undivided except in one specimen. The scale rows usually number 27 at the neck, 31 at the midbody, and 23 near the anus. The rostral scale is nearly twice as long as it

is broad, extending up and back onto the top of the head, and terminating in a point separating the internasals for a part of their length.

Range. S & B (1943) give the range of the bull snake as: "From the northern part of Mexico north to Door County, Wisconsin, in the east, and to Medicine Hat, Alberta, Canada, in the west, and from the Rocky Mountains to Western Indiana." The Minnesota records for this species (Map 29), as for the blue racer, fox snake, and eastern hog-nosed snake, point definitely to the fact that here at the northern limit of its range this species has followed up the Mississippi, St. Croix,

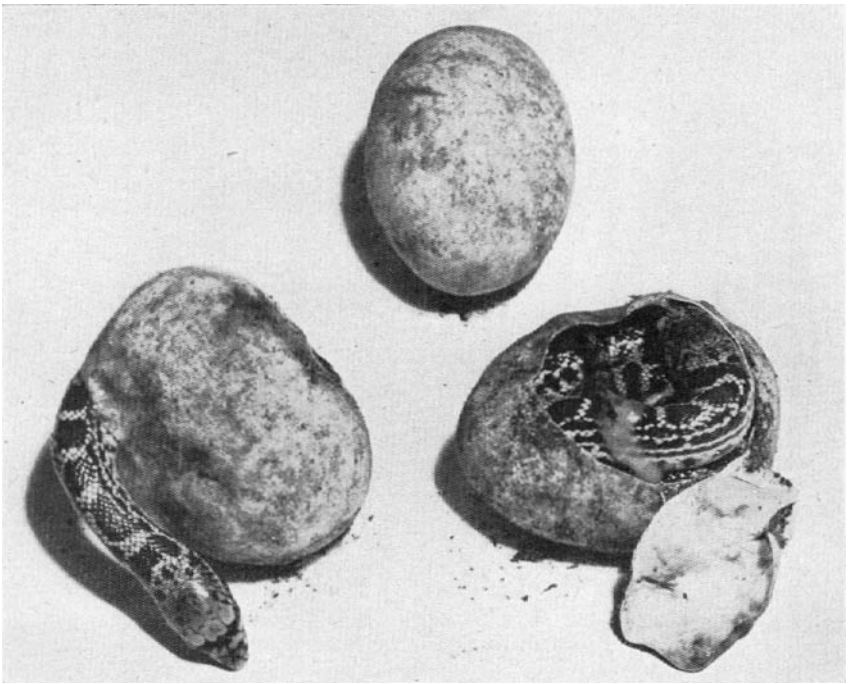


Figure 33. Eggs and emerging young of bull snake: *left*, young emerging normally from egg; *upper*, egg; *right*, egg cut open, showing young coiled within. From photograph by M. H. Doner. (Natural size.)

and Minnesota river valleys. The isolated Polk County record suggests that its range may be continuous up the favorable Minnesota Valley to Big Stone Lake, and from there the ancient gravel beaches of glacial Lake Agassiz provide excellent habitat northward to Polk County. Subsequent field data may substantiate this possibility.

Habits and habitat. This huge but harmless snake terrifies most of those who encounter it. The treatment it usually receives is typified by an excerpt from a newspaper account appearing under the photo-

graph of a woman standing beside a large bull snake, hanging by its head (*Minneapolis Journal*, July 27, 1937): "She killed it with about a dozen blows with a long section of pipe. The snake, which was 6½ feet long and about four inches in diameter, did not fight back, she said." The last statement shows the real character of this valuable snake. Again, in late August 1941, there appeared in the same paper the photograph of a man holding a large bull snake, with the comment: "He's holding a snake, more than five feet long, which he found and killed near a group of children."

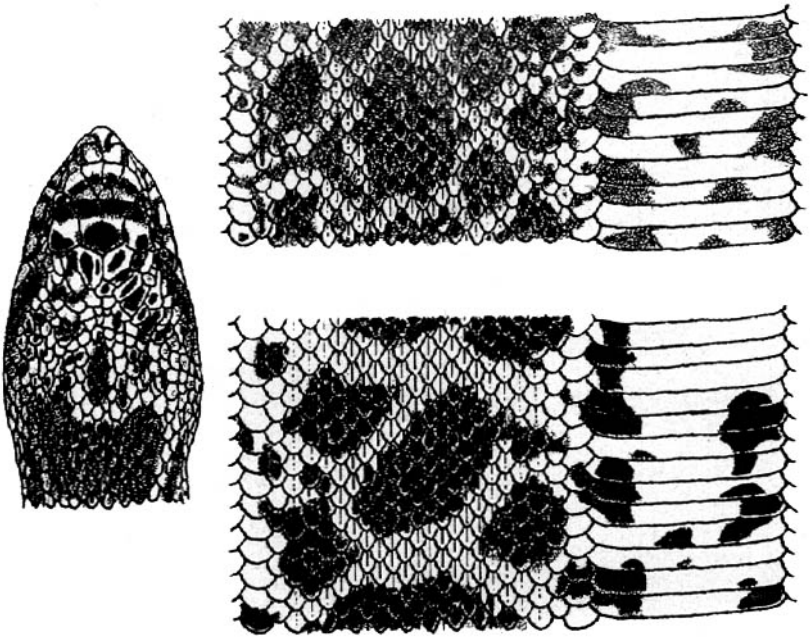


Figure 34. Head of bull snake. *Figure 35.* Pattern of bull snake: *upper*, near head; *lower*, near tail. (Natural size.)

When encountered in the field the bull snake invariably attempts to escape with as little commotion as possible. It puts up no show of fight unless it is cornered and its retreat is cut off. It may then hiss loudly, with a sound like escaping steam, and vibrate its tail rapidly. As with the fox snake, this vibration, when it strikes dry leaves or grasses, produces a distinct buzzing sound, and consequently many a report of rattlers will be found to have originated from mistaken observations of this harmless snake.

Since the bull snake is so large and so easily handled it is a favorite with the "snake charmers" of the side shows. As a matter of fact, it soon becomes extremely docile in captivity, and even the largest speci-

mens may be handled with no fear of their biting. Hisaw and Gloyd (1926) found that this snake kills larger animals by constricting them in its coils and simply swallows smaller and weaker animals alive. They found also that it frequently burrows into the closed holes of the pocket gopher by working its head into the loose soil and pushing and pulling out loads of dirt with loops of its body. After gaining access to the open tunnels, it captures the gopher and crushes it to death by pressing it against the sides of the passage, rather than by coiling about the animal as it does in the open.

To date, most of the bull snake records from Minnesota come from either rocky, sandy, or gravelly situations. The glacial moraines particularly seem to provide favorable habitat, as shown by the abundance of bull snakes in the rugged morainic region south of the Twin Cities. The species shows a decided preference for the open country rather than the woodlands. Bull snakes are often found basking in the warm summer sun. Their love of warmth leads to the death of many, for they consider the paved highways to be excellent flat rocks for sun bathing. When surprised in the open they often make for the nearest striped ground squirrel burrow for protection. The ground squirrel thus provides both food and shelter for this snake and may well prove to be a major factor in maintaining the species in settled regions.

Enemies. A great many bull snakes are killed each year simply because they are large and conspicuous, and many more are killed by highway traffic. The former drain on the species may eventually be cut down through education, but highway traffic will probably continue to take its toll and may prevent this snake from ever becoming common.

Little is known of this snake's natural enemies. Giles (1940) reports bull snake remains as appearing in the food of the raccoon in Iowa. Undoubtedly some of the snake-eating species of snakes, including the milk snake and the blue racer, at times take small specimens of this species.

Food. Frogs, meadow mice, and striped ground squirrels were found in the stomachs of three Minnesota bull snakes. Guthrie (1926) states that he found three striped ground squirrels in a bull snake, and cites an instance of an Iowa farmer's putting bull snakes in a field heavily infested with striped ground squirrels, which were completely cleared from the field by the snakes.

Hisaw and Gloyd (1926) state that the pocket gopher, *Geomys bursarius*, is an important food of this snake. After extensive experiments they concluded that a five-foot bull snake in its yearly six-month active period might be expected to eat an amount of food equal to

about twelve adult pocket gophers. This statement of the quantity of food eaten seems conservative when it is noted that H. J. Pack (1930) reports that the stomach of one western bull snake contained 35 mice.

The bull snake does some damage in eating the eggs of poultry and ground-nesting birds. Ditmars (1936) remarks of a captive specimen: "It swallowed fourteen hens' eggs, breaking the shell of each after the egg had passed about a foot down the throat. The demonstration closed by the supply of eggs becoming exhausted and not from indifference on the reptile's part."

Over (1923) states that in a few instances bull snakes have been known to kill rattlesnakes, but it is probably unusual, since he further reports that the two species are often seen coiled up together, sunning themselves around the entrance to their winter den.

Breeding. The bull snake is an egg-laying species. One specimen (468) contained 15 eggs, varying from 44 to 51 mm. in length and from 32 to 36 mm. in width. Guthrie (1926) gives 13 to 19 as the number of eggs laid. Gloyd (1928) reports sets of 10 and 16 eggs laid on July 4 and 11. He found one set of 12 eggs partially embedded in soft earth under a stone. They were uniform white in color, roughly elliptical in shape, and averaged 52 by 38 mm. in size; the tough, leathery outer coverings adhered closely to one another and held the entire mass together. This set of eggs, he reports, was placed in a box of moist, decaying wood and kept slightly damp. Six young emerged September 18, 76 days after the eggs were laid.

Guthrie (1926) gives the incubation period for Iowa specimens as about 56 days, and states that three bull snakes measured respectively 13½, 14½, and 15½ inches in length at hatching. Since one Minnesota specimen examined was 13 inches long on October 24, 1940, it appears that here, near the northern limit of the species, the eggs may sometimes hatch just in time for the young to search out hibernation retreats. This late hatching of the eggs may prove to be a factor limiting the northward distribution of the bull snake.

Suggested Reading. O. G. Stull, 1940, pp. 1–225. J. E. Guthrie, 1926, p. 180.

MILK SNAKE

Lampropeltis triangulum (Lacépède)

Races. The milk snake has seven recognized subspecies (S & B, 1943). The ranges of two races, *L. t. triangulum* and *L. t. syspila,* are outlined as touching Minnesota. However, the author is convinced that though some milk snakes with the typical characters of *L. t. tri-*

angulum occur in the state, the majority of specimens are intergrades, with only an occasional specimen tending strongly toward the characters of *L. t. syspila.*

Map 30. Range of the milk snake.

Description. The milk snake (Figures 36, 37) is not venomous. It is a medium-sized snake, attaining a maximum length of 3½ feet. An average adult male (187) measures: body, 28⅜ inches; tail, 4¼ inches; total length, 32⅝ inches.

The pattern is a series of dorsal, saddlelike blotches, which are reddish brown to olive grayish brown in adults. There are smaller spots alternating with these blotches in one or two rows; the lower row runs down onto the ventrals. The head is variously marked with blotches. The under part of the head is white. The belly is whitish, with many irregularly placed squarish black blotches. The pattern in very young milk snakes is like that of adults, but the ground color is pale gray and the reddish brown of the blotches is brilliant, making the young snake very beautiful. This rich color fades in older snakes, leaving the adults a much more neutral brown in general tone.

The two races of the milk snake intergrading in Minnesota are distinguished by several characters. The number of dorsal blotches to the vent numbers 35 to 60 in *L. t. triangulum*, 35 or less in *L. t. syspila*; in *triangulum* the dorsal blotches do not extend lower than the third scale rows, in *syspila* to the third row or lower; in *triangulum* there are two rows of spots below the saddles, in *syspila* one row; the light Y-mark on the neck of *triangulum* expands laterally into a collar in *syspila;* and in *syspila* the blotches of the adult retain a redder color than in *triangulum.*

All the scales are unkeeled. The scale rows number 21, occasionally 23 or 19 at the neck, decreasing to 19 or 17 at the anus. The ventral scales number 190 to 216, the subcaudal scales 41 to 53. The loreal scale is present. The upper labials number 7, the lower labials 8 or 9, rarely 7 or 10. There is one preocular. The postoculars number 2, rarely 1. The anal plate is divided.

Range. The milk snake, including all its races, occurs from Maine

to Florida, west across northern Mexico, and northward through Arizona and Utah to South Dakota and northern Michigan. S & B (1943) report the range of *L. t. triangulum* as "eastern North America from Maine through Ontario to Minnesota, south to Iowa and Virginia and in the mountains further south," that of *L. t. syspila* as "Oklahoma, Arkansas, and Tennessee northward to Kansas, Iowa, Illinois, Indiana, and southern Minnesota." The milk snake in Minnesota (Map 30), like most of the larger snakes, tends to follow northward up the Mississippi, St. Croix, and Minnesota rivers. So far records have been secured only from the southeastern part of the state.

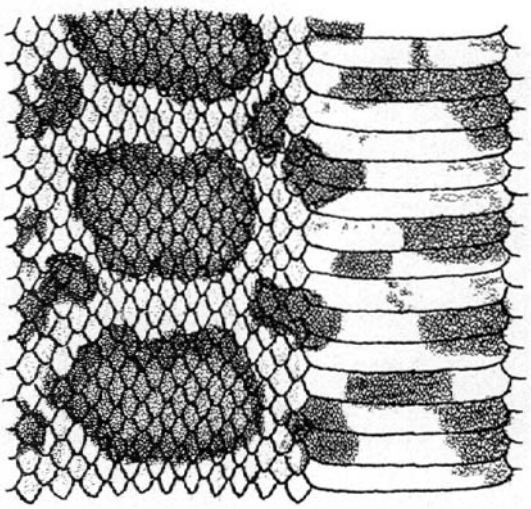


Figure 36. Head of milk snake, *Lampropeltis triangulum*. *Figure 37.* Pattern of milk snake. (Natural size.)

Habits and habitat. In Minnesota the milk snake seems to prefer the brushy or wooded cover to the open country. Rocky places harbor most of the colonies at present, but whether this habitat indicates a real preference of the milk snake, or simply that here, in these least disturbed of the wooded areas, it is best able to persist, is conjectural. The ranging of the milk snake from the dry hills into the moist valleys may represent seasonal movements, for in the few records we have it was found in fall and spring in the hills, about its hibernating quarters, and in summer in the cooler, more moist bottomlands, where food is most abundant.

The milk snake often climbs to seemingly incredible places in search of food. Shelley (1938) describes one as climbing up the clapboard siding of a house and spanning across a foot of space to a tall rosebush

to reach a chipping sparrow's nest, and another as crawling up the overhanging wall of a bridge footing to a phoebe's nest.

The milk snake is highly secretive. Conant (1938) in Ohio writes: "Nearly all the specimens collected . . . were found beneath boards, stones, pieces of discarded sheet-iron, tar paper, etc., or under the bark of rotting logs or stumps. . . . It is probable that this species is more or less nocturnal, especially in hot weather."

The source of the inappropriate name milk snake is discussed by Conant (1938) as follows: "Specimens discovered near stables are often falsely accused of extracting prodigious quantities of milk from cows. Persons who make such accusations fail to consider the small size of the snake and the fact that its mouth is equipped with sharp, hook-like teeth rather than sucking lips. No irrefutable proof has been produced to the effect that snakes ever extract milk from cows."

Food. Two Minnesota milk snakes contained mouse fur and beetles. The milk snakes are widely known for their habit of feeding on other snakes. Even the deadly rattlesnake often falls prey to these cannibals, and there is considerable evidence that the milk snakes are largely immune to its venom. Blanchard (1921) states that the milk snake is known to eat Butler's garter snake, the smooth green snake, the water snake, the ring-necked snake, DeKay's snake, the queen snake or striped water snake, the red-bellied snake, robins' eggs, jumping mice, and the white-footed mouse.

Uhler, Cottam, and Clarke (1939) report that in the stomach contents of nineteen specimens mice formed by far the most important item of food, with snakes and their eggs, young songbirds, birds' eggs, and caterpillars ranking next in the order named.

From an economic point of view, the milk snake's habit of feeding on other snakes is to its discredit, but the predominance of mice in its food greatly overbalances the record in its favor.

Breeding. Conant (1938) reports a 34-inch female as depositing 16 eggs on June 28, 1930; the white, oval eggs had smooth, leathery shells, and averaged 30 mm. in length and 16 mm. in width. He reports a nest of 17 eggs, possibly laid by two females, found on June 26 under a bark slab in a decaying sawdust pile. Ditmars (1936) reports from New Jersey three sets of eggs, laid July 10, 12, and 28, of which the last two contained 11 and 9 eggs, respectively. The three sets hatched in 55–56, 55–57, and 63–65 days. Blanchard (1921) states that the young snakes are about 6¾ to 8¼ inches long.

Suggested Reading. F. N. Blanchard, 1921, pp. 1–260. C. H. Pope, 1937, pp. 14, 104, 122–23.

COMMON WATER SNAKE

Natrix sipedon (Linnaeus)

Map 31. Range of the common water snake.

Races. S & B (1943) recognize eight subspecies of the water snake, of which only one, *N. s. sipedon*, occurs in Minnesota.

Description. The water snake (Figures 38, 39, 40) is not venomous. It is often confused with the venomous water moccasin, which does not occur in or near Minnesota. The common water snake is heavy-bodied and attains a maximum length of somewhat more than 4 feet. Small specimens have a distinct pattern of blotches. Larger adults, especially when dry, appear plain neutral brownish gray, with little or no pattern. The ground color of the body is dusky buff medially, becoming paler and more yellowish on the sides. The neck and fore part of the body are crossed by 4 to 15 ringlike saddles. Farther back on the body these saddles break up into a series of squarish dorsal blotches, alternating with a similar series on each side. The tail pattern is in rings. The dorsal blotches are a dusky chestnut with black borders, which are less distinct in large specimens. The head is olive brown above, with slightly darker, irregular markings on the larger plates. The posterior edge of the labials is black margined. The lower labials and under part of the head are white. The belly is white or yellowish, with many crescent-shaped black marks having reddish-chestnut centers, often brilliant. These marks are larger and more numerous toward the vent and are often arranged in two rows. These belly markings remain distinct in the larger specimens, which lack dorsal markings. Even small specimens (216, 922) occasionally have the pattern both above and below much reduced or absent.

The scales are strongly keeled, the first row or two weakly so. The scale rows number 21 or 23 on the neck; 23, rarely 25, at the midbody; decreasing to 19 or 17 near the anus. The ventral plates in fifteen females numbered 135 to 150; in twelve males, 141 to 151. The subcaudal scales in twelve females numbered 58 to 69; in nine males, 70 to 79. The upper labials number 8, rarely 7 or 9; the lower labials, 9 to 12, usually 9 or 10. There is one preocular; the postoculars num-

ber 2 or 3. The loreal is present. The anal plate is divided. A male specimen (9) measures: body, 24½ inches; tail, 7½ inches; total length, 32 inches.

Range. The water snake, including all its races, occurs from southern Maine, southern Quebec and Ontario, southern Minnesota and eastern Colorado, south to central Texas and Florida. S & B (1943) give the range of *Natrix s. sipedon* as "southern Maine through southern Quebec, southern Ontario, and Wisconsin to eastern Colorado, south to Oklahoma, Tennessee, and northwestern South Carolina." Present Minnesota records show this species occurring in the southeastern part of the state, north to a little above the Twin Cities on the Mississippi and Minnesota rivers, and to Pine County on the St. Croix (Map 31).

Habits and habitat. The common water snake is in fact, as in name, a snake of the water. It is most often taken either in the water or basking on logs, tree roots, rocks, debris, or some other type of support in the immediate vicinity of water. Running streams seem to be its preferred habitat. There it often twines about the roots of partly undermined trees, itself appearing to be one of the roots. If it is observed and approached it slithers into the water so quickly and smoothly as to make capture very difficult.

In summer few water snakes fall victim to traffic, for they keep in or near the streams passing under most highway bridges, but in fall they apparently hibernate in rock crevices and holes, much as other snakes do, and at that time are often found on highways. In three days in October 1942 John Dobie, Clarence Velat, and the author found 35 water snakes on the highway in southeastern Minnesota, often 50 to 75 feet above the river level. Nearly all that were alive were moving away from the river.

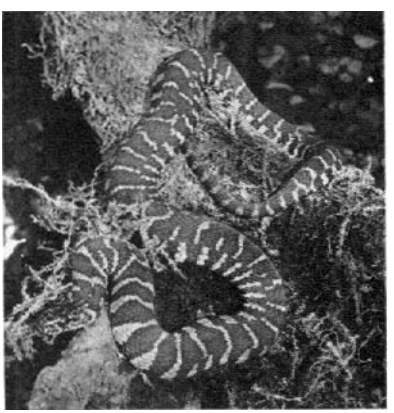
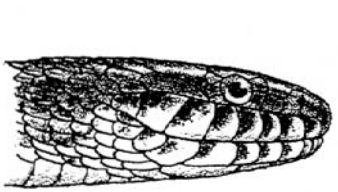


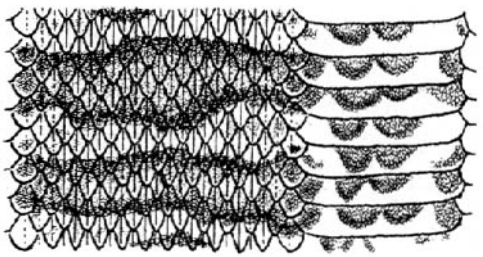
Figure 38. Banded water snake, *Natrix sipedon.* (⅓ natural size.)

