ILLINOIS BIOLOGICAL MONOGRAPHS

VOLUME XVI

PUBLISHED BY THE UNIVERSITY OF ILLINOIS

URBANA, ILLINOIS

TABLE OF CONTENTS

ILLINOIS BIOLOGICAL MONOGRAPHS

Vol. XVI Nos. 1-2

Published by the University of Illinois
Under the Auspices of the Graduate School
Urbana, Illinois
1937

1000—8-37—9888

UNIVERSITY
OF ILLINOIS
PRESS

THE TURTLES OF ILLINOIS

WITH 31 PLATES, 20 MAPS, AND
15 TEXT-FIGURES

BY
ALVIN R. CAHN

CONTRIBUTION FROM THE ZOOLOGICAL LABORATORY OF THE
UNIVERSITY OF ILLINOIS
No. 492

PREFACE

For a number of years the writer has had in mind the production of a monograph dealing with the turtles of Illinois, if for no other reason than the fact that they have, as a group, been much neglected throughout the middle west. In most herpetological literature of the region much space has been given to snakes, salamanders, and frogs, but turtles have received at best a mere mention, being passed off with the enumeration of a species or two in a given locality. This is perhaps due to the difficulty of capturing specimens, coupled with the uncertainty of identifying most species as they sit sunning themselves in security on a log in the middle of a pond, and the very awkward problem of keeping such bulky creatures once they are captured. I suspect, however, that it is also in part due to the fact that there is really very little literature available to the average student or field collector which will enable him to identify with ease and certainty a species once he catches it. Keys there are, but many are located in old publications not everywhere available; many are so highly technical as to require an advanced knowledge of comparative anatomy for their comprehension and use; others are too superficial and general to be of really practical value. It has been the writer's plan, therefore, to present a paper dealing with the various species of turtles found within the boundaries of Illinois, this paper to include keys to the families, genera, and species—intelligible to readers who are not professional herpetologists—together with a full discussion of the life history of each species so far as it is known. Such a discussion must also contain a detailed description of the adult and young, eggs, habits, economic importance, food habits, sex differentiation, and parasites, in order to approach completeness. One real drawback, as the writer sees it, to the ready identification of turtles, is the lack of adequate photographs that will in themselves be an aid (and not a handicap) in the determination of the identity of the species. To that end he has bent every effort to illustrate the present paper with the best photographs he could obtain. All the illustrations are original and have been made especially for this monograph. The photographs are either from living specimens or from freshly preserved material, in the latter case photographed within an hour after killing so as to insure full color values.

The writer has drawn freely upon available literature, as will be seen on consulting the bibliography. This bibliography has been arranged under several headings so as to make it of greater use to both the amateur and the professional student.

The Illinois State Natural History Survey, under the direction of Dr. Theodore H. Frison, has placed at the writer's disposal its collections of Illinois turtles. Unfortunately, the original collection made by Professor H. Garman in 1888 for the State Laboratory of Natural History has disappeared and hence has not been available for study. This has proved to be a serious handicap, for the writer has been unable to obtain specimens of several species listed by Garman from Illinois. To Dr. David H. Thompson and Mr. Francis D. Hunt, of the Natural History Survey, the writer expresses his appreciation for their assistance in procuring specimens for examination from various parts of Illinois, and to the commercial fishermen who have sent in many sacks and barrels full of live turtles for study, the writer owes in large measure the information concerning the geographical distribution within the state. During the summer of 1931, Mr. Joe D. Combs, of the Zoology Department of the University of Illinois, spent two months under the writer's direction, on the Illinois River at Meredosia, collecting information on life histories and obtaining many interesting facts.

To the many friends all over the country who submitted material for comparison and for study, and to the American Museum, the Field Museum, and the United States National Museum, the writer expresses his deep appreciation for all courtesies rendered.

CONTENTS

CONTENTS (Concluded)

ILLINOIS TOPOGRAPHY AND HYDROGRAPHY

The state of Illinois occupies a unique position geographically in the United States, for within its borders many of the major faunal and floral features of the east and west, the north and south, join and to some extent overlap or intergrade. Here representative species of the eastern forests and the western prairies, of the northern and southern forests, come together, and meet with the species of the sand dune region of Lake Michigan. Hence, as one might expect, the biota is varied and rich.

Illinois is essentially a prairie state, but about 42 percent of its total area, or about fifteen million acres, is classified ecologically as having been originally deciduous forest of various types. This great forest, before being destroyed by man, covered most of the southern third of the state, as well as the northeastern section. Here roamed the white-tailed deer *(Odocoileus virginianus),* the black bear *(Euarctos americanus),* timber wolf *(Canis lycaon),* gray fox *(Urocyon cinereoargenteus),* and red fox *(Vulpes fulva).* The remaining region, approximately 58 percent of the total area, was of parkland formation: grass prairies, with clumps of trees scattered through it. With the colonization of the state and its phenomenal growth in population, the forested region was reduced, until at present it is represented by less than 3,000,000 acres. With the deforestation came the cultivation of the land, and this was subsequently accompanied by drainage. The present biota is the product of these changes. Deforestation automatically and directly eliminated the larger species of forest animals, while the indirect effects of deforestation —cultivation and drainage—have had a profound influence upon the aquatic biota. The deforested land can no longer hold its original quota of water, and hence the run-off is rapid and sudden and spasmodic, resulting in floods and in a diminution of the volume of the rivers. There is no possible way in which we can with certainty reconstruct the original faunal distribution within the state, especially in respect to such a group as the turtles, but certain it is that the original distribution of animals was quite different from that which we see to-day. And it requires no prophet to predict that the future holds an even more profound change.

Illinois is essentially a plain, gently rolling in places, in others flat. It is the lowest (average elevation 600 feet) of all the north-central states, lying in the middle of the great interior basin of the North American continent, which is bounded on the east by the Appalachian and on the west by the Rocky Mountains. In general, the elevation decreases from north to south and from east to west, but this is in no sense a regu-

lar decline. The two essential features which interrupt the plain surface of the state are (1) the moraine features of the drift area, and (2) the rock ridges.

The drift areas of Illinois are important in relation to the drainage basins of the state. The southern limit of the glacial drift within Illinois lies at the foot of the Ozark uplift in the southern part of the state; from here is passes eastward into Indiana, and north and west to East St. Louis and Quincy. Thus the major portion of the state is covered with drift (the Illinoian drift of the geologist), with a small area of driftless, non-glaciated country at the extreme southern tip and following up the Mississippi River valley to Quincy and up the Ohio River valley into Indiana, and a second, isolated area in the northwestern corner of the state. The northeastern quarter of the state has for its outstanding topographic features a series of terminal moraines which mark the irregular southern limits of the Michigan lobe of the Labrador glacier, this region being covered with early Wisconsin drift. The narrow band along the shore of Lake Michigan is the Valparaiso moraine, late Wisconsin in origin. These morainic ridges were formed by the retreat of the ice sheet from the Shelbyville moraine and are separated by drift-covered basins which undoubtedly represent old lake beds. The slope of these ridges is gentle on the side that was away from the glacier (west and south) and much more abrupt on the side toward the ice (toward Lake Michigan). Thus the streams are found to flow through these basins, receiving as their tributaries smaller streams flowing down the gentle slopes of the moraines. Hence the drainage of this Wisconsin drift area flows mainly to the south and west. Over the Illinoian drift area the drainage is toward the Mississippi River, in a southwesterly direction. At the southwestern tip of Lake Michigan lies the Valparaiso moraine, the terminus of the late Wisconsin ice sheet; between this and Lake Michigan flow the Des Plaines, Calumet, and Chicago rivers, the last two flowing into Lake Michigan (originally at least), the former finding an outlet through the moraine at an ancient outlet of Lake Michigan known as the "old Chicago outlet."

There are but few places where the underlying rock rises above the superimposed drift, these being in the northwest corner, where the Niagara limestone breaks through to the surface and where there never was any glacial drift; the southern end of the state, where the Ozark uplift crosses the state; and places along the Mississippi River where the lower carboniferous limestones rise as the bluffs along the eastern shore of that river. The rivers are consequently flowing largely through areas of glacial drift, connecting very few lakes, and showing but little drop

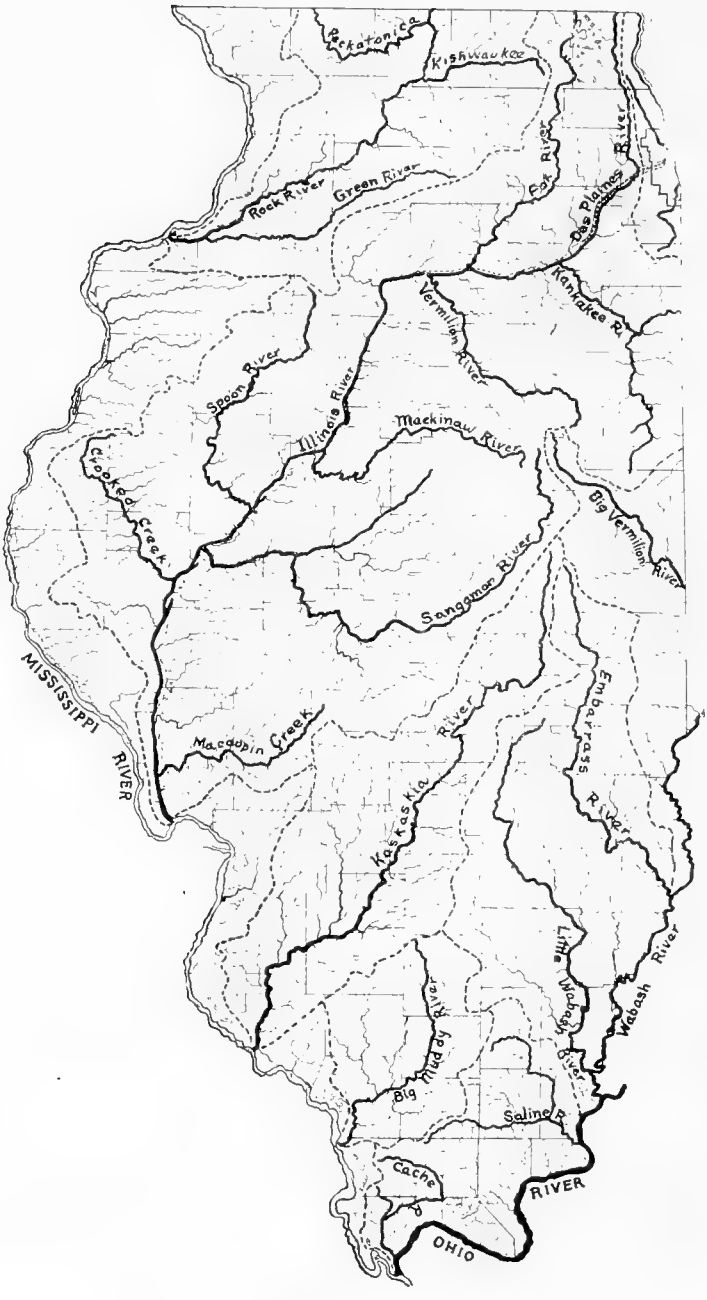
per mile and normally but a sluggish current. The average rainfall of 38.2 inches for the state affords under ordinary conditions a sufficient supply of water to the rivers. The unusual drought of 1930 left the lesser streams and smaller lakes almost destitute of water, and the larger rivers and lakes at a record low mark.

That Illinois is well supplied with streams of all sizes is recognized by a glance at the accompanying map of the river systems of the state, and one cannot help being impressed by the dendritic pattern of these streams. While there are innumerable tiny creeks throughout Illinois, the drainage of the state falls into the basins of five main rivers and Lake Michigan. All five of the rivers empty either directly or indirectly into the Mississippi River; hence all of the state, excepting only the narrow belt between the Valparaiso moraine and Lake Michigan, lies in the drainage area of the Mississippi. Since these river systems are in many cases essential to the understanding of the distribution of certain species of turtles, they are listed here, together with their approximate drainage areas (data from Leverett).

TABLE 1.—THE RIVER SYSTEMS OF ILLINOIS, WITH THEIR APPROXIMATE DRAINAGE AREAS

River system	Square miles
Mississippi River Drainage	
1. Rock River	5,310*
Green River	1,000
Pecatonica River	780*
Kishwaukee River	1,644
2. Illinois River	24,940*
Des Plaines River	1,750
Kankakee River	2,160*
Fox River	1,560*
Vermilion River	1,320
Mackinaw River	1,200
Spoon River	1,820
Sangamon River	5,590
Salt Creek	1,940
Crooked Creek	1,350
Macoupin Creek	1,000
3. Kaskaskia River	6,000
4. Big Muddy River	2,400
5. Ohio River:	
Wabash River	8,890*
Big Vermilion River	1,400
Embarrass River	2,400
Little Wabash River	3,190
Saline River	2,000
Cache River	623

*Exclusive of the drainage area outside the boundaries of Illinois.



TEXT-FIGURE 1.—THE RIVERS OF ILLINOIS

Rock River.—The Rock River rises in Dodge County, Wisconsin, and drains ten large clear-water lakes in that state. It enters Illinois in Winnebago County, flowing with considerable current although its maximum gradient is only two feet per mile. Its banks are low in many places, at least on one side, for the river wanders across its valley, which has bluffs of a moderate height.

Green River.—This river flows for a considerable distance through a channel cut in sand and gravel from the Wisconsin glacier. It is only about 93 miles in length. In its course it meanders through two large swamp areas, where it almost loses its identity as a stream and where it has practically no current, while at its headwaters it flows along with a drop of some 25 feet to the mile. Its banks are low and without bluffs.

Pecatonica River.—This river enters Illinois in Stephenson County, coming from its source in Wisconsin, its entire course in the state lying in the Illinoian drift. It flows through rolling country, some of which is timber land and some prairie, with a drop of only about 6 inches to the mile, its banks largely of rich earth and low.

Kishwaukee River.—This stream is formed by the union of two branches, each with a drop of about 3 feet per mile. Its water is quite clear as it flows through a rolling country, its banks timbered in some places, and in others of the prairie type.

Illinois River.—This is the largest river system in the state, and the river itself is the largest stream. It has a depth that varies to an extreme of approximately thirty feet. In many places it has cut its way through rock and presents beautiful high bluffs in consequence, indicating that in former years it probably had a considerably greater volume of water than it has now. Most of the course of the Illinois was down an ancient river outlet of Lake Michigan, from which, however, it is now cut off, the water of that lake having in late Pleistocene time discharged into the Mississippi instead of into the St. Lawrence. It is bordered by a large flood plain, overflowing it in periods of high water, and by a second flood plain now above the reach of even the highest water, representing the flood plain of the river at the time it received the Lake Michigan discharge. Within this second bottom area there are, in some places, small lakes. The river flows through many swampy areas (overflow ponds) and has a very large population of turtles because of the favorable environment. It is a slow river with an average drop over its entire length of but 3.2 inches per mile. It is rich in aquatic vegetation, which affords excellent shelter for its aquatic fauna. The upper reaches of the river were formerly polluted by the discharges of Chicago into it by way of the drainage canal, and here all normal river life was lacking.

Des Plaines River.—This stream drains a narrow valley lying between the moraines west of Lake Michigan, arising in Wisconsin. Its entire course lies within the late Wisconsin drift, and since this is characteristically a morainic region, many small lakes and marshes are found along its path. Its bed is, in consequence of the region through which it flows, largely sand and gravel. Its passage through the moraine which bounds it on the west is considered to be the old outlet of Lake Michigan during late Pleistocene time.

Kankakee River.—This river has its origin in Indiana, where it flows through what is considered as a glacial lake bed, that of Lake Kankakee. Its valley is therefore quite level, the drop in the 240 miles lying in Indiana averaging less than 5 inches per mile. In Illinois it encounters its limestone base and drops more precipitately at certain points due to this factor. Its bed is largely gravel and rock.

Fox River.—This river rises in Waukesha County, Wisconsin, where it flows through the Wisconsin drift area, connecting a large series of beautiful clear-water lakes. In Illinois it continues its progress through the Wisconsin drift, to enter the Illinois River at Ottawa. Much of its drainage basin lies in morainic areas from which, however, many of the lakes have disappeared because of drainage and cultivation. It is stated that the volume of the river has fallen off at least 50 per cent due to this drainage and cultivation. The channel is therefore narrow and in some places has precipitous banks. It drops from 3 to 5 feet per mile.

Vermilion River.—This is the Vermilion River that discharges into the Illinois, not into the Wabash. It rises in the moraines of Ford and Livingston counties. It has cut for itself a deep channel through parts of its course, with precipitous bluffs and cliffs overhanging the water. It drains no lakes or marshes and hence suffers much loss of water during dry seasons.

Mackinaw River.—This stream rises in McLean County and flows southwest to enter the Illinois below Pekin. Since it starts high in the Bloomington moraine, we find that it drops 40 feet during its first mile, but then slows down to 3 feet per mile over most of its upper reaches. It flows through a very narrow channel, and since it has no marshes to take up its water, it is subject to great variation in times of either heavy rain or drought. It is considered to be the most variable stream in the state.

Spoon River.—This river rises in Bureau County, and for a large part of its course it parallels the Illinois River. It is a river with considerable current as it flows through a relatively narrow valley. In fact, its current is so much greater than that of the Illinois into which it empties at Havana, that it has built up a considerable delta in the latter river. It, too, is subject to great variations in its water content.

Sangamon River.—This stream is reported to have the largest watershed of any of the tributaries of the Illinois River. The first part of its course traverses the early Wisconsin drift, which it leaves near Decatur. Beyond this point it is considerably wider and shallower. It is subject to overflow in rainy seasons, the twelve-foot embankments not acting as a barrier at such times. Its main tributary is Salt Creek, which rises from two heads, the North and South Forks; both have their origin in the Bloomington moraine. The Sangamon has considerable current, as the gradient increases to 10 feet per mile at its mouth.

Crooked Creek.—This is the last tributary of any size of the Illinois on the western side. It flows entirely through Illinoian drift and has a channel which in places is bounded by high bluffs with limestone outcrops at intervals all along its course.

Macoupin Creek.—This flows through a broad valley of Illinoian drift, almost level, with areas of heavy timber along its banks. These banks are largely of black soil, sometimes quite high, sometimes scarcely above the level of the river.

Kaskaskia River.—This is one of the three rivers rising in the moraines of Champaign County (the other two being the Embarrass and the Sangamon). It rises in the area of the late Wisconsin drift, passing through the moraine near Shelbyville. The banks along its upper course are of mud but they become sandy downstream. It is a slow stream, its greatest drop being 3 feet to the mile, but through most of its course the drop is much less. Due to the nature of its flood plain, there is much timber along its valley. It has numerous tributaries, but these are all small.

Big Muddy River.—This is a very crooked river which shows evidence of being an old stream which has cut its channel down to drainage level, flowing through a flood plain which is broad and flat. It is slow and sluggish, dropping less than a foot a mile over most of its course. The water is very muddy for it carries much alluvial material. The last twenty miles of its course are through the Mississippi bottoms, and the backwater of the Mississippi is felt as far upstream as Murphysboro. In passing through these bottoms, the Big Muddy hugs the eastern shore, where bluffs 250 feet high bound its course on that side, the flat flood plain of the bottoms lying on the west.

Wabash River.—For nearly 200 miles the Wabash forms the boundary between Illinois and Indiana, flowing through the pre-glacial bed of a river that at one time was much larger than the present stream. It is a sluggish, muddy river with a drop of less than 8 inches to the mile. Its valley is broad and low, and its bottom lands subject to severe overflows. It is shallow for its size, and numerous rocky rapids interrupt its other-

wise tranquil course. Its water is loaded with sediment in suspension—largely silt—so that it is brown and opaque at all times.

Big Vermilion River.—The upper course of this river passes through a region deep in drift, through which it has cut a narrow course with relatively low banks. In the region of Danville, however, it has cut its way through the drift and flows between steep, high banks over a bedrock course. Its water is fairly clear except in times of flood, and there is little vegetation in the lower reaches of its course. The upper portion, however, is shallow and weed-clogged, with water which is normally quite muddy.

Embarrass River.—The original source of this river in Champaign County is now largely corn fields, but the river starts its course as a tiny weed-choked stream in the Champaign moraine system and Wisconsin drift. Emerging into the Illinoian drift, its valley broadens greatly as its rate of drop falls to less than 1 foot to the mile. There are few tributary streams to the Embarrass as it flows through the relatively young Wisconsin drift, but in the older Illinoian area it receives many tributaries, presenting a typical dendritic system of drainage.

Little Wabash River.—This river rises in the Shelbyville moraine and flows through the Illinoian drift with an average drop of less than 2 feet to the mile. Its valley is broad, with rolling hills and considerable heavy timber growing on the rich sandy loam which is subjected to heavy overflow in flood times.

Saline River.—This stream drains southeastern Illinois which lies north of the Ozark uplift, entering the Ohio near Shawneetown, flowing through Illinoian drift. It is formed by the union of the North, South, and Middle Forks, beyond which point the Saline flows southeast along the base of the uplift. The river drops 35 feet in the 16 miles of its course. The southern banks are high, the northern relatively low, and the course is crooked and the current slight.

Cache River.—This is a small river which enters the Ohio at Mound City. It flows through the driftless area of the state, south of the Ozark uplift. Its course is through flat, alluvial material and cypress swamps, and its bottoms are subject to violent floods. It falls rapidly (150 feet) during the first 20 miles of its course, and but 50 feet in the remaining 50 miles of its length. It is believed that the valley of the Cache River was once the main discharge channel of the Ohio River.

HISTORICAL REVIEW

When one reviews the literature dealing with the Testudinata, especially in the United States, one is impressed by the lack of publications of monographic proportions; they are almost non-existent. By far the

greatest bulk of turtle literature is to be found in works of a general herpetological nature, as Harlan's *Genera of North American Reptilia* (1826), Holbrook's *North American Herpetology* (1836), Gray's many publications, Van Denburgh's *Reptiles of the Pacific Coast,* and innumerable smaller papers. Agassiz' monographic work (1857) on the turtles of the United States still remains the classic example of its kind, and has never been approached by any other publication for the wealth and originality of its contents and the value of its contributions. The other important and perhaps outstanding monographs are those of Surface (1908) on the economic status of the turtles of Pennsylvania, Babcock (1919) on the turtles of New England (which has the finest of colored plates), and Van Denburgh's *Gigantic Land Tortoises of the Galapagos Archipelago,* with which we are not concerned in the present paper. There has been no monograph of the turtles of Illinois published. There is, in fact, no monograph in existence dealing comprehensively with the turtles of the middle west or of any state in the Union west of Pennsylvania. There are numerous taxonomic and anatomical papers which the student must consult, and from the taxonomic series has grown the Stejneger and Barbour *Check List* (1933). Studies of the life histories of turtles are few and very far between, brief and usually very incomplete in the information which they offer. The greater bulk of the turtle literature consists of scattered faunal notes of the occurrence of this or that species in a given circumscribed locality.

Studies in the herpetology of Illinois have been few, and with the notable exception of Michigan, the same can truthfully be said of the surrounding states. This is exceedingly unfortunate, for we cannot but wish that the early herpetologists and general zoologists had left us a more complete record of the interesting herpetological information of their times than we find. The changes in the physical features of the state—deforestation, drainage, agriculture—must have left a profound impression on the amphibian and reptilian life of the region, and a study of these changes in relation to these animals would be most interesting and valuable, had we but the material or the data for study.

The first Illinois list of turtles is included in a very general paper dealing with the animal life of Cook County, Illinois, published by Kennicott in 1855. This list records four species: *Trionyx ferox, Cistuda blandingii, Chelonura serpentina,* and *Emys picta.* It is interesting to note that two of these species are now considered invalid for the state (*Trionyx ferox* and *Emys picta*). The second list of the herpetology of the state is that of Davis and Rice (1883), listing eight species of turtles for the entire state, three of which are no longer valid. Harrison Garman's first paper (1889), dealing with the animals of the Mississippi bottoms around Quincy, Illinois, lists nine species for that region; his

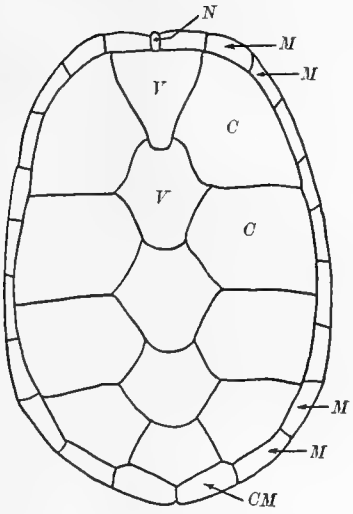
second paper (1890) adds three species to this number. The one and only comprehensive treatise on the herpetology of the state is the paper of Garman, published in 1892, in which he gives not only keys to the species, but a brief description of the forms, together with distributional notes and definite Illinois locality records. Garman's work was done for the Illinois State Laboratory of Natural History, and it is very unfortunate that all the specimens upon which this most important contribution was based have disappeared. Notes on Illinois species have appeared in many publications, and short lists of species found in various circumscribed areas, such as Blanchard's paper on southern Illinois (1924), Hankinson's on the Charleston region (1915, 1917), and Weed's notes from central Illinois (1923), all of which are helpful contributions to a more complete knowledge of the amphibians and reptiles of the state.

Since there is no monograph dealing with the turtles of the middle west, it is hoped that the present contribution, incomplete though it is in all its possible details, will fill for the time being a conspicuous gap. The nomenclature followed is substantially that of Stejneger and Barbour's *Check List of North American Amphibians and Reptiles* (1933), from which the writer has departed only twice: (1) in the genus Chrysemys, in which group he feels that the data presented by Bishop and Schmidt (1931) warrant the adoption of their nomenclature for this group; and (2) in the problem of the *Pseudemys troostii* vs. *Pseudemys elegans,* in which data brought to light subsequent to 1933 have made a departure from their nomenclature apparently advisable.

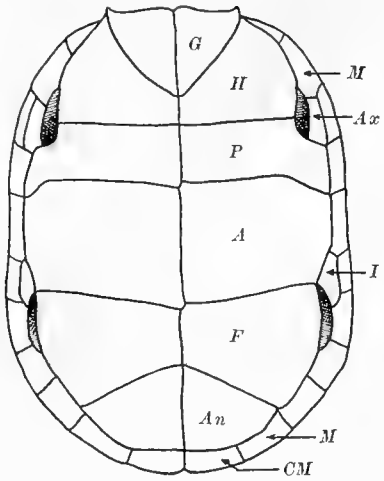
In order to bring before the reader the terminology as used in the present paper, with reference to the dermal and epidermal skeletal elements of the carapace and plastron, the following outline is offered:

1. Epidermal skeleton, composed of scutes:
   - A. Carapace (Text-fig. 2)
     - Vertebral
     - Costal
     - Marginal
       - Nuchal
       - Caudal
   - B. Plastron (Text-fig. 3)
     - Gular
     - Humeral
     - Pectoral
     - Abdominal
     - Femoral
     - Anal
   - C. Bridge
     - Axillary
     - Inguinal

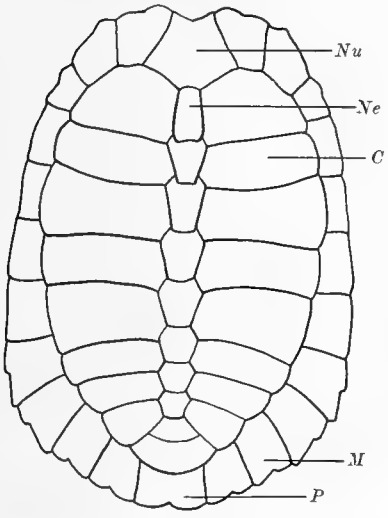
2. Dermal skeleton, composed of bony plates:
   - A. Carapace (Text-fig. 4)
     - Nuchal
     - Neural
     - Costal
     - Marginal
     - Pygal
   - B. Plastron (Text-fig. 5)
     - Entoplastron
     - Epiplastra
     - Hypoplastra
     - Hyoplastra
     - Xiphiplastra



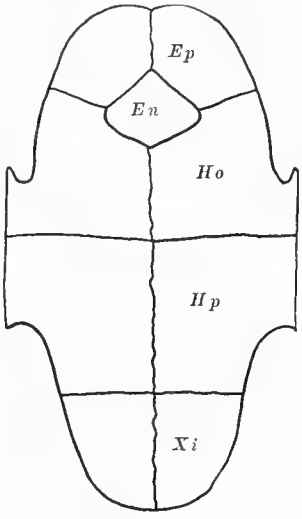
TEXT-FIGURE 2.—The scutes composing the epidermal skeleton of the carapace. *C*—costal; *CM*—caudal marginal; *M*—marginal; *N*—nuchal; *V*—vertebral.



TEXT-FIGURE 3.—The scutes composing the epidermal skeleton of the plastron. *A*—abdominal; *An*—anal; *Ax*—axillary; *CM*—caudal marginal; *F*—femoral; *G*—gular; *H*—humeral; *I*—inguinal; *M*—marginal; *P*—pectoral.



TEXT-FIGURE 4.—The bony plates composing the dermal skeleton of the carapace of *Pseudemys troostii*. *C*—costal; *M*—marginal; *Ne*—neural; *Nu*—nuchal; *P*—pygal.



TEXT-FIGURE 5.—The bony plates composing the dermal skeleton of the plastron of *Pseudemys troostii*. *En*—endoplastron; *Ep*—epiplastra; *Ho*—hyoplastra; *Hp*—hypoplastra; *Xi*—Xiphiplastra.

KEYS TO THE TURTLES OF ILLINOIS

The following keys are intended for the separation of the various species of turtles thus far reported from the state of Illinois. The characters used are, in so far as possible, external, and the keys are so developed as to be an aid to the amateur as well as to the professional herpetologist. The use of osteological or cranial characters which necessitate careful dissection or tedious cleaning up of skeletal material has been avoided wherever possible.

KEY TO THE FAMILIES OF TURTLES OF ILLINOIS

1 (6) Shell covered with horny epidermal shields.....(2)

2 (5) Pectoral shields not in contact with the marginals, but widely separated from them; plastron with 11 shields or less.....(3)

3 (4) Plastron relatively very small, cruciform, composed of 9 shields besides the bridge; carapace flaring and emarginate posteriorly; no hinges present in plastron; head very large; tail long, with dorsal crest of tubercles; 25 marginals.....CHELYDRIDAE

4 (3) Plastron larger, not cruciform, composed of 11 shields; 23 marginal shields, the carapace neither flaring nor emarginate posteriorly; symphysis of lower jaw a long, sharp point.....KINOSTERNIDAE

5 (2) Pectoral shields in contact with the marginals; plastron with 12 shields.....TESTUDINIDAE

6 (1) Shell without horny shields, being covered with skin only..TRIONYCHIDAE

KEY TO THE FAMILY CHELYDRIDAE IN ILLINOIS

1 (2) No supramarginal shields; orbit directed upward and outward; head covered with skin; tail with two rows of large scales on the ventral surface; carapace with three ridges, becoming obsolete in adult.....*Chelydra serpentina*

2 (1) Three or four supramarginal shields on each side just above the region of the bridge; orbit directed laterally; head covered with symmetrical plates; tail with many small scales on the ventral surface; carapace with three very strong, persistent ridges or keels.....*Macrochelys temminckii*

KEY TO THE FAMILY KINOSTERNIDAE IN ILLINOIS

1 (4) Humeral scutes triangular; plastron quite large, nearly filling the aperture; little cartilage between plastral elements; lobes of plastron of approximately equal length....Genus Kinosternon. (2)

2 (3) Size large; carapace flat; ninth and tenth marginals elevated .....*Kinosternon flavescens*

3 (2) Size small; carapace arched; only tenth marginal elevated..... .....*Kinosternon subrubrum subrubrum*

4 (1) Humeral scutes rhomboidal; plastron narrow, not nearly filling aperture; interpectoral suture about equal to interhumeral; posterior lobe of plastron longer than the anterior lobe, and truncate, the angles not rounded; much cartilage between the plastral elements.....Genus Sternotherus. (5)

5 (6) Carapace without a vertebral keel in the adult and without imbricated scutes; head with lateral yellow stripe back of the eye .....*Sternotherus odoratus*

6 (5) Carapace with a vertebral keel and imbricated scutes; head without lateral stripes; spotted.....*Sternotherus carinatus*

KEY TO THE FAMILY TESTUDINIDAE IN ILLINOIS

1 (6) Plastron with transverse hinges.....(2)

2 (5) Beak hooked; shell high and convex; bridge rudimentary or absent; plastron with posterior notch; no bony temporal arch. Genus Terrapene.....(3)

3 (4) Carapace with low vertebral keel; no trace of a bridge; posterior lobe of plastron broader than anterior; plastron hermetically closing the shell; median suture nearly straight, slightly if at all sinuous.....*Terrapene carolina carolina*

4 (3) Carapace without a trace of a vertebral keel; a rudimentary bridge present; plastron not hermetically closing the shell; both plastral lobes of approximately equal width.....*Terrapene ornata*

5 (2) Beak without hook; shell somewhat depressed; bridge narrow but distinct; a bony temporal arch present.....*Emys blandingii*

6 (1) Plastron without transverse hinges.....(7)

7 (14) Carapace without a vertebral keel.....(8)

8 (9) Carapace relatively high, globular, the lateral marginals practically vertical; axillaries and inguinals small and rudimentary; plastron widely but shallowly emarginate; carapace with round yellow dots.....*Clemmys guttata*

9 (8) Carapace much depressed, the lateral marginals about 45° with the vertical; plastron without ligamentous connection with the carapace; axillary and inguinal elements large; posterior margin of plastron truncate or very slightly emarginate..... .....Genus Chrysemys. (10)

10 (13) Plastron yellow or orange, with symmetrical dusky markings.....(11)

11 (12) Plastron with dusky central area, this not radiating out along the sutures.....*Chrysemys picta marginata*

12 (11) Plastron with symmetrical central markings covering most of it, radiating out along the sutures.....*Chrysemys picta bellii*

13 (10) Plastron yellow or orange, without dusky central markings; costal and vertebral shields alternating.....*Chrysemys picta dorsalis*

14 (7) Carapace with a vertebral keel; posterior margin of the plastron deeply notched.....(15)

15 (18) Keel tuberculate and conspicuous.....Genus Graptemys. (16)

16 (17) A triangular or comma-shaped yellow spot behind the eye; second and third vertebral scutes convex before the tubercle; head large; alveolar surface of jaws greatly expanded..... .....*Graptemys geographica*

17 (16) A boomerang-shaped yellow mark behind the eye, the median margins of which parallel each other on the dorsal side of the head and neck; second and third vertebral scutes concave before the tubercle; head relatively small; iris pale..... .....*Graptemys pseudogeographica pseudogeographica*

18 (15) Keel low and rudimentary.....(19)

19 (20) Carapace highly sculptured, with a series of conspicuous concentric rugae on each scute.....*Clemmys insculpta* (hypothetical)

20 (19) Carapace not highly sculptured, without concentric rugae..... .....Genus Pseudemys. (21)

21 (24) Alveolar surface of both jaws with a smooth ridge.....(22)

22 (23) Carapace with conspicuous transverse yellow stripes; a blood-red longitudinal stripe back of the eye; carapace emarginate anteriorly; plastron with a black spot on each scute..... .....*Pseudemys troostii* (formerly *elegans*)

23 (22) Carapace without yellow stripes; no blood red stripe behind the eye; plastron with much black mottling..... .....*Pseudemys troostii* (melanistic males)

24 (21) Alveolar surfaces of both jaws with a tuberculate ridge.....(25)

25 (26) Lower jaw with smooth cutting edge; shell greatly depressed; alveolar surface of upper jaw narrower at symphysis than on sides; outer surface of mandible arched; shell elongate, narrow..... ..... *Pseudemys hieroglyphica* (hypothetical)

26 (25) Lower jaw with serrate cutting edge; shell not greatly depressed; alveolar surface of upper jaw very wide all around; outer surface of mandible flat; shell broad.....*Pseudemys concinna*

KEY TO THE FAMILY TRIONYCHIDAE IN ILLINOIS

1 (2) Nostril circular, without a papilla projecting into it from the septum; snout very narrow, pointed; edge of upper jaw toothed posteriorly; nuchal margin of the carapace without conical tubercles; under surface of feet white or grayish, not mottled....*Amyda mutica*

2 (1) Nostril crescent-shaped, with a papilla projecting into it from the septum; snout not so narrow and pointed, being but little longer than the diameter of the orbit; edge of upper jaw not toothed posteriorly; nuchal border of carapace with a row of conical spine-like tubercles.....(3)

3 (4) Light stripes on head uniting at base of snout; an abundant species .....*Amyda spinifera*

4 (3) Light stripes on head uniting just in front of the eyes; a rare or hypothetical species in southern Illinois only..... .....*Amyda ferox* (hypothetical)

FAMILY CHELYDRIDAE

Emydidae (part) Gray 1825; 1855; Bell 1828
Steganopodes (part) Wagler 1830
Emydae (part) Gray 1831
Elodites Cryptoderes (part) Dumeril & Bibron 1835
Chelydroidae Agassiz 1857
Chelydridae (part) Gray 1870; Cope 1872, 1882

External Characters.—Shell covered with epidermal shields. Carapace relatively small, the posterior border serrated; 25 marginals. Plastron with nine shields, very small and not nearly covering the soft parts; cruciform. The abdominal scutes do not meet on the mid-ventral line, the articulation between the pectoral and femoral elements intervening, and they are further separated from the marginal scutes by a series of (usually two) inframarginals. Neck completely retractile within the shell. Head very large and massive and incompletely retractile within the shell; jaws strongly hooked. Digits moderately long, the claws four or five, the outer toes being clawless. Tail long, at least half the length of the carapace, and highly crested dorsally. Chin with paired barbels.

Osteological Characters.—Temporal region incompletely roofed over; no parieto-squamosal arch present. Squamosal widely separated from the parietal. Cervical vertebrae: second and third opisthocoelous, the fourth amphycoelous; remaining procoelous. Caudal vertebrae: all oposthocoelous. Nuchal plate with very long costiform lateral processes extending ventral to the marginals. Pubic symphysis widely separated from the ischial.

Genus Macrochelys Gray

Chelonura (part) Holbrook 1840
Macroclemys Gray 1855
Macrochelys Gray 1855; 1870
Gypochelys Agassiz 1857
Macroclemmys Strauch 1862

Three or four supramarginal scutes interposed as extra plates between the marginals and the costals in the region of the bridge; carapace with three keels which are very prominent as persistent ridges. Head very large and massive, often wider than long, and with large plates dorsally; orbits directed laterally. Alveolar surface of the jaws very broad; jaw very strongly hooked at symphysis. Tail with three series of dorsal tubercles and with many small scales ventrally. A single species is known; this is by far the largest of the fresh-water turtles, attaining a weight of over 200 pounds.

Macrochelys temminckii (Holbrook)
(Alligator snapper; loggerhead)

Chelonura temminckii Holbrook 1840
Emysaurus temminckii Duméril 1851
Macroclemys temminckii Gray 1855
Macrochelys temminckii Gray 1855
Gypochelys lacertina Agassiz 1857
Macroclemmys temminckii Strauch 1862
Macrochelys lacertina Cope 1872

DESCRIPTION.—Carapace a wide oval, the width approximately two-thirds of the length; anterior margin practically smooth; posterior border with great tooth-like emarginations, these being associated largely with the posterior three marginals. Carapace with three great persistent ridges. The median keel is mid-dorsal down the middle of the vertebral scutes; it is present on each scute but becomes increasingly conspicuous toward the posterior end. On the last two vertebrals the keel arises from the anterior margin of the scute to a high, sharp posterior knob. The lateral keels lie along the dorsal medial edge of the costal scutes; these keels are, like the vertebral ridge, relatively low at the anterior end, and become increasingly prominent posteriorly. In the case of each costal scute the keel arises gradually from the anterior margin to a high, sharp posterior knob which drops abruptly to the edge of the scute. In many cases inconspicuous, low ridges tend to converge toward the tip of the knob. The first costal is roughly triangular; the remaining costals are rectangular. Three or four (rarely five) supramarginal scutes are located between the lateral margin of the anterior three costal scutes and the adjacent marginals; this is in the region of the bridge. Plastron small, narrow, cruciform, not nearly covering the soft parts. The plastral scutes are subject to great variation both in number and in relative position. All of the usual elements are present, but the abdominals are pushed out to form the major portion of the bridge, leaving the pectoral and femoral scutes in contact in the central area. Many small accessory scutes are interspersed throughout, and often there are one or two intergular scutes present. The head is enormously large and massive, the great masseter muscles building up a mound at the posterior region of the

TEXT-FIGURE 6.—The skull of *Macrochelys temminckii*.

head from which the profile slopes in a concave curve to the protruding snout. The beak of the upper jaw projects far beyond the tip of the lower, and terminates in a sharp hook. The cutting edge of the upper

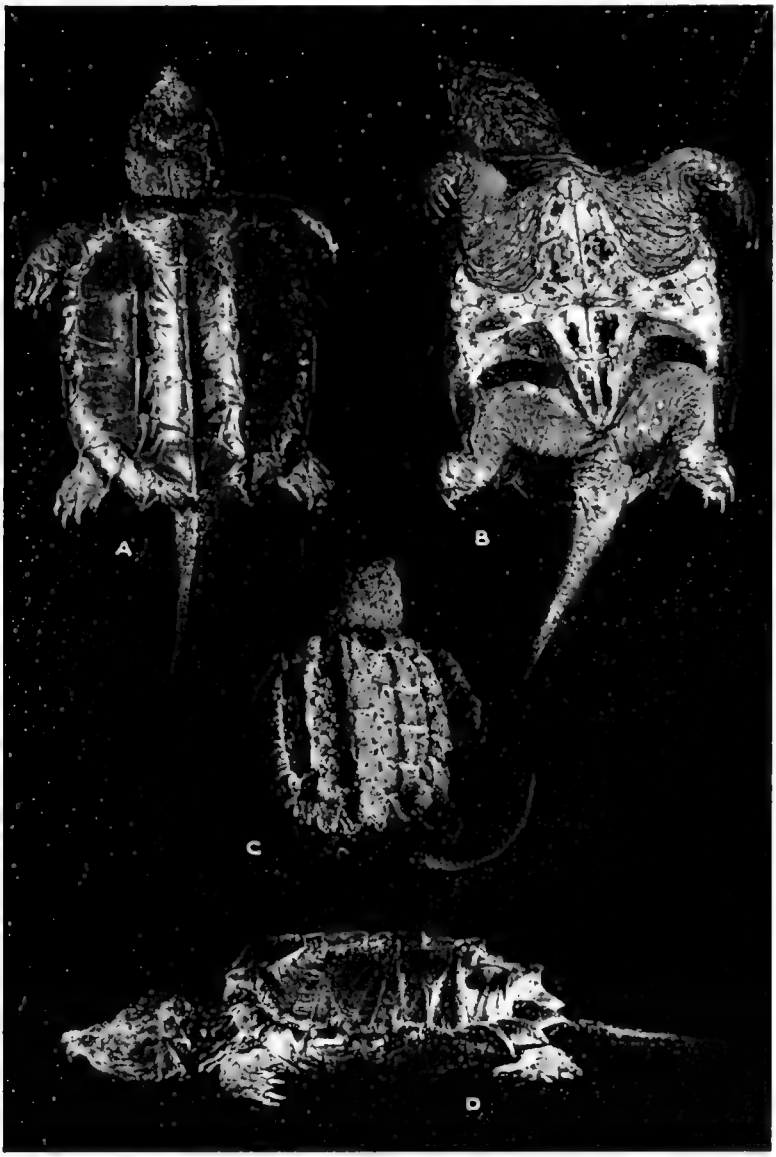


PLATE 1.—*Macrochelys temminckii: A,* Adult specimen weighing 103 pounds, dorsal view. *B,* Same individual, ventral view. *C,* Newly hatched individual (Agassiz specimen, courtesy of the Museum of Comparative Zoology), dorsal view. *D,* Adult, lateral view.

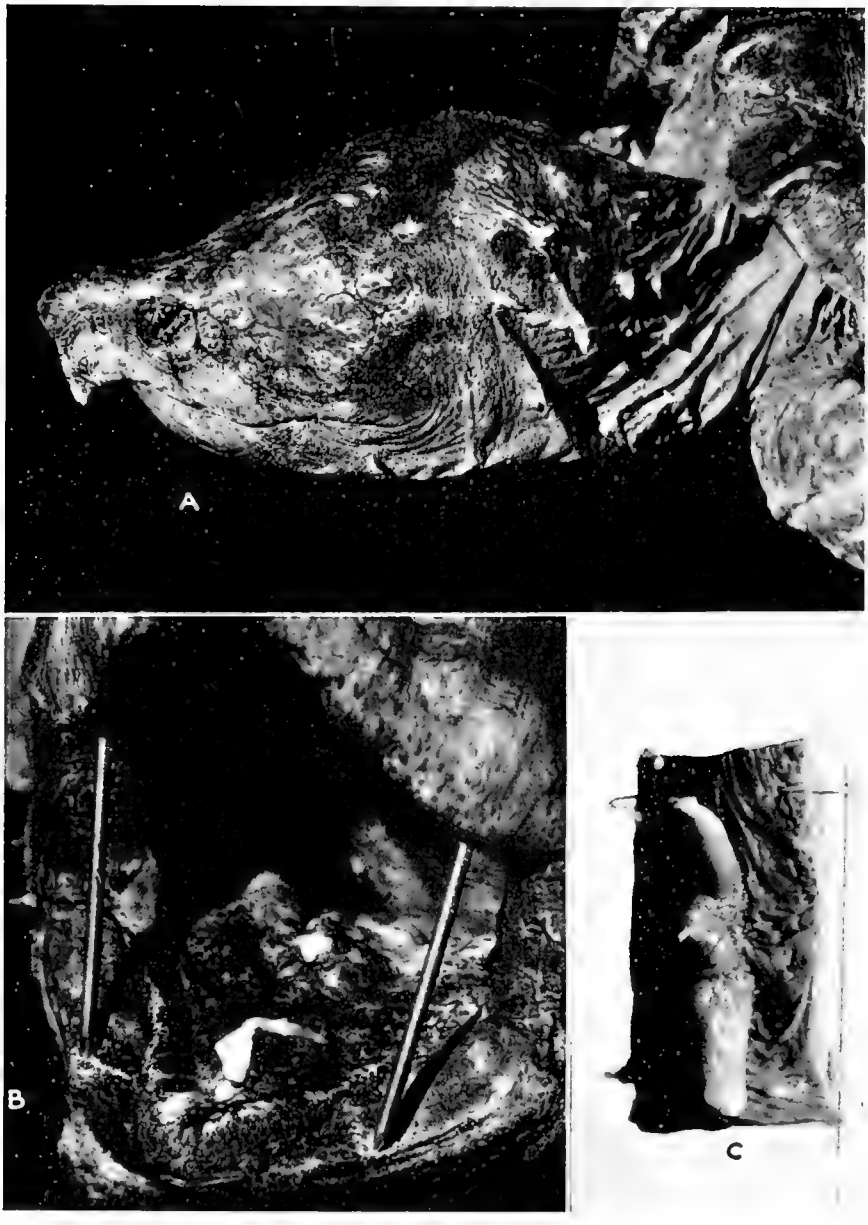


PLATE 2.—*Macrochelys temminckii: A,* Head study of a large adult. *B,* Mouth of the same individual, opened to show the "worm" on the tongue. *C,* Detail study of the "worm" on the tongue.

jaw rises just posterior to the tip of the beak, to descend again posterior to the orbit and rise again toward the angle of the jaw, giving it a wavy contour. The lower jaw is also strongly hooked, with a uniformly curved, sickle-like cutting edge. The top of the head is covered with rather large, imbedded, symmetrical plates. Neck relatively short, stocky; the skin bears many dermal tentacles of various sizes, some quite large and very conspicuous. These tentacles also adorn the chin. The tail is very long, about two-thirds the length of the carapace, and bears on its dorsal surface three low rows of tubercles; the ventral surface is covered with small, rounded scales. Limbs strong and very powerful; feet large; claws very strongly developed. Skin on the ventral surface tuberculate.

Coloration.—Carapace dark brown, without any pattern and often covered with a thick growth of algae. Plastron a paler brown, also unmarked. Head, limbs, and tail dark brown, darker above than below. Head with inconspicuous darker brown spots which are usually quite indistinct. Iris black, with radiating brown or golden brown bars directed toward the pupil.

Young.—The newly hatched young of the alligator snapper are extremely rare, and diligent search failed for a long time to reveal a single specimen in collections. At last, thanks to the kindness of Dr. Loveridge of the Museum of Comparative Zoology, the writer had the opportunity of examining and photographing the original specimen described by Agassiz (1857) and shown in the lithographs as figures 23-27, plate V, volume 2, of his work. The specimen is still in a perfect state of preservation. The newly hatched young exhibit all of the characteristics of the adult, reduced to miniature, and may be separated from the young of *Chelydra serpentina* by the same features. It differs from the adult in that the scutes of the carapace, especially the marginals, are greatly roughened by irregular corrugations and wart-like protuberances, and in the rather fancy, scroll-like formation of the first marginals. Furthermore, the skin of the young is far more highly ornamented with barbels than in the adult, these fairly covering the surface. The body proportions of newly hatched young are more nearly like those of the adult than in most other species of turtles, though the tail is relatively longer.

Sex Differentiation.—There is an insufficiency of material available to warrant any generalizations on this subject, the two specimens which the writer handled both being females.

Geographic Distribution.—The range of the alligator snapper is limited to the Mississippi River and its larger tributaries, and to a few other rivers flowing into the Gulf of Mexico from Texas to northeastern Florida. So far as the writer is aware, Quincy, Illinois, is the most northerly record of the species in the Mississippi, and it is very rare this

far north. It is a southern species, still rather common in the lower Mississippi River from central Arkansas to above the delta region of Louisiana; Hurter (1911) reports it from several localities in Missouri, but it is increasingly rare from central Missouri northward. One record outside of this circumscribed area occurs in Yarrow's *Check-list* (1882); here he records two specimens, U. S. N. M. #12345 from Northville, Michigan. A check on these specimens by Dr. Stejneger shows them to be incorrect. The National Museum never had any specimens of this turtle from Michigan, nor is any turtle listed under the number 12345.

Illinois Records.—There are but a few records of this huge turtle for Illinois, and it must be considered as a rare species within the state, for such a large animal is more than likely to attract attention if present in any numbers. Dr. H. Garman (1892) reports it from Quincy, Cairo, Grayville (Ridgway), and from Union County. The first two records, as well as the last, are for the Mississippi River; Grayville is on the Wabash River. Hay (1892) refers to Ridgway's Grayville specimen, and in his preliminary catalogue he refers to a specimen reported by Garman from "a short distance below Mt. Carmel." This is probably the Grayville specimen again. H. Garman (1889) says for the Quincy region: "This species is said by fishermen and sportsmen to occur here occasionally." To these published records the present writer adds a specimen (weight 96 pounds), from Murphysboro on the Big Muddy River, now in possession of the Southern Illinois State Teachers College at Carbondale, one specimen (weight 33 pounds) from Chester, on the Mississippi, and one (weight 103 pounds) from Metropolis from the Ohio River. The last two specimens are now in the department of zoology of the University of Illinois, in skeleton form. The distribution in the state is therefore within the Mississippi River and certain of its larger southern tributaries.

Map. 1.—*Macrochelys temminckii.*

HABITAT.—The alligator snapping turtle is a highly aquatic species. It shows a marked preference for soft sandy or muddy bottomed streams in which it may partially bury itself in the loose débris. Because of its great size it rarely ascends small streams, and in consequence it frequents normally only the larger rivers tributary to the Mississippi River, as well as that river itself. It is distinctly not a lake species. A certain amount of vegetation is greatly desired by the turtle, as this both affords protection for it and serves as an attraction for its food. Deep holes in the river are its favorite resting places, and in time of danger the turtle retreats to the deepest, darkest hole available, where it remains for a long time almost immobile. It very seldom comes to land; this fact, coupled with its deep-water retreat, is responsible for so few being seen alive.

HABITS.—Although this turtle has been known to science since 1840, its habits and life history are still to a large extent shrouded in mystery. Other than a mention of its presence in a few local lists and a very few brief references to its habits, almost nothing appears in herpetological literature concerning this most interesting species.

The alligator snapper is by far the largest of the fresh-water species of North American turtles. Exactly how big it grows is unknown, but Agassiz reports having seen one alive that weighed around two hundred pounds; Hurter (1911) gives the measurements of one that weighed 148 pounds (see Table 2). An animal so heavy, so awkward, so cumbersome, and so massively armored is essentially slow and sluggish in its movements, and the alligator snapper is not an active species. It is content to lie amid the soft material of the river bottom, or among the waving strands of vegetation, or to wander slowly over the bottom, shifting its great bulk slowly forward as it walks. Usually the carapace is heavily overgrown with algae, and this green camouflage renders the animal inconspicuous in its natural haunts. Indeed, lying half buried in the dark muck, the strands of algae waving in the current, the turtle resembles a partially submerged rock.

TABLE 2.—MEASUREMENTS OF SPECIMENS OF *Macrochelys temminckii*
(Measurements in millimeters; weight in pounds)

Specimen No.	Carapace		Plastron			Head		Tail		Weight
	Length	Width	Length	Width	Depth	Width	Circumference	Total	A-T	
1	625	533	445	...	...	...	635	...	1525	148
2	625	500	425	...	...	...	612	...	...	115
3	610	462	400	388	186	200	627	333	1303	103
4	585	448	388	362	186	175	602	...	1292	96
5	567	437	...	...	...	...	...	...	...	80
6	453	342	303	305	175	123	385	238	822	33

The turtle is almost never seen on land, probably because its bulk and weight make for easier aquatic rather than for terrestrial locomotion. Captive specimens walk with a slow, hesitant gait when they walk at all, raising their great bulk clear of the ground during progression, but settling the plastron in contact with the ground as soon as progression ceases. H. Garman (1892) quotes Ridgway in regard to a specimen taken at Grayville, Illinois, which was "large enough to walk with a man standing on its back." The Metropolis specimen which the writer had for weeks in his laboratory and which weighed 103 pounds, was capable of walking all around the room with a man weighing 165 pounds standing on the shell, and seemed to do so with almost no extra effort.