The water snake will strike vigorously at any would-be captor. It has no venom, however, and its bite is no more dangerous than the needle-toothed bite of a tiny puppy. Its vicious disposition and water-loving habits have given it the popular but erroneous name of water moccasin. The true water moccasin, a dangerously venomous snake, is an entirely different species, which does not occur within several hundred miles of Minnesota's southern boundary.

In captivity water snakes feed readily on their favorite diet of fish and are much less difficult to maintain than are many other species. Occasionally individual water snakes will become fairly tame in captivity.

Food. Two Minnesota water snakes (827, 828) contained undetermined amphibian material, another (577) contained remains of a spider, and a Pine County specimen contained a tiger salamander. From a report by Uhler, Cottam, and Clarke (1939) on the contents of thirty





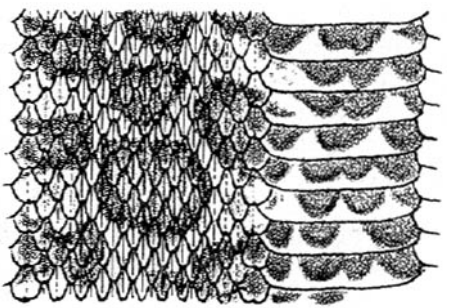


Figure 39. Head of banded water snake. *Figure 40.* Pattern of banded water snake: *upper*, near head; *lower*, near tail. (Natural size.)

stomachs it appears that the water snake preys almost entirely upon cold-blooded animals, though two stomachs contained a few hairs, showing that small mammalian forms are taken at times. Their data show that fishes were the principal food, comprising 60.92 per cent; game and pan fishes made up 13 per cent; non-game and undetermined game fishes, 47.92 per cent; and amphibians, including frogs, toads, and salamanders, 34.66 per cent.

Breeding. The water snakes, like several other species, retain their eggs till hatched, and thus give birth to living young. The following data refer to its breeding in Minnesota. Specimen 533, taken at Shakopee, Scott County, May 10, 1937, contained 44 eggs, averaging 12 mm. in diameter. Specimen 222, taken at Red Wing, June 10, 1930, contained 27 eggs about 15 mm. in diameter. Specimen 829, taken in Houston County, July 30, 1938, contained 26 eggs about 20 mm. in

diameter. Specimen 1018, taken in Washington County in August 1939, contained well-developed embryos still having rather large yolk sacs. Rene B. Stiles reported two female water snakes from near Des Moines, Iowa, as giving birth to 30 and 29 young, respectively, on August 2 and 4, 1940. Conant (1938) reports an Ohio female as giving birth to 19 young on August 23, 1931. The largest brood of *Natrix sipedon* on record seems to be a brood of 44 young reported by Ditmars (1936).

Suggested Reading. K. P. Schmidt and D. D. Davis, 1941, pp. 218–20.

DEKAY'S SNAKE, OR BROWN SNAKE

Storeria dekayi (Holbrook)

Map 32. Range of DeKay's snake.

Description. DeKay's snake is not venomous. It seldom grows to more than 14 inches in length. The largest specimen in the Minnesota collection (162, female) measures: total length, 14¼ inches; tail, 2¾ inches.

The following coloration was recorded of a female taken in Hennepin County, September 30, 1937: middorsal band, 3 scales wide, smoky gray; next two scale rows on either side, slightly darker; sides, light grayish olive; row of dark dots on 7th scale row at 3-scale intervals on anterior half of body; tips of ventrals same color as sides; small dark blotch on either side of the neck; (all these markings often almost obliterated in specimens having darker ground color); top of head from eyes forward, light grayish olive with a few dark specks; dark bar below the eye; dark dot on temporals; belly pale salmon; anterior two-thirds of body with a row of dark dots on anterior edge and near outer tips of ventrals on either side; color of body continuing on tail.

Clausen (1936) states: "The young snakes at the time of birth were very dark or nearly black in appearance and with a grayish-yellow band around the neck. They shed their skins one to two hours after birth and during the first three weeks, shed several times more. After each successive shedding, the color pattern seemed to change from deep black to a rich brown and finally to the grayish brown

adult color. The grayish-yellow neck band darkened with each successive shedding until it eventually blended in with the rest of the color pattern of the body."

The scales, with the exception of the first row, are sharply keeled. The dorsal scale rows number 17 throughout (the red-bellied snake has 15). The ventral scales in nine females numbered 133 to 141; the subcaudals, 46 to 50. The single male specimen in the Minnesota collection had 137 ventral scales and 57 subcaudals. The upper labials number 7, rarely 6; the lower labials 7, rarely 8. There is one preocular; the postoculars number 2. The anal plate is divided.

Range. Conant (1938) reports the range of this snake as "from southern Maine west through the lower peninsula of Michigan to central Minnesota and central Kansas, and south, except peninsular Florida, to the Gulf of Mexico and along the coast to central Guatemala."

Present Minnesota records (Map 32) show it occurring along the Mississippi and lower Minnesota rivers only as far north as St. Cloud.

Habits and habitat. Few Minnesota records exist for this species, but those at hand indicate that its habits closely resemble those of its relative, the red-bellied snake. Several specimens were taken in a maple-basswood forest near Lake Minnetonka, Hennepin County. Several others were retrieved from a window well in a residence near this same woods. Nearly all the remaining records also came from hardwood habitats. A number were taken in October 1942 while they were crossing highways in Winona and Houston counties.

An interesting problem suggests itself in connection with the restricted range of this species in Minnesota as compared with the widespread occurrence of the red-bellied snake. Why should these two closely related species, whose habits, at least what little is known of them, appear to be very similar, show such a variation in ability to survive conditions in this region? A more careful comparison of their life habits or a close study of their comparative abilities to withstand such conditions as cold and drought may shed some light on this problem.

Food. One Minnesota specimen contained an earthworm 3 inches long. Surface (1906) reports that four Pennsylvania specimens contained 67 per cent slugs and snails, 16 per cent insect larvae, and 17 per cent earthworms.

Breeding. Minnesota specimen 265, taken in Hennepin County, gave birth to eight young in August 1929. These young varied little in size and averaged slightly under 4 inches at birth. Specimen 145, taken in Scott County, gave birth on August 11, 1935, to fifteen young, which varied from 4¼ to 4½ inches in length.

Conant (1938) reports an Ohio female as containing 23 embryos and another as containing 24 eggs. Still another contained only 3 embryos. Findings from some careful studies by Clausen (1936) on the breeding of this species may be summarized as follows: mating occurs in February and March on Long Island, New York; gestating females isolate themselves and remain quiet; the gestation period for eight specimens varied from 105 to 113 days; the dates of birth were July 14 to August 1; the number of young was 9 to 20; the length of young was 88 to 108 mm. (approximately 3½ to 4¼ inches); the young ate earthworms ten minutes after birth and fruit flies soon afterward.

Suggested Reading. H. J. Clausen, 1936, pp. 98–102.

RED-BELLIED SNAKE

Storeria occipitomaculata (Storer)

Description. The red-bellied snake (Figure 41) is not venomous. It is a tiny snake and seldom attains a length over 12 inches.

Map 33. Range of the red-bellied snake.

The body ground color is brown, often tending toward gray, with a dark brown line on the 6th scale row on either side and a less distinct line on the 1st scale row. These lines are never prominent and are often almost indiscernible. The top of the head is dark brown finely speckled with black and gray and occasionally with reddish brown as well. A pale buffy spot is sometimes evident on the neck just back of the parietals, and occasionally there is a pair of similar spots on the sides of the neck below this mark. The under part of the head is white. The other under parts are bright scarlet to orange red. The outer tips of the ventrals are finely speckled with gray, black, and brown. The tiny young are almost jet black, with pale spots on the neck merging to form a ring; the belly is pinkish. The young closely resemble young ring-necked snakes.

The scales are strongly keeled except for the first row on either side. (The scales of the ring-necked snake are unkeeled.) The dorsal scale rows number 15 throughout. (*S. dekayi* has 17.) The ventral scales in sixteen females numbered 125 to 135; the subcaudals, 40 to 48. The

ventrals in eight males numbered 120 to 129; the subcaudals, 49 to 54. The upper labials number 6, rarely 5 or 7; the lower labials 7, rarely 6. There are 2 preoculars and 2 postoculars. The anal plate is divided. The following measurements of a male and a female show that, as in most snakes, the tails of males are proportionately longer. Male 786 measures: total length, 10.50 inches (267 mm.); tail, 2.50 inches (63 mm.). Female 161 measures: total length, 10.63 inches (270 mm.); tail, 2.13 inches (54 mm.).

Range. S & B (1943) give the range of the red-bellied snake as "from Ontario and Lake Superior southward to central Florida and Vera Cruz, westward to Kansas, Iowa, and North Dakota."

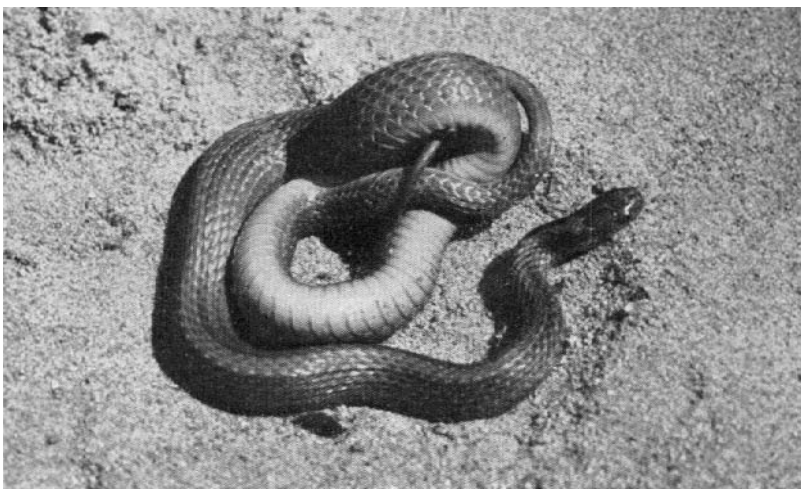


Figure 41. Red-bellied snake, *Storeria occipitomaculata.* (Natural size.)

This snake has been reported oftener from the northern part of Minnesota than from the southern (Map 33). In fact, the red-belly and the garter snake (*Thamnophis s. sirtalis,* and rarely *T. s. parietalis*), seem to be the only snakes found in northeastern and north-central Minnesota. In these regions the red-belly seems to be fairly abundant, at least locally. Mrs. Esther Morcom, a resort owner in northern St. Louis County, writes that a great many of these snakes were in evidence on the trails about the resort during the summer of 1939.

This species does not appear on the prairies proper, but does occur in the poplar thickets and along the wooded streams of the prairies. The lack of records in southeastern Minnesota, where the most collecting has been done, is surprising. Here DeKay's snake seems to take the place of the red-belly.

Habits and habitat. This tiny snake is probably neither as nocturnal

nor as secretive in its habits as it is often said to be, but its small size and inconspicuous dorsal color make it difficult to detect among the leaves and dead grass. That it often comes into the open is shown by the fact that a number of specimens have been found killed while they were crossing highways.

The woodlands are the chosen habitat of this snake. Here it is often found scurrying across a trail or curled up in some sunny spot by a log or rock. In its search for food it naturally spends most of its time under leaves, in brush piles, or about rotting logs, hunting into all the chinks and crannies. This habit accounts for the taking of numerous specimens in window wells, basements, or vegetable cellars. These specimens are frequently pronounced to be the venomous copperhead, or "copper snake." The truth is of course that the red-belly is as innocuous a snake as exists anywhere. Not only is it non-venomous, but also its tiny teeth serve only to cling to the epidermis of its captor's finger and rarely if ever draw even a drop of blood. A fantastic tale of this snake's coiling about a person's ankle, causing a row of festering sores to appear, recently came to the author's attention.

Hibernation. From Treesbank, Manitoba, on October 10, 1934, Criddle (1937) reports an anthill containing 257 snakes, of which 101 were red-bellied snakes. It was situated in hazel brush near a willow swamp. Harvey Gunderson recalls having dug out red-bellied snakes from anthills in western Minnesota. Thus anthills may prove to be a common retreat for the hibernation of this species.

Enemies. Four specimens of the red-bellied snake have been taken from the crops of two broad-winged hawks. Barbara Young, a St. Paul biology teacher, reported taking five specimens of this snake (two were examined by the author), together with five mice, from the stomach of a red-tailed hawk shot near Minneapolis.

Automobile traffic undoubtedly kills many of these tiny snakes every year, but their small size allows most of them to escape the notice of even an observant collector.

Food. Surface (1906) found only slugs in five specimens of the red-bellied snake from Pennsylvania. A number of authors (Conant, 1938; Ditmars, 1936) state that earthworms are a staple food of this species.

Breeding. The red-bellied snake gives birth to living young. Four specimens (161, 267, 281, 536) taken between June 30 and July 19 contained respectively 7, 14, 8, and 5 eggs. Another (284) taken at Minneapolis gave birth to six young, all measuring approximately 3½ inches (88 mm.) in length. Two females from Cass County, reported by Richard Anderson, gave birth to nine and six young on September 5 and 9, respectively.

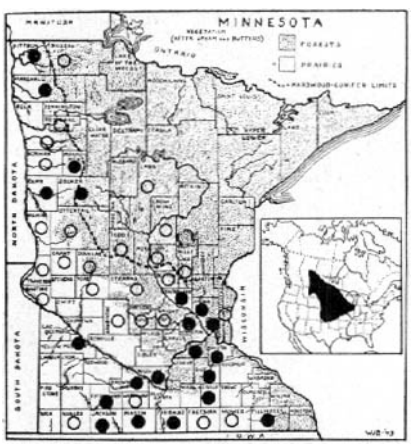
Blanchard (1937) writes as follows of the breeding of this species in northern Michigan. "Ordinarily, these snakes first become parents at the age of 2 years. The earliest of fifty-seven records of births thus obtained is August 8, and the latest September 5. The number of young at a birth in the broods observed (77) was from 1 to 13. . . . Other observers have published 20 instances of births in this species varying from 2 to 14. The length of these snakes at birth, based on measurements of over 300 specimens, varies from 67 mm. to 98 mm., with an average length of 86 mm."

George Rysgaard, a competent observer, reports a large female of this species taken in Pine County as giving birth to 18 young on July 17, 1937. This specimen was not preserved, but Mr. Rysgaard recalls that the belly of this specimen was particularly brilliant, and since *S. dekayi* has never been taken as far north as Pine County it seems likely that the specimen was correctly identified. As far as can be determined, this number of young is the largest on record for a female of this species.

Suggested Reading. F. N. Blanchard, 1937, pp. 151–62.

PLAINS GARTER SNAKE

Thamnophis radix (Baird and Girard)



Map 34. Range of the plains garter snake.

Description. The plains garter snake is not venomous. It is a medium-sized snake, usually 3 feet long or less (maximum, 41 inches, specimen 839). A male (756) measures: body, 21½ inches; tail, 6¾ inches; total, 28¼ inches. The tail is less than 27 per cent of the total length. (It is more than 27 per cent in the western ribbon snake, *T. sauritus proximus*, which may occur in southern Minnesota.)

The ground color is dark brownish, olive gray, or black, and paler below the lateral stripes. There is a median yellow stripe on the back from the head to the tail tip; it is usually rich yellow, tending toward orange, on the neck. There are lateral stripes on the third and fourth scale rows. These stripes are more of a greenish yellow than the median stripe. On some specimens with a paler ground color there are two

rows of squarish black spots alternating with each other in the space between the median and lateral lines. On most specimens there is another row of black spots below the lateral stripe and extending onto the tips of the ventrals. The head is like the ground color of the body. There is almost always a pair of tiny yellow dots along the midline between the parietals. The upper labials are pale yellowish with heavy black posterior margins. (These marks are absent in the western ribbon snake, *T. sauritus proximus*.) The under part of the head is whitish, and the rest of the under parts are pale greenish white. The posterior margin of each ventral scale is black near the outer tip; these margins form a row of black dots just beneath the first scale row.

The scales are strongly keeled, except for the first row. The scale rows usually number 21 on the neck, rarely 19 or 23; these decrease to 17, occasionally 19, at the vent. The ventral scales in thirty females numbered 151 to 170; in fourteen males, 157 to 170. The subcaudal scales in twenty-one females numbered 63 to 77; in ten males, 73 to 86. The upper labials number 7 or 8; the lower labials, 9 or 10, occasionally 8. The preoculars number 1, rarely 2; the postoculars 3, occasionally 2. The anal plate is undivided.

Range. S & B (1943) give the range of this snake as "Illinois and the Great Plains from Kansas and Missouri to Wisconsin and the Canadian Northwest." The range of the plains garter snake in Minnesota (Map 34) coincides with the distribution of the prairies. The occurrence of this snake in a large part of the hardwood belt in central and southeastern Minnesota and on the edge of the coniferous areas farther north is accounted for by the fact that fingerlike extensions of prairie dissect this whole region, with the exception of the extreme southeastern corner. It is of interest to compare this range with that of the common garter snake, *Thamnophis, s. sirtalis* (see Map 35). The plains garter snake is almost as definitely limited to the western part of Minnesota by prairie conditions as the common garter snake is to the eastern part by forests.

Habits and habitat. The ideal habitat of this garter snake seems to be the prairie sloughs and pond margins, where frogs, its principal food, are abundant. It is not limited to the marshes, however, but has the ability to withstand considerable heat and lack of water and is apt to be encountered at considerable distances from such moist lowlands. The finding of 93 plains garter snakes on an eleven-mile stretch of highway is noted in the paragraph on enemies. This highway traversed low, marshy prairie land. On turning from this highway onto another, leading over higher, drier prairie, the author found only an occasional specimen. In July 1938 Warren Nord and the author, while walking

once around a slough 200 to 300 yards across, in southern Anoka County, captured 28 plains garter snakes.

The distinct preference of this snake for the prairie habitat was brought home to the author while he was traveling westward through Clearwater and Mahnomen counties on September 16, 1939, and again on September 14, 1940. These days were bright and sunshiny, but the preceding nights had been chilly, and a number of snakes had come out onto the warm graveled road to sun themselves. At a point a little east of the center of Mahnomen County, the road leaves the coniferous woods rather abruptly at one of the beaches of glacial Lake Agassiz and enters fairly typical prairie land. All the snakes examined on the road through the pine woods were the common garter snake, whereas west from the point where the prairies began all were the plains garter snake. The same situation occurs in southeastern Minnesota, where the plains garter snake occurs up to the brink of the rugged wooded valleys in Houston and Winona counties, whereas none have been taken in the valleys.

Hibernation. As with most reptiles, the time that this species enters hibernation depends on weather conditions. The fall of 1939 was very mild, and snakes were reported active at unusually late dates. A freshly killed specimen was found on the pavement in Anoka County on November 5, and Arnold Erickson found six or eight specimens active in Hennepin County at midday of November 12.

No data have been secured regarding the type of den chosen by these snakes as hibernating quarters. The group of six or eight reported by Erickson were found close together on the south-facing side of an open, sandy hill. Since these sluggish, chilled snakes could hardly have traveled any great distance from the spot where they were seen, it seems probable that they were utilizing some deserted burrow, perhaps that of a striped ground squirrel. The wide-open type of habitat of this species would have few protected shelters other than such burrows into which they could retire. Criddle (1937) reports finding eight plains garter snakes hibernating in an anthill with a great many smooth green and red-bellied snakes. The author has found a few plains garter snakes gathering with many common garter snakes for hibernation in holes along the wooded banks of the Mississippi north of Minneapolis.

Enemies. Man certainly ranks high as a factor in reducing this species, for enormous numbers are killed every year in the fields and by motor traffic. While traveling on highways through prairie regions in spring and fall, one often encounters a freshly killed plains garter snake every few miles. Occasionally this mortality is extremely high. On Sep-

tember 17, 1939, the author found 93 of these snakes on an eleven-mile stretch of graveled highway in southern Norman and Mahnomen counties. Several wet, chilly days and nights preceded the 17th, which was a warm, sunny day. The sun-warmed road surface afforded an excellent basking place for the snakes from the surrounding prairie. About 75 per cent had already been crushed by cars. At least a third of the specimens were examined, and all proved to be of this species. The count was made before noon, and a much larger mortality undoubtedly occurred on this road before nightfall.

Coues (1878) says of the plains garter snakes: "They are themselves preyed upon by hawks, especially the Marsh Harrier (*Circus cyaneris hudsonius*) and Swainson's Buzzard (*Buteo swainsoni*)."

Food. Nineteen Minnesota plains garter snakes contained the following foods: one American toad, six swamp tree frogs, one common tree frog, one leopard frog, one wood frog, two tiger salamander larvae, three unidentified tadpoles, numerous unidentified vertebrates (probably tadpoles), one fish, several beetles, damsel flies and grasshoppers, and unidentified mammal hair, probably from the meadow mouse.

The author has records of a score or more instances of specimens of leopard frogs being disgorged by live snakes in the field. The presence of the mammal hair in one specimen indicates that the plains garter snake does not limit its diet to cold-blooded prey.

Brous (1882) stated: "During the drought of hot summers, the receding waters left the fishes in shallow pools within creek beds, an easy prey to their numerous enemies. . . . Here the fishes . . . were unwilling cotenants with the snakes. The latter are fond of fish, and would devour great numbers of the smaller ones, chasing them from one part of the shallow pool to the other. Mr. J. L. Wortman . . . while fishing one day . . . caught numbers of chub (Cyprinidae) and, throwing them on the mud . . . observed a garter-snake seize and swallow one of the fish six inches in length."

Ruthven (1908) states: "One of these [foods] is that staple article of diet of so many of the plains forms in the fall—the grasshopper. . . . I have often seen these snakes coiled up on a shock of wheat with a grasshopper's legs protruding from the corners of its mouth and there can be little doubt that it forms an important part of the food in the upland habitat. . . . In the stomachs of some specimens from a patch of upland prairie in Clay County, Iowa, I found two small mammals and a bird. All of these had undoubtedly been found dead as they were all badly fly blown."

Breeding. The ability of garter snakes to persist in well-populated areas is undoubtedly due in large measure to the enormous number of

young they produce. Eleven Minnesota specimens gave birth to young varying in number from 5 to 92, the majority having between 20 and 60. The largest number, 92, was reported by Richard Anderson of Minneapolis, who had the female segregated in a cage at the time of the birth. Minnesota records indicate that the young are born in late July and early August. Ruthven (1908) found females in western Iowa that gave birth to young on August 31 and September 7, 8, 29, and 30 (1907).

Suggested Reading. Alexander G. Ruthven, 1908, pp. 71–75.

COMMON AND RED-SIDED GARTER SNAKES
(Two Subspecies)
Thamnophis sirtalis (Linnaeus)

Map 35. Range of the common and red-sided garter snakes. Circles indicate common garter snake and triangles indicate red-sided garter snake.

Races. S & B (1943) recognize six subspecies of *Thamnophis sirtalis*. Two of these subspecies, the common, *T. s. sirtalis*, and the red-sided, *T. s. parietalis*, occur in Minnesota.

Description. These garter snakes are not venomous. The common garter snake (*T. s. sirtalis*) is a medium-sized snake, occasionally exceeding 3 feet in length, but usually several inches shorter. Adult female 314 measures: body, 21¼ inches; tail, 6⅛ inches; total length, 27⅜ inches. Adult male 244 measures: body, 19 inches; tail, 6¼ inches; total length, 25¼ inches.

The ground color is dark brownish, with greenish olive or black dorsally between the lateral stripes. The snake has a single median stripe and lateral stripes on the second and third scale rows. These stripes are pale yellow, all of about the same tint. The sides below the lateral stripes are much lighter than the dorsal ground color, often light greenish, bluish, or yellowish, almost merging into the yellow of the stripes. A peculiar reddish-brown cast on the lower sides toward the head is often found in the red-sided form. There are two series of dark spots between the median and lateral stripes, outlined by a light tint on the interspaces between the scales in the common garter snake (*T. s.*

sirtalis). In this form flecks of red are sometimes evident on these interspaces near the lateral stripes. With the extension of these red areas and the partial fusing of the upper series of dark spots, this subspecies merges into the red-sided form (*T. s. parietalis*), which is characterized by considerable amounts of red in these interspaces. The head is the same color as the ground color of the body, or slightly darker in the common garter snake. The head is often brownish in the red-sided garter snake. Both labials are whitish or yellowish, the upper series occasionally narrowly margined with black posteriorly. In about half of the specimens studied (44) there was a pair of tiny yellow dots on either side of the suture separating the parietals. The under part of the head is white. The under parts of the body and tail are pale bluish, yellowish, or greenish. In about half the specimens studied there was a series of black dots near the outer ends of the ventrals.

The scales are keeled. The scale rows number 19 at the neck, 17 at the anus. The ventral scales in fifty-two females numbered 141 to 170; in twenty-six males, 153 to 168. The subcaudal scales in thirty-eight females numbered 58 to 81; in twenty-three males, 73 to 88. The upper labials number 7, occasionally 8; the lower labials, 9 or 10, occasionally 8. There is one preocular; the postoculars number 3, rarely 2. The anal plate is undivided.

Range. This garter snake, including its six subspecies, has a very extensive range. It occupies roughly all North America from the 52° parallel of north latitude south to Florida, Texas, and southern California with the exception of the deserts and high mountains. The red-sided and common garter snakes intergrade in a broad diagonal belt from northwest to southeast across Minnesota. The red-sided form occurs (S & B, 1943) in "Iowa and Minnesota, Missouri westward to Utah, eastern Nevada, through southern Idaho to Oregon, Washington, Alberta, and Manitoba"; the common garter snake in "eastern United States and Canada, north to about the 52nd degree of latitude, west to Minnesota, Missouri, southward to eastern Texas." Typical common garter snakes, lacking the red markings, are definitely limited to wooded habitats in Minnesota (Map 35, black circles). Specimens showing red between the scales occur throughout most of the state (Map 35, black triangles). Those having the more extensive red markings, typical *T. s. parietalis,* occur largely in the prairie portions of the state.

Habits and habitat. Typically marked individuals of the two subspecies of this Minnesota garter snake are readily distinguished. They have different common names and different habitat preferences. As indicated, the common garter snake is a woods form, limited sharply

to the west by the prairies, and only the red-sided form occurs westward onto the prairies. Ruthven (1908) states that the range of the red-sided form is greater than that of any other known garter snake and includes a number of biotic regions. In the author's experience, the plains garter snake (*T. radix*) is much the more abundant and widespread of the two prairie garter snakes in Minnesota.

There is little doubt that the garter snakes are the commonest snakes throughout Minnesota and are more frequently seen than all other snakes combined. They are also found in more widely differing places than most other snakes. They are wanderers, likely to appear on lawns and in gardens, streets, meadow margins, woods, and wastelands. However, they show a preference for moist to wet habitats or the vicinity of such places, where at least a fair amount of vegetation affords protection and a food supply. They occur most numerously in wastelands, where they are less subject to the disturbance and destruction occasioned by cultivation.

Hibernation. Along the east-facing bank of the Mississippi River near the author's home just above Minneapolis, considerable numbers of garter snakes are seen early in April as they emerge from numerous dens in the wooded bluffs. Here rotting tree stumps afford access to the sandy and rocky subsoil layers, through channels formerly occupied by the roots of the trees. Chipmunk and woodchuck burrows along the banks also provide suitable winter dens. The snakes disperse during the summer and in the fall congregate again in these same places, disappearing during cold spells and reappearing on warm days, until winter finally forces them into hibernation. Evidently only a few degrees above freezing temperatures are needed to stimulate this hardy species into activity about the mouths of these hibernating dens. In the fall of 1940 George Rysgaard reported active garter snakes on the south-facing rocky Mississippi River bluffs in Minneapolis as late as November 23.

Enemies. Perhaps the greatest enemy of this species is highway traffic. On September 4, 1939, 25 to 30 dead garter snakes were found on the fourteen-mile stretch of pavement between Minneapolis and Champlin. On September 14, 1939, on three-eighths of a mile of highway two miles south of Zimmerman, in Sherburne County, the author identified 35 garter snakes (33 common and 2 red-sided). This was on a bright, sunny, fall morning preceded by cold, wet weather—a combination of conditions that often brings out snakes in numbers to sun themselves on the pavement.

A strange case of turning the tables was brought to the author's attention by M. H. Doner of Winona, who reported taking a small

garter snake from the stomach of a large leopard frog, *Rana pipiens*, a species that normally figures prominently in the diet of garter snakes.

Food. Eight Minnesota specimens that were examined contained food. Three had taken American toads; three, leopard frogs; one, a tiger salamander; and one, undetermined fish. Carrion is not refused, for one had taken the foreleg of a pocket gopher, an animal much too large to have been taken whole. Joe Ehein reported that a garter snake (species not determined) in McLeod County took young yellow warblers from a nest three feet up in some bushes, and Dr. T. S. Roberts states that another (species not determined) took young song sparrows from the nest.

Uhler, Cottam, and Clarke (1939) report the food of twenty-four garter snakes as follows: "The garter snake subsists largely on earthworms and other invertebrates and on cold-blooded vertebrates. Only one stomach contained a few field mice (*Microtinae*) hairs. . . . For the twenty-four well-filled stomachs earthworms (mostly *Lumbricus terrestris*) averaged 37.42 per cent of the total content. . . . More than half of the total food was obtained among the amphibians. Salamanders, which were preyed upon by eight of the twenty-four specimens, contributed 31.37 per cent of the average meal. . . . Toads (mostly *Bufo fowleri*) . . . had been taken by six of the twenty-four serpents and composed 25.01 per cent of the average meal. . . . Surprisingly, no frogs entered into the diet of the garter snakes studied."

Root (1928) reports a garter snake as eating trout entrails. When he captured the snake as it attempted to escape and returned it to its meal, it immediately resumed feeding, even while being held by the tail.

Breeding. Little is known about the gestation period of this snake, or any other, for that matter. Rahn (1940) found motile sperm in the uteri of garter snakes after periods up to three months of separation from males. He states: "It is thus shown that in snakes and turtles, in contrast to most higher vertebrates, the act of mating and ovulation may be divorced by a time interval of several weeks or longer—and that effective fall mating with fertilization occurring in the spring may be quite possible."

The common and red-sided garter snakes, like the others of this group, bring forth surprisingly large broods. This fact undoubtedly accounts for their continued abundance in heavily populated areas. Eighteen Minnesota broods of young and embryos ranged from 3 to 61, with the majority producing 20 to 50 young.

Schneck (1882) reports a remarkable brood of 78 young, 5 to 7 inches long, taken from a female of this species. Numerous reports indicate that the young are born from late July to the middle of Sep-

tember. Ruthven (1908) reports a northern Iowa specimen as giving birth to 73 young on September 30, 1907.

Growth. Over a period of two years the author marked a total of 160 common and red-sided garter snakes taken near hibernation retreats in a three-acre woodlot just north of Minneapolis. Of these, 13 were retaken later. This study suggests that there is either a great predominance of males over females, or a distinct tendency toward segregation of the sexes during hibernation, since of 142 of the larger snakes whose sex was determined only 20 were females. A careful study of the size of the snakes at different seasons and of the growth of those retaken shows that the young measure 10 to 13½ inches as winter begins, that no measurable growth takes place during hibernation, that during their second summer the majority of the young attain a length of 17 to 20 inches, and that their rate of growth from then on is so varied as to make recognition of age groups impossible. Females attain a larger size than males. The largest Minnesota male specimen measured 27 inches; the largest female, 33½ inches. These data on growth agree essentially with those derived by Blanchard (1933) from a similar study in Michigan.

Suggested Reading. Alexander G. Ruthven, 1908, pp. 1–201.

MASSASAUGA, OR SWAMP RATTLESNAKE

Sistrurus catenatus (Rafinesque)

Map 36. Range of the massasauga, or swamp rattlesnake.

Races. S & B (1943) recognize two subspecies of this rattlesnake, of which one, *S. c. catenatus*, occurs in Minnesota.

Description. The massasauga, or swamp rattlesnake (Figures 42, 45D) is dangerously venomous. It is a small (maximum, 3 feet), dark-colored, stout rattler, with much smaller rattles than the timber rattlesnake. The largest of three specimens examined (female, specimen 86) taken near Nelson, Buffalo County, Wisconsin, measures: body, 21¼ inches; tail, 1¾ inches; total length, 23 inches.

The structure and functioning of the fangs, the structure and growth of the rattles, and the function of the pits on the head are the same as those of the timber rattler.

The ground color is dark olive buff. The pattern is made up of: a median row of 27 to 33 saddle marks of dark neutral brown, bordered narrowly with black and outlined with very light yellow; a row of smaller, less distinct spots alternating with these marks; another row of sharply outlined spots lying directly below the saddles and sometimes joining them; and a third lateral row of spots, including only the first two scale rows, alternating with these spots and grading into the black of the belly. The head has the same ground color as the body. There is a light bar on top of the head, connecting the eyes, and a dark bar from the eye to the gape. The area below the pit is dark, with light margins. The under parts are largely black. Many of the ventral scales are light margined.

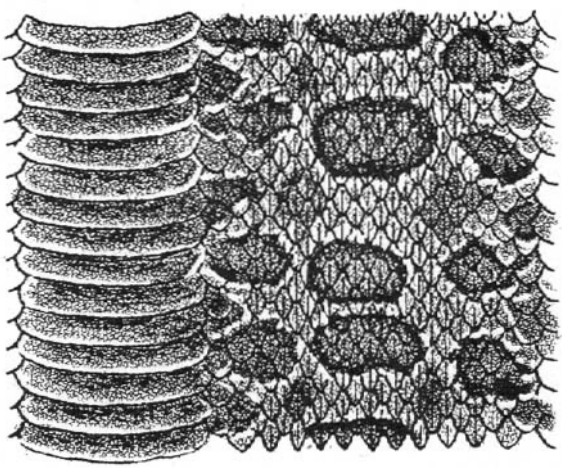


Figure 42. Pattern of massasauga, or swamp rattlesnake, *Sistrurus catenatus.* (Natural size.)

The dorsal scales are strongly keeled, but become progressively less so on the sides, and the first scale row is smooth. The scale rows number 27 on the neck, decreasing to 19 near the vent. The top of the head is covered by plates (Figure 45D), not with small scales as in the timber rattler. The upper labials number 12 or 13; the lower labials, 12 to 14. There is a deep pit on either side of the head below the line from eye to nostril. The ventral plates in two males numbered 138 and 140; in one female, 141. The subcaudals in two males numbered 28 and 30; in one female, 21. The anal plate is undivided.

Range. Gloyd (1940) gives the range of the massasauga as extending from central New York, the northern tip of Lower Michigan, and southeastern Minnesota, southwestward north of the Ohio River to

New Mexico, southern Texas, and Mexico. The Minnesota distribution (Map 36) is based on two records from Wabasha County—specimen 142 and a specimen taken in June 1937 by E. L. Lawrence and sent alive by Rene B. Stiles to the Staten Island Zoo.

Habits and habitat. The massasauga is a rattler of the swampy bottomlands. Minnesota rattlesnake hunters agree that this species is never encountered in the rocky bluffs, where the timber rattler occurs. Local residents report that many have been washed up on the long rock jetties near the big river dams during the high waters in spring and early summer.

There are no records of deaths from the bite of the massasauga. However, its venom is highly toxic and Ditmars (1936) wrote: "The bite of an adult, if strongly delivered—both fangs thoroughly perforating the flesh—might produce the death of a man."

Conant (1938) states that: "In the New Haven Marsh . . . it is common enough so that specimens are frequently seen and cases of snake bites are not rare. Yet many natives of this area pay little attention to it." Of its habitat in Ohio, he writes: "It appears to be confined, more or less, to the vicinity of bogs and marshes and other poorly drained areas . . . but spreads out over the surrounding farming country during the summer. It often hides under shocks of grain. . . . Almost every specimen collected was more or less lethargic, made little or no attempt to bite and failed to sound its rattle. Several were nearly stepped upon but did not move."

Food. Ruthven, Thompson, and Gaige (1928) state that frogs form the bulk of the stomach contents in the specimens they examined and that in two instances snakes (one a rattlesnake) were found in the stomachs examined. Taylor (1892) states that the contents of the stomachs of this species show that its food is almost wholly made up of mice and animals of that class. Conant (1938) says that a large proportion of the food consists of mice.

Breeding. One female massasauga taken near Nelson, Buffalo County, Wisconsin, gave birth to 8 young on August 6, 1933. They were only slightly under 8 inches long. A second female 23 inches long, taken near the same locality on July 22, 1933, was found to contain 5 young about 6¾ inches long. This record suggests a possible birth date near that of the above record. P. L. Swanson (1933) reports several massasaugas giving birth to young between August 15 and September 10, and gives the size of the young as approximately 8½ inches. Conant (1938) reports a specimen in the Northwestern University collection as containing 12 embryos.

Suggested Reading. O. P. Hay, 1887, pp. 211–18. Roger Conant, 1938, pp. 112–16.

TIMBER, OR BANDED, RATTLESNAKE

Crotalus horridus (Linnaeus)

Races. S & B (1943) recognize two subspecies of this rattlesnake, of which one, *C. h. horridus*, occurs in Minnesota.

Map 37. Range of the timber rattlesnake, *Crotalus horridus*.

Description. The timber, or banded, rattlesnake (Figures 43, 44, 45C) is dangerously venomous. It is a heavy-bodied snake with a short tail terminated by one or more podlike rattles. The largest specimen examined (235, female), taken at Whalen, Fillmore County, measured: body, 45 inches; tail to base of rattles, 3 inches; total length, 48 inches.

The ground color varies greatly, but is usually a grayish yellow, often tending toward brownish. The pattern is usually a series of 22 to 26 complete or incomplete bands. Near the neck these take the form of jagged black saddle marks, with lateral black marks opposite their tips, or nearly so. These marks connect into bands on the posterior part of the body. The ground color darkens posteriorly, often approaching black near the tail. In some dark-phase specimens this ground color becomes so dark as nearly to obscure the pattern. The tail is usually black. The basal rattle is black; the others are horn color. There is usually a rich brown stripe, three or four scales wide, from the head to well back on the body, grading into the dark color near the tail. The dorsal ground color of the head is usually browner than the body, frequently becoming greenish yellow on the sides of the head. There is often a dark bar from eye to gape. In many specimens these head markings are indistinct or lacking. The labials are finely speckled with black. The iris matches the surrounding scales in color; the pupil is a narrow vertical slit. The under parts, including the first two scale rows, are brownish white, usually heavily speckled with black, becoming quite dense posteriorly in many specimens, but always leaving a median band, largely unmarked, tending toward a pale orange brown. The under part of the head is pale brownish laterally and white centrally.

The dorsal scale rows are very strongly keeled. The scale rows number 25 to 29 anteriorly, decreasing to 19 near the vent. The top of the head is covered by small scales, with large supraocular plates in

contrast (Figure 45C). The upper labials number 11 to 14; the lower labials, 13 to 15, rarely 11. There is a deep pit on each side of the head between the nostril and the eye. The ventral plates in eight females numbered 170 to 175; in five males, 164 to 170. The subcaudal scales are largely in a single series. In eight females they numbered 19 to 21; in five males, 24 to 25. The anal plate is undivided.

Figure 43. Timber, or banded, rattlesnake, *Crotalus horridus.* (⅓ natural size.)

Range. This rattlesnake, including its two subspecies, ranges (S & B, 1943) from Maine to northern New York, southwestward along the Ohio and Missouri rivers to eastern Kansas, with an extension up the Mississippi to southeastern Minnesota, thence south to central southern Texas and Florida.

There are many rumors of the occurrence of this rattlesnake at a number of points throughout the southern half of Minnesota, and it is possible that some may be correct, but to date positive records are at hand from the six southeastern counties only (Map 37). In July 1939 the author examined two sets of rattles in the possession of a farmer, taken from snakes killed "years ago" on his farm in St. Croix County, Wisconsin, across the St. Croix River from Afton, Minnesota. The farmer had neither seen nor heard of any taken near there for at least fifteen years. This report indicates that rattlers formerly occurred along the St. Croix, but probably have now disappeared.

Both Keating (1825, I) and Featherstonhaugh (1847, I) reported rumors of rattlers about Mankato. Recent reports from that region have proved to be erroneous, and though the rocky habitat in that

area is favorable and may harbor a few rattlers, no positive evidence is at hand.