Macrochelys temminckii is extremely ferocious. Possessed of a vicious temper, its ire is easily aroused and, once angry, the turtle is a creature to beware of. The neck is rather long and the bulky head comes shooting out from its concealment within the shell with astonishing speed, and with force sufficient to throw the entire animal into the air and forward in the direction of the strike. The masseter muscles are enormous, often so bulky, in fact, as to make the head wider than it is long; this is especially true in the very large specimens. The muscles pile up on top of the posterior region of the skull and give the face a sharply concave profile. The jaws are sharp-edged and strongly hooked, and when the masseter gets into action, the lower jaw comes up with the snap of a steel trap. The 103-pound specimen was able to cut through a broom handle with one snap of the jaws, the cut surface appearing as if it had been made by a sharp axe.

Almost the only account of the habits of this species is quoted herewith from Agassiz (1857); this account has reference to a specimen from Texas, but illustrates well the disposition of the animal:

> I kept two for several years in my fish-pond. They became very tame, but finding they were eating my fish I shot one, and wounded the other with a fish-gig; but his sagacity prevented my capturing him. I fed the perch and minnows with bread, which the alligator turtle devoured greedily. One day, after he had eaten, he remained upon the rock where I had fed him, and which was only about a foot beneath the surface, where it shelved over water ten feet deep. A swarm of minnows and perch were picking up crumbs around him, apparently unconscious of his presence. His head and feet were drawn sufficiently within his shell to be concealed. His mossy shell could not well be distinguished from the projections of the rock on which he was lying in ambush. Several large bass were gliding around him, occasionally darting at the minnows. One of these, about fourteen inches in length, came within striking distance of his head, which he suddenly thrust out and fastened upon him, fixing his aquiline bill deeply into his side and belly. He immediately drew the fish under him, and, holding him down firmly to the rock with his forefeet, ate him greedily, very much as a hawk devours its prey. I drew out a large line and hook and baited it with a minnow, and threw it to him, determined to get rid of this skilful angler. He seized it; I gave a sharp jerk, and fastened it in his lower jaw. Finding him too heavy to lift by the hook upon a rock six feet perpendicular, I led him around to the lower end of the pool, where

the bank was low, and the water shallow. But, after getting him within a few feet of the edge of the water, he anchored himself by stretching forward his forefeet, and resisted all my efforts to get him nearer. He seemed to be in a furious rage, and, after several sharp snaps at the line, he broke the hook and retreated into the deepest part of the pool. I never could get him to bite at any thing afterwards; and, finding I had a design upon his life, he became very shy. I afterwards discovered him in deep water, eating the bread which fell from the shelving rock, on which he had fed for several years, but upon which he never ventured afterwards when I was near. I threw a gig at him, and fastened it in his neck; but, by a violent effort with one of his forefeet, he tore it loose and ran under the rock. I frequently saw him after his escape, but always in the act of retreating to his hiding-place, which was entirely inaccessible. I intended sinking a steel trap, baited with beef, to secure this sagacious old fellow, but my removal to the city probably saved his life. If these two turtles made a nest or deposited eggs while I had charge of them, I never discovered it. They kept all their love for one another, and their domestic affairs a profound secret from their master.

The mouth of the alligator snapper contains one of the most remarkable structures I am acquainted with, and one which deserves especial mention: this structure is the tongue. Dark yellow-gray in color, with vague, lichen-like patches and wrinkles over its surface, the tongue bears along its mid-dorsal line a white, fleshy object that strikingly resembles a whitish earthworm or slender grub. This object is elongated and tends to be round in cross-section. It is attached to the tongue over what is approximately the middle third of the length of this appendage, both ends being free. The anterior end is slightly expanded, thick, fleshy; the posterior end tends to taper and is more slender, terminating posteriorly in what looks like a small bunch of short, fleshy setae. A similar bristle arises from the mid-dorsal region of the attached third. An examination of the tongue shows that this strange object is controlled by a series of long, slender muscles which run to it just under the surface of the skin over the tongue. As to the function of this "worm" Ditmars (1908) has the only account of it:

> With its colours in perfect harmony, it [the turtle] lies motionless on the soft bottom, ready to seize, with a lightening-like dart, the suspicious fish that comes its way. While thus resting it is able to entice its prey by a remarkable appendage attached to the inside of the lower jaw, close to the region of the tongue. [As a matter of fact, it is *on* the tongue.] This is a well-developed filament of flesh, white and distinct from the yellowish mouthparts and resembling a large grub to such a degree of nicety that the popular-minded observer, seeing the object in the reptile's mouth, would declare it to be the larva of some insect. More striking, however, is the reptile's power to keep this appendage in motion, giving it the aspect of crawling about in a small, circular course. With the mud-colored shell lying close to the bottom, the jaws thrown open to a great extent, this organ is put in motion. Every other portion of the creature is as motionless as a rock. In this position of rigidity the shell looks like a great round stone and blotches of fine, waving moss intensify the deception; the big head looks like another stone, beneath which there is a cavern and in this cavern crawls the white grub, to all appearances an object dear to the hearts of finny wanderers. But woe to the luckless fish that swims within reach of those yawning jaws.

A 33-pound specimen which the writer had in his laboratory gave just one very brief exhibition of the "crawling grub" act, which was exactly as Ditmars has described it. The control which the turtle can exercise over this remarkable appendage is nothing short of astonishing.

TEXT-FIGURE 7.—The "worm" on the tongue of *Macrochelys temminckii.*

This organ is the more remarkable when one considers that there is nothing parallel to it in any other American turtle. The writer would suggest that an interesting problem lies here in working out the embryological development and origin of this unique structure. From the point of view of evolution and of adaptation, it is certainly interesting to note that the largest of all our fresh-water turtles, a species so large and cumbersome as to make fish-catching by dexterity out of the question, we find developed a fishing lure so highly perfected and so efficient as to make dexterity on the part of the turtle entirely unnecessary!

NESTING HABITS.—So far as I know, there is no account of the nesting habits in the literature, and the writer has failed entirely in obtaining any information on this phase of the life history. Mr. Viosca writes from New Orleans that he has never seen a nest, or taken either the eggs or young. The smallest specimen which his field collectors have brought in has a carapace length of 178 mm, and this specimen he kindly loaned me for measurements. Agassiz figures both the egg and the newly hatched young, but gives no account of either. I have no idea where the nest is made, or how it is dug, though probably similar in many respects to that of *Chelydra serpentina.* There is no information on the number of eggs laid, or on the season at which laying occurs, or on the period required for incubation. Thanks to Dr. Loveridge of the Museum of Comparative Zoology at Harvard, I was able to borrow, as I have said, the original material from which Agassiz figured the egg (Pl. 30,

fig. *D*) and the young (Pl. 1, fig. *C*). Search failed to yield any other egg or young of this species in any of the larger universities and museums, though perhaps some exist in institutions which I failed to contact. The alligator snapper is no longer nearly so common as it was a decade ago, and it is highly desirable that someone who has the opportunity work out and contribute to science the life history—yes, and the embryology—of this great turtle which seems to be doomed in the not far distant future to extinction.

Eggs.—The eggs are perfect spheres, covered with a hard, smooth shell of fine texture and without a glaze. They are, naturally, the largest eggs laid by our North American turtles. The egg figured by Agassiz, the photograph of which appears in this monograph, measures 36 mm in diameter.

Food Habits.—With such jaws as this turtle possesses, one would assume without any further evidence that the alligator snapper is carnivorous. Such proves to be the case. The staple diet consists of fish, and they will apparently eat any species of any size which comes within catching range. I fed a sucker weighing a trifle under two pounds to the 33-pound turtle I had in the laboratory. The turtle watched the activities of the fish for about five minutes, never taking its little eyes off the prospective victim. Then with a sudden projection of the head, the jaws closed on the side of the fish near the tail, severing completely the latter appendage and taking a slice of sucker as cleanly and neatly as if done with a sharp carving knife. This the turtle swallowed quickly, using the front foot to assist the morsel into the mouth. The remaining part of the fish was pulled apart as Agassiz has described. No doubt they would eat almost anything alive that came within reach, whether it be fish or mammal, but there is no evidence of a scavenger habit. In captivity they show a marked liking for bread and raw hamburger. Although other turtles of various pond species were kept in the same aquarium, the alligator snapper never troubled them, though they climbed and roosted all over it constantly.

Economic Importance.—So far as Illinois is concerned, the alligator snapper has little economic importance, due to its rarity. The meat is dark and strong, and has a rather offensive musky odor which might interfere somewhat with its palatability. Clark and Southall (1920) say: "It is especially abundant in the swamps of Louisiana, where an active fishery is carried on at certain seasons. It reaches an immense size. Its sale is confined chiefly to southern markets. As it is too large to ship in barrels, it is prepared for shipment by drilling holes with a breast drill through the edge of the upper and lower shells on each side of the neck and feet, running wires through and fastening it so that the head and legs can not be protruded."

PARASITES.—The leech *Placobdella parasitica* is common on this turtle. Of endoparasites, the nematode *Zanolophorus* sp. is usually abundant in the large intestine, over 250 having been taken from one specimen. Of trematodes, *Lophotaspis intenora* Ward and Hopkins 1931 has been taken in the Arkansas specimen, and *Distomum* sp. in the form of very immature specimens. An undetermined Linguatulid was found in the large intestine.

GENUS CHELYDRA SCHWEIGGER

Chelydra Schweigger 1814	Saurochelys Latreille 1825
Chelonura Flemming 1822	Cheliurus Rafinesque 1832
Rapara Gray 1825	Emysaurus Duméril & Bibron 1835

No supramarginal scutes between the marginals and costal scutes in the region of the bridge; orbit directed outward and upward; head covered with skin, not with symmetrically placed plates; tail with two rows of large scales ventrally; carapace with ridges fairly prominent in young specimens, becoming obsolete in large individuals; jaws moderately hooked.

Chelydra serpentina (Linnaeus)

(Snapping turtle; mud-turtle; hard-shelled turtle)

Testudo serpentina Linnaeus 1758	*Chelonura serpentina* Flemming 1822
Chelydra serpentina Schweigger 1812	*Rapara serpentina* Gray 1825
Chelydra lacertina Schweigger 1814	*Emysaura serpentina* Duméril & Bibron 1835
Emys serpentina Merrem 1820	*Chelydra emarginata* Agassiz 1857

DESCRIPTION.—The carapace is broad and depressed, not much longer than it is wide. It is higher toward the anterior end than in the posterior region, and the anterior margin is smooth and entire while the posterior border is coarsely and conspicuously serrated. The vertebral scutes are all rectangular, the first approaching a square. The anterior and posterior borders of the second vertebral scute are approximately equal in length, but the posterior margins of the third and fourth vertebrals are shorter than the anterior faces. In the case of the last vertebral scute the reverse is true: the anterior border is much shorter than the posterior. A vertebral keel is present in immature specimens, though no trace of it is to be found in mature individuals. The first costal is triangular; the remaining rectangular, the second being slightly the largest of this series. In young snappers and individuals approaching full growth there is a tendency toward a costal keel, which is very pronounced in the young and increasingly inconspicuous in older individuals until in fully adult turtles this keel is also absent. This costal keel, when present, arises gradually from the anterior margin of each costal scute, coming to a blunt point near the posterior margin. The marginals are 24 in number exclusive of the nuchal, which is well developed and costiform, extending long lateral arms under the anterior marginals. There are no supra-

marginals present as in *Macrochelys temminckii*. The serrations of the marginals are confined to the posterior three pairs for the most part, and there is a deep, curved notch between the caudal marginals. The plastron is very small and cruciform, leaving most of the soft parts of the ventral surface of the body exposed. The scutellation of the plastron is very definite and does not show the variation and eccentricities exhibited in the alligator snapper. Two interpretations exist for the condition found in the plastron: one holds that the anterior scutes are the humerals, the gulars being absent. This leaves an extra, elongated scute to form the

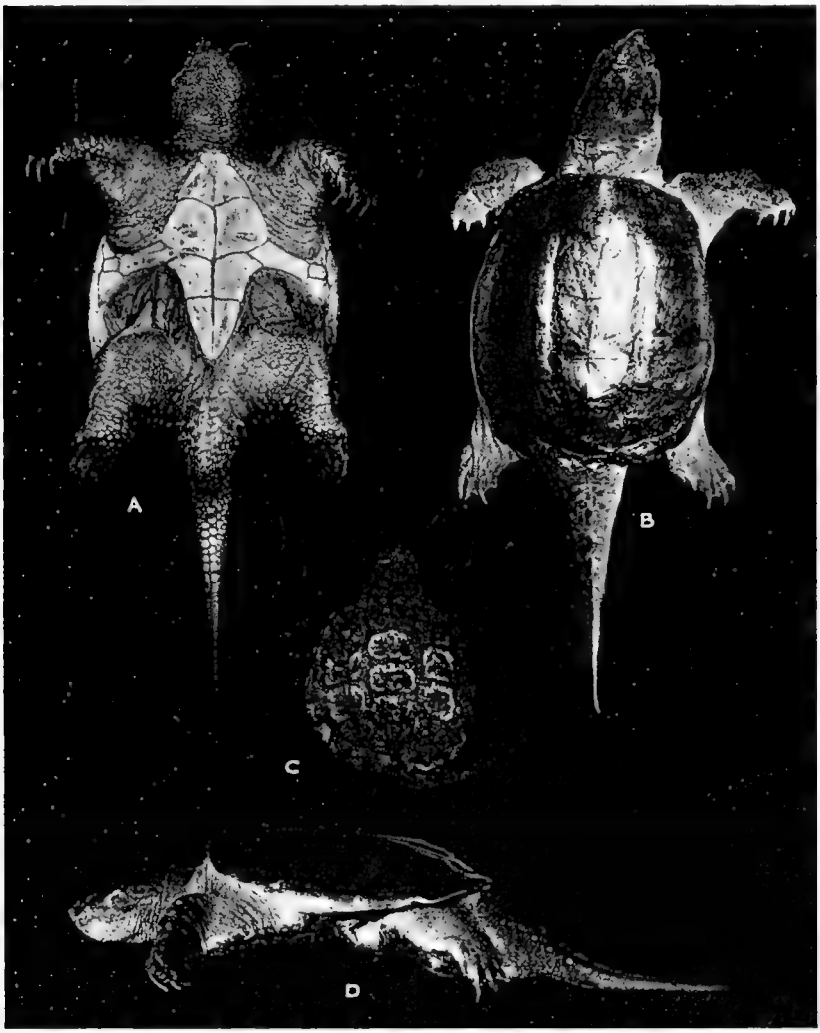


PLATE 3.—*Chelydra serpentina: A,* Adult, ventral view. *B,* Adult, dorsal view. *C,* Newly hatched young, dorsal view. *D,* Adult, lateral view.

major portion of the bridge. The second explanation is that the anterior plates are the gulars, in which case this extra plate becomes the displaced abdominal. The latter seems to the writer to be the correct interpretation of the situation. This elongated abdominal, then, is separated from the marginals by usually two inframarginal scutes, and the axillaries and inguinals are very small and inconspicuous. The pectoral scutes are the largest of the series. The head is large, triangular, and flattened dorsally. It is covered with skin and does not have the bony plates characteristic of the alligator snapper, though the ridged surface of the parietal, frontal, and postfrontal bones of the skull give the top

TEXT-FIGURE 8.—The skull of *Chelydra serpentina*

of the head a roughened appearance. The snout is pointed. Both jaws have a median tooth, posterior to which the cutting edge of the upper jaw is practically straight, though both jaws are strongly hooked at the symphysis. The orbits are directed outward and upward. The posterior portion of the head bears wart-like tubercles which increase in number and in prominence down the neck, and which are more numerous on the ventral surface. A pair of small gular barbels is located at the tip of the chin. Fore and hind limbs strong and powerful and covered with tubercles which are more prominent on the ventral surface. The anterior face of the fore limbs with strong, overlapping sharp-edged scales. The digits are fully webbed. Fingers five in number, each bearing a coarse, strong claw; toes also five, the fifth, however, being rudimentary and without a claw. The tail is long and powerful; it is covered on the ventral surface by two rows of small scales, and bears a median dorsal row of horny tubercles, each with a bony core, and on each side a row of much smaller wart-like projections.

COLORATION.—The carapace varies from olive brown to rich mahogany brown which in old individuals is often concealed beneath a thick growth of algae. In old specimens the carapace is without markings, though in immature specimens there often shows a series of radiating black lines which focus at the apex of the costal and vertebral knobs. The plastron is plain, dull yellow, or buff. The soft parts are

dark brown, darker above than below, the ventral tubercles tending to be light in color. The jaws are often streaked with black.

YOUNG.—Young specimens tend to be lighter and brighter in color than mature ones. The small snappers are very rough dorsally and show three conspicuous tuberculate ridges or keels on the carapace which grow less conspicuous as the animal matures. All keels finally disappear. The tail is much longer, proportionately, in young snappers: in newly hatched young the tail at least equals the length of the carapace, while in two-thirds-grown individuals it equals approximately two-thirds the length of the upper shell. In young individuals the color markings of the carapace are much more conspicuous, and the top of the head, eye-lids, and jaws show dark brown mottling and streaking.

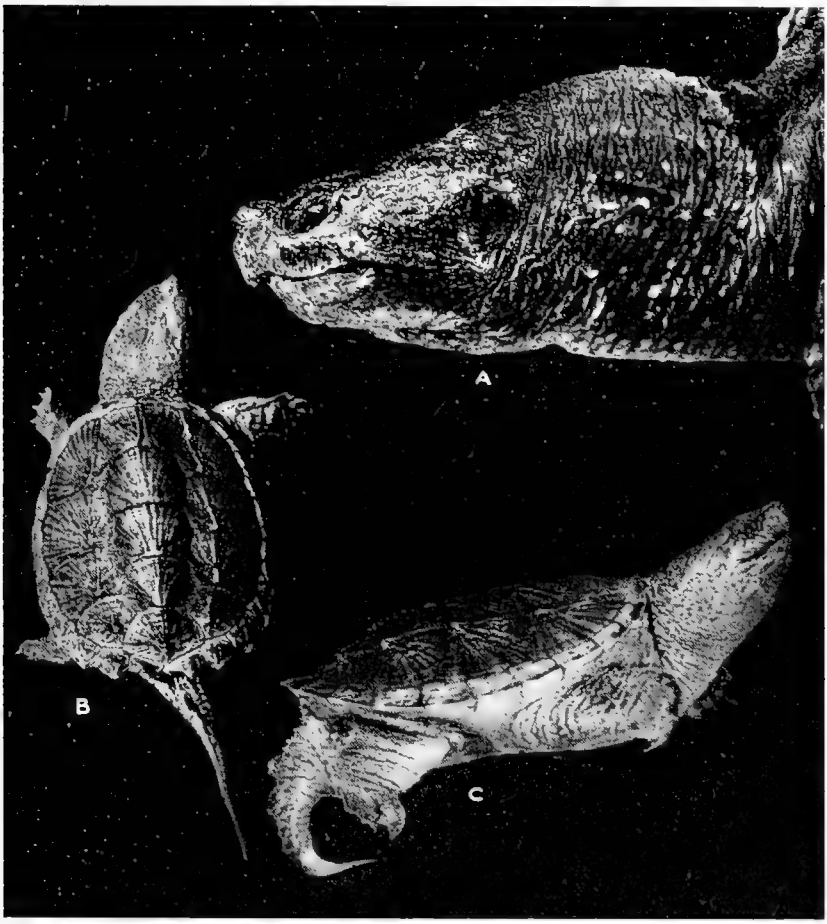
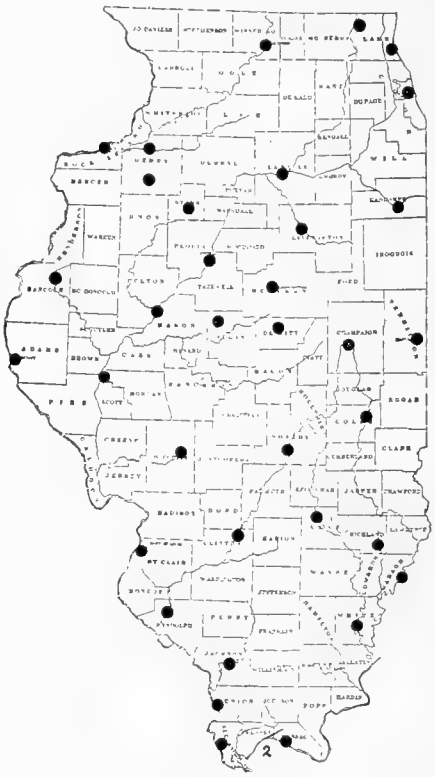


PLATE 4.—*Chelydra serpentina: A,* Head study of a large adult. *B,* Immature individual, four inches long, dorsal view. *C,* Lateral view of the same individual.

Sex Differentiation.—The anus of the male is nearer to the tip of the tail than it is in the female.

Distribution.—The common snapping turtle, *Chelydra serpentina,* has a very wide range of distribution. From central Canada (I have found the species nearly to Hudson Bay) the range is known to extend to the Gulf of Mexico and southward almost to the equator. From the east the range extends from Nova Scotia and the Atlantic seaboard westward to the Rocky Mountains. It is reported as common in South Dakota and Iowa. In Colorado it has been taken at least as far west as Boulder and vicinity. In Texas its range covers at least the eastern half of the state, and from here it is common eastward through Oklahoma, Kansas, Arkansas, and Louisiana. A closely allied species, *Chelydra osceola* Stejneger, is found in central and peninsular Florida.

Illinois Records.—*Chelydra serpentina* has a state-wide distribution in Illinois. Yarrow (1882) reports specimens in the National Museum (#9724, 12066) from Mt. Carmel; H. Garman (1892) from Nippersink Lake in Cook County; Green River at Geneseo; Quincy; Peoria; Havana; Normal; Champaign; Union County and Mt. Carmel. Hurter (1911) has specimens from St. Clair County, and Gaige (1914) from Richland County. Weed (1923) reports the snapper from Meredosia, and Hankinson (1917) reports it at Charleston. The Field Museum has specimens from Clinton (#481), Havana (1758, 2466), Fox Lake (1906), Olive Branch (2179, 2217), Meredosia (3291), and Highland Park (8108). The writer has examined specimens from the following localities: Havana, Peoria, Quincy, Champaign, Meredosia, Clinton, Danville, Robinson, Middleton, Rockford, Rock Island, Pontiac, Carlinville, Carthage, Shelbyville, Louisville, Evansville, Carlisle,



Map 2.—*Chelydra serpentina.*

Murphysboro, Carmi, Kankakee, Ottawa, Wyoming, Kewanee, Metropolis, and Horseshoe Lake in Alexander County.

HABITAT.—The common snapper, *Chelydra serpentina,* is almost entirely an aquatic species. Its favorite environment is a stagnant pond or weed-grown lake or river. Amid the vegetation the turtles prowl for their food, or lie half buried in the soft mud bottom which characterizes waters of this type. They inhabit rivers of any size; they are common in the Mississippi, and I recently caught two that weighed over ten pounds apiece in the Embarrass River in Champaign County, where that stream is less than two feet wide. Though they prefer ponds and weeds, they are, nevertheless, sometimes found in clear streams and crystal lakes, for these turtles are great wanderers. While not at all abundant in the region of central Ontario, I have found the snapper in the rocky, inhospitable, cold lakes of that province. During the summer, and especially at the egg-laying season, the snapper is wont to wander far afield, leaving the water and traveling into the grassy fields or into plowed or sandy areas. During the seasons of excessive drought, they leave their native ponds as they dry up and with apparently unerring instinct travel overland to more congenial and habitable regions.

HABITS.—Though very aquatic, the snappers are less able swimmers than other equally aquatic turtles such as the soft-shelled species of the genus Amyda. Their great bulk and weight make for poor swimming, and these turtles turn but seldom to this mode of progression. They prefer to travel by slowly and laboriously walking along on the bottom. They are often seen floating lazily near the surface of the lake, the shell entirely beneath the surface film, but the nostrils and ever-watchful eyes protruding above it. Here they paddle slowly and aimlessly about, or are content just to float and do nothing at all. When disturbed, or when they are convinced that they have been observed, the head is slowly and carefully withdrawn, so slowly as to leave hardly a ripple on the surface to disclose their whereabouts. Once out of sight, they swim to the bottom and there conceal themselves.

On land the snapper is slow and awkward in its movements. It is incapable of rapid locomotion because of its bulk but, having few enemies outside of man, it has little need for rapid locomotion. When walking through a swamp or over soft ground it leaves a very characteristic trail, consisting of a slender somewhat undulating line made by dragging the heavy tail over the ground, on each side of which may be seen the impression of the feet. So heavy are the larger turtles that these tracks are often very conspicuous. When frightened or disturbed while on land, the turtle does not withdraw within its shell, but with jaws agape, prepares for action. It follows every motion of the intruding party, pivoting

awkwardly on its hind feet if necessary so as to keep its powerful jaws always pointed at the moving danger. It stands its ground without, apparently, the slightest idea of a passive retreat. If teased, its irascible temper breaks all bounds, and the turtle flings itself violently at the intruder with such force as to carry it clear of the ground and considerable distance forward, the jaws snapping shut as the head shoots out. Once it fastens its jaws on an object, the snapper is extremely reluctant to let go again, and may be lifted clear of the ground and carried off if it makes contact with a stout stick. If unsuccessful after several attempts to reach the object of its wrath, the turtle becomes sullen and withdraws its head within the shell, keeping, however, the jaws fully open and making occasional half-hearted but dangerous lunges. The withdrawal of the head into the shell is accompanied by a hissing sound which is produced by the sudden expelling of breath as the head is violently jerked back and the capacity for storing air is lessened. Under circumstances producing anger, the snapper emits a strong, musky odor which in large specimens is both disagreeable and penetrating.

The snapper obtains its food either by waiting for it to come within range of its jaws, or by stalking it. In the first case the turtle, partially concealed by its growth of algae and half buried in the mud, waits patiently for a fish or crayfish to approach; then, with a lightning strike of its head, it seizes its victim. When stalking its prey the turtle advances so slowly that its movement is scarcely discernible. The neck is extended and rigid; the feet are lifted and advanced with all the care and caution practiced by a setter advancing upon a covey of quail. When just within reach of its victim the jaws are slowly opened. Then the strike.

The turtle is a voracious feeder, and from the time it emerges from hibernation until that condition is resumed, it feeds ravenously. Thus, as the summer wears on, we find the snapper "putting on" weight and becoming fatter and fatter until it becomes positively corpulent, great rolls of fat bulging over the edges of the all too small plastron. This stored material tides the animal over the winter months of its inactivity.

When fall comes the snapper is among the earliest species of turtle to go into hibernation. During the summer this species leads a more or less solitary existence, each individual going its own way, and while many snappers may be found in a suitable pond, the species is distinctly unsocial in its habits and not gregarious. With the approach of the cooler weather of October, and the ensuing drop in the temperature of the water, the snappers begin to congregate in places suitable for hibernation. At Meredosia, on the Illinois River, hibernation begins about the middle of October, and by the end of that month the last snapper has, as a rule, disappeared. A majority of the snappers go down into the mud at the

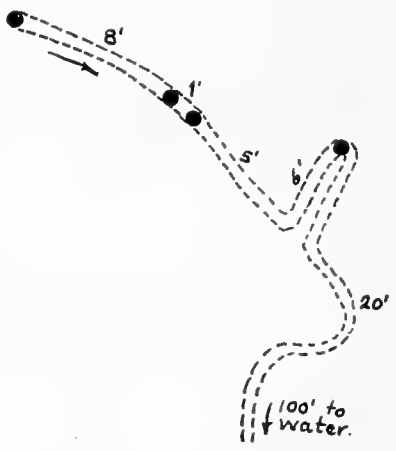
bottom of the pond or slough, usually to a depth of ten to twelve inches, where they "mud up" for the winter. Another favorite place is the burrow of the muskrat (*Ondatra zibethica*). In these burrows snappers congregate in great numbers. Clark and Southall (1920) report as much as five tons of snappers taken from such burrows at Muscatine, Iowa, in a single season. Twenty-six large snappers were taken from a single burrow, and from another runway 1420 pounds of snappers were removed. Yet another favorable site for hibernation is beneath logs partially buried in wet mud. Once they have turned in for the winter the snappers do not come out again until spring, usually about the middle of May. It is while the turtles are in hibernation that the market catches are made by turtle hunters. The method used is that of probing with a sharp stick until a turtle is located, the creature then being hauled out with an iron hook fixed at the end of a long stick. The gregarious wintering habits make wholesale catches possible, for where there is one turtle there usually are more.

In captivity the snapper is sullen and always dangerous to handle. While they eat well they never become tame as do many of the smaller species. In spite of prolonged "hunger strikes" during which they may go for months without eating, the turtles live well under artificial conditions, and may be kept for years in good condition even in crowded quarters.

Nesting Habits.—In mid-June the spirit to lay seizes the snappers and the female forsakes her accustomed watery environment to search for the right spot to deposit her eggs. I have trailed snappers for more than half a mile from water during the egg-laying season. In regard to the site chosen for the nest, I cannot refrain from inserting the admirable account by Professor Jenks, which Babcock (1919) quotes:

> Leaving my horse unhitched, as if he, too, understood, I slipped eagerly into my covert for a look at the pond. As I did so, a large pickerel ploughed a furrow out through the spatterdocks, and in his wake rose the head of an enormous turtle. Swinging slowly around, the creature headed straight for the shore, and without a pause scrambled out on to the sand. She was about the size of a big scoop-shovel; but that was not what excited me, so much as her manner, and the gait at which she moved; for there was method in it and fixed purpose. On she came, shuffling over the sand toward the higher open fields, with a hurried, determined seesaw that was taking her somewhere in particular, and that was bound to get her there on time. I held my breath. Had she been a dinosaurian making Mesozoic footprints, I could not have been more fearful. For footprints on the Mesozoic mud, or on the sands of time, were as nothing to me when compared with fresh turtle eggs on the sands of this pond. But over the strip of sand, without a stop, she paddled, and up a narrow cow-path into the high grass along a fence. Then up the narrow cow-path on all fours, just like another turtle, I paddled, and into the high, wet grass along the fence. I kept well within sound

of her, for she moved recklessly, leaving a trail of flattened grass a foot and a half wide. I wanted to stand up—and I don't believe I could have turned her back with a rail—but I was afraid if she saw me that she might return indefinitely to the pond; so on I went, flat on the ground, squeezing through the lower rails of the fence, as if the field beyond were a melon-patch. It was nothing of the kind, only a wild, uncomfortable pasture, full of dewberry vines, and very discouraging. They were excessively wet vines and briary. I pulled my coat-sleeves as far over by fists as I could get them, and with the tin pail of sand swinging from between my teeth to avoid noise, I stumped fiercely, but silently on after the turtle. She was laying her course, I thought, straight down the length of this dreadful pasture, when, not far from the fence, she suddenly hove to, warped herself short about, and came back, barely clearing me, at a clip that was thrilling. I warped about, too, and in her wake bore down across the corner of the pasture, across the powdery public road, and on to a fence along a field of young corn. I was somewhat wet by this time, but not so wet as I had been before wallowing through the deep, dry dust of the road. Hurrying up behind a large tree by the fence, I peered down the corn-rows and saw the turtle stop, and begin to paw about in the loose soft soil. She was going to lay. I held on to the tree and watched, as she tried this place, and that place, and the other place—the eternally feminine. But *the* place, evidently, was hard to find. What could a female turtle do with a whole field of possible nests to choose from? Then at last she found it, and whirling about, she backed quickly at it, and, tail first, began to bury herself before my staring eyes.



TEXT-FIGURE 9.—Showing the wandering of a female *Chelydra serpentina* in search of a nesting site; black dots indicate holes dug.

If the nest site be a vertical bank of soft material, the turtle backs into it, causing the loose material to fall upon her carapace until she may be completely hidden from view. When she comes out, climbing uphill to do so, the material on her back slides down into the hole and buries the eggs. If digging into a flat field, the hole is scratched out with the claws, the turtle backing into it as the digging progresses. The nest itself is a chamber considerably wider than the tunnel leading down to it from the surface, and is an expansion to one side of the axis of the tunnel. It often lies a foot below the surface, the angle of the tunnel being between 45° and 60° with the horizontal. In this subterranean chamber the eggs are laid, often in two or three layers, with no dirt between the strata. Occasionally odd nesting sites are chosen, such as the cinder area between the tracks of a railroad right of way, where I once saw one digging.

Eggs.—The snapping turtle usually lays her eggs early in the day and is seldom found laying after ten or eleven o'clock in the morning. These eggs are perfectly spherical and are covered with a tough, white shell. So strong is this shell membrane that the egg will bounce several times if dropped on a hard surface. In a fresh egg one pole is white, the other pinkish, and the egg contains a very large air chamber occupying nearly half the space within the shell. There is a great discrepancy in literature as to the number of eggs laid by a single female in her nest. Thus Surface (1908) says that "from twenty to one hundred may be laid in one nest, according to the size of the female," while Hay (1892) gives the number as "from 30 to 70." The writer doubts very much that these high numbers represent the egg complements of one female, since, after examining a great many female snappers, there is every evidence that the average number is far below this. From 20 to 30 eggs constitute a normal clutch, and when a much larger number is reported, the conclusion must be drawn that more than one turtle is responsible. Since the turtle has, at the time of laying her eggs, not only the eggs to be laid that season in her body but also the growing eggs for the succeeding season, care must be taken in counting the eggs in the body cavity not to confuse clutches which will mature during different years. In size the eggs measure about 33 mm on an average. The incubation period is not known. The young snappers extricate themselves from the egg by means of a tiny "egg tooth" on the tip of the snout, with which they pick away the shell.

Food Habits.—The common snapper is largely a carnivorous species A list of the animals upon which it normally preys would run through many of the classes of animals, both vertebrate and invertebrate, which are available for it to feed upon. Among the vertebrates, fish, frogs, tadpoles, salamanders, snakes, birds, and mammals are commonly found in the digestive system, while among the invertebrates, snails, insects, insect larvae, and crayfish are predominant. Fish and crayfish probably make up the bulk of the food, because both of these animals are common in the habitat selected by the snapper. Aside from these items, the turtles are scavengers and will clean up any carcasses or meat thrown into the water in which they live. Thus I have found bones of animals such as dogs, cats, and rabbits in the stomach, as well as pieces of bones of much larger animals showing the saw marks of the butcher. The marvel is how these great masses are eventually passed from the digestive system without tearing it to shreds. All food taken is swallowed under water and apparently the turtle is unable to swallow unless beneath the surface. Young ducks are often captured, the turtle grabbing them by their submerged legs and dragging them under water, there to drown and be

pulled to pieces by the hawk-like beak. In spite of their preëminently carnivorous habits, occasional individuals are found whose stomach is full of grass, leaves, and other vegetable matter. Sometimes this represents aquatic vegetation, but more often terrestrial plants. In other words, when the turtle is out of water it cannot obtain its usual animal food, yet it is adaptive enough to subsist on a vegetable diet. The young feed on insect larvae which they find buried in the mud.

Economic Importance.—That the snapping turtle destroys a great many fish is a fact. The list of species identified includes such forms as the crappies, the sunfishes, perch, bass, suckers, carp, and a large variety of minnows. In spite of this, in many localities the species of fish eaten are of little or no economic importance to man. Along the Illinois River these turtles, caught in hoop nets, often destroy a considerable number of valuable fish before the fishermen arrive to take up the nets; also they are powerful enough in some cases to tear their way out of the net, leaving a fine exit for the captive fish. Their destruction of young ducks, both of domestic and wild species, is often serious. Since wild ducks and

Table 3.—Measurements of the Snapping Turtle, *Chelydra serpentina*
(Measurements in millimeters; weight in grams)

Specimen No.	Carapace		Plastron			Head	Tail		Weight	Sex
	Length	Width	Length	Width	Depth		Total	A-T		
1	232	187	160	156	94	50	171	156	2450	♀
2	327	271	231	230	122	71	270	190	5906	..
3	59	50	40	36	28	14	55	45	58	..
4	320	272	224	220	110	62	245	195	5783	..
5	202	170	144	217	85	45	170	139	1606	..
6	272	231	197	...	100	61	200	172	2521	..
7	300	256	219	...	...	...	275	...	....	..

birds of similar habits tend to breed in the proximity of weedy lakes and take their broods of young into such ponds immediately after hatching, and since such ponds form the natural habitat of the snapper, this depredation is greater than it would at first appear. In Ontario I have seen snappers catch young loons.

Set against these items which must be checked as detrimental from the point of view of man, we have the scavenger habits of the turtle and its economic importance as a food animal. The snapper will eat any dead animal matter it comes across—including fish left on a stringer in the lake by careless fishermen. Since their capacity seems almost unlimited, they play an important part in the "clean-up" of waters polluted by waste material of this nature. As food for man the snapper affords

an easily obtained and usually available supply of wholesome, nutritious meat. The meat is likely to be rather "strong" and, so far as I personally am concerned, one must acquire a taste for turtle meat. A large individual yields a surprising quantity of flesh: one can figure on obtaining an amount of eatable meat equal to about one-half of the total weight of the turtle. The market value is about twenty-five cents a pound, dressed, and the turtle, therefore, becomes one of the cheapest of the available meats. In spite of this fact, the market for snappers has steadily decreased during the last decade.

Parasites.—The snapper is almost always heavily infested with the leech *Placobdella parasitica,* and I have removed 44 specimens from a twelve-pound turtle taken at Meredosia. The leeches congregate especially in the angles under the fore and hind limbs, about the anus, and around the eye sockets. Nematodes of the species *Spironoura chelydrae* are often extremely abundant in the intestine. The trematode *Allossostoma parvum* Stunkard has been taken from snappers at Urbana, as has the trematode *Camallanus trispinosus* (Leidy).

Miscellany.—There is on hand an unusual carapace of *Chelydra serpentina,* taken from the Rock River at Rockford in 1927, now the property of the State Natural History Survey. This carapace presents a most weird appearance. In the first place, it is highly domed like a derby hat; in the second place, it is wider than it is long. It is perfectly formed as to osseous elements and normal as to scutes, excepting only that the costal scutes are greatly elongated to compensate for the doming. The following measurements of the carapace are of interest:

	Freak	*Normal*
Length	221 mm	313 mm
Width	257 mm	256 mm
Height	128 mm	84 mm

Regarding this specimen, Dr. David H. Thompson of the Natural History Survey, who saw the turtle alive, writes: "This turtle was caught by some boys in the fishway of the Oregon dam on the Rock River in June, 1927. It was kept alive for several weeks at Rockford, where I saw it and had the opportunity of watching its unusual behavior. The head and legs were of a size in keeping with a very much larger individual. When it walked on land it did not drag its plastron on the ground as is usual, but walked upon its tip-toes, with the body carried two or three inches clear of the ground. This habit of walking, together with its very long legs and neck, gave it a very grotesque appearance."

FAMILY KINOSTERNIDAE

Kinosternon Spix 1824
Emydidae (part) Gray 1825; 1844; 1855
Steganopodes (part) Wagler 1830
Emydae (part) Gray 1831
Elodites Cryptoderes (part) Duméril & Bibron 1835
Cinosternidae Agassiz 1857; Cope 1882
Chersemyda (part) Strauch 1862
Chelydradae (part) Gray 1870

External Diagnosis.—Carapace elongate, oval, either highly convex or relatively flat; usually smooth, but keeled in one species; marginals 23 in number, not flaring. Nuchal scute small dorsally, but larger ventrally, underlying the adjacent marginals. Plastron moderately large, rounded anteriorly and either truncate or shallowly emarginate posteriorly. Dermal skeleton covered with epidermal scutes. Plastron with 10 or 11 scutes, the anterior pair coalescing into one in some species; anterior lobe movable upon a fixed central portion. Pectoral scutes widely separated from the marginals. Axillaries and inguinals, together with the wings of the abdominals, forming the bridge. Neck completely retractile within the shell. Head large, pointed, with a large rhomboidal plate dorsally and with a projecting snout. Lower jaw terminating in a sharp point. Eyes located well toward the anterior end of the head. Digits moderately well developed; webbed. Five fingers and four toes bearing claws. Tail terminating in a nail.

Osteological Diagnosis.—Plastron composed of eight bones, the entoplastron being absent. Nuchal plate produced into costiform processes underlying the marginals. Temporal region not roofed over; no parieto-squamosal arch present. Pubic-ischial symphyses in contact, separating two foramina. Phalanges with condyles. Caudal vertebrae procoelous.

Genus Sternotherus (Gray)

Sternotherus Gray 1825
Kinosternon (part) Spix 1824
Sternothaerus Bell 1825
Cinosternon (part) Wagler 1830
Staurotypus (part) Duméril & Bibron 1835
Kinosternum (part) LeConte 1854
Armochelys Gray 1855
Cinosternum Agassiz 1857
Ozotheca Agassiz 1857
Goniochelys Agassiz 1857

Plastron narrow, approaching cruciform; posterior lobe not more than one-half the width of the aperture and longer than the anterior lobe; lobes but slightly movable and incapable of closing the aperture. Wings of abdominal scutes narrow, not grooved posteriorly; much cartilaginous material between certain plastral elements centering around the abdominals. Carapace highly arched or domed, unkeeled; first vertebral scute in the form of a long, narrow triangle.

Sternotherus odoratus (Latreille)

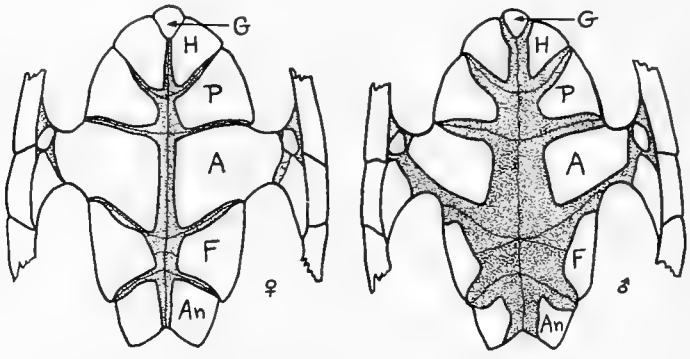
(Musk turtle; stink-pot)

Testudo pensylvanica, B., Schoepff 1792
Testudo odorata Latreille 1802
Testudo glutinata Daudin 1802
Emys odorata Schweigger 1814
Terrapene boscii Merrem 1820
Terrapene odorata Merrem 1820
Cistuda odorata Say 1825
Sternothaerus odoratus Bell 1825
Sternothaerus boscii Bell 1825
Kinosternum odoratum Bonaparte 1830
Kinosternon odoratum Gray 1831
Staurotypos odoratus Duméril & Bibron 1835
Kinosternum guttatum LeConte 1854
Aromochelys odorata Gray 1855
Ozotheca odorata Agassiz 1857
Ozotheca tristycha Agassiz 1857
Goniochelys triquetra Agassiz 1857
Aromochelys guttata Strauch 1862
Aromochelys tristycha Strauch 1862
Cinosternum odoratum Boulenger 1889
Aromochelys carinata (part) Garman 1892
Aromochelys odoratus Davis & Rice 1883

DESCRIPTION.—Carapace long and somewhat narrow, widest posteriorly through the seventh marginal scute, the curvature being almost alike at the anterior and posterior ends. The shell is highly arched, rounded, and in old individuals smooth, but there is occasionally a faint trace of the vertebral keel which is prominent in young individuals. The nuchal scute is very small, hardly larger in the adult than in a newly hatched young. The first vertebral scute is greatly elongate, triangular, the apex pointing backward; the second, third, and fourth vertebrals are more or less hexagonal or shield-shaped, the fourth being the smallest of the series. The anterior margin of the last vertebral scute is approximately half as wide as its posterior margin. The costals are enormously large, covering the greater portion of the carapace, the posterior lateral angles of the first three curving backward. The marginals are elongate and narrow, with the exception of the last pair and the caudals, which two pairs are fully twice the width of the other marginals. The plastron is small, not nearly covering the soft parts, and is rounded anteriorly and truncate posteriorly. It differs from the plastron of other Illinois turtles in that the adjacent (paired) scutes do not touch each other, being separated by a cartilaginous mass of varying diameter. The single gular is very small; the humerals are small, the pectorals being about twice their size. The abdominals are by far the largest of the ventral scutes. The narrow bridge is formed by a small wing of the abdominal and the axillary and inguinal scutes which intrude themselves between the abdominals and the marginal plates so that these do not make contact. There is a movable transverse hinge between the pectoral and abdominal scutes, and a less movable hinge posterior to the abdominals. Head large, the snout projecting; the jaws are strong, the lower being hooked. Two, three, or four gular tentacles at the tip of the chin, and another pair, more widely separated, farther back on the neck, which is very long.

The feet are large, the toes webbed; digits 5-4, the claws small and short. The anterior border of the front legs bears three elongate transverse scales; the posterior limbs exhibit a small series of similar scales on the heels. The skin is everywhere covered with small fleshy papillae.

Coloration.—Carapace brownish olive or dark "horn" color above, darkest toward the mid-dorsal line and shading into yellowish on the marginals. Usually uniform in color, but sometimes exhibiting dark transverse lines especially on the costals. Often the carapace is so overgrown with algae as to completely obscure the markings. Plastron yellowish, sometimes with indications of dark brown blotches or lines



Text-figure 10.—Plastron of male and female *Sternotherus odoratus* to show sex variation in the amount of cartilage (stippled). *A*—abdominal; *An*—anal; *F*—femoral; *G*—gular; *H*—humeral; *P*—pectoral.

along the sutures, the fleshy or cartilaginous parts between the scutes with a decidedly pink tint. Head and neck dark olive. A short yellow stripe extends along the edge of the snout to the anterior margin of the eye and continues vaguely posterior to it, to terminate in an irregular yellow spot above and behind the ear. A second stripe begins just ventral to the nostril and extends backward along the side of the neck, passing below the tympanum. The extent of the first mentioned stripe shows great variation, and the second stripe may occasionally be absent. The lower jaw is mottled with yellow. The papillae are for the most part yellow or orange against the dark olive of the skin.

Young.—In young specimens just hatched (carapace length 23 mm), the carapace is rough and exhibits three distinct and conspicuous keels: one mid-dorsal and extending down the vertebral scutes, and a pair of lateral keels along the upper third of the costal scutes. In arrangement these are not unlike those of the young snapping turtle *Chelydra serpen-*

tina; indeed, young *Sternotherus odoratus* are more often than not confused with this species. The surface of the carapace is roughened by tiny irregularities which disappear with age, giving it a sandpaper-like appearance. Carapace highly arched and nearly black in color. Plastron grayish, mottled with pale yellow; a pale yellow spot on the mid-ventral

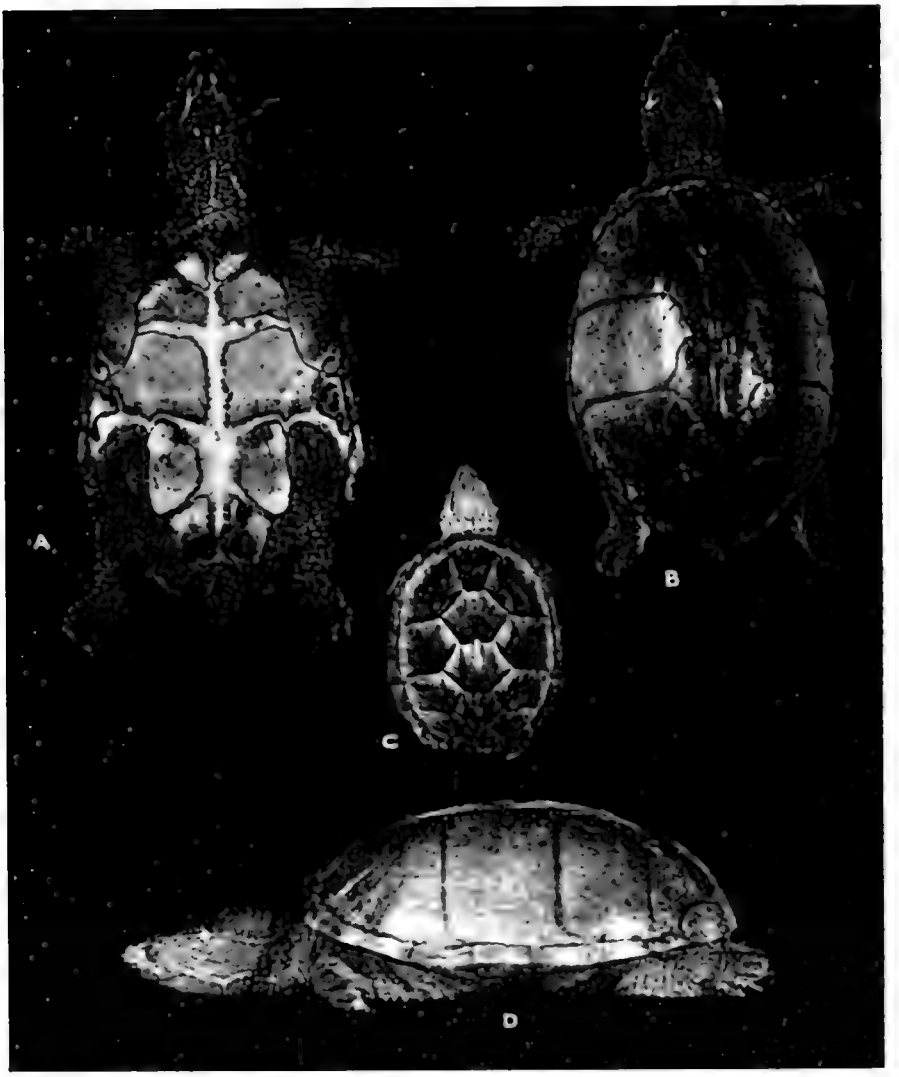


PLATE 5.—*Sternotherus odoratus: A,* Adult female, ventral view. *B,* Dorsal view of the same individual. *C,* Young specimen, three and a quarter inches long, dorsal view. *D,* Adult, lateral view.

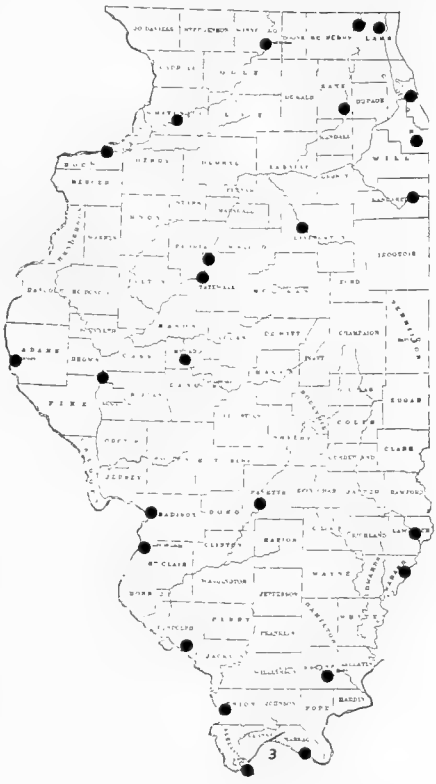
surface of each marginal scute. In young 42 mm long the mid-dorsal vertebral keel is still very prominent and highly notched, but the costal keels are reduced to a terminal nob at the posterior margin of each scute. Both carapace and plastron are now a lighter brown and the plastron shows a greater amount of yellow mottling. The stripes on the head are usually very conspicuous at this stage of growth.

Sex Differentiation.—The tail is much longer and stouter in the male than in the female, and usually bears a blunt terminal nail. The dorsal surface of the tail in the male is smooth, while there is a mid-dorsal row of tubercles down the tail of the female. The plastral scutes of the males are smaller than those of the females of the same size, the areas between the scutes in the males being in consequence larger (see Text-fig. 10). The male exhibits two oval patches of scales on the inner surface of the hind limbs, one above and one below the knee, these areas being absent in the female. In cross-section, the plastron of the male is concave, that of the female flat or slightly convex.

Geographical Distribution.—*Sternotherus odoratus* is a species which has a very wide distribution over the United States. Its range extends over the entire eastern portion of the country to Maine and Massachusetts; westward it extends to western Missouri and Texas. The northern limit is southern Canada, from which it extends southward to and including Florida. Over the greater part of this vast range the species is common, becoming distinctly less abundant in Missouri and northeastern Texas.

Illinois Records.—This species is reported by H. Garman (1892) from Deep Lake in Lake County; Chicago; Peoria; Little Fox River at Phillipstown; and from Running Lake in Union County. Hurter (1911) records it from Madison and St. Clair counties on the Mississippi River; Weed (1923) from Meredosia on the Illinois River; Hay (1893) from Mt. Carmel on the Wabash. Blanchard (1924) reports it from Carrier Mills in Saline County, and Yarrow (1882) records a specimen (#14) in the U. S. National Museum from Chicago. In the Field Museum in Chicago are specimens from Momence (#323), Havana (#1754), and Homewood (#4092). The writer has examined many dozens of specimens from the following localities: Meredosia, Havana, Peoria, Rockford, Rock Island, Prophetstown, Aurora, Pontiac, Petersburg, Vandalia, Metropolis, Cairo, Mt. Carmel, Chester, Lawrenceville, and Quincy. In so far as the distribution within the state is concerned, the species is decidedly more abundant in the southern half than in the northern, and more common toward the east than toward the west. In terms of the number of individuals per given area it is more abundant in the Illinois River than in any other large stream within the state.

HABITAT.—This little species is highly aquatic in its habits, showing a marked preference for the smaller lakes and streams. The ideal habitat is a small, slow-moving, muddy-bottomed stream having an abundance of aquatic vegetation, or a semi-stagnant slough. They tend to avoid clear-water lakes, as well as all gravel or rock-bottomed waters. Small vegetation-choked lakes are an ideal environment, and in such localities they pick the deeper portions, seldom coming to land. So far as streams are concerned, the species tends to avoid the larger rivers, as is well illustrated by the situation at Meredosia on the Illinois River. While *Sternotherus odoratus* is found in the main channel of the river to some extent, the numbers in such a locality are as nothing when compared to the abundance of the species in Meredosia Bay.



MAP 3.—*Sternotherus odoratus.*

HABITS.—Probably the most aquatic of our local turtles, not excepting the soft-shells (Amyda) or the snapper (Chelydra). So aquatic is the musk turtle that it seldom comes to dry land, being content to wander about amid the bottom mud and vegetation of the lakes and streams. This tendency accounts for the overlooking of the species by observers in many localities where it is really common, for, unless one goes out looking for it, one is likely never to suspect its presence. For eleven summers the writer collected in the clear-water lakes of southeastern Wisconsin without ever seeing a musk turtle. Early one June morning he found one crossing the road coming from a swamp area. Later in the day he seined a pond in the middle of the swamp and captured 52 specimens in half an hour. The puddle was alive with them, their pointed snouts poking through the vegetation-covered surface, yet all but invisible amid the tangle of reeds and rushes. On a half-submerged log eight specimens were basking in the sun, only to disappear into the water at the first hint of danger. Where the species is found it is likely to be abundant, but

since it shows such a definite environment preference, it is likely to be of very local distribution.