Rugged, rocky bluffs farther up the Minnesota River near Redwood Falls and Granite Falls and along Big Stone Lake may have a scant rattler population, but no specimens support the numerous rumors. Keating (1825, I) stated: "One of the guides, Joseph Reinville . . . informed Mr. Colhoun that he had killed them [rattlesnakes] on Big Stone Lake." If the timber rattler extended up along the Minnesota River at that time, the snakes Keating mentions may have been of this species, but there is also a possibility that they were the prairie rattler, *C. viridis*. On November 5, 1938, C. L. Claggett of Montevideo re-

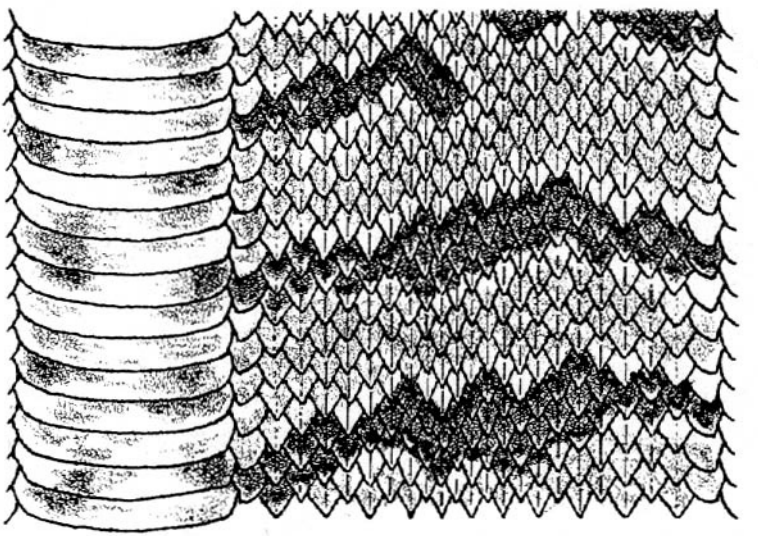


Figure 44. Pattern of timber, or banded, rattlesnake. (Natural size.)

ported to the author in some detail the capture of a 42-inch rattler on the highway just west of Granite Falls in October 1937. The rattles were preserved, but to date he has not been able to locate them.

Rumors of rattlers persist in the St. Cloud region. As early as 1855 Head, writing from Fort Ripley, stated: "The rattlesnake, if ever met above the Falls of St. Anthony, must be very rare. Two are reported to have been killed at Sac [presumably Sauk] Rapids about 50 miles south of this place." Thus, even in those early days there were rumors, but no proof, of the existence of the rattlesnake in that region.

Thus it appears that rattlesnakes may occur in a few places in southern Minnesota other than the six southeastern counties, but none from such points have been examined.

Abundance. Bounty payments give some indication of rattlesnake populations in Minnesota. The total numbers of rattlers on which bounties were paid in three southeastern counties in 1939 were as follows: Fillmore County, 202; Houston County, 2059; Wabasha County, 306; total, 2567. In 1941, Houston County alone is reported to have paid bounties on 5957 rattlers.

These figures might lead one to believe that the bluffs of southeastern Minnesota are literally overrun by rattlesnakes; but definitely they are not. It should be pointed out that it is a common practice among rattlesnake hunters to capture the females and keep them until the young are born and claim bounty on both adults and young. Since an average of about 7 young are born to each female, the 1939 total of 2567 might represent as few as 321 adult females. However, a fair proportion of those taken would be males, and undoubtedly substantially more than this number were taken.

The same hibernating dens are used by the snakes year after year, and the local hunters' knowledge of their location explains how so many snakes are taken in an area where snakes seem not at all abundant. In fact, Klauber (1937), writing on the same point with respect to the prairie rattler, states: "Thus, Mr. C. B. Perkins, within three years in raids on dens in prairie dog towns near Platteville, Colorado, collected over 800 prairie rattlesnakes at the beginning and end of the hibernating season; but during the summer, in the same and contiguous areas, assiduous collecting produced less than half a dozen specimens."

Habits and habitat. Rocky bluffs of limestone, dolomite, and sandstone seem to afford the ideal habitat for the timber rattler in Minnesota. Here are the caves and crevices for the winter dens, the exposed rock shelves for the early spring sun baths, undisturbed land for an abundance of food animals, and not too dense a human population, all of which seem to be essential in a habitat for this species.

The best time for collecting the reptiles is in the spring, when they are coming from their winter dens in the rocks, and again in the fall when they are returning to them. Local hunters state that the rattlers spread out into the cooler, more moist lowlands during the summer.

The timber rattlesnake does not have a vicious disposition. When encountered in the field it first tries to avoid notice by lying still, but if seen it attempts to escape to the nearest crevice. Usually it sounds its rattle in warning before striking, but if surprised it will strike without rattling. If found away from its den on cold spring or fall days it may be quite sluggish, but when cornered under ordinary summer conditions it seems always ready to defend itself vigorously. The strike is commonly delivered from the coiled position, when it

can reach to about two-thirds of its length, but it can also strike from other positions.

The likelihood that death will result from rattlesnake bites is often overstated. C. H. Pope (1937) states: "The death rate in this country [all venomous snakes] ranges from 3 or 4 percent, in cases receiving prompt and proper medical attention, to about 15 percent in poorly treated or untreated ones." He further states that in the United States alone snakes probably kill about 160 persons annually, and ranks the timber rattlesnake fourth among the species of rattlers in point of number of fatal bites inflicted over a given period.

The treatment of snake bites is discussed in the Introduction.

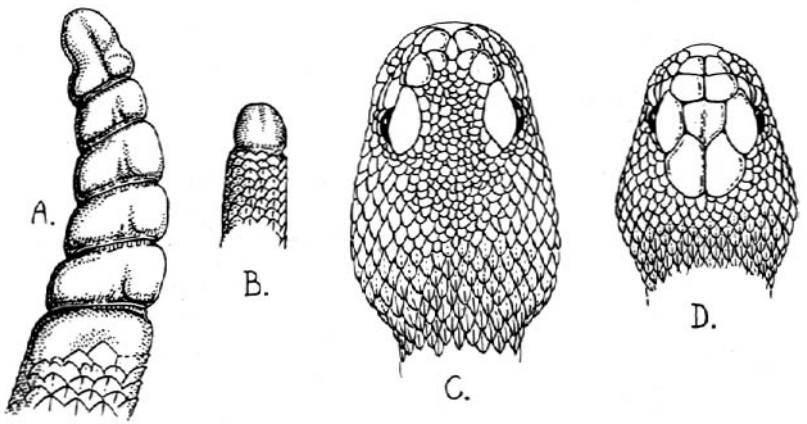


Figure 45. *A*, permanent button and four rattles of rattlesnake; *B*, prebutton of newborn rattlesnake; *C*, head scales of banded rattlesnake; *D*, head scales of massasauga.

The rattle. From the point of view of specialized structures, the rattlesnake is an exceedingly interesting animal. The rattle, which characterizes this group of snakes, is a series of thin, interlocking, podlike structures terminating the tail (Figures 45A, 45B). These structures rattle against one another when the tail is vibrated and produce a buzzing or hissing sound. In the newborn snake the tail is terminated by a single domelike cap, the prebutton (Klauber, 1940), which is shed with the first skin. Underlying this prebutton is the permanent button, which is constricted about the middle. After the next moult the first rattle appears. This rattle also is elongated, with a constriction near the middle, and the expanded terminal portion fits loosely within the bulbous proximal portion of the button, thus preventing the button from being lost with the shed skin. Each succeeding rattle has a large bulbous base with two constrictions and two expanded portions of

progressively smaller size, which fit into the bases of the two previously formed rattles.

The number of rattles shows the number of moults the snake has passed through, not its age in years. With an abundance of food a snake may shed four or five times within a single year. The button and first rattles are frequently lost through wear, and five to ten rattles are a usual number. Grinnell and Storer (1924) mention a rattlesnake (not *C. h. horridus*) with twenty-two rattles, and this string Klauber (1940) cites as "one of the longest probably-reliable records in the literature."

Klauber (1940) describes kymograph experiments recording the rate of movement of buzzing rattles as from 40 to 60 cycles per second. The rapid motion results in a steady sound, much like that produced by a small jet of escaping steam.

The fangs. The fangs, or venom-injecting weapons, of the rattlesnake consist of a pair of very long maxillary teeth in positions similar to those of the canine teeth of a dog. The fang has a heavy base, tapered conical form, and an abrupt curve about midway in its length, leaving the tip portion nearly straight. The basal portion is hollow, the canal opening through a slitlike aperture along the front surface of the fang just back from the tip. These fangs resemble hypodermic needles and serve perfectly to inject the venom from the poison glands imbedded in the muscle masses above the base of the jaws on either side of the head.

The fangs are movable and when not in use lie with the points back and are covered by loose folds of mucous membrane. When the snake's mouth is widely opened the fangs are erected at right angles to the upper jaw. The mechanism may be compared roughly to a parallelogram of bones, the fangs being attached to the anterior side of the figure. When the parallelogram is collapsed onto the base the fangs lie down. When it is brought up to the form of a rectangle the fangs are erected.

C. H. Pope (1937) states that a series of captive western diamond-backed rattlesnakes studied by Mrs. Wiley shed their fangs on an average of once every twenty days. Thus the removal of the active fangs does not necessarily permanently disable the venom-injecting ability of the snake.

Facial pits. The function of the pits in the sides of the heads of rattlesnakes, which give the pit vipers their name, has long been a matter of speculation. Writers have variously called them auditory organs, glands, organs of a sixth sense, tactile organs, tear sacs, ducts giving air access to the poison, and organs of some chemical sense.

Experiments by Noble and Schmidt (1937) show that these pits function as heat detectors, enabling the snake to recognize the presence and direction of warm-blooded prey that comes within striking range of its fangs.

Food. Two Minnesota rattlesnakes examined for food contained, respectively, unidentified mammal hair and two white-footed mice, *Peromyscus noveboracensis.* A very large rattler, 4½ feet long, with 15 rattles and a button, taken June 15, 1939, on the Wisconsin side of the Mississippi River near Red Wing, contained a full-grown gray squirrel, *Sciurus carolinensis.*

Uhler, Cottam, and Clarke (1939) give the most extensive published report on food, based on a study of 141 specimens from Virginia: "The food of the individuals collected consisted almost entirely of small mammals and birds. The former made up nearly 87 per cent of the total and occurred in 133 stomachs, while birds formed a little more than 13 per cent and were found in twenty-one. Traces of bones that appeared to be of amphibian origin were in two stomachs. The three leading foods were mice, chipmunks, and cottontail rabbits. . . . Remains of game birds were found in only two stomachs and formed 1.82 per cent of the total food."

Breeding. The timber rattler gives birth to small litters of young in late summer and early fall. Rene B. Stiles reported a 40½-inch female from northeastern Iowa bearing 11 young on September 9, 1940. An average sized young snake from the brood measured 11½ inches. Ove Hoegh of Houston County reported that eight female rattlers with their 56 young were submitted for bounty, or an average of 7 young per female. He further reported that the females gave birth to 3 to 13 young, usually in August. Conant (1938), Gloyd (1940), and Ditmars (1936) report females from other parts of the range of this snake as giving birth to 7 to 12 young, between September 1 and 18. The young varied from 7⅜ to 12¼ inches in length.

Suggested Reading. L. M. Klauber, 1937, pp. 1–56; 1939, pp. 1–61; 1940, pp. 1–62. R. L. Ditmars, 1936, pp. 367–70. Hutchison, 1929, pp. 43–57.

Turtles

Order TESTUDINATA

Turtles are four-legged reptiles having an upper, dome-shaped shell (*carapace*) and a lower plate (*plastron*), which are joined together by a bony bridge on either side (Figure 46). Except in the two soft-shelled turtles, the carapace is composed of bony plates overlaid by hard dermal plates. Turtles differ strikingly from other vertebrates

in having the shoulder girdle enclosed within the ribs. The jaws are without teeth, but dermal plates provide cutting and crushing surfaces. Female turtles lay their eggs in holes excavated by the hind legs, cover them with soil, and leave them to hatch by the heat of the sun. The basal portion of the tail is usually heavier in males than in females. The plastron of males is often concave, whereas that of females is flat or convex.

SNAPPING TURTLE

Chelydra serpentina (Linnaeus)

Map 38. Range of the snapping turtle.

Races. S & B (1943) recognize two subspecies of this turtle, of which one, *C. s. serpentina*, occurs in Minnesota.

Description. The snapping turtle (Figures 47, 48F, 49) has a heavy, rough carapace with a strong saw-toothed outline posteriorly and a tail almost as long as the carapace.

It is by far the largest turtle in Minnesota. E. A. Kobs took a 45-pound specimen in Ramsey County which had a carapace 17½ inches long and an over-all length of 48 inches. A commercial turtle hunter in western Minnesota reported (correspondence) that he had marketed several snappers of 50 pounds and one of 67 pounds. Babcock (1919) reports one weighing 86 pounds. It had been fattened in a swill barrel for some time. The measurements of two specimens, one a small adult and the other a newly hatched young turtle, are given below.

	Small Adult (117)		*Newly Hatched Young (744)*	
	INCHES	MM.	INCHES	MM.
Carapace length	7.37	186	1.24	30
Carapace width	6.23	157	1.09	27
Body depth	3.27	83	0.62	16
Plastron length	5.55	141	0.78	20
Plastron width	2.82	70	0.47	12
Tail	6.68	171	1.33	33

The form of young and adults is similar, except that the heavy sculpturing of younger specimens is reduced in older adults. The

carapace is moderately domed and broadly ovate in outline, with the posterior marginal plates strongly pointed, producing a coarse, saw-toothed outline behind. There are heavy, tuberculate crests on the vertebral and costal plates, forming a median keel and a lateral keel on either side. The plastron is very small, with only a narrow bridge immovably attaching it to the carapace on the pectoral and abdominal plates, leaving both pairs of legs entirely free. The head is very heavy, the snout pointed, and the upper jaw knife-edged and notched and hooked at the top. The lower mandible is sharply pointed and curved upward at the tip. The crushing surfaces of the jaws are narrow and without ridges. The feet and legs are very powerful, the toes moder-

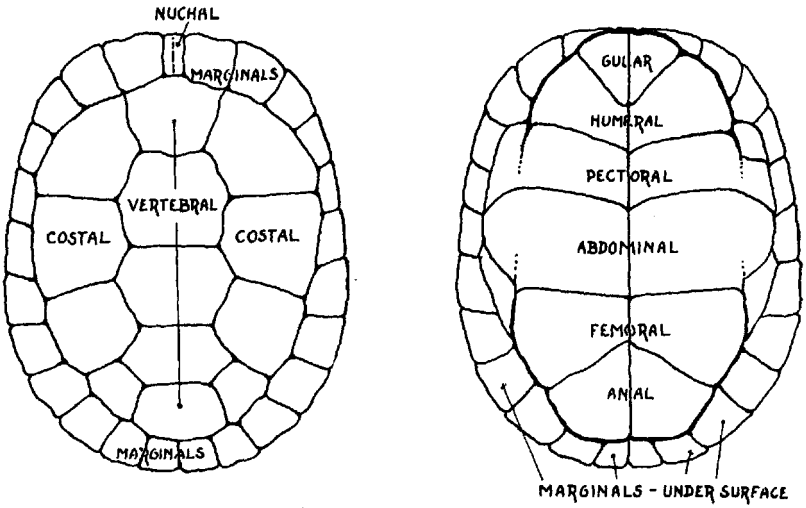


Figure 46. Left, carapace of turtle, with names of plates; *right,* plastron of turtle, with names of plates.

ately webbed. The tail is nearly as long as the carapace, and much longer than that of any other Minnesota turtle, and has a dorsal crest of heavy, laterally compressed scales.

Range. S & B (1943) state that the snapping turtle occurs over eastern North America, except peninsular Florida, from southern Canada and Nova Scotia to the Gulf of Mexico and west to the Rocky Mountains.

There is little doubt that this turtle occurs throughout Minnesota, though there are few records for the northern part of the state (Map 38). Records for Manitoba (Jackson, 1934) indicate that it probably occurs throughout northwestern Minnesota.

Habits and habitat. This turtle seems to require nothing more specific than permanent water as a habitat. Slow, sluggish streams and ponds

and lakes where vegetation is fairly abundant seem to favor the greatest populations of snapping turtles. In the clearer, swifter flowing rivers and streams in southern Minnesota this species is not as abundant as the soft-shelled turtle, *Amyda spinifera,* which seems to be primarily a river turtle.

In the oxbow ponds and weed-choked bays, snapping turtles are often seen pushing slowly about in the shallows with their backs partly out of water. When they are at rest, their algae-covered backs perfectly simulate slimy rocks. These seemingly dull-witted reptiles are surprisingly keen at detecting enemies. They often tumble into the water when an intruder is still a hundred yards or more away.

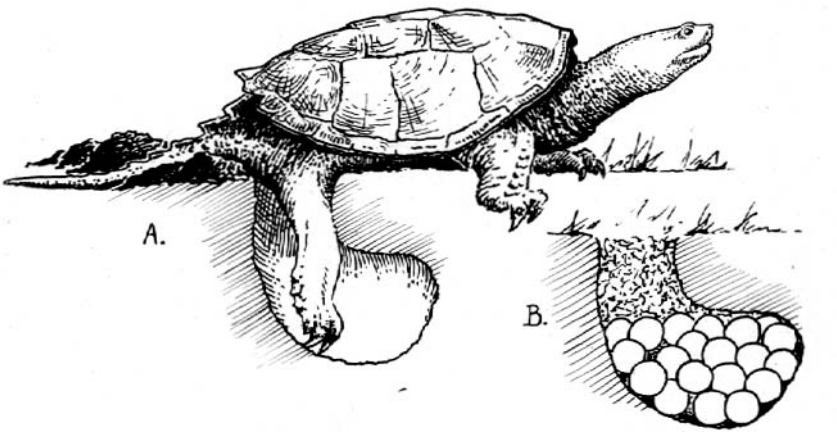


Figure 47. A, snapping turtle digging nest cavity; *B,* completed nest. Drawn from photographs by A. Dawes DuBois. (⅛ natural size.)

When surprised on land, as it frequently is during the egg-laying season in June, the snapper opens its mouth, hisses loudly, and strikes out viciously with its surprisingly extensible neck. Any would-be tormentor is wise to stay well beyond reach of its powerful jaws, for a finger can easily be badly mangled in the crushing grip of a large snapper. Once a grip is secured the reptile hangs on with bulldog tenacity and often the jaw muscles must be cut to loosen its hold.

The snapper seems more at home on land than most turtles. It raises the plastron well off the ground and walks on the toes, with a fairly steady gait, owing to the greater degree of freedom afforded the legs by the proportionately smaller plastron, which covers less than half the lower surface. This small plastron affords much less protection than the large, lidlike ones of some other turtles, but this lesser degree of protection is compensated for by the greater aggressiveness of the snapping turtle.

Hibernation. According to the turtle hunters, these turtles prefer to winter either down a few inches in the muddy bottoms of streams or ponds or in holes below the water level in the banks of the smaller, meandering streams.

In fall, when the temperature of the water drops to within a few degrees of freezing, the snappers begin burrowing into their hibernation quarters, and at that time turtle hunting is most productive. They often hibernate in groups, which facilitates capture. Clark and Southall (1920) report that as many as twenty-six have been found in one muskrat burrow, and that one fisherman obtained twenty snappers, weighing

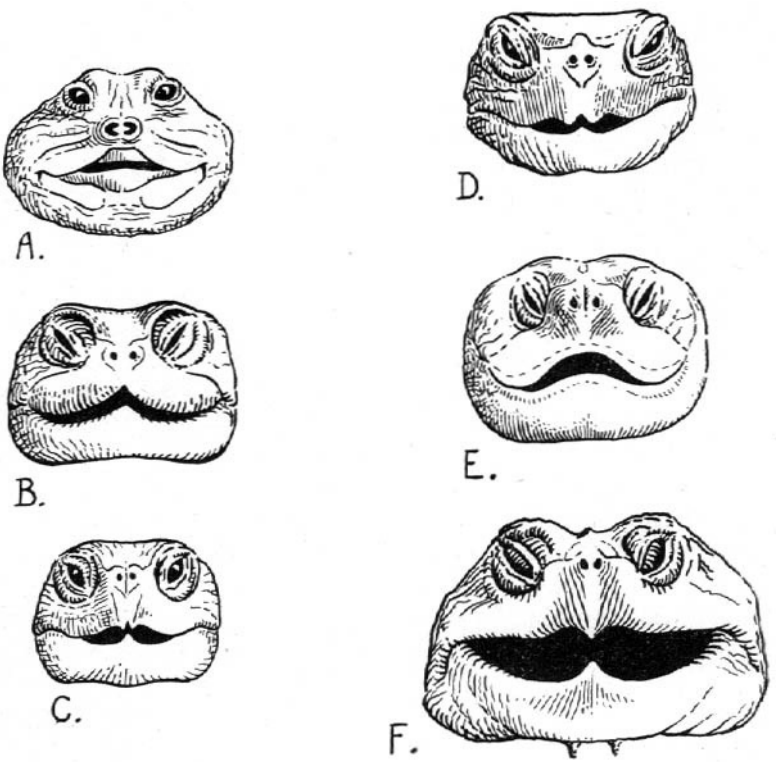


Figure 48. Heads of turtles: *A*, spiny soft-shelled turtle; *B*, Blanding's turtle; *C*, painted turtle; *D*, wood turtle; *E*, map turtle; *F*, snapping turtle. (Natural size.)

from 10 to 20 pounds each, under a log in one of the sloughs of the Mississippi River. These turtles are occasionally seen moving slowly about under the ice, indicating that their hibernation is not complete,

and they become active very soon after the disappearance of the ice in spring.