The musk turtle is well adapted to its aquatic habitat. The feet are large, the toes well webbed. It can swim rapidly and strongly when necessary, but it prefers to wander aimlessly about on the bottom, poking about among the plant stems and bottom débris in search of food. It walks slowly along on the bottom, moving its head from side to side to peer under a dead leaf or to push half its body into the soft mud under a piece of rotten wood. The very long neck is highly mobile and the strong jaws snap voraciously and retain whatever food they find. When not wandering, the musk turtle may remain for hours at a time entirely motionless under a log, the head partially retracted. At such times the "moss" covered shell blends admirably with the bottom vegetation and affords the turtle what little protection it needs in its naturally somewhat opaque and dark surroundings.

Its highly aquatic adaptation has been shown by Ditmars (1908) who kept the musk turtle in a deep aquarium for several weeks. Here the turtles swam and crawled about in entire comfort, paddling to the surface occasionally for air, yet having no out-of-water footing. Under similar conditions almost every other species (except probably *Chelydra serpentina*) will die of exhaustion in a few days. The writer carried this experiment further, and kept *Sternotherus odoratus* under similar conditions for eighteen weeks without harm to the turtles.

The musk turtle is very timid by nature. The least disturbance sends it scurrying off its basking log, to which it will not return for hours after the danger is past, and then only after a prolonged, careful scrutiny of the situation from its nearly submerged position. When disturbed while on land, the head is retracted quickly, the legs drawn in, and the tail curled tightly under the shell. Thus it remains motionless for a long time. Eventually the head begins slowly to protrude, so slowly that its movement is barely perceptible. Then, after watching carefully for the least inkling of danger, the legs and tail are brought forth and the turtle resumes its journey. The manner of withdrawing within the shell is peculiar and is described by Agassiz (1857) as follows:

> The forelegs are carried round before the body; the elbow, somewhat raised, is carried directly back by the side of the head and neck into the scapular arch, the skin at the same time rolling off toward the feet and shoulders and leaving its muscles as naked as those of the neck and scapular arch about it; the forearm is turned back, but not quite on to the humerus; the hand is either laid in against the head and neck, or turned back on to the humerus. . . . The hind legs are withdrawn nearly horizontally, the knees like the elbows, though in a less degree, stripped of the skin; the foreleg is turned back upon the femur, and the foot again turned forward upon the foreleg. The tail is turned to one side. The head is drawn back to within the scapular arch, the skin rolling off from the neck, but not folding together before the head, as in the Emydoidae.

If annoyed or molested to a point where its slow anger is aroused, the turtle snaps viciously at any object within reach. The jaws are opened wide while the head is still completely withdrawn; then the head and long neck are slowly projected and moved toward the offending object. A sudden snap over a short distance, and the jaws close upon whatever disturbing element is within their reach. If they close upon the object of their wrath, the turtle attempts to retract the head again under the shelter of the carapace, still holding to the captured object.

When handled, or when its anger is awakened, the turtle emits a strong fetid or musky odor, which is responsible for the common name of "musk" turtle. This is due to a secretion emitted by a pair of well-developed glands which underlie the anterior lateral angles of the carapace. The material secreted is highly volatile, and the odor characteristic of the kinosternid group permeates the atmosphere for a distance of some feet. *Sternotherus odoratus* probably has these glands developed to a greater extent than any other member of the family; certainly the odor emitted is stronger than in any other species.

The males bear "stridulating organs" on the hind leg, as has been mentioned. By rubbing these patches of horny tubercles together, they are reported to make "stridulating sounds," but the present writer has not observed this performance. Whether this is associated with the mating phenomena is not known.

Nesting Habits.—There are but a few descriptions available of the nesting habits of this turtle, and these vary considerably. The summer work of Mr. Combs at Meredosia yielded no data on this subject, but the writer has twice seen the nest-digging in southeastern Wisconsin. In one instance the nest was in the sand about 150 feet from the pond in which the turtle lived. At 6:20 on the evening of June 22, the female came slowly out of the water and paused for about ten minutes at the water's edge while she looked about with her head raised to the fullest extent. Satisfied that all was well she headed off through the tall reeds straight for the patch of sand; there was no uncertainty in movements. Arriving here she paused again for a few minutes, her head again erect. Then she walked deliberately out to nearly the middle of the open area and began to dig. The process was slow and leisurely, the dirt being scraped away with alternating strokes of the hind feet, and piled up into two small heaps on each side of the hole. When the depth of the hole was about equal to the length of the carapace, she deposited her eggs therein, after which she filled in the hole again with her hind feet and headed straight back to the water. The time required for the digging, laying, and covering was forty-seven minutes, during which time she paid no attention to anything around her. When I dug the nest out I found it to be semicircular in shape, the roof arched to conform to the curva-

ture of the carapace. The hole descended at an angle of 50° to a depth of four and a half inches, and contained three eggs. The second case was similar in all particulars save only that this time the nest was dug in the grass of a lawn a hundred feet from the water and fifty feet above it on a hilltop. Here the ground was much harder; the nest was but two and three quarters inches deep, yet required nearly an hour for excavation. A distinct variation in nesting habits is reported by Eigenmann (1896) for the Turkey Lake country of Indiana: "The eggs are laid in the rotten wood in the tops of stumps standing in the margin of the lake. The turtles were frequently found in the tops of these stumps, and some of their eggs wedged as far into the rotten wood as the finger could bore. Rotten logs removed some distance from the water are also favorable places for egg-laying, and in a mucky place of small area at the edge of the lake 362 eggs were taken at one time. While passing along a wheat field some turtles were seen coming from it, and on inspection it was found that they had deposited their eggs in the ground in depressions made by a cow while walking over the ground when it was soft. Still other eggs were found in bundles of rushes drifted together." That this stump-utilization habit is unusual is indicated by Eigenmann's further statement: "The present large number [of stumps] is due to the rising of the lake after the building of the dam and the subsequent cutting down of the trees whose boles had become submerged. The habit of laying eggs in stumps cannot be much more than fifty years' duration." Quite frequently the writer has found stray eggs lying about in swamps, indicating that the female had passed an egg without any attempt at nest-building at all. Such eggs never hatch.

From circumstantial evidence at hand it would seem that the musk turtle lays either early in the evening, at night, or very early in the morning. Agassiz reports seeing it laying at half-past eight in the evening. The normal laying season in Illinois seems to be late in June. In southeastern Wisconsin I once found the nest of *Sternotherus odoratus* containing two eggs with very young living embryos within, on September 22. Whether this is a freak, or whether there may perhaps be a second laying season under particularly favorable climatic conditions, is not known. Neither is it known whether these young turtles would have hatched that fall or have "wintered" within the egg. Agassiz reports *Cinosternum pensylvanicum (= K. subrubrum)* laying one egg on October 7 which was, however, apparently unfertilized.

Eggs.—The normal egg complement is three, though occasionally four or five eggs are encountered. Babcock (1919) reports as many as seven in a clutch. The eggs are of an elongated elliptical shape, the ends equally rounded, and are covered with a hard, smooth shell of very fine

texture. This shell is exceedingly brittle. The average of 112 eggs measured by the writer shows their size to be 27.6 mm in length by 14.8 mm in width. Of the period of incubation nothing is known. The chief enemies of the eggs of this turtle are the skunk and the raccoon. Both of these animals have a decided fancy for turtle eggs, and the writer has found dozens of nests which have been dug out by them, the discarded eggshells lying about the excavation.

Food Habits.—*Sternotherus odoratus* is primarily a carnivorous species, feeding principally upon aquatic insects, tadpoles, worms, mollusks, crayfish, and occasionally upon small fish. Insects such as grasshoppers and beetles are often found in the stomach contents, these probably being individuals that fell into the water and were snatched from the surface film by the ever-watchful turtle. Snails and clams, always species of small size, are often eaten. The species of fish which have been taken by the writer from the stomachs examined have always been "minnows": *Umbra limi, Notropis whipplii spilopterus, Poecilichthys* sp., *Notemigonus crysoleucas auratus.* Fishermen who practice their art in the shallow, weedy lakes, often catch these turtles on their hooks, particularly if still-fishing with live worms or grubs.

Economic Importance.—This species, the smallest of our native Illinois forms, has practically no economic status one way or the other. Their flesh is never eaten because of the musky flavor, and they have but little tendency toward the habits of a scavenger. The fish they eat are of no consequence to anyone. They have been reported to eat fish eggs, but this certainly is a minor item in their diet and of no importance.

Table 4.—Measurements of Illinois Specimens of *Sternotherus odoratus*, (Measurements in millimeters; weight in grams)

Specimen No.	Carapace		Plastron			Head	Tail	Weight	Sex
	Length	Width	Length	Width	Depth				
1.....	123	83	94	56	51	28	41	...	♂
2.....	119	80	94	56	50	26	30	253	♀
3.....	124	82	87	52	42	25	40	233	♂
4.....	109	77	79	53	39	24	36	176	♂
5.....	101	70	75	49	36	23	35	134	♂
6.....	93	69	74	55	36	20	30	124	♂
7.....	90	65	72	50	35	19	26	119	♂
8.....	89	66	69	50	34	17	25	109	♀
9.....	112	75	86	56	41	25	28	185	♀
10.....	128	81	90	58	44	27	48	238	♂
11.....	110	76	79	55	40	26	43	188	♀
12.....	104	73	80	54	41	22	..	170	♂
13.....	111	81	86	57	42	23	25	201	♂
14.....	82	64	65	46	35	15	23	98	♀

Parasites.—The musk turtle is almost always the host to a large number of leeches. The commonest species found on them is *Placobdella parasitica,* which attaches itself in numbers to the soft parts, but which apparently does the turtle no harm. On one occasion, however, I found a turtle in which a leech of this species had worked itself into the eye socket and had caused blindness in the associated eye. Internally nematode parasites are usually very abundant from the posterior end of the stomach through the small intestine.

Genus Kinosternon Spix

Terrapene (part) Merrem 1820
Kinosternon Spix 1824; Bell 1825
Cinosternon Wagler 1830
Uronyx Rafinesque 1832
Monoclida Rafinesque 1832
Staurotypus (part) Duméril & Bibron 1835
Kinosternum LeConte 1854
Goniochelys Agassiz 1857
Cinosternum Agassiz 1857
Thyrosternum Agassiz 1857
Platythyra Agassiz 1857
Swanka Gray 1870

Plastron moderately wide, the posterior lobe about two-thirds the width of the aperture and approximately equal in length to the anterior lobe; emarginate posteriorly and with rounded lateral angles; each lobe movable on a transverse hinge and capable of partially closing the aperture. Wings of the abdominal scutes wide and bearing a posterior groove. Carapace somewhat depressed rather than domed; first vertebral scute widely triangulate, the anterior base being two-thirds to three-fourths the height of the scute.

Kinosternon flavescens (Agassiz)

Platythyra flavescens Agassiz 1857
Cinosternum flavescens Cope 1875
Kinosternum flavescens Cope 1892
Kinosternon flavescens Stone 1903

Description.—The largest species of the family Kinosternidae found in North America, the carapace measuring up to 146 mm in length. Shell broad, greatly depressed, flat, often even-dished along the mid-dorsal line of the carapace. Carapace: first vertebral scute triangular, the apex (anterior margin) equal in length to the sides; truncate at the posterior margin. Second, third, and fourth vertebral scutes roughly hexagonal, with the anterior margin greater than the posterior. Fifth vertebral truncately triangular. First, second, and third costal scutes very large; the fourth conspicuously smaller. Marginals 22 in number, plus the nuchal. Nuchal scute very small. Ninth and tenth marginals conspicuously large, triangular, the apexes contiguous and the two scutes of equal height. Caudal marginals relatively small. This condition of the three pairs of posterior marginals is to be found in no other kinosternid. Scutes mostly smooth, with a slight tendency toward rugosity in the posterior region. Plastron large, and similar in type to that found in

the *K. subrubrum* group. Gular large, unpaired, its length approximately equal to the interhumeral suture. Humerals roughly rectangular. Pectorals triangular, the interpectoral suture very short (cf. Boulenger 1889, p. 36). Abdominals nearly square, the wings grooved posteriorly. Femorals triangular, with a very short interfemoral suture, this suture approximately one-seventh of the interanal suture. Anals triangular, with

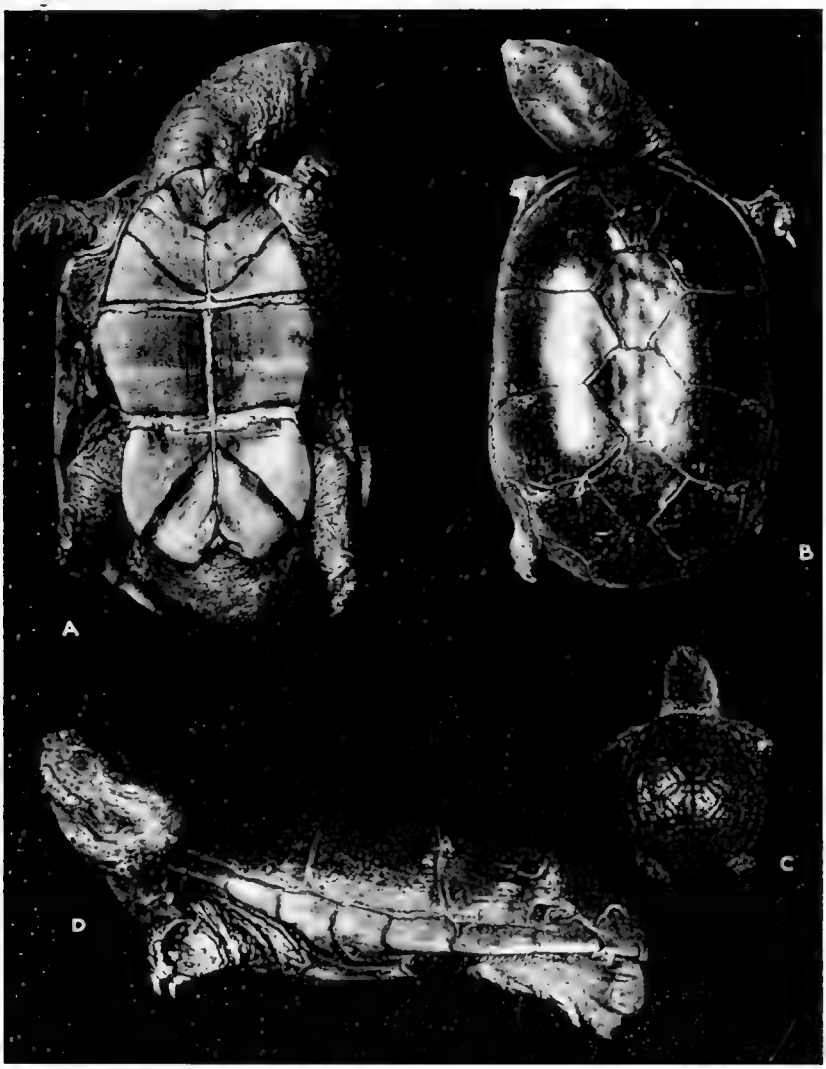


PLATE 6.—*Kinosternon flavescens: A,* Adult, ventral view. *B,* Same individual, dorsal view. *C,* Newly hatched young, dorsal view (Oklahoma specimen). *D,* Adult, lateral view.

a long interanal suture, and with a conspicuous round-shouldered notch posteriorly. Considerable cartilaginous material is found along the pectoral-abdominal and the interabdominal suture, and still more along the abdominal-femoral suture, the amount varying with the sex of the individual, being greater in males than in females. Axillary small; inguinal long and narrow, reaching to the seventh marginal. Head large and powerful. Top of head with a small bifurcated U-shaped nasal plate, the arms of the "U" following the dorsal rim of the orbit to its posterior margin. The shell of the upper jaw reaches the anterior ventral margin of the orbit, following half-way up it, but does not make contact with the nasal plate, leaving a fleshy bridge between the snout and the anterior dorsal margin of the orbit. Snout pointed. Upper jaw strongly hooked and with a prominent "first tooth." Posterior to this the profile of the jaw appears as a curved blade without any further prominent "teeth." Gular barbels prominent; second pair of barbels on the throat either inconspicuous, uni-lateral, or absent. Neck with but a few tubercles dorso-laterally and none ventrally. Horny scales on the wrist practically absent; inconspicuous. Claws on the fore limb strong, but highly graded as to length: the outer (fifth) is very small, the fourth twice its length, the third three times its length, the second four times its length, the first (inner) like the third. Posterior claws also graded, but to a much less extent. Tail long in the male, short in the female, but usually with a distinct terminal nail or "claw" in both sexes. Apparently this nail is in rare cases absent.

Coloration.—Carapace olive green, uniform in tone, the sutures being finely edged with black, which is increasingly inconspicuous in the older and larger specimens, yet wanting in newly hatched young. This black margin tends in some specimens to overlap the suture as in *K. subrubrum hippocrepis,* while in others it lies as the posterior boundary of the anterior scute, much as in *K. subrubrum subrubrum.* Plastron light in color, yellowish, with a tendency toward brown. Soft parts gray-green, darker above and lighter beneath; unmarked. Throat, sides of neck, and head yellow. Head without markings of any kind. Jaws horn colored, mottled with dark olive.

Young.—The young exhibit the general configuration and coloration of the adult, but are much more circular in form. The most conspicuous difference lies in the condition exhibited by the marginals in newly hatched and very young individuals. Whereas in the adult the ninth and tenth are conspicuously large and elevated, in very young individuals (32 mm) this is not the case, these two scutes being actually smaller and less elevated than the seventh and eighth. In young having a carapace 67 mm in length the conspicuousness of the ninth and tenth marginals is already well established and typical of the adult condition.

A further feature of the young lies in the fact that the costal and vertebral scutes bear what appears to be a broad band impressed along the

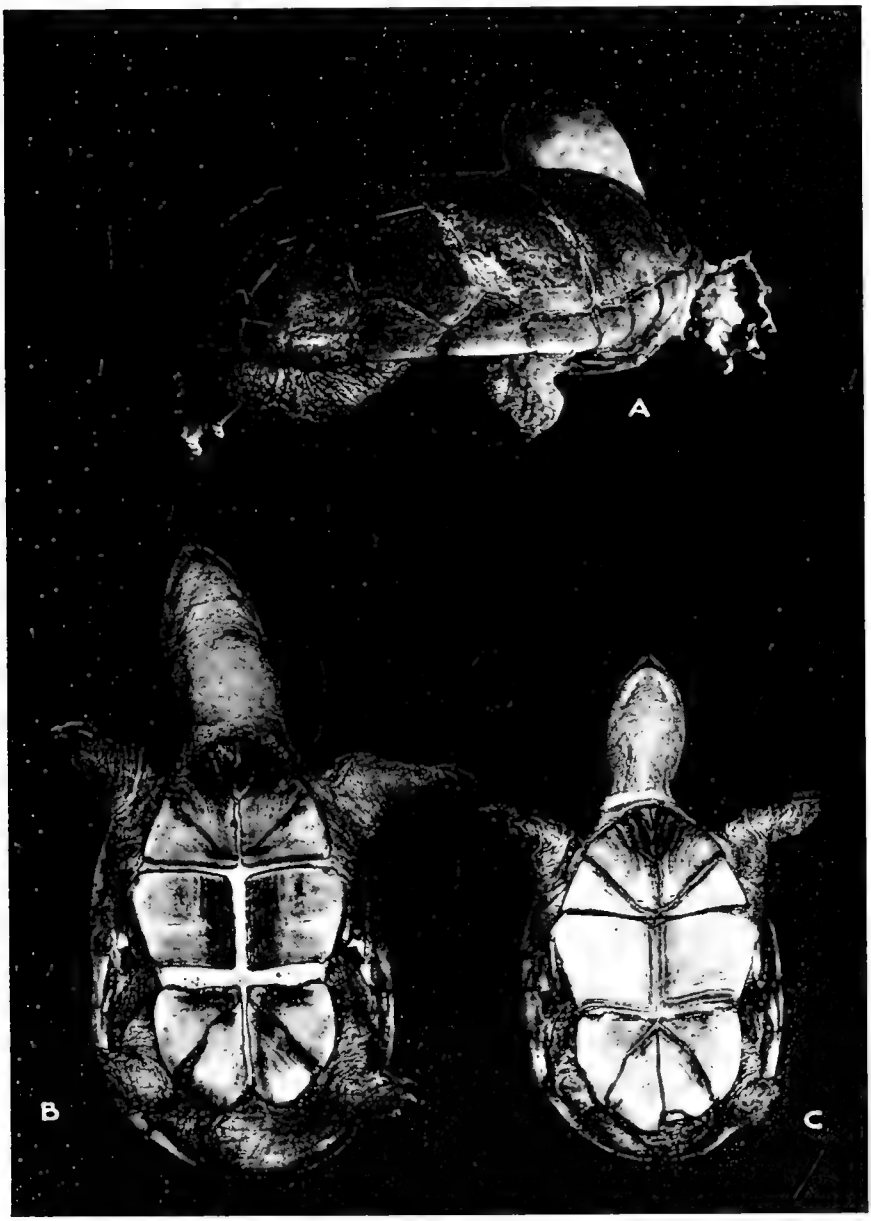


PLATE 7.—*Kinosternon flavescens: A,* Three-quarters posterior view of an adult, to show the relative size and shape of the last three marginal scutes. *B,* Adult male, ventral view. *C,* Adult female, ventral view.

anterior and lateral margins of the scutes, this band being separated from the rest of the scute by a tiny ridge, giving the scutes an appearance of being slightly rugous. (The above descriptions are taken from specimens #3642, 4617, and 9958, Museum of Zoology, University of Oklahoma, kindly loaned by Dr. A. I. Ortenburger).

Sex Differentiation.—The typical kinosternid features hold true in this species in so far as sexual dimorphism is concerned. In males, the tail is much longer than in females. The beak of the upper jaw is more pronounced in males than in females. The male has "stridulating organs" on the inner surface of the hind legs well developed in the form of a group of small, but strong, horny tubercles, which are absent in the females. Males are considerably larger than females.

Geographical Distribution.—*Kinosternon flavescens* is distinctly a western and southwestern species, the occurrence of which within the limits of Illinois is, to say the least, surprising. Stejneger and Barbour (1923) give its range as "Texas, north to Kansas and Colorado, west to Arizona." Yarrow (1882) reports it from Fort Yuma, California, Fort Union, New Mexico, and Utah; Boulenger (1889) from Arkansas, Western Texas, and the Gila River; Siebenrock (1907) from Arkansas, Texas, and Arizona. Ortenburger and Freeman (1930) report that "without question this is one of our commonest, if not *the* commonest turtle in Oklahoma wherever water is available."

Illinois Records.—Until the report by Cahn (1931) of the finding of this species in Illinois, it was unrecorded from the state. At the time of publication of that paper, five specimens only had been taken, all of these on the Illinois River at Meredosia Bay. These were taken by Dr. David H. Thompson of the Illinois State Natural History Survey, who reported that he had seen probably twenty to twenty-five additional specimens on the Illinois River between Meredosia and Peoria—a distance of approximately 90

Map 4.—*Kinosternon flavescens.*

miles by river. During the summer of 1931 Mr. Joe Combs, working and collecting for the writer at Meredosia Bay, was able to obtain an additional 11 specimens, comprising both sexes, so that the number now on hand from Illinois totals 16. One of these has been deposited in the United States National Museum, #83190.

HABITAT.—From all reports, *Kinosternon flavescens* is preëminently a pond turtle. In western Oklahoma, where it is one of the commonest of the turtles found, it inhabits roadside ditches and cattle ponds (often artificially constructed) of almost any size. So common is it in this western region that Ortenburger finds one or more per each hundred or two hundred feet of roadside ditch. They are highly aquatic, as is the case in other kinosternid species, and seem most at home in the muddy bottoms of shallow ponds, where they often lie partially buried in the soft material. The same applies to the species as found in Illinois. While the five original specimens were taken from hoop nets used by fishermen to catch catfish, ten of the remaining eleven specimens were all taken from a single small, muddy overflow pond which had but a few inches of water in it. This temporary pond was but a hundred feet from the river, yet had no connection with it. The turtles must therefore have chosen to inhabit it rather than the river, and they were found lying in the soft mud at the bottom, apparently quite content. The sixteenth specimen was found walking down a sandy path near the edge of the river.

Unfortunately, we can give almost no information concerning this interesting turtle. Of the habits, nest, eggs, and incubation periods nothing is known, so far as I have been able to ascertain. Agassiz (1857) figures the newly hatched young, but not the egg, and gives no information or discussion of the species. It was hoped that some light might be thrown on these obscure phases of its life history as a result of the work of the summer of 1931, but the field work yielded no results in this

TABLE 5.—MEASUREMENTS OF ILLINOIS SPECIMENS OF *Kinosternon flavescens*
(Measurements in millimeters; weight in grams)

Specimen No.	Carapace		Plastron			Head	Tail		Weight	Sex
	Length	Width	Length	Width	Depth		Total	A-T		
1	146	98	121	86	45	30	58	22	483	♂
2	138	98	114	79	43	30	57	20	422	♂
3	128	90	108	75	42	27	53	18	391	♂
4	140	99	121	83	45	30	54	18	446	♂
5	132	94	118	77	43	28	55	19	412	♂
6	105	78	93	60	41	23	51	16	253	♂
7	132	93	114	76	50	29	56	18	401	♂
8	137	97	112	84	51	30	55	19	457	♂
9	137	94	120	83	53	29	54	19	419	♂
10	135	94	104	75	49	31	53	17	412	♂
11	142	97	120	75	49	30	56	20	461	♂
12	142	97	120	73	48	31	54	20	450	♂
13	112	86	106	69	42	22	22	11	296	♀

direction. As a matter of fact it is interesting to note that of the 16 specimens taken to date, fifteen are males. Whether or not this preponderance of males is of any significance in relation to the habits of the species is not at present clear. The single female was taken on June 20 from the temporary pond previously mentioned. Dissection showed the ovary to be small, but it contained two ovarian eggs well along in their development and apparently to be laid in a month or so. The stomach contained a quantity of vegetable matter which apparently was either grass or some semi-aquatic plant having similarly slender leaves.

Just how we are to explain the appearance of this species in a thriving condition so far removed from its hitherto known range is something of a problem. That they are thriving is indicated by the fact that the bigger specimens taken are larger than any loaned me from the region of their greatest abundance. Probably no river in the United States has been more thoroughly "worked" by zoologists than has the Illinois, particularly at the very place from which these turtles came. The Illinois State Natural History Survey began its investigations here in the 1870's, and has continued almost without interruption to date. Garman, gathering material for the Survey, collected here, yet found no evidence of this species. It escaped the notice of the investigators who inspected hundreds of nets set by fishermen over a period of many years, and which caught thousands of turtles. True, these men were not interested in turtles, yet its peculiar form might well have attracted attention. Are we to conclude that it is a new arrival in the district, or that it is simply a rare species which has, somehow, been overlooked? Or are we to say that it is a "transplant" recently introduced or liberated in the vicinity? The latter view seems highly improbable in view of the numbers recorded and the abundance of the species once its optimum environment is located, not to mention the distribution over 90 miles of the river. The condition of the female indicates that the species is breeding, hence established. About all that can be said is that the turtle is rare, that its distribution in the state is limited according to our present knowledge to the middle reaches of the Illinois River, and that it is an established species.