Food. Of three Mississippi River snappers taken in July in Wright County, one contained about a teacupful (95 per cent) of crayfish remains and a few unidentified fish bones (5 per cent), one a teacupful (100 per cent) of crayfish remains, and one contained four crayfishes (85 per cent) and a few small fish bones (15 per cent).

Most authors credit the snapper with being largely, if not wholly, carnivorous. However, Lagler (1943) reports that food from 186 snapping turtles taken from natural waters in Michigan was made up roughly of one-third water plants, one-third game fishes, and one-third dead fishes and other carrion, insects, crayfishes, snails, and clams.

It is true, as often stated, that the snapping turtle takes waterfowl, both adult and young, but little is known about the extent of such depredations. A single field observation of a snapper taking a duck attracts great popular attention and is remembered for years by the observer. It is probable that the seriousness of the snapper's preying upon our waterfowl has been greatly exaggerated. After examining several hundred snapper stomachs, Lagler (1943) states that, contrary to report, there is an extremely low incidence of bird remains in the food of the snapping turtle.

The value of the snapper as a scavenger has probably gone largely unappreciated. Dead fish, birds, or other animals undoubtedly form an even larger part of this reptile's diet than most food analyses indicate, since this form of food is by no means always distinguishable from that taken alive.

Economic importance. The snapping turtle is used extensively as food, and many are sold in the markets. A professional turtle hunter from western Minnesota (correspondence with Gustav Swanson) wrote in 1939: "When they used to be really thick, I shipped out around 50,000 pounds annually, but during the past three years I have been turning out only twenty to twenty-five thousand each season." Another turtle hunter from west central Minnesota reports (correspondence) selling, largely to eastern markets, about 50,000 pounds of snappers during his best year. His 1940 shipments amounted to 28,600 pounds, and during the last five years his shipments totaled 123,000 pounds. Prices vary from 10 cents to 30 cents a pound, dressed weight.

A number of methods are employed in catching turtles. One widely used method is called "noodling." A long iron rod with a small sharp-pointed hook at the end is used to probe for hibernating turtles in stream banks, muskrat burrows, or lake or pond bottoms. When the

hollow sound of the rod striking a turtle's back is heard, the hook is engaged under the edge of the shell, and the turtle is pulled to the surface. Traps of various kinds are the most effective means of taking snappers. Baited hoop nets of heavy cord or chicken wire are very successful (Lagler, 1943a). Many are taken in seines of various types. Baited setlines are frequently used.

Turtles are not used for food as widely as they might be, owing largely to a natural antipathy toward them, together with lack of information about handling and cooking them. Speaker (1942) gives the following directions for butchering turtles: "By lifting the turtle off the ground by its tail, its head will protrude and can be easily cut off

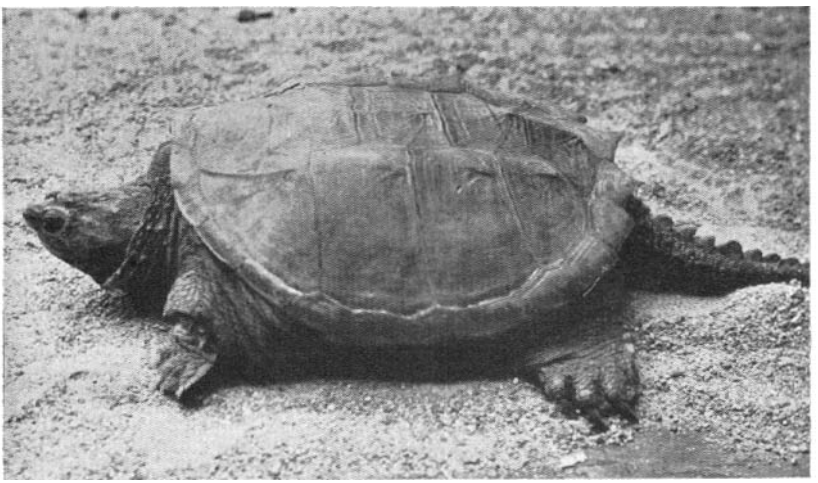


Figure 49. Snapping turtle, *Chelydra serpentina.* (⅓ natural size.)

with a sharp axe. It should be allowed to bleed freely for about half an hour. The most simple way to dress out the dead turtle is to turn it on its back and proceed as follows: Insert a very sharp knife through the skin at its junction with the upper shell and cut completely around the under side of the top shell. It makes little difference where the knife is started, but it should follow the outline of the top shell as closely as possible. The top shell should be separated from the lower shell by running the knife through the tough cartilage which connects the two. This cartilage is immediately below the top shell and can be severed easily. Next the turtle is turned over (the lower shell being down) and the top shell lifted off. The four feet are then cut off at the first joint. The skin from the legs, neck, and tail can be pulled off or may be removed more easily by pouring scalding water over it. The next

step is to remove the turtle meat from its attachments to the lower shell. The most important pieces to save are the legs, the neck, and the tail. There are two tenderloins in the back, however, which are delicious and well worth saving on the larger animals. The pieces may be cut up in much the same manner as chicken or other fowl. Some prefer to leave the bone intact, while others remove it from the meat. Either is satisfactory."

Speaker highly recommends the following recipe for sautéed or fried turtle: "Pour about ½ cup of flour into a No. 6 (medium) paper sack. Add 1½ teaspoons of salt and ⅛ teaspoon pepper. Place a few pieces of turtle at a time in the sack and shake well. When all pieces of turtle have been well floured, proceed to fry as follows: Melt ½ cup of lard or vegetable fat in a medium-sized frying pan. When hot, drop in pieces of turtle and brown rapidly on both sides. Reduce heat, place cover on pan, and add ½ cup of water. Cook slowly until meat is very tender. This will depend somewhat upon the size of the turtle. The procedure is exactly the same as frying chicken. If desired, turtle meat can be placed in an oven after it has been browned instead of completing the process on top of the stove in the frying pan."

Breeding. C. H. Pope (1939) reports several instances of the mating of captive snapping turtles and states that the dates of mating included all the months from April to October and that no season of particular activity was noted. This observation is not surprising, for Hildebrand (1929) has shown that diamond-back terrapin females laid fertile eggs after four years of separation from males. However, the laying of eggs seems largely limited to June.

Various accounts (C. H. Pope, 1939; Ditmars, 1936) indicate that snapping turtles vary considerably in nest-constructing skill. A narrow-necked, retort-shaped nest cavity is built by the most skillful turtles. Here the eggs, 20 to 40 in number, are deposited (C. H. Pope, 1939), and the female carefully covers them with earth. At the author's suggestion, A. Dawes DuBois photographed a snapping turtle while it dug a nest cavity and laid its eggs. (This turtle, found near Lake Minnetonka, had a 10-inch carapace.) The entrance to the cavity was two inches in diameter and the nest chamber was about six inches across and six inches deep, leaving the uppermost of the 24 eggs about three inches below the surface when covered. From the numerous photographs kindly furnished by Mr. DuBois, Figure 47, showing the method of digging the nest and the completed nest, was drawn. The eggs are spherical, usually a little more than an inch in diameter, and have white shells, strongly calcified, but still tough.

Nests are excavated in a great variety of locations from sandy shores to hilltops, and in loose sandy soil without plant cover to tough sod on clay soils. The two main requirements appear to be not too dry a soil and a fairly open site where the sun can provide sufficient heat for successful incubation. Marius Morse reports that the eggs from two snapping turtle nests in Crow Wing County hatched on August 28, 1939. The eggs observed by Mr. DuBois were laid on June 9 and hatched on September 19, an incubation period of 101 days.

The frequency with which tiny young are found in spring and early summer suggests that some may survive the winter, even in Minnesota, either in the egg or in the nest cavity. A newly hatched snapper was found crossing a road near Biwabik in central St. Louis County on September 18, 1943, indicating that at least some young emerge from the egg well ahead of freezing weather, even so far north. Toner (1940) reports from central Ontario the unearthing on May 12, 1940, of a brood of 22 newly hatched snapping turtles from a depth of only six inches in light, sandy soil—presumably from the original nest cavity. As yet few data are available on the wintering of eggs and young in this latitude.

Suggested Reading. Roy L. Abbott, 1941, pp. 46–49. A. R. Cahn, 1937, pp. 34–45. C. H. Pope, 1939, pp. 72–83. Karl F. Lagler, 1943, pp. 265–80.

WOOD TURTLE

Clemmys insculpta (Le Conte)

Description. The wood turtle (Figures 48D, 50) is a medium-sized species, its carapace rarely reaching 9 inches in length. Male 1108, taken at Northfield, Rice County, October 7, 1940, measures as follows:

	INCHES	MM.
Carapace length	8.12	205
Carapace width	5.55	141
Body depth	2.48	62
Plastron length	7.33	185
Plastron width	3.97	100
Tail	3.35	85

Map 39. Range of the wood turtle.

The carapace is fairly high-domed, with a more or less pronounced keel, a rather irregular margin, becoming bluntly saw-toothed posteriorly, and a slight outward flare at the hind legs. The dorsal

plates have concentric grooves and ridges, radiating cross grooves, and a tubercle at the growth center. All these characters are more prominent in younger adults, in which the carapace appears to be beautifully sculptured. The plastron is nearly as long as the carapace, but narrower than in Blanding's turtle, and without a movable hinge. It is flat in females, concave in males. Like the carapace, the plastron has a prominent concentric groove and ridge pattern, especially in the younger turtles, but the pattern is not so pronounced as on the carapace. The head is heavy and angular, the snout pointed as viewed from above and very deep as seen from the side. The upper jaw has a cutting edge, with a small, sharp notch in front, bordered by a

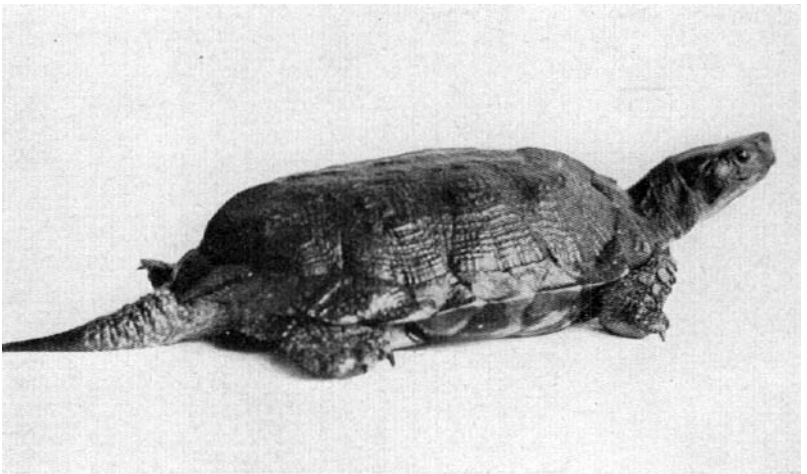


Figure 50. Wood turtle, *Clemmys insculpta.* (¼ natural size.)

fairly heavy, toothlike projection on either side. The lower jaw is sharply pointed and upcurved in front. The crushing surfaces are narrow. The feet are strongly clawed and have small webs. The short tail is longer from vent to base in males than in females.

The color above is blackish, brownish, or greenish, often with inconspicuous yellowish dots or lines radiating out from the growth centers. The plastron is rich yellow, the outer posterior corners black. The under parts of the legs and the skin about the plastron are often bright orange-yellow, less brilliant on the neck. The under marginals are yellow, with black outer posterior corners. The head is black above; below it is yellow with black mottlings. Small, sharp lines run at right angles to the mouth on both the upper and lower jaws.

Range. S & B (1943) give the range of the wood turtle as:

"Eastern North America from Nova Scotia to Virginia, west to Michigan, Wisconsin, and Iowa; southwestern Ontario. Not found in Ohio, Indiana and Illinois." Present records show that it occurs also in eastern Minnesota (Map 39). However, it must be considered rare in Minnesota, since only a few scattered occurrences have been reported. Arnold Erickson found several specimens in the brush-grown, swampy portions of small streams entering the St. Croix River in eastern Pine County (119, 151). One record (872) comes from Chisago County, just to the south of Pine County. These records suggest that the wood turtle is probably rather generally distributed along the St. Croix. A doubtful Hennepin County record (not preserved, possibly a transported specimen), a single specimen from Lake Pepin, Goodhue County (1097), a pair taken at Northfield in Rice County (1108, 1109), and Dr. F. R. Keating's report of it in Olmsted County constitute the remaining records for the state at present.

Habits and habitat. The wood turtle, as its name signifies, is primarily a species of the woods. It is the most terrestrial of the Minnesota turtles. All present Minnesota records come from wooded streams, spring holes, woods ponds, or their immediate vicinity.

C. H. Pope (1939) states: "The wood turtle is both aquatic and terrestrial, the general consensus of opinion being that it spends the midsummer months in dry meadows or woodlands, but frequents the vicinity of ponds, brook or swamp during the autumn and spring, often entering the water. . . . Most of the records are for damp to wet or actually aquatic situations."

Few data seem to have been accumulated regarding the hibernation of this turtle. Bishop and Schoonmacher (1921) describe finding a number of specimens hibernating under water in abandoned muskrat holes in the side of a little stream. Surface (1908), writing from Pennsylvania, states that it has been found wintering in decaying vegetation of comparatively dry woods. Since thousands of snapping turtles successfully survive Minnesota winters in bank burrows and the mud of small stream bottoms, the wood turtle inhabiting the same type of stream will probably be found to hibernate in similar situations.

Surface (1908) states that a friend gave him a young wood turtle about two inches in diameter which he took from the stomach of a large-mouthed black bass. Present-day traffic probably takes toll of this species, since it wanders on land to considerable distances, and the absence of reports of its being killed by traffic in this area is doubtless accounted for by its rarity in Minnesota.

Food. The wood turtle is said to be fairly omnivorous. The findings of Surface (1908) from twenty-six Pennsylvania specimens show about half and half vegetable and animal food taken. Molluscs and insects were prominent in his list of foods; two birds taken were probably carrion; and many terrestrial plants were eaten, a finding that substantiates the general opinion that this turtle is to a considerable extent terrestrial. Lagler (1943) reports essentially the same feeding habits from Michigan. Like most chelonians, the wood turtle makes use of its forefeet together with its jaws in tearing apart its food.

Breeding. C. H. Pope (1939) states that spring mating takes place in New York and New Jersey during May or the latter part of April, and that a pair was found copulating on October 1 in New York.

The female (6¾ inches long) of a pair taken at Northfield in Rice County, on October 7, 1940, was found to contain six eggs approximately three-fourths of an inch in diameter. On the other hand, specimen 511, a female 6¼ inches long, had dormant ovaries. The condition of these two females suggests that this turtle matures when the carapace is between 6 and 7 inches long.

Babcock (1919) reports: "The laying season of the wood tortoise corresponds with that of our other New England turtles (roughly June 10 to June 25). . . . The eggs, as with other species, are deposited in a cavity in the ground prepared by the female, then covered, and left to be hatched by the heat of the sun." C. H. Pope (1939) states that freshly laid eggs seen by Green were elliptical (38 by 26 mm.), and that the parchmentlike shell was white.

This turtle is capable of producing a sound, an uncommon accomplishment among turtles. C. H. Pope (1937) writes that the male wood turtle is known to make a "distinct yet subdued note not unlike that of a teakettle" and audible at thirty or forty feet, and that even the female can give a low whistle. Presumably, he writes, the whistle has sexual significance.

Suggested Reading. Harold L. Babcock, 1919, pp. 403–6. C. H. Pope, 1939, pp. 92–99.

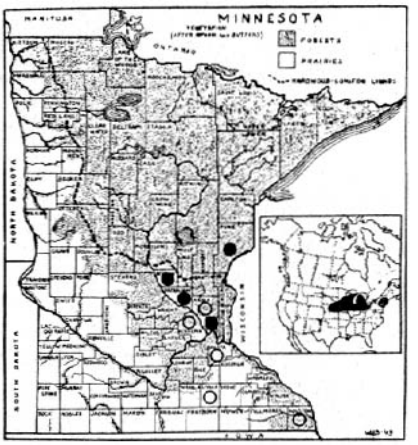
BLANDING'S TURTLE

Emys blandingii (Holbrook)

Description. Blanding's turtle (Figures 48B, 51) is a medium-sized turtle, attaining a maximum carapace length of 10 inches. The measurements of two specimens, an adult male and a young turtle, are given below.

	Adult Male (1058)		*Young (510)*	
	INCHES	MM.	INCHES	MM.
Carapace length	9.87	250	1.23	30
Carapace width	6.52	165	0.99	25
Body depth	3.66	93	0.62	16
Plastron length	8.74	222	1.09	27
Plastron width	4.64	117	0.70	18
Tail	3.37	85	1.17	29

The adult has a high, dome-shaped carapace, comparatively flat on top, the margin essentially smooth in outline. In the small young the carapace is flatter, with a pronounced keel, still evident in four-inch specimens. In the young the plates of the carapace are ridged radially, and have concentric growth ridges showing the annual growth distinctly. In older specimens the intermediate rings become confused with the annual rings, and all completely disappear in old adults. The plastron is nearly as long but not as wide as the carapace, and is hinged on the pectoral and abdominal plates. There are concentric growth rings on the plastron in the young. These rings disappear in old adults. The plastron is concave in males, flat in females. The head is small, with a pointed snout. The cutting edge of the upper mandible forms a sharp, inverted V in front. The feet are strongly clawed, but not broadly webbed. The tail is short in both sexes. The tail of the male is longer in the basal portion, placing the vent a little beyond the edge of the carapace; in the female the vent lies beneath the carapace.



Map 40. Range of Blanding's turtle.

The adults are black above, with a great many small, yellowish dots. The chin, throat, and under part of the mandible are clear yellow. The plastron is yellow, the outer posterior corners of the plates black.

Range. This turtle occurs in two separated areas, one from western Pennsylvania to Nebraska and upper Michigan to northern Indiana, the other in the New England States.

So far the Minnesota records for this species come from the east central and southeastern parts of the state (Map 40). Suitable habitats farther west, along the Iowa line, may harbor Blanding's turtles, since Blanchard (1922) reports the species in Dickinson County, Iowa, just south of Jackson County, Minnesota.

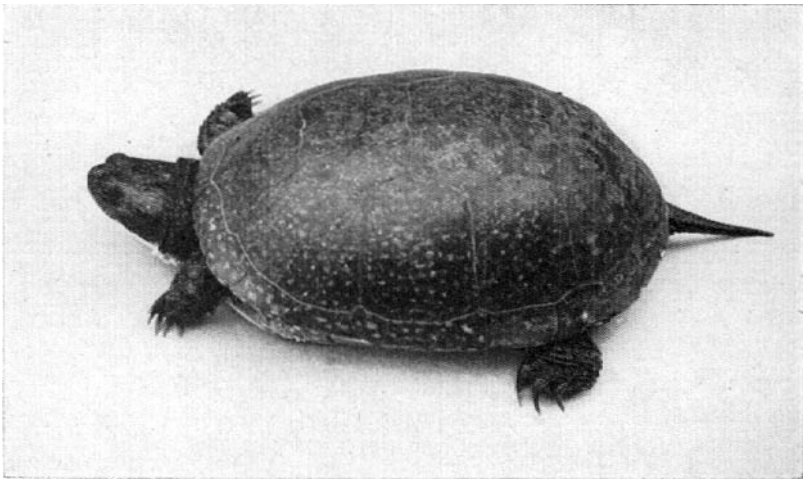


Figure 51. Blanding's turtle, *Emys blandingii.* (¼ natural size.)

Habits and habitat. The shell of Blanding's turtle suggests rather well-developed terrestrial habits, but so far the author has found little evidence of such habits. To be sure, these turtles are occasionally found dead on the highways some distance from water, but usually in early summer, during the egg-laying period. At such times many more of the commoner, more highly aquatic snapping and painted turtles also fall victim to traffic. The appearance of some terrestrial plant foods in the stomachs of these turtles suggests that they must forage on land to some extent. Cahn (1937) states that in certain regions it is largely a terrestrial species, whereas in others it is almost entirely aquatic in its habits. These turtles are most commonly encountered moving slowly about in the shallow waters of small, meandering streams, drainage ditches, or marshy places. Minnesota records come largely from sandy areas, but this habitat preference has not been mentioned by other writers.