Kinosternon subrubrum subrubrum (Lacépède)

Testudo subrubra Lacépède 1788
Testudo pensylvanica Gmelin 1788
Emys pensylvanica Schweigger 1814
Terrapene pensylvanica Merrem 1820
Cistudo pensylvanica Say 1825
Kinosternon pensylvanicum Bell 1825
Kinosternon oblongum Gray 1844
Kinosternon doubledayi Gray 1872
Kinosternon punctatum Gray 1870
Thyrosternum pensylvanicum Agassiz 1857
Swanka fasciata Gray 1872
Cinosternum pensylvanicum Boulenger 1917
Kinosternon subrubrum subrubrum Stejneger & Barbour 1917

DESCRIPTION.—Carapace rather elongate and narrow; smooth, unkeeled. The curvature of the shell is gradual at the anterior end, appearing to be somewhat depressed, and abrupt posteriorly beginning with the fourth vertebral scute; the fifth vertebral is nearly vertical. The anterior margin of the carapace is almost truncate, the posterior oval in outline. Costal scutes very large, transverse in their major axis. Vertebral scutes relatively small; marginals very small and elongate. The first vertebral

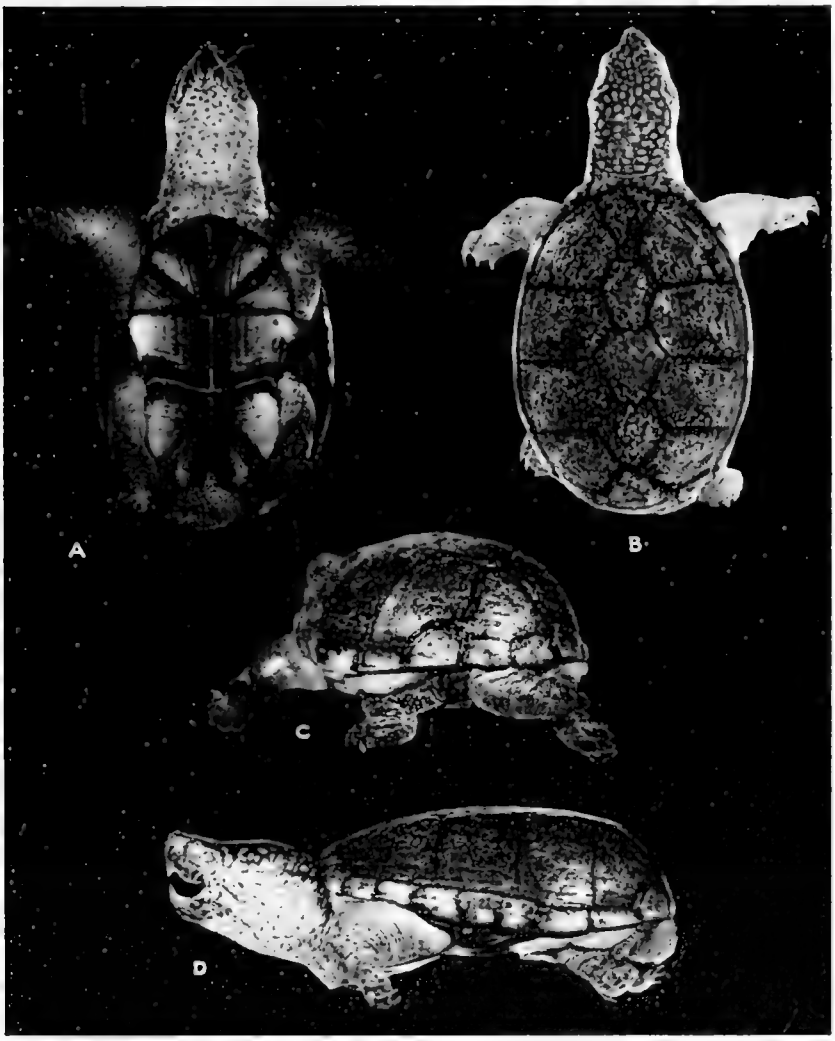


PLATE 8.—*Kinosternon subrubrum subrubrum: A,* Adult, ventral view. *B,* Dorsal view of the same individual. *C,* Three-quarters posterior view, to show the relative size and shape of the last three marginal scutes. *D,* Adult, lateral view.

scute is triangular, truncate at its apex, which is directed posteriorly; the second, third, and fourth are roughly hexagonal; the fifth pentagonal. Costal scutes in a graded series, the first being the largest. The gular is very small, wider in front than behind, and larger in its ventral aspect than in its dorsal. Marginals entire, though occasionally showing a slightly sinuate condition, but never flaring. The tenth marginal is much enlarged, encroaching into the posterior margin of the fourth costal scute. The plastron is acutely rounded in its anterior border and shallowly notched posteriorly; both anterior and posterior lobes are movable. Gular scute single, triangular, and less than half the length of the anterior plastral lobe. Humeral scutes with their median suture are very short, so that the humerals almost meet the abdominals; the pectorals are not involved in the bridge. Abdominals almost square, their wings forming the major part of the bridge. These wings bear a posterior groove and exhibit a prominent anterior shoulder. Femorals triangular, the apex posterior-lateral, and with a very short interfemoral suture. The anals are tringular, with the apex directed anteriorly. Axillary very small, elongate; inguinal large. The axillary and inguinal scutes meet between the wings of the abdominals and the marginals, to help complete the bridge. In some specimens the plastral scutes are rough and exhibit a series of concentric striae; in others these striae are worn down, leaving the plastron smooth. Head large, the snout somewhat attenuated; jaws strong, the upper hooked. A pair of barbels under the chin, and a second pair farther back on the throat. Eyes located well forward. Limbs short but strong, the anterior with several transverse scales on the dorsal surface, and a few small scales on the palm. Posterior limbs without the dorsal scales, but exhibiting the palmar series. Digits 5-4; claws short, stout, curved. Tail short. Skin finely tuberculate.

Coloration.—The carapace is uniformly olive brown, each scute with a narrow black margin along the suture. This black band is confined to the scute anterior to the suture, not overlapping the suture as in the case of *Kinosternon subrubrum hippocrepis*. The plastron varies from brown to yellow or horn-color, the brown apparently wearing off with age, but persisting along the sutures. The head is olive brown, with distinct yellow mottlings in the form or irregular lines and amoeboid spots. Under side of the head yellow with olive-brown reticulations and spots, becoming indistinct on the neck. Remaining soft parts grayish brown. Iris chestnut brown.

Young.—The young conform to the general plan of the adult, except that the carapace often exhibits a trace of three small keels, one row on the vertebral scutes and one row on each of the costal series.

Sex Differentiation.—The males bear a small patch of horny, keeled tubercles on the posterior side of the leg, and another similar

patch below the thigh. The male has the tail terminating in a horny, nail-like claw.

Geographical Distribution.—The range of *Kinosternon subrubrum subrubrum* can at present be given best only in general terms, and may be said to include the eastern portion of the United States from New York, where it is very rare, westward to Illinois. Hay (1892) reports it from Knox county (southwestern) and from Terre Haute (westcentral) Indiana under the name of *K. pensylvanicum.* It extends from these more northern states southward to include Tennessee (Blanchard 1922) and Louisiana (Viosca 1931), but seems not to reach peninsular Florida. Under the older name of *Kinosternon pensylvanicum* (and the various spellings of both generic and specific names) is included both *subrubrum subrubrum* and *subrubrum hippocrepis,* and since the earlier investigators failed to recognize the two closely related forms and did not differentiate between them, it is very difficult at the present time to delimit exactly either form because of this inclusion.

Illinois Records.—Under the name of *Cinosternum pensylvanicum,* this form is included in the herpetology of Illinois by Garman (1892). At least it is presumed by the writer that the form to which Garman has reference is *K. subrubrum subrubrum,* for the Garman collection of turtles has completely disappeared, and it is impossible now to check on his specimens. This must not be construed as a reflection upon the excellent work of Garman, but without the original material for study and verification, it is difficult to do more than interpret his designation. As to the occurrence of *subrubrum* in Illinois, Garman says: "Southern Illinois, not rare; Peoria (Brendel); Mt. Carmel, common (Ridgway)." The only specimen which the present writer has from Illinois is a very typical shell found near Cairo in 1930. The turtle was found dead in a swamp north of Cairo, in a locality to which it could not possibly have been washed by floods of the Mississippi River.

Map 5.—*Kinosternon subrubrum subrubrum.*

HABITAT.—The discussion which follows is based of necessity upon our knowledge of the species as found in localities other than Illinois. *K. subrubrum subrubrum* is found in ponds, muddy ditches, and weedy lakes. Its general environmental preferences are rather similar to those of *Sternotherus odoratus,* although it is considerably less aquatic than that species. It is normally absent from streams with gravel bottom and current, preferring the mud in which it can bury itself for protection, and the quiet waters more often associated with mud conditions. It is not adverse to journeys upon land, and may be found quite a distance from its usual abode during the summer. In this respect it differs markedly from *S. odoratus.*

HABITS.—Unlike the other Illinois species of the family, this form exhibits a tendency to appear frequently on the dry land, wandering away from the water for considerable distances. Whereas the other species hibernate in the mud at the bottom of the ponds, *K. subrubrum subrubrum* has often been found buried six to twelve inches down in the dry soil quite removed from the proximity of water. Other burrows, apparently in dry soil, are found to terminate in a small chamber close to the ground-water level, in which the bottom at least is wet and muddy. When the turtles emerge from their burrows after hibernation, they are very sluggish, rather emaciated, and heavily caked with dried mud.

This turtle, however, spends most of its time in water, where it wanders about in search of food much as does *S. odoratus.* It is a strong swimmer, capable of making rapid progress with this method of locomotion. To quote Agassiz (1857): "The slender legs are fitted for traveling on dry land, but easily carry the body through the water over its bottom. When surprised away from the water, the animal seeks the nearest hiding-place; if danger is close at hand, it quickly withdraws the exposed parts into the shield, and, if pressed still farther, it resorts at last to biting, not throwing the head quickly and forcibly out as the Chelydoidae do, but stretching it out rather slowly toward the assailant, and then snapping the jaws forcibly upon it." Although this quotation is applied by Agassiz to kinosternid turtles in general, it fits admirably the observed behavior of the present species. While not as vicious as *Sternotherus odoratus,* this species is capable of biting when occasion seems to demand, preferring, however to retreat within its shell. After the head is withdrawn, *K. subrubrum subrubrum* has a greater degree of protection, due to the larger size of the plastral element, and to the fact that the plastral lobes more completely close the ventral aperture.

When disturbed, this musk turtle emits the same type of musky odor which is characteristic of the family, though to a much less degree than in *S. odoratus.* In fact, the writer has found the odor emitted by

specimens in the laboratory to be very weak and not at all disagreeable. It is doubtful whether this excretion is of any protective value.

Nesting Habits.—The writer has never seen the nest of this species, and there is little information in the literature describing the nesting habits. Presumably they are not very different from those of *Sternotherus odoratus*. Brimley (1903) reports that the eggs are sometimes found in holes in the banks of streams, and that they are frequently plowed up in low ground.

Eggs.—The eggs of this species resemble those of *S. odoratus* so closely as to be almost indistinguishable from them, though they are a trifle smaller in size. They are an elongated oval in shape, with blunt ends, and are covered with a shell of remarkable thickness for so small an egg. This shell is of very fine texture, perfectly smooth, due to a slight glaze, and exceedingly brittle. The eggs number from two to five in a clutch, three being the usual number deposited by one female. The average size of 7 eggs measured by the writer shows them to be 27.4 mm by 14.3 mm. Nothing is known of the period of incubation.

Food Habits.—This is largely a carnivorous species, which is reported to feed upon fish and insects. A specimen shipped to me from Louisiana had the remains of earthworms and five beetle wing coverts in the stomach. Kept in the laboratory, they seem entirely satisfied with a diet of chopped meat. In nature, they are reported to nibble daintily at the baited hooks dangled by fishermen for more valued prizes.

Economic Importance.—The small size and the musky flavor of this little turtle makes it unfitted for human consumption. It is very doubtful whether the food habits of the species render it either an economic asset or liability.

Parasites.—When compared with specimens of *S. odoratus,* this species is much less parasitized by leeches, due probably to its more frequent journeys to land. The alimentary canal is far freer of internal parasites; though the writer has taken nematodes on several occasions from the pyloric end of the stomach.

FAMILY TESTUDINIDAE

Testudinidae, Emydidae (part) Gray 1825; Bell 1828; Ritgen 1828
Tylopodes, Steganopodes (part) Wagler 1830
Testudinidae, Emydae (part) Gray 1831
Chersites, Elodites Cryptoderes (part) Duméril & Bibron 1835
Emydoidae, Nectemydoidae, Deirochelyoidae, Evemydoidae, Clemmydoidae, Cistudinina, Testudinina Agassiz 1857
Chersemydina (part) Strauch 1862
Testudinidae, Cistudinidae, Emydidae, Malaclemmydae, Pseudemydae, Bataguridae Gray 1870
Testudinidae, Emydidae (part) Cistudinidae Cope 1882

Chersemyda (part) Strauch 1890
Cryptoderinea (part) Vaillant 1894
Emydinae Siebenrock 1909

External Diagnosis.—Turtles having a bony shell, covered with epidermal scutes, which is moderately (never greatly) depressed, or (extralimital) highly arched. Carapace oval, broadest posteriorly, and highest at about the middle, from which the shell slopes in all directions to flaring marginals. Scutes of carapace: 5 vertebrals, 8 costals, 25 marginals. Plastron with 12 (rarely 11) scutes; axillary and inguinal elements usually present. Anterior lobe of plastron (and rarely also the posterior lobe) in some species movable on a transverse hinge capable of closing the aperture. Toes broadly webbed in aquatic species and imperfectly webbed in terrestrial forms. Head of moderate size, covered with smooth skin, and retractile within the shell. Jaws naked. Digits moderate to short and with either 4 or 5 (extralimital exceptions) claws. Tail short.

Osteological Diagnosis.—Nuchal plate without costiform processes. Plastron composed of 9 dermal elements, the entoplastron present. Caudal vertebrae procoelous. Temporal arch usually present; no parietosquamosal arch. Phalanges with condyles. Neck completely retractile.

Genus Clemmys Ritgen

Emys (part) Duméril 1806
Chersine (part) Merrem 1820
Clemmys Ritgen 1828
Clemmys (part) Wagler 1830
Terrapene (part) Bonaparte 1830
Chelopus Rafinesque 1832; Cope (part) 1865
Geoclemys (part) Gray 1855
Nanemys Agassiz 1857
Calemys Agassiz 1857
Glyptemys Agassiz 1857
Actinemys Agassiz 1857
Mauremys Gray 1869
Sacalia Gray 1869
Emmenia Gray 1869
Eryma Gray 1869

Shell moderately depressed. Axillary and inguinal elements well developed, reaching exactly to the first and fifth costal scutes; bridge wide. Alveolar surfaces of the jaws narrow and without a sharp medial ridge. Endoplastron with a suture between the humeral and pectoral bones. Choanae located between the eyes; skull without a dorsal medial ridge, and with a bony temporal arch present. Neck fairly long. Tail stout in the adult. Digits fairly well webbed.

Clemmys guttata (Schneider)

(Spotted turtle; speckled turtle)

Testudo guttata Schneider 1792
Testudo punctata Schoepff 1792
Emys guttata Schweigger 1814
Emys punctata Merrem 1820
Terrapene punctata Bonaparte 1830
Nanemys guttata Agassiz 1857
Clemmys guttata Strauch 1862
Geoclemmys sebae Gray 1869
Geoclemys guttata Gray 1870
Chelopus guttatus Cope 1875

DESCRIPTION.—Shell oval, somewhat depressed. It is wider posteriorly and without a trace of a vertebral keel in the adult. First vertebral scute pentagonal, shield-shaped, the remaining vertebrals hexagonal. The second vertebral with the anterior border shorter than the posterior; third vertebral with the anterior and posterior margins approximately

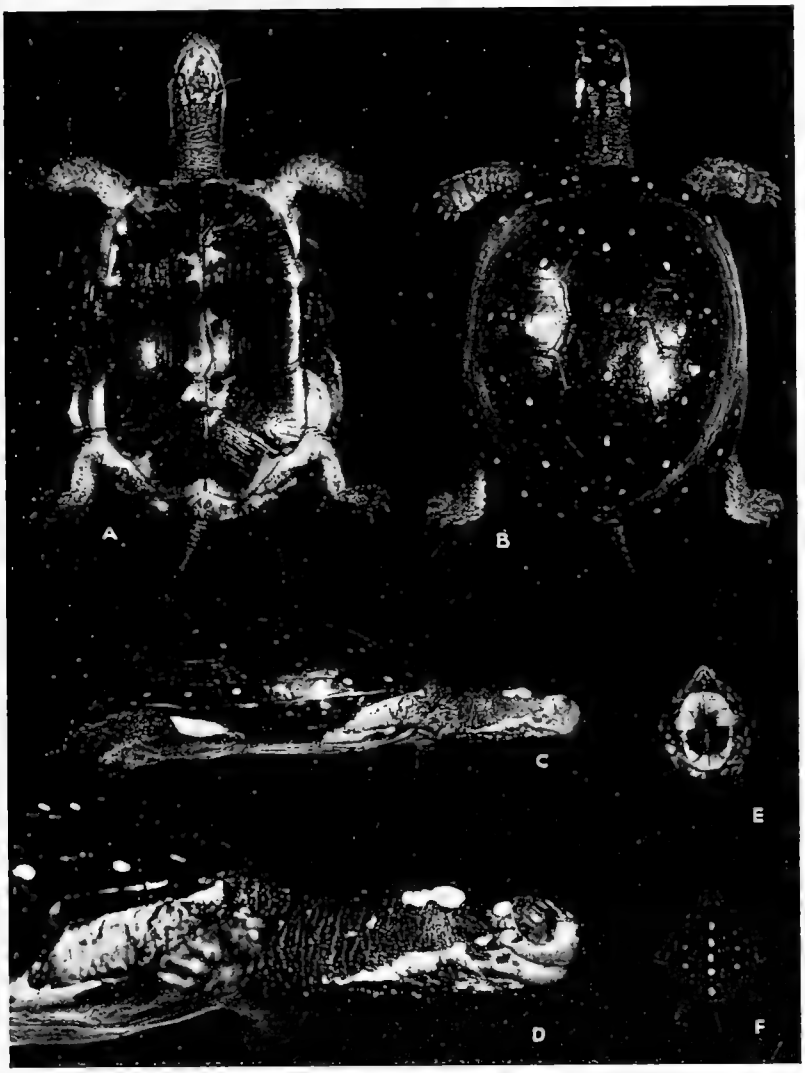


PLATE 9.—*Clemmys guttata: A,* Adult, ventral view. *B,* Adult, dorsal view. *C,* Adult, lateral view. *D,* Head study of an adult. *E,* Newly hatched young, ventral view. *F,* Same individual, dorsal view.

equal in length. The fourth vertebral has its posterior margin only a trifle over one-half the length of the anterior border. In the costal series the first scute is the largest, but the second the widest; the first tends toward the triangular, though it is a trapezium, while the remaining are rectangular, the posterior scute tending toward square. The fourth costal is the smallest of the series. Nuchal long and exceedingly slender. Outer border of the marginals entire, not emarginate or serrate, though there is a shallow notch between the caudal marginals. There is a tendency toward sculpturing or rugosity on the scutes of the carapace. Plastron large, filling most of the aperture, the posterior lobe more than three-quarters the width of the carapace. The anterior lobe is truncate and without a movable hinge. Gulars sharply triangular. Humerals triangular, the interhumeral suture being very short, so that the posterior angles of the gulars almost touch the pectorals. Pectoral scutes rectangular. The abdominals are the largest of the plastral elements and, while rectangular are approaching the square. Femorals approaching triangular, the interfemoral suture being short and from two to three times the length of the interhumeral suture. Anal scutes large, the interanal suture usually a trifle longer than the interabdominal suture; a shallow notch exists between the posterior margin of the anals. Gulars usually with fine longitudinal striations. The remaining plastral elements tend to have concentric striations which are markedly angular in character centering about the posterior lateral angle of each scute; in old specimens, however, these striations are likely to be worn away. The bridge is rather narrow, approximately one-half the width of the posterior lobe, and involves the full width of the abdominals and the posterior half of the pectorals. Axillaries and inguinals absent, or very small and rudimentary. Head moderate to small, covered with a tightly drawn and perfectly smooth skin. Snout blunt, the upper jaw with a deep median notch and with the alveolar surface very narrow. Lower jaw with a wide sheath externally, and with a sharp, upward hook. Skin of the neck finely granular. Legs and feet covered with scales, those on the anterior face of the limbs large and overlapping. Feet rather small, imperfectly webbed, the toes with short claws. All 5 of the digits of the fore limb with claws; hind limb with only 3 digits bearing claws. Tail short.

Coloration.—Carapace uniformly black, with an occasional tendency toward rust. Each scute bears from one to ten or more round, bright orange-yellow spots. The tendency is for each of the marginals to bear a single round spot, but often more than one is present on the scute. The plastron is mostly black, and is blotched with orange. Head and neck black, dotted dorsally with orange, and with a large orange blotch just above the ear; ventral surface mottled with orange and with a tendency toward a lateral stripe extending backward from the angle of the jaw

(see discussion of color *in re* sex differentiation). Limbs black above, with orange dots, the orange predominating ventrally. Tail black, with a few small orange dots dorsally, blending into orange around the anus.

YOUNG.—The very young exhibit a trace of a vertebral keel, which entirely disappears with age. Each scute of the vertebral and costal series bears but a single yellow to orange spot, while on many of the marginals the dorsal spot is absent. With increasing age, other spots appear on the carapace as well as upon those marginals which originally did not possess a spot.

SEX DIFFERENTIATION.—In the male, the plastron is somewhat dished or concave in the central area, while in the female this concavity is absent. While the tail is about the same length in both sexes, the anus of the male is placed in a position to bring it *beyond* the edge of the carapace, while in the female it is under the carapace. Yerkes (1905) has pointed out that, although the females are slightly smaller than are the males, they bear about 15 per cent more spots on the scutes of the carapace, the average number for males being 60, for females 69. The concavity of the plastron of the male and the position of the anus are listed by Blake (1921), who also gives the following sex distinguishing features: (1) The horny part (sheath) of the jaw of the male is dusky, of the female pale yellow. (2) The female has a conspicuous yellow or orange mandibular stripe reaching half the length of the neck, while the male has but a few spots or at most a very weak streak here. (3) The throat of the male is black, with few yellow specks, while the female has the throat heavily streaked and spotted with yellow. (4) The female has a well developed supra-auricular yellow line, or a series of yellow spots, while in the male this line is poorly developed. (5) In the female there are a few yellow spots on the crown in front of the eyes, while in the male there are but one or two such spots.

GEOGRAPHICAL DISTRIBUTION.—The spotted turtle, *Clemmys guttata,* is an eastern species, the western limit of whose range lies in Wisconsin and Illinois. It is common throughout the Atlantic States from Maine to northern Florida. It is less common in the northern reaches of its range in the New England states, but is a common species in the southern members of this group. Morse (1904) reports that, while not rare in Ohio, it is found over most of the state, but is not a common turtle; Ruthven *et al* (1912) report it from most of the counties composing the southern third of Michigan. In Indiana, Hay (1892) reports it from a number of localities in the northern part of that state, including Lake Maxinkuckee, and in his "Preliminary Catalogue" he reports it as being "rather common about La Porte and in the marshes of the Kankakee River." The westernmost records lie in southern Wisconsin. For this state Higley (1889) reports it from Walworth county, Beloit, Madison,

and Eau Claire; to these records Pope and Dickinson (1928) add specimens from Waukesha County and from Fond du Lac County, and Cahn (1929) adds a second record from Waukesha County.

Illinois Records.—*Clemmys guttata* has not previously been reported from Illinois, and no mention of it occurs in the literature of this state. The University of Illinois now has in its collection two specimens of the species collected by the writer in June, 1927, in a small pond just beyond the Illinois end of Wolf Lake, Cook County. So far as the writer knows, these constitute the only Illinois records.

Habitat.—The spotted turtle is an aquatic species which, however, spends a considerable amount of its time on land, often quite away from the water. Its choice of habitat lies with swamps, small weedy ponds, and streams, and in the east even salt marshes. Above all else it prefers a swamp or a pond with a muddy bottom in which it can bury itself, and avoids streams with a marked current. As between lakes and streams, its preference is for lakes and shallow ponds. When the spirit moves—which may be at any time during the summer—the turtle undertakes overland journeys of considerable length, wandering about in sphagnum bogs or out into the open fields. These journeys are not necessarily associated with the nesting instinct or with the drying up of the ponds; they seem, rather, to be the gratification of a "wanderlust" which frequently attacks the turtles and drives them afield.

Map 6.—*Clemmys guttata.*

Habits.—These turtles exhibit a very marked difference in some of their habits when their behavior in water is compared with that on land. In the water they are exceedingly shy and wary. Sunning themselves on a protruding log out in the pond, or in the midst of a clump of half-submerged grass, the first sign or suspicion of danger sends them scooting off their perch into the protection of the mud and aquatic vegetation.

A desirable log may have turtles piled on top of it in two or three layers, the late arrivals climbing up on the backs of those already enjoying the sunshine. Experiments carried out by the writer years ago with this species in Massachusetts, showed that individuals have certain favorite perches and that they tend to return to the same sunning place day after day throughout the season, indicating at the same time that while in the water they are not given particularly to wandering far from their favorite spot. On land, however, the turtle is quite solitary in its habits, and seldom is more than a single individual found. The impulse which sets them wandering seems to destroy at the same time the gregarious instinct, and their rambles on shore are quite solitary. The timid disposition persists on land, and the turtle withdraws its head quickly when danger threatens and is very slow about resuming its progress when the crisis is over. Just why this species should be so shy is a problem, for it has almost no enemies outside of animals like skunks which dig up its eggs. Associated with this timidity there is no trace of aggressiveness or viciousness under any circumstances; no matter how much the turtle is teased or annoyed it never snaps. In captivity this timidness persists for a long time, but eventually at least partially wears off and the creature makes a very good aquarium or terrarium pet.

Nesting Habits.—The spotted turtle lays its eggs between the middle of June and the first of July over most of its range. Copulation, according to Babcock (1919), occurs in the water. A true amplexus takes place, the male embracing the female so tightly that the pair can be raised out of water by lifting the male, which is on top. The female leaves the water in order to find the proper place for her nest, and often wanders quite a distance from the water's edge. The site selected may be either in sand or in dirt, but it is always in material of fine texture. The hole is dug with the hind legs entirely, and is a vertical pit from two to four inches deep, and without any notable terminal chamber. The time required is upward of half an hour, depending upon the type of material being excavated. Standing about vertical in the hole, with little more than the head and shoulders protruding, the turtle lays her complement of eggs. When oviposition is completed, the female crawls out of the hole, and fills up the cavity with the excavated dirt, using, again, only the hind legs. If the turtle is disturbed while digging the hole, she retreats within the shell and patiently waits until things quiet down; she seldom will withdraw from the site of operations or give up the hole she has begun. Agassiz (1857) states that the spotted turtle lays her eggs in the evening between four and eight-thirty. This unusual time of day for a turtle to lay—unusual because most other species lay earlier in the day—may well be the result of the timid disposition possessed by the species.