Food. Lagler (1940) reports the contents of the stomachs of fifty-one Blanding's turtles as follows:

	PERCENTAGE
Crustaceans	56.6
Aquatic insects	21.4
Carrion	10.3
Fish	5.0
Miscellaneous	2.7
Water plants	3.9

Conant (1939) states: "They were seen eating snails, crayfish, earthworms, and fish, and such items of carrion as dead fish and dead

turtles. In captivity they took all of the above plus lettuce, meat, and chopped fish."

Cahn (1937) writes: "Unlike other species of pond turtles, Blanding's turtle apparently feeds readily both on land and in the water. On land it eats grasses, leaves, berries, and other succulent vegetation with relish, and has no difficulty in swallowing this food in the absence of water. [Highly aquatic turtles must be submerged in order to swallow.] Insect larvae, grubs, slugs, and earthworms vary the vegetable diet on land, the animal matter composing about 30 per cent of the contents of the only 'terrestrial' stomachs available to the writer for study."

Breeding. Dr. John C. Brown of St. Paul reported (correspondence) taking a large female Blanding's turtle (10¼-inch carapace) along the Minnesota River in Dakota County. The following summer (date not recorded) it laid 17 eggs. Four of these (898) are white, elongate in shape, and, after being blown and dried, vary in size from 36 by 24 mm. to 38 by 25 mm.

From southern Ontario, J. R. Brown (1927) describes a Blanding's turtle that dug a bottle-shaped hole in sandy soil and deposited 11 eggs, on July 17; the eggs were covered and left to hatch. Cahn (1937) gives 6 to 10 as the size of the clutch of eggs of this species, though, he states, "the ovaries of a large female will be found to contain hundreds of eggs of various sizes, these, of course, being the supply for future years."

Since seven out of ten records of specimens killed on the highway were found between May 8 and June 20, it seems logical to assume that this interval represents the egg-laying period of this species in Minnesota.

The report by Conant (1939) of a newly hatched Blanding's turtle found on September 3 on an island in Lake Erie seems to be the sole bit of published information regarding the hatching dates of this species.

Suggested Reading. A. R. Cahn, 1937, pp. 75–84. C. H. Pope, 1939, pp. 108–15.

MAP TURTLE

Graptemys geographica (Le Sueur)

Description. The female map turtle (Figure 48E) attains a carapace length of about 10 inches; that of the male rarely exceeds 5 inches. The measurements of an adult female and an adult male are given below.

	Female (1056)		*Male (521)*	
	INCHES	MM.	INCHES	MM.
Carapace length	9.25	234	4.61	116
Carapace width	6.81	172	3.74	95
Body depth	2.99	76	1.56	39
Plastron length	8.12	206	4.25	107
Plastron width	4.42	111	2.25	56
Head width	1.56	39	0.66	17
Tail	2.05	51	1.81	45

Map 41. Range of the map turtle.

The carapace in the young is nearly circular; in adults it becomes more elongate. Each vertebral or median plate of the carapace rises to a prominence at the posterior margin; these prominences are most pronounced on the second and third plates. As viewed from the side, the contour of these plates is a straight or convex line from this prominence, or tubercle, forward. (In the false map turtle the contour is concave.) These prominences form a slight keel on the carapace; this keel is much more pronounced in the young. The posterior carapace margin is saw-toothed in outline. The costal plates are smooth in adults; they have concentric ridges in the young. The plastron is roughly twice as long as wide. It is immovably attached to the carapace by a wide bridge about one-third the length of the plastron. It is nearly flat in both sexes. The plastron is deeply notched posteriorly and square across the front. The lower jaw is heavier and the grinding surfaces wider than in the false map turtle. The mouth line, as viewed from the front, is a wide, inverted U shape. The tail is short, and is longer and heavier basally in males than in females.

The carapace in adults is dingy brownish black or greenish, often without markings. Varying yellowish lines are evident, or even prominent, in the young. The under part of the marginals is variously lined with bands of dark greenish gray and yellow. The plastron in adults is a dingy yellowish, with traces of dark along the sutures. In the young it is variously marked with black along the sutures; the black often expands into spots or blotches, but seldom covers more than half the plastral area.

The head is black or greenish, lined longitudinally with dull yellow. There is an isolated prominent oval yellow spot just behind the eye. (Compare with false map turtle.) The head and neck are more prominently lined beneath than above.

Range. S & B (1943) give the range of the map turtle as: "Mississippi Valley north to Iowa, southern Wisconsin, Illinois, southern Michigan, east to Pennsylvania and New York, Canada north to Ottawa River, shores of Lake Ontario, Vermont, Lake George, and Lake Champlain; eastern Tennessee and southwestern Virginia, west to eastern Kansas, southwestern Missouri, eastern Oklahoma, and eastern Texas." Minnesota records (Map 41) show this turtle occurring in the Mississippi River to the center of the state.

Keating (1825, II) reports this species (*Testudo geographica*) from both Lake of the Woods and Rainy Lake. However, this identification is probably erroneous, for he does not report the painted turtle, *Chrysemys bellii,* which is known to occur in these waters, and it is probable that the turtles he observed were of the latter species.

Habits and habitat. In Minnesota the map turtle, like the spiny soft-shelled turtle, seems to prefer the larger rivers. However, the soft-shell inhabits the more open waters, with sandy or even rocky bottoms, and the map turtle is found only in the quiet backwaters, in old oxbow ponds or sloughs connected with the rivers at high water, where there is considerable aquatic vegetation.

These turtles are particularly abundant on the downstream side of a long, wooded sand point jutting out into Lake Pepin in Goodhue County. Many map turtles occur in the Mississippi River near Monticello in Wright County, where the river flows slowly in a meandering course, with numerous oxbow ponds.

The map turtle is very shy. Often rows of them are found basking on floating planks and logs. If they are approached without extreme caution several heads will go up for a few seconds, and then the whole group will tumble *en masse* into the water. The alarm spreads with great rapidity, and in a moment all the turtles in sight may be gone.

Hibernation. From northern Indiana, Evermann and Clark (1916) state that the map turtle does not hibernate, but many, if not all, keep walking about on the bottom of the lake, where they can be seen through the ice whenever it is clear. Cahn (1937) states that these turtles are among the earliest to make their appearance in the spring. Newman (1906) corroborates this statement. Both Cahn and Newman agree with Evermann and Clark that map turtles are among the very last to go into hibernation.

Economic value. This species is little used for food. C. H. Pope (1939) states that it is of distinctly second-rate value as a source of food, but nevertheless sometimes finds its way to market. He writes: "Eight among thirteen reports on its status say that it is used as food, three deny this, and two report limited use. The flesh is palatable." Clark and Southall (1920), in a survey of the turtle industry along the Illinois River, state that the map turtle is probably as good a food turtle as the others, but that they saw none on the market.

Food. Three specimens of Minnesota map turtles contained the following foods: one (1060), 100 per cent remains of snails and small clams; one (1059), 75 per cent snails and clams, 10 per cent aquatic insects and larvae, 10 per cent crayfish, and 5 per cent small crustaceans, plus a few leaves probably taken accidentally; and one (1056), 85 per cent aquatic vegetable matter and 15 per cent crayfish.

The broad, flat surfaces of the jaws of this turtle are adapted to crushing the shells of snails and small clams. C. H. Pope (1939) observed that while the turtle is feeding the claws are used to get rid of the larger fragments of the shells.

Lagler (1940) states: "Map turtles (*Graptemys geographica*) from wild waters had eaten crayfish, snails, and clams. Also included in their food were a few small fishes and some carrion, insects, and now and then a little aquatic vegetation."

Breeding. Two large female map turtles were taken at Frontenac in Goodhue County on June 8, 1940. One contained 10 eggs in the oviduct, with the leathery shells already formed; apparently the eggs were about to be laid. The other female (with a 10-inch carapace) contained 18 eggs, an unusually large number. These two sets of eggs varied from 32 to 39 mm. in length and 21 to 24 mm. in diameter. Cahn (1937) gives 10 to 16 as the number of eggs for this species, with 12 to 14 by far the commonest number; the average size, he states, is 32 by 21 mm.

Another female, with a $6\frac{7}{16}$-inch carapace, taken on July 6, 1940, showed completely undeveloped ovaries, indicating that sexual maturity must come when the carapace is of larger size. This record agrees with the observation of Newman (1906), who writes: "On no occasion have I caught a female nesting whose carapace length was less than nineteen centimeters [approximately $7\frac{1}{2}$ inches] and whose age was less than fourteen years—according to the age record afforded by the annual growth rings on the scutes." He states further that the map turtle begins to lay very early in June, somewhat earlier than other species observed, and that the eggs hatch, as a rule, late in August or early in September. One Minnesota specimen (851) had

a carapace length of only 28 mm. when taken on May 21, 1938, indicating either hibernation immediately after hatching in the fall or successful wintering in the egg.

Suggested Reading. B. W. Evermann and H. W. Clark, 1917, pp. 485–88. C. H. Pope, 1939, pp. 168–75. A. R. Cahn, 1937, pp. 105–13.

FALSE MAP TURTLE

Graptemys pseudogeographica (Gray)

Races. Three subspecies of this turtle are recognized (S & B, 1943). By far the most widespread is *G. p. pseudogeographica*, which is the form occurring in Minnesota.

Description. The false map turtle is similar to the map turtle, from which it differs mainly in the development of the carapace keel and in head markings. The measurements of a female (1089) are given below.

	INCHES	MM.
Carapace length	8.51	217
Carapace width	6.49	165
Body depth	3.38	86
Plastron length	7.95	202
Plastron width	3.50	97
Head width	1.22	31
Tail length	2.28	58

Map 42. Range of the false map turtle.

The carapace is very similar to that of the map turtle. The tubercles on the posterior margin of the vertebral plates are more pronounced in this species than in the map turtle. The profile of the keel on these plates has a concave outline anterior to the tubercle, at least on the second or third plates. The young, like the young of the map turtle, show pronounced concentric grooves and ridges on the plates of the carapace; in adults they become comparatively smooth. The plastron is very similar to that of the map turtle. The head is narrower and lighter structurally than that of the map turtle, especially in males. The grinding surfaces of the mandibles are much narrower in this species. The mouth line as viewed from the front is a wide inverted U shape, similar to that of the map turtle.

The coloration of the two species of map turtles is similar, but there are several distinguishing marks. The false map turtle has a boomerang-shaped mark behind the eye, with the points directed backward, the

upper end usually connecting with the pattern of lines on the neck. (This mark is oval in the map turtle.) There is usually a rounded spot on the front lower surface of the lower mandible, replacing the narrow line in the map turtle. The black marking on the plastron is more extensive in the young false map turtle than in the young map turtle.

Range. S & B (1943) give the range of the false map turtle, including its three subspecies, as the Mississippi Valley east to Pensacola, Florida, and Ohio, north to Wisconsin and northern Iowa, west to eastern Kansas and Texas. Minnesota records for this species all come from two counties, Goodhue (1053) and Washington (790) (Map 42), indicating that beyond reasonable doubt the species occurs also in the Mississippi south to the Iowa line. Pope and Dickinson (1928) report specimens in the University of Wisconsin collections from Trempealeau County, just below Winona, Minnesota.

Habits and habitat. Cahn (1937), writing from the center of abundance of this turtle in Illinois, states: "This abundant turtle within the state is distinctly of aquatic habits; indeed, so strictly does it remain in the water, that it is usually referred to in the literature as 'eminently aquatic.' It is found in lakes, ponds, sloughs, and larger rivers, and is about equally abundant in all of these types of habitats. It is more common in waters abundant in bottom vegetation among which the turtles delight in wandering, and distinctly less common in the clearer waters."

It apparently possesses the same wary disposition as the map turtle, and in general its habits, except its feeding habits, seem to be very similar.

Economic importance. Cahn (1937) rates the snapper and the softshell as the turtles most used for food, with the false map turtle third in importance.

Clark and Southall (1920) state that on the Illinois River the false map turtle was used as a substitute or partial substitute for the diamond-back terrapin, and that queens (females) were quoted at one dollar each.

Food. A comparison of the jaw structure and feeding habits of the two map turtles is interesting. The map turtle has very heavy jaws, with wide grinding or crushing surfaces, and feeds largely on molluscs. The false map turtle has much lighter jaws, with narrower crushing surfaces, and is primarily a vegetarian, at least in the adult stage. Garman (1890), who seems to have been the first to point out this fact, states that the digestive tubes of most of the adult false map turtles

examined contained only sedge bulbs, though in some cases this species was found to have eaten crayfish.

Cahn (1937) substantiates these findings. He states that unlike many other turtles, the false map turtle is almost exclusively a vegetarian when adult; that the young turtles are both carnivorous and herbivorous in habits; but that their carnivorous tendencies diminish and soon disappear when they reach a carapace length of 120 to 130 mm. (about 5 inches).

Breeding. A Minnesota specimen (1089), taken October 4, 1940, contained 9 eggs half an inch in diameter in the ovary, probably the clutch to be laid the following spring. Another (1088), taken on the same date, contained 30 eggs, varying from half an inch to seven-eighths of an inch in diameter, probably representing two clutches, to be laid in the two following years. Cahn (1937) states that the number of eggs laid varies from 7 to 13, with 9 or 10 the most common number, and that the eggs are white, elliptical, and covered with a soft, leathery shell of fine texture. He found 71 eggs of 7 sets to average 32.7 by 22.5 mm. The false map turtle, he states, begins nesting in July, and its nesting habits are essentially the same as those of other species.

Suggested Reading. A. R. Cahn, 1937, pp. 113–22.

PAINTED TURTLE

Chrysemys bellii (Gray)

Races. S & B (1943) recognize two races of the painted turtle, of which one, *C. b. bellii*, occurs in Minnesota. (*C. b. marginata* is reported from southern Wisconsin.) Some recent writers (Bishop and Schmidt, 1931; C. H. Pope, 1939) place this turtle as a subspecies of the eastern *C. picta.*

Map 43. Range of the painted turtle.

Description. The painted turtle (Figure 48B), commonly called a mud turtle, is the small turtle with bright yellow and red markings underneath, found throughout Minnesota. The carapace length of sixteen adult female painted turtles measured 115 to 172 mm., and

averaged 146.4 mm.; in twenty males it measured 100 to 150 mm., and averaged 132.9. The measurements of an adult female and a hatchling are given below.

	Adult Female (20)		*Hatchling (852)*	
	INCHES	MM.	INCHES	MM.
Carapace length	6.25	158	0.94	24.0
Carapace width	4.61	116	0.84	21.5
Body depth	2.37	59	0.25	6.5
Plastron length	5.71	145	0.91	23.0
Plastron width	3.04	77	0.56	14.0
Tail length	2.99	50	0.66	17.0

The carapace is smooth, low-domed, and essentially smooth in outline, except for a small notch on either side of the nuchal and one between the posterior marginals. There is no keel. The head is rather small; the eyes are large. The cutting edge of the upper mandible has a small, sharp notch in front, bordered on either side by a small tooth. The plastron is large. It is heavily bridged to the carapace on the pectoral and abdominal plates, and straight or only slightly notched posteriorly. The feet and legs are strongly clawed and fully webbed. In adult males the claws on the forefeet are always longer than those on the hind feet; in females, they are equal or shorter. The tail is short. The anus is beyond the margin of the carapace in males; under the edge of the carapace in females.

Above, the painted turtle is black, greenish, or brownish, often with narrow light margins or a few narrow yellow lines on the plates. The marginals underneath are black with yellow or red markings, with a light bar across the center. This bar is often expanded, leaving a yellow centered black spot on the suture between each pair of plates. The black areas are variously lined with yellow or red. The plastron is yellow or reddish, with an extensive black patch in the center mottled with yellow, running outward along the sutures. In large specimens this patch sometimes disappears. The bridge is mottled black and yellow or red. The head and neck are black, lined with yellow or greenish. The tail, feet, and legs are black with yellow stripes.

In newly hatched young the carapace is nearly round, with a distinct medial keel, the carapace surface nearly flat from keel to margin. The head is proportionately broader and heavier than in adults, and the tail is much longer in proportion to the length of the carapace.

Range. The painted turtle, including its two subspecies, has a very wide range, its boundaries extending from the Allegheny Mountains

west through southern Ontario, Michigan, and Wisconsin westward to British Columbia and south, east of the Cascades, to New Mexico, Texas, and Tennessee (S & B, 1943). C. *p. bellii* occupies the western part of this range from Upper Michigan, central Wisconsin, and Missouri westward. It is probable that the species occurs throughout Minnesota (Map 43), though it is not common in the deep, rocky lakes in the extreme north and northeast.

Habits and habitat. The ponds and lakes where aquatic vegetation is abundant seem to afford optimum conditions for this turtle, and in such places it becomes extremely abundant. Its habit of basking in the sun on floating logs, debris, muskrat houses, or any suitable situation projecting just above the water level makes its presence easily detected. Although it is not easy to approach the painted turtle closely, it is perhaps the least wary of all Minnesota turtles.

Especially during the nesting season in June and early July, these turtles are found wandering about on land, often at some distance from water. At this time many are killed as they cross the highways. Later, in the summer and fall, they wander again, though to a lesser extent, and a few are killed by traffic. The number killed on the highways, together with the frequency with which they are seen basking, indicates that this turtle is by far the most abundant of those found in Minnesota.

Pearse (1923) made an extensive study of the growth rate of the painted turtles of Lake Mendota, at Madison, Wisconsin. His conclusions are that a turtle nearly doubles its length and weight during the second year of its life; that after twelve years it would be about 125 mm. (4.9 inches) long and the growth rate would have decreased to about one-thirtieth of that during the first two years. He states that an ordinary adult turtle measuring 150 mm. (5.9 inches) is about twenty-five years old.

Food. Surface (1908) concludes from a study of 86 Pennsylvania specimens that the species is "omnivorous, and almost equally herbivorous and carnivorous." Lagler (1943) reports that the food of 394 Michigan specimens consisted of about two-thirds water plants and one-third animal food, largely insects and crustaceans. Less than 2 per cent of fish appeared in the diet.

Scavenging is common with this genus of turtles, as noted by Newman (1906): "*Chrysemys* is not restricted in its diet, but makes use of any sort of animal food that comes its way. I have observed individuals feeding on dead fish, dead clams, decaying tortoises, worms, meat, and aquatic insects. They even capture the soft and defenseless young of [the soft-shelled turtles]."

Breeding. The nesting season of the painted turtle, like that of most other turtles, is in June and early July. The females often wander considerable distances from water in locating suitable nesting sites. The hind legs are used alternately in digging the bottle-necked nest that receives the eggs. The eggs are white and elliptical, and have tough, leathery shells. Cahn (1937) states that the number of eggs laid varies from 4 to 10, with 6 or 7 the normal number. A set of 8 eggs from Hennepin County measured from 30.5 to 33.5 mm. by 18 to 20 mm.

Mrs. R. F. Skarnes reported that a painted turtle observed at Lake Minnetonka was laying eggs during the first week in June 1938. Two of the eggs were found hatching on October 23, giving an incubation period of 140 days. Again on July 4, 1943, Mrs. Skarnes noted a painted turtle laying eggs in a driveway. When the nest was opened on October 10, each of the 8 eggs had been neatly cut in half by the egg tooth of the young, and the young turtles began squirming about the moment they were disturbed. The incubation period in this instance was 98 days. This observation is similar to one made by I. A. Laudenslager in Isanti County. As late as July 7, in 1940, Mr. Laudenslager found a nest of the painted turtle nearing completion. On opening the nest October 8 he found two newly hatched turtles. Thus the incubation period in this instance was 92 days.

Evidently not all late nests are successful, for E. G. Perine marked a nest of this turtle at Lake Minnetonka, completed on July 7, 1942, and unearthing the eggs on May 9, 1943, found nearly full-grown embryos dead in the shell. Newman (1906), in northern Indiana, states that, "like *Graptemys*, the broods are sometimes belated in hatching, so that forced hibernation of embryos results." Nichols (1933) reports a set of eggs laid June 25, 1928, on Long Island, New York. When the nest was investigated on October 28, all the eggs were found to have hatched, and the young were in a mass among the shells. Owing to the lateness of the season Nichols believed there was little likelihood that the turtles would emerge from the nest cavity that fall.

These reports come from milder climates than that of Minnesota. However, three Minnesota specimens, taken on May 21, 25, and 27, were less than 26 mm. (1 inch) in length, and had prominent navel scars, suggesting either that newly hatched young winter successfully or that unhatched eggs can withstand the extreme winter conditions in Minnesota.

Suggested Reading. Sherman C. Bishop and F. J. W. Schmidt, 1931, pp. 123–39. A. R. Cahn, 1937, pp. 122–29, 138–45.

BROWN SOFT-SHELLED TURTLE

Amyda mutica (Le Sueur)

Description. The brown soft-shelled turtle closely resembles the spiny soft-shell, from which it differs mainly as follows: the nostrils lack the lateral projection from the septum separating them, and the carapace lacks the series of spines rising from the anterior edge, both present in the spiny soft-shell; several writers (Surface, 1908; Hay, 1892) mention a depression along the median line of the carapace as present in this species and absent in the spiny soft-shell.