Eggs.—The eggs usually number either two or three, very rarely four, and in shape are an elongated ellipse with sharply curved ends. They are covered with a tough, white membranous shell. The size varies closely around 30 mm by 16 mm.

Incubation.—Babcock (1919) publishes some interesting data on the period of incubation. The eggs in question were laid on June 15, on which date they were buried in sand. They hatched on September 6, giving an incubation period of 82 days for this individual. However, nothing is said as to the conditions under which these eggs were kept—whether natural or artificial, whether indoors or out—so that there is no way of telling whether this is a normal incubation period for the species or whether the regular interval has been interfered with. Upon hatching, the young are possessed of an "egg tooth," a horny tubercle on the tip of the snout, which is the pick used by the baby in breaking the shell when it is ready to emerge. This tubercle disappears at the end of the first week, and the stump of the umbilical cord disappears at about the same time, though the umbilicus remains visible for a long time thereafter. The young are very active on hatching and are good climbers. The rate of growth of the carapace, as reported by Babcock, is as follows: at hatching, 26 mm; first month, 30 mm; second month, 32 mm; fifth month, 32 mm. On the tenth day the young were fed angle worms, but at the end of the second month they ceased eating and did not survive the winter. Perhaps the slow rate of growth following the first month after hatching (October to February), outside of the fact that the young refused to eat, is associated with the period of normal hibernation.

Food Habits.—*Clemmys guttata* is largely a carnivorous species, although vegetable matter figures in its diet to a small degree. Surface (1908), who has published the only comprehensive account of the food habits of turtles, says, in regard to twenty-seven specimens examined: "Only one-ninth of the individual specimens had eaten vegetable matter, and in fact there was very little plant tissue found in the stomachs, while all of them contained animal matter. Not only is it remarkable that all contained animal tissue, but also that all of them had eaten insects." A list of the animal forms found includes: worms, slugs, snails, small crustaceans, crayfish, millipedes, spiders, and insects representative of the Ephimerida, Plecoptera, Odonata, Hemiptera, Neuroptera, Lepidoptera, Coleoptera, Diptera, and Hymenoptera. Many of the insects eaten are not aquatic species, and these probably were picked up from the surface of the water rather than gathered during the terrestrial journeys. Like most aquatic turtles, the spotted turtle apparently eats and swallows only under water, and hence it appears doubtful that much material is consumed while on land. Hay reports it as eating tadpoles and small frogs. They also eat angleworms and soft-bodied forms of insect larvae.

Economic Importance.—Probably none so far as man is concerned. The insects eaten represent few that are either a benefit or a detriment to man and, since the turtle is too small to be considered as a table delicacy, the spotted turtle has no dollar and cents value to man. It is not a scavenger.

Parasites.—Because of its habitual visits to the land and on account of its habit of sunning itself for long hours out of water, this species is less infected with leeches than most of our water turtles, though leeches are usually abundant in its favored environment.

Table 6.—Measurements of Illinois Specimens of *Clemmys guttata*
(Measurements in millimeters)

Specimen No.	Carapace		Plastron			Head	Tail		Sex
	Length	Width	Length	Width	Depth		Total	A-T	
1.....	109	87	99	71	40	16	26	20	♀
2.....	114	76	95	68	40	16	31	25	♀

Genus Emys Duméril

Emys (part) Duméril 1806
Terrapene (part) Bell 1825
Cistudo (part) Gray 1831
Lutremys Gray 1855
Emyoidea Gray 1870
Emys plus Emyoidea Baur 1889
Neoemys Lindholm 1929

Plastron united to the carapace by a ligamentous attachment. Plastron divided by a ligamentous hinge between the pectoral and abdominal scutes (between the hyosternal and hyposternal elements of the endoskeleton) into two movable lobes; hind lobe truncate posteriorly or with but a shallow notch, and smaller than the aperture. Humero-pectoral suture overlying the entoplastron. Skull with a bony temporal arch; alveolar surfaces of the jaws without a median ridge; choanae between the eyes very large; dorsal surface of the head covered with undivided skin and without plates of any kind. Webs of feet extending to the claws.

Emys blandingii (Holbrook)

(Blanding's turtle; glass turtle)

Cistuda blandingii Holbrook 1838
Lutremys meleagris LeConte 1854
Emys meleagris Agassiz 1857
Emys blandingii Strauch 1862
Emydoidea blandingii Gray 1870
Neoemys blandingii Lindholm 1929

Description.—The following description is taken from an exceptionally beautiful and unusually large specimen (carapace length, 240 mm). Shell oblong, moderately high but with the carapace flat dorsally, not arched or domed. Vertebral scutes large and wide. First vertebral

pentagonal, the sum of the two anterior faces exceeding considerably the length of the posterior margin, and meeting these borders at the median point in such a wide obtuse angle as to approach a straight line. Second, third, and fourth vertebrals much wider than long, especially the third; they are hexagonal, with the margins remarkably straight except for the anterior margin of the second and the posterior margin of the fourth, which are dished. The fifth vertebral is roughly triangular, all sides tending to curve outward. Costals large, tending toward the square. The second is the largest of the series; the fourth the smallest. There is a faint trace of rough, concentric striae at the outer margins of the scutes. Marginals 27 in number, with an even edge and no emarginations. There is a wide notch between the caudal marginals. Nuchal long and very slender. Plastron distinctly oblong, truncate anteriorly and with the wide posterior emargination. It is composed of two lobes separated by a ligamentous hinge between the pectorals and abdominals. The posterior lobe is larger than the anterior and forms a ligamentous union with the marginals. Gulars sharply triangular. Humerals tend toward the triangular, but are truncate at the interhumeral suture, which is the shortest of the median articulations. Pectorals oblong or rectangular, as are the abdominals, and these two scutes are of very nearly the same size. Femorals much wider at their lateral margins than at the median suture, the posterior margins being curved to receive the anal scutes. Anals large and with a wide notch involving the entire posterior margin of the scute. Bridge very small indeed, and neither the pectoral nor abdominal scutes enter into its composition, it being represented by the ligamentous hinge between these elements and the marginals. Axillary very small and rudimentary; inguinal absent. The head is medium in size, flat dorsally, and covered with a smooth, tightly drawn skin. Cutting edge of the jaws almost straight, the upper with a wide but shallow median notch, the lower slightly upturned at the symphysis. Nostrils terminal and very close together. Neck long. Anterior limbs covered with strong, transverse scales on their anterior surface; digits five, the outer four with a strongly curved claw each, the fifth with but a rudimentary claw. Posterior limb larger than the anterior, covered with small scales, and with a projecting scale in place of the fifth digit; the remaining four digits with strongly curved claws. Tail long.

Coloration.—Carapace black or dark brown, with an intricate pattern of pale yellow spots and dashes radiating from a center at the posterior-median margin of the scute. The ground color of the vertebral series is black, while on the costal and marginals, particularly of the anterior two-thirds of the shell, the ground color is pale yellow with the intricate pattern in black upon it. These two arrangements of color intergrade imperceptibly at the vertebral-costal suture, and the carapace is much

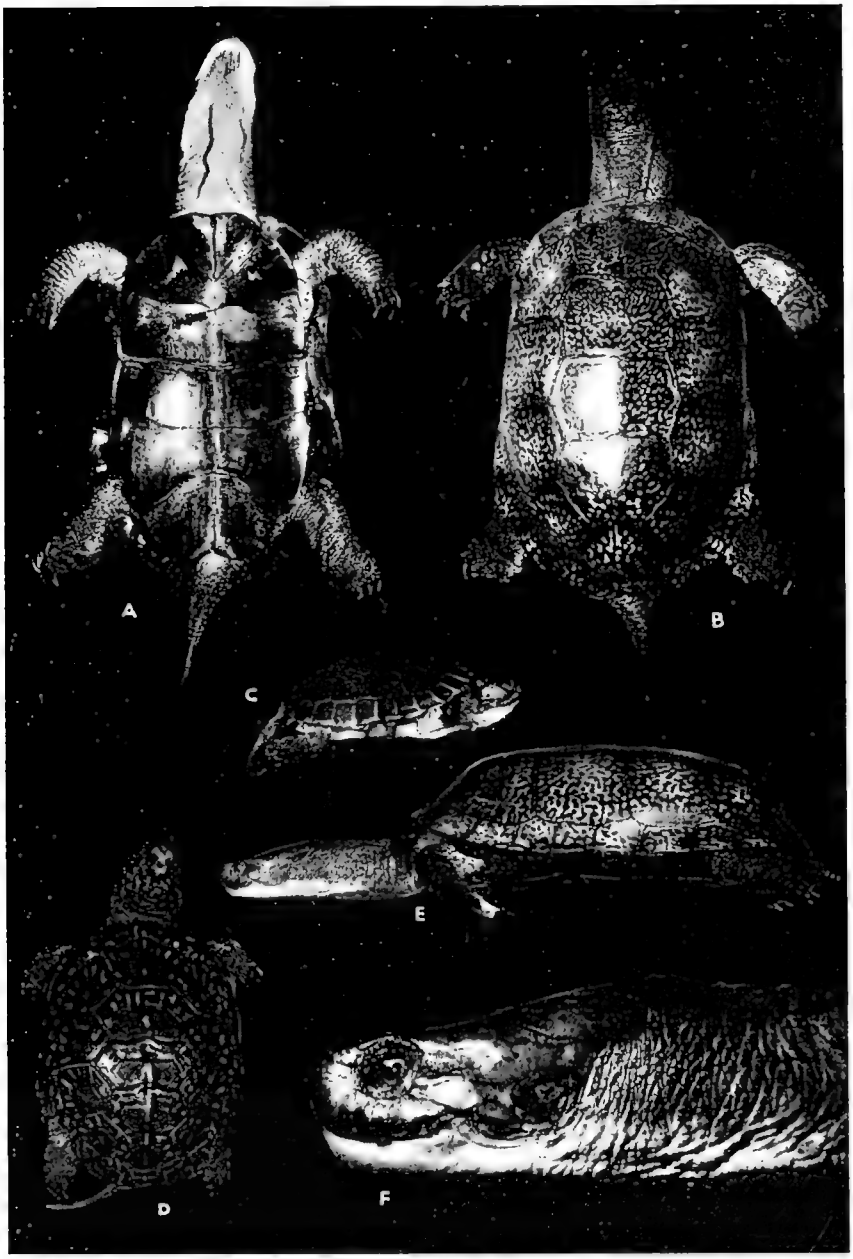


PLATE 10.—*Emys blandingii: A,* A very large adult, ventral view. *B.* Same individual, dorsal view. *C,* Newly hatched young, lateral view. *D,* Immature individual, length three and a quarter inches, dorsal view. *E.* Adult, lateral view. *F,* Head study of an adult.

lighter in color anteriorly than posteriorly. Plastron brownish yellow, blotched asymmetrically with great areas of black, these more pronounced at the lateral margin of the scutes. Head brownish olive above, finely mottled with irregular black lines, increasing in number posteriorly. Neck the same color as the head. Under parts of head and neck bright yellow. Upper jaw edged with black; lower jaw yellow. Legs dark above, lighter below, each scale tending to show a black spot.

Few specimens that I have ever seen exhibit the perfection of markings shown by the specimen just described. Often the markings on the carapace are obscure or even absent, as in a specimen taken at the southern tip of Lake Michigan, in which there is no trace of color markings whatsoever. This specimen is mahogany brown above, mottled irregularly with large areas of black.

Young.—The newly hatched young have apparently not been described in detail, and the writer failed in his efforts to obtain specimens for this purpose. Fowler (1906) says that they are "nearly circular and black." Through the courtesy of Dr. Loveridge of the Museum of Comparative Zoology, I have been able to borrow and to photograph their young specimen (#1634) which is the original of Agassiz' figures 20-22, plate 4 (1857). This little specimen is black, without markings on the carapace, the surface of which is granular; the plastron shows a *central* black area covering most of the surface, and a thin light peripheral area which probably was yellow. The plastron is one and one-half times the length of the tail. In the writer's collection is a specimen with the carapace length 66 mm. A strong vertebral keel is evident, this highest on the fourth vertebral scute. Each dorsal scute has a posterior median area sharply demarked, and this exhibits a coarsely granular or porous surface. From this area, radiating streaks of yellow extend over the rest of the scute. The keel shows yellow areas. The plastron is yellow, with symmetrically placed areas of mahogany brown on each scute. In this specimen the wings of the pectoral and abdominal scutes form a short bridge terminating in the ligamentous hinge. Top of the head brown, spotted with yellow.

Sex Differentiation.—The tail of the male is longer than that of the female; in the male the shell is three times the length of the tail, or less, while in the female it is four times the length of the tail.

Geographic Distribution.—*Emys blandingii* is a northern species with a range covering the northern quarter of the United States from New England on the east to Iowa and Minnesota on the west. While nowhere really abundant, the center of its abundance apparently lies in northern Indiana, from which region its numbers grow less as the range extends both east and west. Ditmars (1908) says that "eastward of the Central States it is comparatively rare, though the range extends into the

Alleghanean region and northeastward through Pennsylvania and New York into Massachusetts, Rhode Island and New Hampshire. The species does not occur near the coast regions of New York, Connecticut or New Jersey." It is not common anywhere in New England, though there are scattered records over most of Massachusetts (Babcock). Surface (1908) considers it rare in Pennsylvania, and does not give any specific locality records. The first Pennsylvania record is that of Stewart (1928) for Lewisburg, and Netting (1932) adds two more; hence it must be considered rare in that state. Morse (1904) reports that it is nowhere abundant in Ohio, but says that it is found in streams flowing into Lake Erie and into the Ohio River. In Michigan, Ruthven *et al* (1912) report it from numerous counties in the southern part of that state. For Indiana, the state in which most authorities claim it is most common, Hay (1892) says that it is found only in the lake region of the northern part of that state, while in his "Preliminary Catalogue" he says "it is found sparingly in northern Indiana." For Wisconsin, Hoy (1883) reports it as "abundant on the prairies;" Higley (1889) says it is common, and Pope and Dickinson (1928) record specimens from nine counties. In Iowa, Blanchard (1922) reports a specimen from Dickinson County, mentioning that this record is the most westerly for the species, as well as the first for Iowa. It is reported by Nash from Ontario, Canada.

MAP 7.—*Emys blandingii.*

ILLINOIS RECORDS.—It is of especial interest to note that the type specimen was taken by Holbrook (1838) from "The Fox River" in Illinois, this being the only species of turtle the type specimen of which was taken in this state. Kennicott (1855) reports it as "common on the prairies." Garman (1890) reports of this species that "as late as 1870 it was rather common about water on the prairies of central Illinois; it is now very rare, only one example having been taken in the past six

years." Two years later Garman reports it as "throughout the state, commoner north; rare at present," and records specimens only from Normal and Urbana. There is no evidence to bear out the statement that *Emys blandingii* has this distribution in the state—at least not at the present time—and it is extremely doubtful whether it ever occurred throughout the state. Hankinson (1917) reports it from Charleston, and Weed (1922) records it as "abundant" in the Chicago area. In the Field Museum are specimens from Lake Forest (#2435), Meredosia (3403, 3427), Chicago (3247), as well as seven eggs from Waukegan (5953). The writer has examined specimens from the following Illinois localities: Peoria, Havana, the Illinois-Mississippi canal near Rock Island, Meredosia, Cook County, and Charleston. The Illinois River at Meredosia yielded three specimens, including the large one described, while the other localities yielded a single specimen each. It is a rare turtle over most of northern Illinois, and absent from the southern half of the state.

Habitat.—This species shows a considerable amount of variability as to its mode of life and habitat preference. Speaking in general terms, *Emys blandingii* is a semi-aquatic turtle: in certain regions it is largely a terrestrial species, while in others it is almost entirely aquatic in its habits. Thus in the region south of the tip of Lake Michigan the individuals of this species tend to spend a great amount of time out of water, wandering about in the fields, woods, and sandy areas quite far from water. In the region about Meredosia on the Illinois River, individuals are not ordinarily found far from the water, the turtles spending most of their time in the river itself or in either the tributary streams or adjacent swampy areas. Thus Garman (1892) says that it is oftener found in water than on land, but that it is essentially a terrestrial species —a rather curious mixture of ideas. The original habitat seems to have been the wet prairie regions of the state, but the draining of the soil and the cultivation of the fields have so altered the pristine conditions that the turtle has become extinct over most of what was originally its primary range. This would account in a measure, then, for the diverse habitat selections we find today, some individuals of an original swamp species attempting to adapt themselves to the dry land conditions they find, others taking to a more aquatic existence where large rivers and an abundance of water afford such an environment.

Habits.—There is probably no turtle found in Illinois whose habits and life history are less known than are these phases of the life cycle of *Emys blandingii*. Apparently not a common species anywhere, it has been largely neglected. Yet there has been a considerable amount of work done on the only other species of this genus, *Emys orbicularis* of southern and eastern Europe and southwestern Asia and northern Africa.

Incidentally, this curious distribution of two such closely related turtles *(Emys orbicularis* formerly ranged over Germany, Holland, Denmark, and the British Isles) is explained on the theory of old "land bridges" said by geologists to have existed during the Mesozoic and Cenozoic eras and as recently as the Pleistocene. Of especial interest in this distribution are the postulated bridges between America and Europe across Greenland and Iceland on the east and the Asiatic bridge across what is now the Bering Strait on the west.

Blanding's turtle is very timid by nature. When frightened while sunning along the shore of the lake or upon a log in the pond, it plunges at once into the obscurity of the water and remains for hours hidden and withdrawn. Eventually it gathers enough courage to poke its eyes out of water, and then scrutinizes the surroundings with exceeding care before venturing upon further exposure. If surprised on land, it withdraws at once into its shell, which it closes as tightly as possible, and there it remains sealed and quiescent for a long time. If things remain quiet, the anterior lobe is slowly opened a crack so that the turtle can see out; if this experiment proves successful, the opening is increased and the head slowly, almost imperceptibly protrudes for a better view, and only after long deliberation will the turtle venture further. Morse (1904) makes the rather curious observation that once the turtle has withdrawn within its shell "no amount of thumping will cause it to open the hinged plastron" from which he assumes the very timid nature of the species. No amount of "thumping" will cause any turtle to forsake the protection which its shell affords.

Though entirely at home on land, where the hinged plastron affords it efficient protection, *Emys blandingii* is an excellent swimmer, holding its own in all aquatic requirements with any of the species of pond turtles. Its underwater movements are fast and decisive; it swims with bold strokes that carry it forward with good speed. The bottom vegetation offers it hiding facilities which it utilizes when disturbed, and it may on occasion be seen walking slowly about on the bottom in search of food. It can hold its breath with any of the pond turtles, and is capable of remaining under water fully as long as species of the genus Chrysemys. The variegated pattern and peculiar shading of the carapace blends well with the light and shadow of the vegetation.

As to the hibernating period, there is also little information, due to the rarity of the turtles. Apparently they go into hibernation early, and come out rather late. The long period of inactivity is spent under water in many cases, and often in the mud at the bottom of the pond. Specimens have been taken at Meredosia from the underwater runways of the muskrat *(Ondatra zibethica)* and also from the mud of springfed

ditches. They are most often found while in hibernation by the probing method used to locate turtles during the winter, and the curious name of "glass turtle" arises from the peculiar glass-like sound caused by the steel point of the probe hitting the carapace of the turtle.

Nesting Habits.—In the literature, information on the nesting and breeding habits is confined to quotations from Agassiz as to the number of eggs laid, and very little else besides. Gadow (1901), however, has some interesting notes on the very closely allied *Emys orbicularis* which, since the species are very closely similar besides being the only two representatives of the genus in the world, may, perhaps, be of some interest, though whether they are relevant or not must be left to the future to determine.

> During the pairing season, on warm spring nights, they emit short piping sounds, and when they have found each other, the couple swim about together. The white, hard-shelled, long, oval eggs, averaging 25 to 15 mm, and about ten in number, are laid on land. This is a very laborious and curious business. The female having selected a suitable spot, not loose sand, but rather hard soil free from grass and other dense vegetation, prepares the ground by moistening it from the bladder, and the anal water-sacs. Then it stiffens the tail and bores a hole with it, moving the tail but not the body. The hind limbs then scoop out the hole, the broad feet moving alternately and heaping up the soil on the side, until the hole is about five inches deep, that is as far as the hind legs will reach. The eggs are laid at the bottom in one layer, divided and distributed by the feet. Lastly, the soil is put in again and the tortoise, by repeatedly raising its body and falling down, stamps the soil firm and flat, roughens the surface a little with its claws, and leaves the nest to its fate. Nothing but an accident leads to its discovery. The young are hatched, according to locality and the kind of season, either in the same autumn or not until the next spring.

Eggs.—The eggs number from 6 to 10, though 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. The eggs when laid are covered by a tough, white, unglazed shell. The average size of eight eggs which composed the complement removed from the oviduct of a large female just about to lay is 36.6 mm by 25.2 mm. The largest egg was 38 mm by 26 mm.

Incubation.—If *Emys blandingii* resembles *Emys orbicularis,* it is altogether possible that the eggs do not hatch until the spring following their deposition, passing the winter with a retarded metabolic rate so far as the embryo is concerned. Agassiz has hinted in several cases that this may occur, and experimentation and investigation of this phase of testudinate development would be of great interest.

Food Habits.—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. 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" stomach available to the writer for study. In their water environment they feed with equal avidity upon frogs, tadpoles, crayfish, minnows, and the larger larvae of aquatic insects. It speaks well for the speed of this turtle to note that it catches these active forms with apparent ease and surety. Also it is interesting to note that this species is able to swallow food both under water and while on land.

TABLE 7.—MEASUREMENTS OF ILLINOIS SPECIMENS OF *Emys Blandingii*
(Measurements in millimeters)

Specimen No.	Carapace		Plastron			Head	Tail	Sex
	Length	Width	Length	Width	Depth			
1.....	240	164	220	116	83	38	103	♀
2.....	172	122	170	98	63	28	65	..
3.....	64	50	50	40	26	13	25	..

ECONOMIC IMPORTANCE.—This turtle is far too rare to have any economic value to man, but there is an abundance of good meat on it, which is both palatable and of excellent flavor. It is never a scavenger by habit, and its innocuous food habits certainly cannot be damaging to man.

PARASITES.—Though I have examined only three Illinois specimens, I have failed to find any trace of either trematode or nematode parasites, nor any evidence that the species is seriously attacked by leeches.

GENUS TERRAPENE MERREM

Terrapene (part) Merrem 1820
Cistuda (part) Flemming 1822
Cistudo Bonaparte 1830
Emys (part) Wagler 1830
Diclida (part) Rafinesque 1832
Pyxidemys (part) Fitzinger 1835
Emyoides Gray 1844
Onychotria Gray 1849
Pariemys Cope 1895
Toxaspis Cope 1895
Didicla Fowler 1906 (= Diclida Raf.)

Shell high, globular, convex. Plastron large, completely filling the aperture, rounded anteriorly and posteriorly, and united to the carapace by a ligament and movable upon it. Plastron divided into two movable lobes by a transverse hinge between the pectoral and abdominal elements; axillary and inguinal scutes rudimentary. Humero-pectoral suture meeting the entoplastron at about its middle. Dorsal surface of the head covered by smooth skin only. Alveolar surface of the jaws narrow and

without a median ridge; upper jaw with beak projecting downward. Choana between the eyes large; no bony temporal arch present. Digits with but a slight web or none. Tail very short.

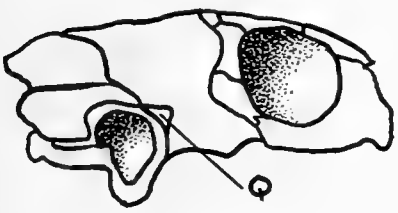
Terrapene carolina carolina (Linnaeus)

(Common box turtle; sand turtle)

Testudo carolina Linnaeus 1758
Testudo carinata Linnaeus 1758
Testudo brevi-cauda Lacépède 1788
Testudo clausa Gmelin 1788
Testudo incarcerata Bonnaterre 1789
Testudo incarcerata-striata Bonnaterre 1789
Testudo virgulata Daudin 1802
Emys clausa Schweigger 1812
Emys virgulata Schweigger 1812
Emys schneideri Schweigger 1812
Cistudo clausa Say 1825
Terrapene clausa Merrem 1820
Terrapene carolina Bell 1825
Terrapene maculata Bell 1825
Terrapene nebulosa Bell 1825
Terrapene virgulata Fitzinger 1825
Emys carolina Gray 1831
Cistudo carolina Gray 1831
Pyxidemys schneideri Fitzinger 1835
Pyxidemys virgulata Fitzinger 1835
Pyxidemys clausa Fitzinger 1835
Cistudo virginea Agassiz 1857
Terrapene carinata Strauch 1862
Cistudo clausa clausa Cope 1875
Cistudo carinata S. Garman 1884
Cistudo carolina carolina H. Garman 1892
Didicla (= Diclida) *carolina* Fowler 1906

Description.—The range of variations of shape, markings, and color of *Terrapene carolina carolina* is almost unlimited, so that any two specimens are hardly more than similar even though they have come from the same locality. So infinite are these variations that I can do no better than to describe a typical specimen and indicate the range of various characters. The shell is usually oval, somewhat narrower toward the anterior end than toward the posterior, but in some cases the individuals are nearly round. Carapace highly convex, arched, globular, the marginals entire over the anterior two-thirds of the carapace, but tending to become serrate in the posterior third, with a conspicuous though small caudal notch. Vertebral scutes of moderate size. The first vertebral is pentagonal, the two anterior margins tending to unite medially in a point which intrudes into the posterior margins of the first paired marginals. Second and third vertebrals hexagonal, the anterior and posterior margins almost equal and longer than those of the remaining four sides which are approximately equal. The fourth vertebral tends to be heptagonal in some specimens, hexagonal in others, the variation occurring in the anterior margin. Fifth vertebral, the smallest of the series, roughly hexagonal and wider than long. There is a distinct, though low and blunt, vertebral keel, most conspicuous on the second, third, and fourth scutes. The anterior three costals are large. The first is trapezial in shape, the dorsal (median) margin being the shortest. Second costal the largest of the series, rectangular. Third costal roughly rectangular and somewhat smaller than the second. Fourth costal by

far the smallest of the series and about the size of the fifth vertebral, tending toward square. Nuchal small or (rarely) absent. Anterior and posterior marginals flaring, the posterior more so than the anterior, though the caudals are nearly vertical; edge entire up to about the eighth scute where serration usually begins. There are twelve paired marginals. All scutes of the carapace with finely etched concentric lines. The focus of these lines lies at the posterior median border of the vertebral scutes, in the center of the dorsal third of the costals, and at the posterior-lateral angle of the marginals. Plastron large, completely closing the aperture. It is divided into two lobes by a ligamentous hinge between the pectoral and abdominal scutes, both lobes being movable. It is attached to the carapace by a ligamentous hinge in lieu of any trace of a bridge. Gulars large, triangular. Humerals a truncate triangle, the interhumeral suture being short. Pectorals rectangular and approximately twice as wide as long. Abdominals also rectangular, larger than the pectorals. Femorals very large, triangular, the interfemoral suture being the shortest of the ventral sutures, and the plastron is widest across the femorals. Anals very large, triangular, the interanal suture the longest of the ventral median contacts, and without an interanal notch. There is a tendency to show concentric striae on the plastral elements, but these are usually nearly worn off; the focus of these is at the posterior lateral angle of the scutes. The mid-ventral suture tends to be a straight line, with few undulations. Axillary and inguinal elements usually absent, or at best very rudimentary. Head of medium size, covered with a smooth, tightly drawn skin. Upper jaw hooked, entire, *without* a notch at the symphysis; lower jaw with an upward hook. Alveolar surfaces narrow and without a median keel or ridge. Limbs and feet strong, scaly; digits with very rudimentary web, or free. Claws of the fore feet short, but strong and five in number; four claws on the hind feet, longer than those on the fore. Tail short and stubby. Of osteological characters, Taylor (1895) points out that the zygomatic arch is absent; the quadrato-jugal is rudimentary and triangular, articulating only with the quadrate; post-orbital arch wide, the jugal being relatively wide and short; phalanges: fore limb 2-3-3-3-2 or 2-3-3-2-2; hind limb; 2-3-3-3-2.