Map 44. Range of the brown soft-shelled turtle.

Range. S & B (1943) give the range of this turtle as: "Mississippi River and tributaries; north to South Dakota and Minnesota; east to western Pennsylvania; west to Kansas, Oklahoma and Texas. Recorded from northern localities on the Trinity, Brazos and Colorado Rivers."

At present this turtle is included in the Minnesota list on the strength of one newly hatched specimen (482) found in Brownsville, Houston County, August 21, 1900 (Map 44). There is a specimen in the University of Wisconsin collection from the Mississippi River in Pepin County, Wisconsin, opposite Goodhue and Wabasha counties in Minnesota (Dr. George Wagner, correspondence). The paucity of data indicates that, beyond a doubt, the species is rare in Minnesota.

Habits and habitat. Apparently the habits of this species, including its habitat choice, feeding, and breeding, closely parallel those of the spiny soft-shelled turtle.

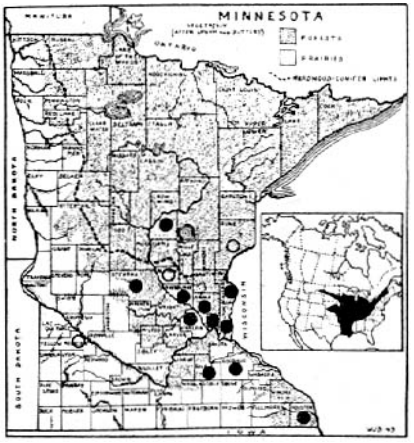
Suggested Reading. A. R. Cahn, 1937, pp. 176–84.

SPINY SOFT-SHELLED TURTLE

Amyda spinifera (Le Sueur)

Races. S & B (1943) recognize two subspecies of this turtle, of which one, *A. s. spinifera*, occurs in Minnesota.

Description. The spiny soft-shelled turtle (Figures 48A, 52) is a large, very flat turtle, having a tough, leathery covering instead



Map 45. Range of the spiny soft-shelled turtle.

of the bony plates found in other turtles. A spiny soft-shelled turtle from Lake Pepin (June 6, 1940, not preserved) had a 15-inch carapace.

An adult female (856), taken in Chisago County in August 1938, measures:

	INCHES	MM.
Carapace length	12.98	330
Carapace width	10.74	273
Body depth	2.81	70
Tail, anus to tip	0.86	22

The carapace is very flat, leathery, and broadly ovate in outline, and has a very thin edge. There is a row of small conical spines on the anterior edge of the carapace. (This row of spines is lacking in *A. mutica.*) The rest of the carapace is somewhat granular in texture. The plastron is fairly complete; it extends anteriorly to the margin of the carapace, but posteriorly only about two-thirds the carapace length, leaving the tail and hind legs exposed. The head is narrow, the snout elongate and pointed, ending in a tubular form. There is a shelflike lamella inside each nostril, projecting outward from the septum between the nostrils. (This lamella is lacking in *A. mutica.*) Both lips appear as fleshy rolls turned back in folds, but interrupted in front, exposing the sharp, hard, cutting beak. The legs are strong, the feet widely webbed. The tail is very short. It reaches the posterior edge of the carapace in females, but projects well beyond in males. The vent is very near the tail tip in both sexes.

The form of this turtle is constant from the newly hatched young to the adult, but the color changes considerably. The tiny young are usually a clear olive gray or greenish above, with a dark submarginal line touching the margin anteriorly, but well in from the margin posteriorly. There are a number of small circular dots or rings scattered over the carapace inside this line. The head is greenish, with a dark line from the snout to the eye, breaking behind the eye into two dark lines with a yellowish border. The neck has dark lines. Underneath, the turtle is plain ivory, yellowish, or pinkish, with or without darker mottlings.

In female specimens 6 to 7 inches long, the dorsal pattern of the young becomes a beautiful marbled pattern of several shades of dark

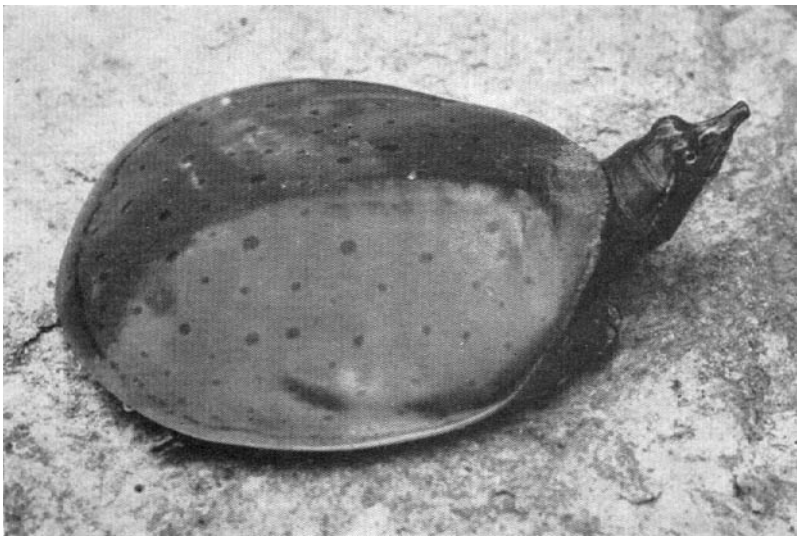


Figure 52. Spiny soft-shelled turtle, *Amyda spinifera.* (½ natural size.)

olive, brown, greenish, or gray, but with the submarginal line still present. In the larger ones this pattern becomes less distinct, and the carapace is often brown in tone, with irregular blotches of dark or lighter shades. The plain carapace, with the round dots or circle markings, is retained by the adult male. Conant (1938) states that he has seen no adult males in which the circular spots were not present.

Range. S & B (1943) give the range of the spiny soft-shelled turtle as: "Mississippi River and tributaries, west to Colorado, north to Montana; St. Lawrence River and tributaries; east to Vermont, western New York, and Pennsylvania."

The rather sparse scattering of records for Minnesota (Map 45) indicates that this turtle occurs up the Mississippi River at least into Crow Wing County. The St. Croix River harbors the species as far up as eastern Pine County. The Minnesota River probably has this turtle well up toward its source in Big Stone Lake, though at present a sight record by R. M. Berthel, from Yellow Medicine County, is the only evidence.

Keating (1825, II) reports from Lake of the Woods a soft-shelled turtle "of which the species could not be determined, the lower shell alone being visible." Apparently on the basis of this record, Holbrook (1842, II) includes these waters in the range of this species, but in the light of present records it seems best to regard this identification as mistaken.

Habits and habitat. The spiny soft-shelled turtle seems to prefer the larger streams and lakes, where it is most abundant in the more open waters bordered by sandy beaches. Its swimming ability, which is far greater than that of any other turtle, enables it to cope better than most species with moving waters. It is highly aquatic, but is often seen basking in the sun on sandy beaches or rocks.

These turtles have been seen poking about in rocky places, apparently searching for the crayfishes that dart out from the protection of the boulders. Newman (1906) describes the large-mouthed black bass as accompanying the soft-shells, and feeding either on the materials stirred up by them or on the minnows that followed the turtles. Spiny soft-shells sometimes settle on the bottom with a flipping movement, allowing the sediments or sand to settle over their backs, completely concealing them except for the head, and in this position they lie in wait for any crayfish or aquatic insect that may pass. When it does, out darts the long, snakelike neck, and the prey is quickly snapped up in the powerful jaws, in a positive and astonishing manner. Such feeding is usually done in shallow water, where the turtle is able to stretch up its head from time to time for a breath of air. However, Gage (1886) has shown that the soft-shell is equipped for true aquatic breathing, and can remain submerged for as many as ten hours at a time without inconvenience.

Hibernation. Evermann and Clark (1916) state that the soft-shelled turtle is the last turtle to make its appearance in the spring and the first to disappear in the fall. Their last record in the fall in northern Indiana was September 7, and the first adults were seen in the spring on April 29. "As none were seen moving under the ice," they remark, "it is thought that they spend the winter in a quiescent state."

Economic importance. There is almost no demand for this species in the market, owing to ignorance of its food value. Several writers (Cahn, 1937; Evermann and Clark, 1916; Clark and Southall, 1920) comment on the high regard of turtle fishermen for the fine quality of the meat of this turtle. Since it does not stand shipment well, fishermen have a twofold reason for keeping this turtle for themselves and filling their orders in distant markets with the snapper, which stands shipment more successfully.

Food. Eighteen Minnesota specimens of the spiny soft-shelled turtle contained 44 per cent crayfish, 29 per cent aquatic insects, 8 per cent fish, 19 per cent unidentified matter. Lagler (1940) corroborates these findings: "That very adept swimmer, the soft-shelled turtle (*Amyda s. spinifera*), long thought to prey extensively on fish, was found to feed mostly on crayfish and burrowing mayfly larvae and other in-

sects." Surface (1908) found one specimen full of kernels of field corn, to the amount of about two average ears.

Breeding. Sandy beaches are the preferred, if not the exclusive, site for the nests of this turtle. The female is very wary when digging the nest cavity and depositing her eggs. In this respect the species appears to differ markedly from most other turtles. The technique, however, is much the same. The eggs are very nearly round, and about an inch in diameter (22.0 to 28.5 mm.), and resemble ping-pong balls. The white shells are tough, but contain considerable calcareous material. Two Minnesota females contained respectively 26 and 12 eggs. Nests of 24 and 30 eggs have been found. One held 56 eggs, but they were of two slightly differing sizes, and probably were from two females.

Regarding the egg-laying period, Earl Partridge, living on the shore of Lake Minnetonka, reported (correspondence) seeing the first soft-shell laying eggs on the beach on June 14 and the last one on July 6. Examination of several females taken during this period confirms these dates as marking the beginning and end of the nesting period of this turtle.

Numerous reports indicate that the young hatch in September. Robert Coppess, a federal game warden, took several eggs with easily recognizable young in Crow Wing County on August 30, 1939. Albert Van S. Pulling reported (correspondence) that several eggs from a nest found on September 11, at Winona, hatched about September 15. An egg from a nest found by the author on July 4, at Minneapolis, contained a well-formed young turtle on September 8, 66 days after the discovery of the nest.

Suggested Reading. Roger Conant, 1938, pp. 157–61. H. L. Babcock, 1919, pp. 419–25.

Glossary

Adhesive pads or *discs.* Expanded tips of the toes and fingers in amphibians, especially those of tree frogs.

Aestivate. To assume a dormant state during the summer.

Allantois. One of the fetal membranes in higher animals, concerned with the nourishment of the embryo.

Amnion. One of the fetal membranes in higher animals, enclosing the embryo.

Anal plate or *scale.* The transverse plate covering the anal opening. It may be entire or divided in two by a diagonal suture. (See Figure 19.)

Carapace. The upper shell of a turtle. (See Figure 46 for names of plates.)

Costal grooves. Vertical grooves on the sides of salamanders, corresponding with the position of the ribs.

Cranial crests or *ridges.* Hard, bony ridges extending backward between the eyes in toads.

Cutting tubercles. Hard, sharp-edged projections, usually dark in color, on the soles of the feet in toads.

Dorsal. Pertaining to the back.

Dorsolateral folds. See *lateral folds.*

Eft. The reddish, terrestrial, subadult form of the newt.

Femoral pores. A row of tiny pits on the scales under the thighs of certain lizards.

Frontal plate. The single large plate lying between the supraoculars in snakes and lizards. (See Figure 19.)

Gular fold. A fold in the skin across the throat.

Hibernate. To assume a dormant state in winter.

Interorbital ridges. See *cranial crests.*

Keeled. Having a ridge on the surface. (See Figure 19.)

Labial scales. Scales bordering the mouth, above (upper labials) and below (lower labials). (See Figure 19.)

Larva (pl., *larvae*). In certain animals, the earliest immature stage, usually differing markedly from the adult form.

Lateral folds. Heavy ridges of skin in frogs, extending from the head backward along the sides of the back. (See Figure 12.)

Loreal scale. The scale lying between the preocular and nasal scales. (See Figure 19.)

Metamorphosis. The change from one form to another; in amphibians, referring to the change from aquatic, gill-bearing larvae to air-breathing land forms.

Nasal plates. The plates bordering the nostril. (See Figure 19.)

Nuchal. The plate or scale on the midline at the front of the carapace of a turtle. (See Figure 46.)

Occipital condyle. A knoblike projection on the skull, making contact with the first vertebra of the neck.

Oculars. Scales bordering the eye. (See Figure 19.)

Opercular membrane. The thin skin covering the internal gills in tadpoles.

Oviparous. Laying eggs.

Ovoviviparous. Retaining eggs within the body until they hatch.

Palmar tubercles. Wartlike projections on the palms of the forefeet.

Parietal plates. The two large plates immediately behind the frontal and supraocular plates in snakes. (See Figure 19.)

Parotoid glands. Prominent, oval, swollen areas with pitted surfaces, on either side of the neck in toads.

Plantar tubercles. Small, wartlike projections on the soles of the feet.
Plastron. The lower shell of a turtle. (See Figure 46 for names of plates.)
Postoculars. Scales contacting the eyes behind.
Preoculars. Scales contacting the eyes in front.
Red eft. See *eft.*
Rostral plate or *scale.* Plate or scale forming the tip of the snout. (See Figure 19.)
Scale rows. The number of rows of scales, counted diagonally, covering the back from the ventrals on one side to the ventrals on the other side. (See Figure 19.)
Spermatophore. A gelatinous mass, produced by male salamanders, having a small head containing sperm cells.
Spiracle. The opening in the left side of the opercular membrane of tadpoles, through which water passes from the gill chamber.
Subcaudals. The transverse scales or plates on the under side of the tail in snakes and lizards. (See Figure 19.)
Supraocular. Scale contacting the eye above. (See Figure 19.)
Tympanum. The large, round, external ear drum just back of the eye in frogs and toads. (See Figure 12.)
Ventral. Pertaining to the lower surface.
Ventrals. The transverse scales or plates on the bellies of snakes and lizards. (See Figure 19.)

Bibliography

ABBOTT, ROY L. 1941. The Biology of Chelydra. Nat. History, Vol. 47, No. 1, pp. 46–49.

BABCOCK, HAROLD L. 1919. Turtles of New England. Boston Soc. Nat. History Mem., Vol. 8, pp. 325–431.

BAILEY, REEVE M. 1939. *Carphophis amoena vermis* and *Lampropeltis calligaster* in Iowa. Copeia, No. 4, pp. 218–20.

BAILEY, REEVE M., AND BAILEY, MARIAN K. 1941. The Distribution of Iowa Toads. Iowa State Coll. Jour. Sci., Vol. 15, pp. 169–77.

BALL, E. D. 1916. Iowa Acad. Sci. Proc., Vol. 22, pp. 343–44.

BELTRAMI, J. C. 1828. Discovery of the Sources of the Mississippi and Bloody Rivers. London: Hunt and Clarke. Vol. 2, pp. 1–545.

BISHOP, SHERMAN C. 1926. Notes on the Habits and Development of the Mud Puppy, *Necturus maculosus* (Raf.). New York State Mus. Bull., No. 268, pp. 5–38, pls. 1–11.

1941. The Salamanders of New York. New York State Mus. Bull., No. 324, pp. 1–365, figs. 1–66.

1941a. Notes on Salamanders with Descriptions of Several New Forms. Michigan Univ., Mus. Zoology, Occ. Papers, No. 451, pp. 1–21, pls. 1–2.

1943. Handbook of Salamanders. Ithaca, N. Y.: Comstock Publishing Co., pp. i–xiv, 1–555, 1 color pl., figs. 1–144.

BISHOP, SHERMAN C., AND SCHMIDT, F. J. W. 1931. The Painted Turtles of the Genus Chrysemys. Field Mus. Nat. History Pub., Zool. ser., Vol. 18, pp. 123–39.

BISHOP, SHERMAN C., AND SCHOONMACHER, W. J. 1921. Turtle Hunting in Mid-winter. Copeia, No. 96, pp. 37–38.

BLANCHARD, FRANK N. 1921. A Revision of the King Snakes: Genus Lampropeltis. U. S. Nat. Mus. Bull., No. 114, pp. i–vi, 1–260, figs. 1–78.

1922. The Amphibians and Reptiles of Dickinson County, Iowa. Iowa Univ. Studies in Nat. History, Vol. 10, pp. 19–26.

1928. Topics from the Life History and Habits of the Red-backed Salamander in Southern Michigan. Am. Naturalist, Vol. 62, pp. 156–64, figs. 1–4.

1933. Eggs and Young of the Smooth Green Snake, *Liopeltis vernalis* (Harlan). Michigan Acad. Sci. Papers, Vol. 17, pp. 493–508, pls. 51–56, figs. 51–57.

1937. Data on the Natural History of the Red-bellied Snake, *Storeria occipito-maculata* (Storer), in Northern Michigan. Copeia, No. 3, pp. 151–62.

1942. The Ring-neck Snakes, Genus *Diadophis*. Chicago Acad. Sci. Bull., Vol. 7, No. 1, pp. 1–144, figs. 1–26.

BLANCHARD, FRANK N., AND FINSTER, ETHEL B. 1933. A Method of Marking Living Snakes for Further Recognition. Ecology, Vol. 14, pp. 334–47.

BRAGG, ARTHUR N. 1936. Notes on the Breeding Habits, Eggs, and Embryos of *Bufo cognatus* with a Description of the Tadpole. Copeia, No. 1, pp. 14–20.

1937. Observation on *Bufo cognatus* with Special Reference to the Breeding Habits and Eggs. Am. Midland Naturalist, Vol. 18, pp. 273–84.

1937a. A Note on the Metamorphosis of the Tadpoles of *Bufo cognatus*. Copeia, No. 4, pp. 227–28.

BRECKENRIDGE, W. J. 1937. A Correction in the Range of *Potamophis striatulus*. Copeia, No. 4, p. 231.

1938. Additions to the Herpetology of Minnesota. Copeia, No. 1, p. 47.

1938a. Minnesota Lizards. Minneapolis Public Lib. Mus. Nature Notes, Vol. 1, No. 19, pp. 10–12.

1940. Reptiles and Amphibians of Minnesota. Minneapolis Public Lib. Mus. Nature Notes, Vol. 3, No. 2, pp. 411–18.
1940a. Reptiles and Amphibians of Minnesota. Minnesota Wildlife Conservation, 1st Short Course Proc., pp. 36–40.
1941. Minnesota Turtles. Conservation Volunteer, Vol. 2, No. 7, pp. 11–16.
1941a. Minnesota Rattlesnakes. Conservation Volunteer, Vol. 1, No. 6, pp. 10–12.
1941b. Snake Myths versus Facts. Conservation Volunteer, Vol. 3, No. 13, pp. 11–14.
1942. Ring-necked Snakes in Minnesota. Copeia, No. 2, p. 128.
1942a. A Large Hog-nosed Snake from Minnesota. Copeia, No. 2, p. 128.
1942b. Minnesota's Non-poisonous Snakes. Conservation Volunteer, Vol. 4, No. 21, pp. 10–15.
1942c. Amphibians and Reptiles of Minnesota. Minnesota Acad. Sci. Proc., Vol. 9, pp. 67–68.
1942d. Frogs and Toads of Minnesota. Conservation Volunteer, Vol. 5, No. 27, pp. 32–36.
1943. Do You Recognize Minnesota's Lizards? Conservation Volunteer, Vol. 6, No. 33, pp. 21–24.
1943a. The Life History of the Black-banded Skink, Eumeces septentrionalis septentrionalis (Baird). Am. Midland Naturalist, Vol. 29, No. 3, pp. 591–606, figs. 1–7, tbl. 1.
1943b. Those Puzzling Salamanders. Conservation Volunteer, Vol. 6, No. 31, pp. 9–12.
1944. The Pilot Black Snake in Minnesota. Copeia, No. 1, p. 64.

Brous, Henry. 1882. Observations on Garter Snakes. Am. Naturalist, Vol. 16, p. 564.

Brown, J. Roland. 1927. A Blanding's Turtle Lays Its Eggs. Canadian Field Naturalist, Vol. 41, p. 185.

Burt, Charles E. 1931. A Study of the Teeid Lizards of the Genus Cnemidophorus. U. S. Nat. Mus. Bull., No. 154, pp. 1–280.

Cagle, Fred R. 1940. Eggs and Natural Nests of Eumeces fasciatus. Am. Midland Naturalist, Vol. 23, pp. 227–33.
1942. Herpetological Fauna of Jackson and Union Counties, Illinois. Am. Midland Naturalist, Vol. 28, No. 1, pp. 164–200.

Cahn, Alvin R. 1937. The Turtles of Illinois. Illinois Biol. Monographs, Vol. 16, pp. 1–218, pls. 1–31, figs. 1–15.

Carver, Jonathan. 1796. Travels through the Interior Parts of North America. Philadelphia: Key and Simpson, pp. i–xx, 1–360.

Clark, H. Walton, and Southall, John B. 1920. Fresh Water Turtles: a Source of Meat Supply. U. S. Commissioner of Fisheries Rept. for 1919, Appendix 7, pp. 1–20, pls. 1–8.

Clausen, H. J. 1936. Observation on the Brown Snake, *Storeria dekayi* (Holbrook), with Especial Reference to the Habits and Birth of Young. Copeia, No. 2, pp. 98–102.

Cochran, M. Ethel. 1911. The Biology of the Red-backed Salamander, *Plethodon cinereus erythronotus* (Green). Biol. Bull., Vol. 20, pp. 332–49.

Conant, Roger. 1938. The Reptiles of Ohio. Am. Midland Naturalist, Vol. 20, pp. 1–200, pls. 1–26, maps 1–38.
1940. A New Subspecies of the Fox Snake *Elaphe vulpina* Baird and Girard. Herpetologica, Vol. 2, No. 1, pp. 1–14.

Cope, Edward Drinker. 1889. The Batrachia of North America. U. S. Nat. Mus. Bull. No. 34, pp. 1–515, pls. 1–86, figs. 1–119.
1900. The Crocodilians, Lizards, and Snakes of North America. Smithsonian Inst. Ann. Rept. for 1898, pp. 153–1294, pls. 1–36, figs. 1–347.

COUES, ELLIOT, AND YARROW, H. C. 1878. Notes on the Herpetology of Dakota and Montana. U. S. Geol. Survey Terr. Bull., Vol. 4, pp. 259–91.

CRIDDLE, STEWART. 1937. Snakes from an Ant Hill. Copeia, No. 2, p. 142.

CURRAN, C. H., AND KAUFFELD, CARL. 1937. Snakes and Their Ways. New York: Harper & Brothers, pp. 1–285, figs. 1–62.

DICKERSON, MARY C. 1931. The Frog Book. New York: Doubleday, Doran & Co., pp. i–xvii, 1–251, color pls. 1–16, halftones 1–95.

DITMARS, RAYMOND L. 1936. The Reptiles of North America. New York: Doubleday, Doran & Co., pp. i–xvi, 1–476, color pls. 1–8, halftones 1–135.

DRAKE, CARL J. 1914. The Food of *Rana pipiens* Schreber. Ohio Naturalist, Vol. 14, pp. 257–69.

DUNN, EMMETT R. 1926. The Salamanders of the Family *Plethodontidae*. Smith Coll. 50th Anniversary Pub., pp. v–viii, 1–441, maps 1–86.

1940. The Races of *Ambystoma tigrinum*. Copeia, No. 3, pp. 154–62.

DYMOND, J. R., SNYDER, L. L., AND LOGIER, E. B. S. 1928. A Faunal Survey of the Lake Nipigon Region, Ontario. Royal Canadian Inst. Trans., Vol. 16, Part 2, pp. 233–91.

EVERMANN, B. W., AND CLARK, H. W. 1917. The Turtles and Batrachians of the Lake Maxinkuckee Region. Indiana Acad. Sci. Proc. for 1916, pp. 472–518.

FEATHERSTONHAUGH, G. W. 1847. A Canoe Voyage up the Minnay Sotor. London: Richard Bentley. Vol. 1, pp. i–xiv, 1–416; Vol. 2, pp. i–vii, 1–351.

GAGE, SIMON H., AND GAGE, SUSANNA P. 1886. Aquatic Respiration in Soft-shelled Turtles (*Amyda mutica* and *Aspidonectes spinifer*); A Contribution to the Physiology of Respiration in Vertebrates. Am. Assoc. Adv. Sci. Proc., Vol. 34, pp. 316–18.

GARNIER, J. H. 1883. The Mink or Hoosier Frog. Am. Naturalist, Vol. 17, pp. 945–54.

GARMAN, H. 1890. The Differences Between the Geographic Turtles. Essex Inst. Bull., Vol. 22, pp. 70–83.

GILES, LEROY W. 1940. Food Habits of the Raccoon in Eastern Iowa. Wildlife Management Jour., Vol. 4, pp. 375–82.

GLOYD, HOWARD K. 1928. The Amphibians and Reptiles of Franklin County, Kansas. Kansas Acad. Sci. Trans., Vol. 31, pp. 115–41.

1932. The Herpetological Fauna of the Pigeon Lake Region, Miami County, Kansas. Michigan Acad. Sci. Papers, Vol. 15, pp. 389–409.

1940. The Rattlesnakes, Genera *Sistrurus* and *Crotalus*. Chicago Acad. Sci., Special Pub. No. 4, pp. i–vii, 1–266, pls. 1–31.

GRINNELL, JOSEPH, AND STORER, TRACY I. 1924. Animal Life of Yosemite. Berkeley: Univ. California Press, pp. 1–750, color pls. 12, figs. 1–65, maps 1–2.

GROBMAN, ARNOLD B. 1941. A Contribution to the Knowledge of Variation in *Opheodrys vernalis* (Harlan), with a Description of a New Subspecies. Michigan Univ., Mus. Zoology, Misc. Pub. No. 50, pp. 1–38, map 1.

GUTHRIE, J. E. 1926. The Snakes of Iowa. Iowa State Coll., Agr. Exp. Sta. Bull. No. 239, pp. 146–92, pls. 1–5, figs. 1–21.

HAMILTON, W. J., Jr. 1932. The Food and Feeding Habits of Some Eastern Salamanders, Copeia, No. 2, pp. 83–86.

1934. The Rate of Growth of the Toad (*Bufo americanus* Holbrook) under Natural Conditions. Copeia, No. 2, pp. 88–90.

HAY, O. P. 1887. The Massasauga and Its Habits. Am. Naturalist, Vol. 21, pp. 211–18.

1892. The Batrachians and Reptiles of the State of Indiana. Indiana Dept. Geology and Natural Resources, 17th Ann. Rept., Vol. 17, pp. 409–610, pls. 1–3.

HEAD, S. F. 1855. Some Remarks on the Natural History of the country about Fort Ripley, Minnesota. Smithsonian Inst. 9th Ann. Rept., pp. 291–93.

HENNEPIN, LOUIS, 1698. A New Discovery. London: Bentley *et al.* (Reprinted 1903. Chicago: A. C. McClurg & Co.) Pt. I, pp. 1–299; Pt. II, pp. 1–355.

HILDEBRAND, SAMUEL F. 1929. Review of Experiments on Artificial Culture of Diamond-back Terrapin. U. S. Bur. Fisheries Bull., Vol. 45, pp. 25–70.

HINCHLEY, MARY H. 1880–82. Notes on Eggs and Tadpoles of *Hyla versicolor*. Boston Soc. Nat. History Proc., Vol. 21, pp. 104–7.

HISAW, FREDERICK L., and GLOYD, HOWARD K. 1926. The Bull Snake as a Natural Enemy of Injurious Rodents. Jour. Mammalogy, Vol. 7, pp. 200–5.

HOLBROOK, JOHN EDWARDS. 1842. North American Herpetology. 2d ed.; Philadelphia: [privately printed]. 5 volumes.

HOOD, HELEN HINCHER. 1934. A Note on the Red-backed Salamander at Rochester, New York. Copeia, No. 3, pp. 141–42.

HOYT, J. SOUTHGATE Y. 1941. High Speed Attained by *Cnemidophorus sexlineatus*. Copeia, No. 3, p. 180.

HUDSON, GEORGE E. 1942. The Amphibians and Reptiles of Nebraska. Nebraska Conservation Bull., No. 24. Nebraska Univ. Conservation and Survey Div., pp. 1–146, pls. 1–20, maps 1–32.

HURTER, JULIUS, 1911. Herpetology of Missouri. St. Louis Acad. Sci. Trans., Vol. 20, pp. 59–274.

HUTCHISON, R. H. 1929. On the Incidence of Snake-bite Poisoning in the United States and the Results of the Newer Methods of Treatment. Antivenin Inst. of America, Vol. 3, No. 2, pp. 43–57.

JACKSON, V. W. 1934. A Manual of Vertebrates of Manitoba. Winnipeg: Manitoba Univ., pp. 1–42, figs. 1–178, maps 1–7.

KEATING, WILLIAM H. 1825. Narrative of an Expedition to the Source of St. Peter's River, Lake Winnepeek, Lake of the Woods, etc. London: George B. Whittaker. 2 vols., pp. 1–458, 1–248, appendix 1–156.

KLAUBER, LAURENCE M. 1937. A Statistical Study of the Rattlesnakes. IV. The Growth of the Rattlesnake. San Diego Soc. Nat. History, Occ. Papers No. 3, pp. 1–56, tbls. 5–16.

1938. Notes from a Herpetological Diary, I. Copeia, No. 4, pp. 191–97.

1939. A Statistical Study of the Rattlesnakes. VI. The Fangs. San Diego Soc. Nat. History, Occ. Papers No. 5, pp. 1–61, figs. 17–46.

1940. A Statistical Study of the Rattlesnakes. VII. The Rattle. San Diego Soc. Nat. History, Occ. Papers No. 6, pp. 1–62 tbls. 31–33, figs. 47–71.

KUMPF, K. F. 1934. The Courtship of *Ambystoma tigrinum*. Copeia, No. 1, pp. 7–10.

KUMPF, K. F., AND YEATON, S. C., Jr. 1932. Observations on the Courtship Behavior of *Ambystoma jeffersonianum*. Am. Mus. Novitates, No. 546, pp. 1–7, figs. 1–3.

LAGLER, KARL F. 1940. Turtles, Friends or Foes of Fish Culture. Progressive Fish Culturist, U. S. Bur. Fisheries, May–June, pp. 14–18.

1943. Food Habits and Economic Relations of the Turtles of Michigan with Special Reference to Fish Management. Am. Midland Naturalist, Vol. 29, No. 2, pp. 257–312.

1943a. Methods of Collecting Freshwater Turtles. Copeia, No. 1, pp. 21–25.

LEMON, PAUL C. 1942. Observations on a Captive Great Horned Owl. Flicker, Vol. 14, Nos. 2–3, pp. 17–22.

LOUISIANA DEPARTMENT OF CONSERVATION. 1935. Frog Industry in Louisiana. Div. Fisheries, Bull. No. 26, pp. 1–44.

MCILHENNY, E. A. 1937. Notes on the Five-lined Skink. Copeia, No. 4, pp. 232–33.

MILLER, NEWTON. 1909. The American Toad. Am. Naturalist, Vol. 43, pp. 730–45.

MOORE, JOHN A. An Embryological and Genetical Study of *Rana burnsi* Weed. Genetics, Vol. 27, No. 4, pp. 408–17.

NEWMAN, H. H. 1906. The Habits of Certain Tortoises. Jour. Comp. Neurology and Psychology, Vol. 16, pp. 126–52.

NICHOLS, JOHN T. 1933. Further Notes on Painted Turtles. Copeia, No. 1, pp. 41–42.

NOBLE, GEORGE K. 1929. Further Observations on the Life History of the Newt, *Triturus viridescens*. Am. Mus. Novitates, No. 348, pp. 1–22, figs. 1–7.

NOBLE, GEORGE K., and BRADY, M. K., 1930. The Courtship of the Plethodontid Salamanders. Copeia, No. 2, pp. 52–54.

NOBLE, GEORGE K., and MASON, E. R. 1933. Experiments on the Brooding Habits of the Lizards, *Eumeces* and *Ophisaurus*. Am. Mus. Novitates, No. 619, pp. 1–29, figs. 1–6.

NOBLE, GEORGE K., and SCHMIDT, A. 1937. The Structure and Function of the Facial and Labial Pits of Snakes. Am. Philosoph. Soc. Proc., Vol. 77, pp. 263–88, pls. 1–5.

ORTENBURGER, A. I. 1928. The Whip Snakes and Racers. Michigan Univ. Studies, Univ. Museums Mem., Vol. 1, pp. i–xviii, 1–247, pls. 1–36, figs. 1–64.

1930. Notes on Some Reptiles and Amphibians from Western Oklahoma. Oklahoma Univ. Biol. Survey Pub., Vol. 2, No. 4, pp. 175–88.

OVER, WILLIAM H. 1923. Amphibians and Reptiles of South Dakota. South Dakota Geol. and Nat. History Survey Bull. No. 12, pp. 1–34, pls. 1–18.

PACK, H. J. 1930. Snakes of Utah. Utah Agr. Exp. Sta. Bull. No. 221, pp. 1–30, figs. 1–10.

PATCH, CLYDE L. 1939. Northern Records of the Wood-Frog. Copeia, No. 4, p. 235.

PEARSE, A. S. 1923. The Growth of the Painted Turtle. Biol. Bull., Vol. 45, pp. 145–48.

PIERSOL, W. H. 1910. Spawn and Larvae of *Ambystoma jeffersonianum*. Am. Naturalist, Vol. 44, pp. 732–38.

POPE, CLIFFORD H. 1937. Snakes Alive and How They Live. New York: Viking Press, pp. i–xii, 1–238, figs. 1–28.

1939. Turtles of the United States and Canada. New York: Alfred A. Knopf, pp. i–xviii, 1–343, figs. 1–99.

POPE, PHILLIP H. 1915. The Distribution of the Northern Frog, Rana septentrionalis Baird, in Maine. Copeia, No. 16, pp. 1–2.

1924. The Life History of the Common Water Newt (*Notophthalmus viridescens*) together with Observations on the Sense of Smell. Carnegie Mus. Ann., Vol. 15, pp. 305–68, pls. 41–51.

POPE, T. E. B. 1930. Wisconsin Herpetological Notes. Wisconsin Acad. Sci. Trans., Vol. 25, pp. 273–84.

1931. Wisconsin Herpetological Notes. Wisconsin Acad. Sci. Trans., Vol. 26, pp. 321–29.

POPE, T. E. B., AND DICKINSON, W. E. 1928. The Amphibians and Reptiles of Wisconsin. Public Mus. City Milwaukee Bull., Vol. 8, pp. 1–138, pls. 1–21, figs. 1–28.

RAHN, HERMANN, 1940. Sperm Viability in the Uterus of the Garter Snake, *Thamnophis*. Copeia, No. 2, pp. 109–15.

ROOT, LOUIS A. 1928. Note on a Garter Snake. Copeia, No. 167, 52–53.

RUTHVEN, ALEXANDER G. 1908. Variation and Genetic Relationships of the Garter Snakes. U. S. Nat. Mus. Bull., No. 61, pp. i–xii, 1–201.

1911. A Biological Survey of the Sand Dune Region on the South Shore of Saginaw Bay: Amphibians and Reptiles. Michigan Geol. and Biol. Survey Pub. 4, Biol. ser. 2, pp. 257–72.

RUTHVEN, ALEXANDER G., THOMPSON, CRYSTAL, AND GAIGE, HELEN T. 1928. The Herpetology of Michigan. Michigan Handbook ser., No. 3, Michigan Univ. Museums, pp. i–ix, 1–229, pls. 1–19, figs. 1–52.

SCHMIDT, F. J. W. 1926. List of Amphibians and Reptiles of Worden Township, Clark County, Wisconsin. Copeia, No. 154, pp. 131–32.

SCHMIDT, KARL P. 1929. The Truth about Snake Stories. Field Mus. Leaflet 10, pp. 1–19.

1938. A Geographic Variation Gradient in Frogs. Field Mus., Zool. ser., Vol. 15, pp. 377–82.

SCHMIDT, KARL P., AND DAVIS, D. DWIGHT. 1941. Field Book of Snakes of the United States and Canada. New York: G. P. Putnam's Sons, pp. i–xiii, 1–365, pls. 1–34, figs. 1–103.

SCHMIDT, W. J. 1919. Ueber das Verhalten der verschiedenartigen Chromatophoren beim Farbenwechsel des Laubfrosches. Archiv für Mikroskopische Anatomie, Abt. 1, pp. 414–55, Tafel XIX–XXII.

SCHNECK, J. 1882. A Prolific Garter Snake. Am. Naturalist, Vol. 16, p. 1008.

SCHOOLCRAFT, HENRY ROWE. 1834. Narrative of an Expedition through the Upper Mississippi to Itasca Lake. New York: Harper & Brothers, pp. 1–307.
1855. Summary Narrative of an Exploratory Expedition to the Sources of the Mississippi River. Philadelphia: Lippincott, Grambo & Co., pp. 1–596.

SCOTT, THOMAS G. 1938. Wildlife Mortality on Iowa Highways. Am. Midland Naturalist, Vol. 20, pp. 527–39.

SCOTT, THOMAS G., and SHELDAHL, R. B. 1937. Black-banded Skink in Iowa. Copeia, No. 3, p. 192.

SHELLEY, LEWIS O. 1938. Milk snakes vs. birds. Auk, Vol. 55, p. 548.

SMITH, B. G. 1911. Notes on the Natural History of *Ambystoma jeffersonianum*, *A. punctatum* and *A. tigrinum*. Wisconsin Nat. History Soc. Bull., Vol. 9, pp. 14–27.
1911a. The Nests and Larvae of Necturus. Biol. Bull., Vol. 20, pp. 191–200.

SPEAKER, EVERETT B. 1942. Me-Shi-Ke, the Turtle, A Very Tasty Fellow. Iowa Conservationist, Vol. 1, No. 10, pp. 5–6.

STEJNEGER, LEONARD, AND BARBOUR, THOMAS. 1933. A Check List of North American Amphibians and Reptiles, 3d ed.; Cambridge, Mass.: Harvard Univ. Press, pp. i–xiv, 1–185.
1943. Same. 5th ed.; Cambridge, Mass.: Harvard College Mus. of Comp. Zoology Bull., Vol. 93, No. 1, pp. i–xix, 1–260.

STILES, RENE B. 1938. The Milk Snakes in Minnesota. Copeia, No. 1, p. 50.

STULL, OLIVE G. 1940. Variations and Relationships in the Snakes of the Genus *Pituophis*. U. S. Nat. Mus. Bull., No. 175, pp. i–vi, 1–225, tbls. 1–14, figs. 1–84.

SURFACE, H. A. 1906. The Serpents of Pennsylvania. Pennsylvania Dept. Agr., Div. Zoology Bull., Vol. 4, Nos. 4–5, pp. 114–208, pls. 14–42, figs. 4–23.
1908. First Report on the Economic Features of the Turtles of Pennsylvania. Pennsylvania Dept. Agr., Div. Zoology Bull., Vol. 6, Nos. 4–5, pp. 105–96, pls. 1–12, figs. 1–16.

SWANSON, GUSTAV. 1935. A Preliminary List of Minnesota Amphibians. Copeia, No. 3, pp. 152–54.

SWANSON, PAUL L. 1933. The Size of *Sistrurus catenatus catenatus* at Birth. Copeia, No. 1, p. 37.

TAYLOR, EDWARD H. 1935. A Taxonomic Study of the Cosmopolitan Scincoid Lizards of the Genus Eumeces. Kansas Univ. Sci. Bull., Vol. 23, pp. 1–643, pls. 1–43, figs. 1–84.

TAYLOR, W. E. 1892. Ophidia of Nebraska. Nebraska State Board Agr., Ann. Rept. for 1891, pp. 310–57.

THOMPSON, MILTON D. 1939. A Key to Snakes of Minnesota. Minnesota Acad. Sci. Proc., Vol. 7, pp. 27–29.

TONER, G. C. 1940. Delayed Hatching in the Snapping Turtles. Copeia, No. 4, p. 265.

TRAPIDO, HAROLD, AND CLAUSEN, R. T. 1938. Amphibians and Reptiles of Eastern Quebec, Copeia, No. 3, pp. 117–25.

UHLER, F. M., COTTAM, C., AND CLARKE, T. E. 1939. Food of the Snakes of the George Washington National Forest, Virginia. 4th North American Wildlife Conf. Trans., pp. 605–22.

VIOSCA, PERCY, JR. 1937. A Tentative Revision of the Genus *Necturus* with Descriptions of Three New Species from the Southern Gulf Drainage Area. Copeia, No. 2, pp. 120–38.

WEED, A. C. 1922. New Frogs from Minnesota. Washington Biol. Soc. Proc., Vol. 35, pp. 107–10.

WRIGHT, ANNA ALLEN, AND WRIGHT, ALBERT HAZEN. 1942. Handbook of Frogs and Toads. 2d ed.; Ithaca, N. Y.: Comstock Publishing Co., pp. i–xi, 1–286, pls. 1–88.

WRIGHT, A. H. 1915. The Mink Frog, Rana septentrionalis Baird, in Ontario. Copeia, No. 23, pp. 46–48.

1920. Frogs–Their Natural History and Utilization. U. S. Bur. Fisheries, Doc. No. 888, pp. 1–44.

1932. Life-Histories of the Frogs of Okefinokee Swamp, Georgia. New York: Macmillan Co., pp. i–xv, 1–497, pls. 1–45, fig. 1.

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