TEXT-FIGURE 11.—The skull of *Terrapene carolina carolina*. *Q*—quadrate.

COLORATION.—Extremely variable. The carapace is dark brown or nearly black, with blotches, stripes, and hieroglyphics of yellow or orange. Sometimes the yellow predominates, sometimes the dark brown

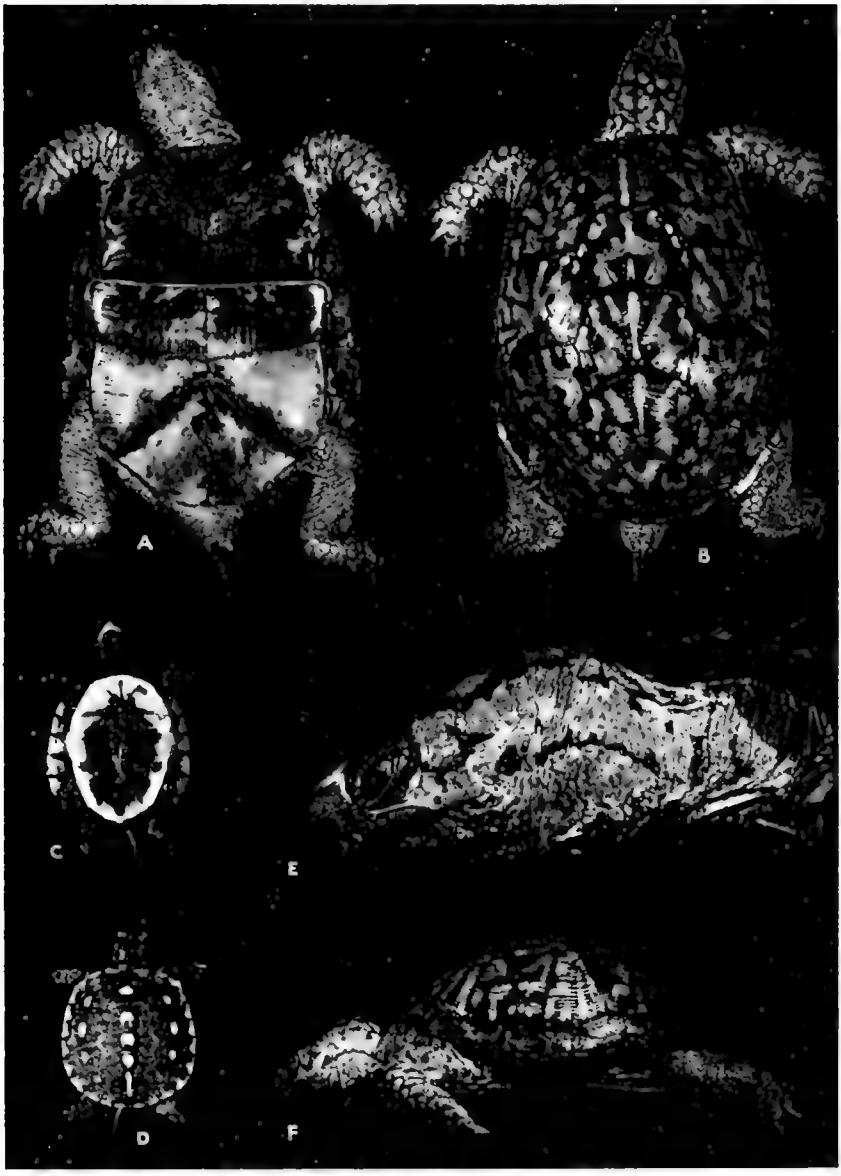
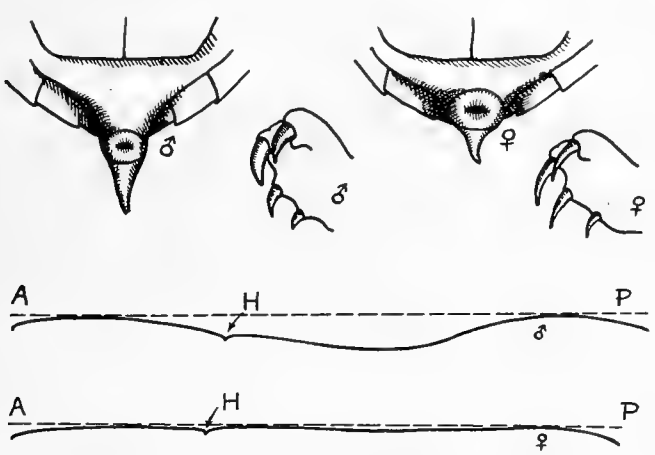


PLATE 11.—*Terrapene carolina carolina: A,* Adult male, ventral view. *B,* Same individual, dorsal view. *C,* Newly hatched young, ventral view. *D,* Newly hatched young, dorsal view. *E,* Head study of an adult. *F,* Adult, lateral view.

ground color. While the yellow markings are extremely irregular, the tendency or plan is for them to radiate from the center of the growth point of the scute. The vertebral keel is marked by either a yellow line or a series of elongated yellow blotches. The plastron varies from clear yellow to clear ebony black or mahogany brown, with every conceivable variation between. Sometimes the colors are demarked into distinct areas of solid color; sometimes the entire plastron is intricately mottled. Soft parts brown, sparsely or heavily marked with round spots of yellow or orange, particularly about the neck and fore limbs. Jaws yellow, with black spots or lines. Iris varies from brown to bright scarlet.

YOUNG.—The young are much more round than the adults and the vertebral keel is far more distinct and considerably higher in proportion. Each vertebral scute tends to have a yellow spot on the portion of the keel associated with it, and there is a similar yellow spot on each costal, while the marginals usually have a yellow mark (not a round spot) at their lateral margins. I have one young turtle of this species which does not have a trace of the usual spots on the carapace. The color of the carapace is, otherwise, uniformly brown. Plastron yellow, with a large central area of dark brown occupying most of it. The tail is relatively larger in the very young than in the adults.



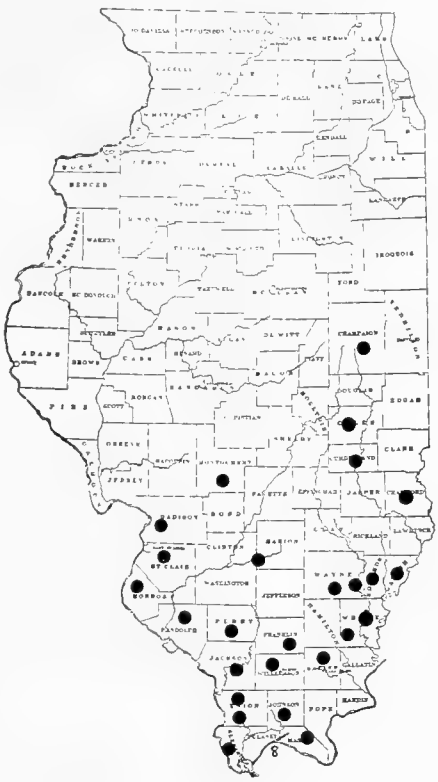
TEXT-FIGURE 12.—Sex differentiation in *Terrapene carolina carolina*. *(Above)* Ventral views of the tail and of the right hind foot, male and female. *(Below)* Diagrammatic longitudinal sections through the plastron, male and female. *A*—anterior; *H*—hinge; *P*—posterior.

Sex Differentiation.—There are a number of secondary characters which are associated with the sex of the individual, and these may be listed as follows: (1) The tail of the male is longer than that of the female, the difference lying in the distance of the anus from the plastron, not in the distance from the anus to the tip. (2) Hence the anal aperture opens beyond the carapace in the male, and below the carapace in the female. (3) The claws of the hind foot of the male are short and stocky and considerably curved; in the female the claws are longer, more slender and less curved. (4) Plastron of the male is concave in the anterior region of the hind lobe just posterior to the hinge; no such concavity exists in the female. (See Text-fig. 12 for diagrams representing longitudinal cross sections through the plastron.) (5) The carapace of the male tends to have a greater flare at its posterior corners than is the case in the female. (6) The nuchal notch is more marked in the male than in the female. (7) Relative height and width of the male is greater than of the female. (8) The iris of the male tends to be red or pink; of the female yellow or brown. (This is generally but not always true).

Geographic Distribution.—The range of *Terrapene carolina carolina* includes the major portion of northeastern United States, extending as far north as the Great Lakes and the St. Lawrence River. It occurs over most of New England, including the coastal states of Maine, Massachusetts, and New Jersey, and extending southward to Georgia. The western limit of its range lies in Wisconsin, Illinois, and Missouri. In Pennsylvania (Surface, 1908) it is found to be statewide, excepting for the pine barrens country, where it is absent. Morse (1904) reports that, while nowhere abundant in Ohio, it is to be found over the entire state, and Hay (1892) reports a similar distribution for Indiana. Ruthven *et al* (1912) report it from several southern counties in southern Michigan. Blanchard (1922) reports it from western Tennessee, while Hurter (1911) reports but a single specimen taken from the west side of the Mississippi, in Missouri. In the northwestern portion of its range it is reported from southern Wisconsin as far north as Green Bay by Pope and Dickinson (1928), although Higley (1889) fails to mention it for that state, while Cahn (1929) adds one record for southern Wisconsin. There is no ground for the statement by Pope and Dickinson that it is probably "statewide" in its distribution in Wisconsin.

Illinois Records.—Within the state of Illinois there are records of the box turtle, *Terrapene carolina carolina,* from numerous localities. Yarrow (1882) reports specimens from Mt. Carmel (9512) and Fairfield (9939) in the U. S. National Museum. Garman (1892) records it from Duquoin, Eldorado, Cobden, Anna, Fairfield, and Mt. Carmel. Hurter (1911) found it in Madison, Monroe, St. Clair, Randolph and Union

counties in the Mississippi River region; Hankinson (1915, 1917) reports it from the Charleston region, Blanchard (1924) in Johnson and Monroe counties, and Shenck (1886) has some interesting notes from Albion. The Field Museum has a specimen from Olive Branch (2219). Gaige (1914) reports *T. carolina* from Richland county, but in a personal letter this is corrected, the specimen proving to be *Terrapene ornata*. The present writer has examined specimens from the following localities: Centralia, Robinson, Toledo, Anna, Cobden, Mt. Carmel, DuQuoin, Alto Pass, Litchfield, Norris City, Urbana, Carmi, Benton, Marion, Charleston, and Carbondale.



Map 8.—*Terrapene carolina carolina.*

Habitat.—The common box turtle is distinctly and preëminently a woods species, essentially terrestrial in its habits, yet, as we shall see later, with certain aquatic or semi-aquatic inclinations. Its favorite haunt is in dry deciduous woods with plenty of underbrush and herbaceous ground cover. Here the turtles wander in search of food by day and seek shelter under the protection of the brush at night. Again, the turtles wander out into the grassy fields or into areas under cultivation. Hillsides afford a congenial environment, especially those with a southern exposure, where the early spring sun limbers them up after hibernation.

Habits.—Because of the very gentle nature possessed by these turtles and the ease with which they adapt themselves to confinement they have been much studied and watched, and there is a considerable literature on their general behavior. The box turtle is of a very timid disposition. If discovered, it freezes in whatever position it happens to be, and awaits further developments without a movement. If the danger approaches, it withdraws its head within the shell with a hissing sound caused by the expulsion of the air from the lungs necessary to accommodate the inclusion of the head and neck within the limited space available. The legs

are drawn in, after which the front and hind lobe of the plastron are closed tightly, and the turtle is impregnable. So tightly do the lobes close the aperture that it is impossible to insert a knife blade into the crack if one would pry a lobe free: one is far more likely to break the blade than to succeed in opening the shell. Again, if the turtle is teased too much, it is likely to resort for a time to snapping and feeble lunges, especially during the breeding season when the males seem to develop somewhat of a temper. Under "domestication," however, both the temper and the timidity are quickly overcome, and the turtle soon learns to eat eagerly from the hand that offers food.

Hibernation begins with the cooler weather of late October. At first the turtles dig in at night only and come out during the warmer portions of the day, but as the days grow cooler the turtles remain longer and longer in their holes until they fail to appear at all during the daytime. At first they do not bury themselves to a depth of more than a few inches. As the weather grows colder they work themselves further and further into the ground until they have gone down from a foot to eighteen inches or even to a depth of two feet. The following tabulation shows the progressive depths of hibernation as found by the writer by probing down to a turtle known to be hibernating:

Date	*Depth* (in inches)	*Date*	*Depth* (in inches)
October 21	2	November 25	16
October 28	5	November 30	19
November 4	5	December 5	19
November 11	9	February 9	19
November 18	11		

If taken out of hibernation the turtle is to all appearances dead, but in the proximity of heat it slowly revives and in a few hours is looking around inquisitively. The species comes out of hibernation in April, the exact time depending largely upon the weather. If a late cold spell descends upon the turtles after they are out, many die of exposure: apparently their adjustment to the environment is a rather slow process.

A great deal has been written both about the avoiding of water by the box turtle and about the aquatic habits of the species. The belief is firmly fixed in the popular and scientific mind that the box turtle avoids water, and the appearance of many brief notes, many written apparently in a spirit of astonishment, calling attention to a turtle found somewhere associated with water have failed to make much of an impression. The significance of these notes, namely, that *Terrapene carolina carolina* has a distinct use for and attraction to water has not yet filtered through the consciousness of the writers. Yet such is the case. During the hot

periods of the summer we find the box turtle going into a state of aestivation closely akin to its period of hibernation, during which it remains quiescent, buried in the ground. Often this aestivation is passed buried in mud, as noted by Hurter (1911), Overton (1916), Engelhardt (1916), and others. The site is usually a mudhole, and in the wet mud, buried to a depth of from two inches to nearly a foot, the turtles spend the periods of excessive heat. If the space is limited, the turtles pile up on top of each other, and Hurter reports six taken from a space three feet in diameter. Latham (1916) reports a regular procession of box turtles heading toward a small mudhole in August, with sixty to seventy individuals already gathered in and about the puddle.

A still more (apparently) unusual use of water by the box turtle came under my observation during the fall of 1931 and the winter following. In the spring of that year I liberated some 24 adult specimens of *Terrapene carolina carolina* and 17 of *T. ornata* representing both sexes in an outdoor pen measuring 40 by 12 feet. At one end a pipe poured a steady stream of water, forming a puddle six inches deep and about a yard in extent. In late October all of the *T. ornata* went into hibernation and were seen no more until spring. It was a very mild fall, and *T. carolina carolina* did not begin to think about hibernation until November 2, and soon afterward all went into the ground except five specimens, which about this time took up their abode in the water and were apparently quite contented in the puddle. The interesting part is that these remained in the water the entire winter, occasionally poking their noses out for air on the milder days, but remaining almost immobile during the three months of winter. On a particularly mild day in January one specimen came out on the land, and went in again in the afternoon; the air temperature of this day was 11° C. Two days later (January 29), one went for a walk and got too far from the water; it was found frozen to death the next day. The following data in regard to one of these water-hibernating turtles are of interest: air temperature, 3° C; water temperature, 10° C; body (rectal) temperature, 9.5° C. Subsequent readings showed that the body temperature remains about 1° C below that of the surrounding water.

The box turtle is capable of swimming and is, in fact, quite good at it, though because of the globular form of its shell and the shortness of its legs, swimming is an awkward and laborious process. It swims at the surface, with the dome of the carapace and the head out of water, and I have never seen one swim below the surface; in fact, they seem to be too buoyant to get under. The turtle paddles slowly along, resting repeatedly as it floats at the surface, to continue its progress toward shore at broken intervals. The young seem to be more aquatic than the adults.

PLATE 12.—*Terrapene carolina carolina:* Box turtles in copulation. The female is on the left, the male on the right.

This turtle leads a rather uneventful, quiet sort of life. During the day the creatures wander about rather aimlessly in search of food. When night comes they sometimes dig into the ground and conceal themselves; with morning they dig out again, working forward, not backing out of the hole by which they entered their retreat. As they eat they grow fat, and specimens taken in the late fall prior to hibernation are likely to be so fat that they are unable to withdraw completely within the shell. They are comical at such times. If pressure be applied at one end of the shell the turtle pops out at the other end as it attempts to withdraw the end that is in danger within the protection of the shell, a procedure which its corpulent condition renders impossible.

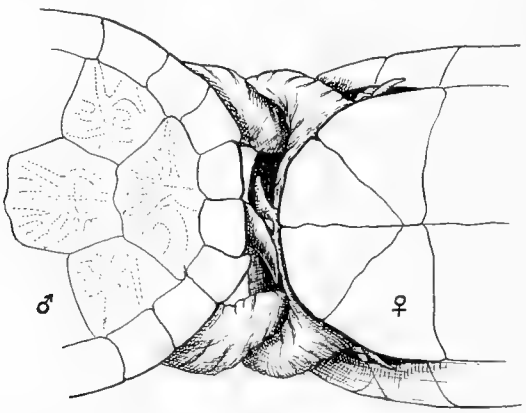
There are a number of interesting notes scattered through the literature which throw some light on the longevity of this species. Thus Dr. Shenck (1886) records an item of interest from Albion, Illinois. A turtle with initials engraved upon its carapace in 1824 was recaptured in 1865, marked with an additional initial and again liberated. It was recaptured again in 1885 within half a mile of the original spot of its capture, still bearing clearly all of the initials. Hence this turtle was 61 years old at least, but to this must be added the fact that it was already fully grown when the initials were first put on in 1824. Initials carved on turtles ordinarily cannot be taken too seriously as proving anything, but this case seems to be authentic. It emphasizes further the fact that the range of the individual box turtle is very limited and that the adults at least are not prone to wander far from "home." Not only are they long-lived, but the fact that they may survive under difficult conditions is indicated by turtles which Dr. R. W. Shufelt kept alive, without either food or water, for an entire year.

Nesting Habits.—Copulation takes place very shortly after the animals emerge from hibernation, the male mounting the female for a considerable period of time, after having subdued her by a rather vicious attack during which the beak and front feet are effectively used. The act of copulation has been described by Cahn and Conder (1932). The pair described was found in copulation, the male standing nearly erect upon the posterior end of his carapace, his legs pressed firmly into the inguinal area of the female, being assisted in this by the female which, her legs outside those of the male, pressed his legs yet more firmly in place. This represents a sort of "posterior amplexus." How long the pair had been thus in contact is unknown, but they remained thus for an hour and three-quarters, during which time they were handled frequently and photographed. This report is confirmed by Ewing (1933).

Prior to the act the male may follow a given female for days. After copulation the male remains as if exhausted, immobile for several hours, while upon the female the process seems to have no effect whatever.

The nest is made usually in sand, but eggs have been found deposited in the rich agricultural soil of cultivated fields. The nest is dug entirely with the hind legs, and requires several hours for completion, for the work is done leisurely. It is between three and four inches wide and extends into the ground a distance of three or four inches. The female backs into the hole as she digs and continues until she is nearly below the surface of the ground. In this excavation she deposits from three to eight eggs, five to seven being the average number. Each egg is worked into its proper position after it is laid, and by manipulation with the hind feet, each is buried separately. It takes about three-quarters of an hour to complete the laying of the eggs. When the last egg is concealed, the turtle fills up what remains of the hole, smoothing the surface and eradicating all signs of the nest by dragging the plastron over the ground several times. The period of incubation is about three months. Females of the species, liberated in my outdoor pen in early June (at which time dissection of certain ones showed hard-shelled eggs in the oviduct), had the young hatch on October 8. However, this pen was shaded by buildings and by vegetation, and received but little direct sunlight, which may perhaps have lengthened the period of incubation.

It is a well-known fact that, in spite of the abundance of *Terrapene carolina carolina* in certain regions, the newly hatched or partially grown young are but rarely found in nature. The young which hatched in my pen headed immediately toward the puddle of water at one end, entered it and remained hidden in the vegetation and beneath the bottom débris until I fished them out before the cold weather set in. In the laboratory they immediately burrowed under the sphagnum which covered the ground in their little enclosure, and remained embedded in the moist earth



TEXT-FIGURE 13.—Posterior ends of the shells of a pair of *Terrapene carolina carolina* in copulation; ventral view of plastron of female; dorsal view of carapace of male.

for weeks at a time. These facts may well give a clue to the reason for the scarcity of small box turtles. The very young possess a terminal egg tooth which they use in picking their way out of the egg; it is lost within a week after hatching.

Eggs.—The eggs number, as we have said, between three and eight in a clutch. They are oval in shape, the curvature of the ends being equal. The shell membrane is very thin and flexible, the eggs having a soft, pliable feel when handled. The average size of a typical egg is 33.17 mm by 19.5 mm, this figure obtained by measuring 54 eggs of the species. The largest egg in the series examined measured 35 mm by 19 mm; the smallest 30.5 mm by 18.5 mm. Ewing (1933) offers interesting data on the subject of the eggs and incubation period, and shows that for Washington, D. C., "the earliest date of egg laying was June 22; the latest date was July 14. The average date for egg laying was July 1. The average date for the emergence of the first young individual of a nest was September 26. The average number of eggs laid at any one time by a female was 3. The percentage of eggs found to be fertile was 78.6." In a table he shows the incubation period to vary from over 69 days to over 103 days, and from his data one obtains the average incubation period as 88 days.

Food Habits.—The diet of *Terrapene carolina carolina* is a mixture of both vegetable and animal matter, with the former predominating in most cases. The vegetable material consists of a great variety of plants, including the roots, stems, and leaves of a host of species of flowering plants, berries, fruits, and some seeds. Fungi are particularly liked according to a number of authorities, though I have never found evidence of this in specimens examined from Illinois. The animal matter consumed includes earthworms, snails, slugs, myriapods, and a great variety of insect species, coleopterous forms ordinarily predominating. Reports mention the fact that the box turtle is fond of lettuce and of cucumbers and muskmelons and that they sometimes damage these crops; this damage cannot, however, really amount to much. In captivity the young feed well upon bananas, lettuce, apples, and various succulent fruits, but if not permitted to hibernate they cease eating entirely, no matter what enticing morsels are offered them, and death usually follows before the winter is over.

Economic Importance.—The insect-eating proclivities of this species make it a highly desirable turtle to have around, for the diet includes many species of noxious insects—such as cutworms, grasshoppers, caterpillars of various species, ants, flies and their larvae, and several species of injurious beetles. Though usually edible, the box turtle is ordinarily not used for food. Babcock (1919) reports an instance in Pennsylvania

where, during a coal strike, the miners went afield and gathered in box turtles which they ate, and which promptly made them ill. It is assumed that they had fed upon some species of poisonous "toadstool" which rendered the turtles temporarily poisonous, but which did not poison them. This is a more than likely supposition, for the box turtle is particularly fond of fungi of various sorts. It is not at all a scavenger and only rarely or under peculiarly adverse circumstances preys upon other vertebrates of any sort.

PARASITES.—Being a terrestrial form, the box turtle is not subjected to attacks of leeches, and intestinal worms are not overly common. I have on two occasions dissected out the large white larvae of a species of botfly imbedded in the neck region. These occupied a cavity nearly half an inch deep, yet seemed to cause the turtle but little inconvenience.

TABLE 8.—MEASUREMENTS OF ILLINOIS SPECIMENS OF *Terrapene carolina carolina*
(Measurements in millimeters; weight in grams)

Specimen No.	Carapace		Plastron			Head	Tail		Weight	Sex
	Length	Width	Length	Width	Depth		Total	A-T		
1	134	105	128	75	62	22	36	20	371	♂
2	94	84	93	65	48	16	26	20	169	♀
3	138	108	142	90	75	22	27	24	550	♀
4	137	101	135	75	70	22	27	25	536	♀
5	122	96	118	76	69	20	22	18	317	♀
6	141	111	139	86	73	22	20	15	584	♀
7	141	112	130	80	60	23	35	18	424	♂
8	99	79	96	61	50	17	25	20	166	Im. ♀
9	89	70	84	57	41	18	..	..	116	Im. ♂
10	139	113	132	82	65	23	30	14	452	♂
11	141	112	137	79	60	24	31	14	416	♂
12	125	92	121	77	55	20	35	20	294	♂
13	50	46	48	37	22	10	18	15	27	Im. ♂
14	81	65	80	51	38	15	16	14	106	Im. ♂
15	151	116	141	87	68	21	38	31	620	♀
16	145	110	135	81	66	22	40	18	475	♂
17	140	110	133	82	71	22	36	33	496	♀
18	60	56	57	41	27	12	16	14	31	Im. ♀

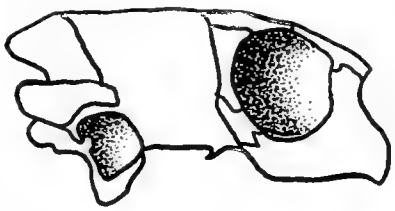
Terrapene ornata (Agassiz)

(Painted box turtle; sand turtle)

Cistudo ornata Agassiz 1857
Terrapene ornata Baur 1891
Terrapene ornata cimarronensis Cragin 1894

DESCRIPTION.—Shell broadly oval, the width equalling approximately three quarters of the length. Carapace high, but much flattened dorsally; anterior slope gradual, posterior (caudal) slope abrupt. First vertebral scute pentagonal, the anterior margins meeting in a median point which projects far into the nuchal. Second, third, and fourth vertebrals hexagonal, the width exceeding the length. Fifth vertebral pentagonal, and placed nearly vertically; it is the smallest of the series. There is no

trace of a vertebral keel. Costal scutes large, wider than long. The first costal trapezial, the median dorsal margin the shortest. Second and third costals roughly rectangular, approximately twice as wide as they are long. Fourth costal trapezial, and the smallest of the costal series. Nuchal small, forked posteriorly, the tip of the first vertebral fitting into the V-shaped notch. Anterior and posterior-lateral marginals flaring, the mid-lateral and caudal marginals vertical and without a flare; no intercaudal notch. Plastron large, but not quite filling the aperture. It is divided into an anterior and posterior lobe by a ligamentous hinge between the pectoral and abdominal scutes, both lobes being movable. The plastron is widest across the abdominal scutes. Gulars acutely triangular. Humerals approaching triangular, with a short interhumeral suture which is usually (though not always) the shortest of the mid-ventral sutures. Pectorals rectangular, the interpectoral suture usually exceeding the interhumeral suture, though this is not always the case. Abdominals rectangular. Femorals trapezial, the interfemoral margin the shortest of the sides. Anals large, the largest of the plastral elements, triangular; their posterior margin is even, straight; and there is no inter-anal notch. The longitudinal mid-ventral suture undulates considerably as small portions of the right and left plastral elements tend to intermesh. The plastron is attached to the carapace by a bridge formed by a very short wing of the abdominals; it is inconspicuous, but distinct. Axillary element large and conspicuous; inguinal either rudimentary or absent. Often the scutes of the carapace show concentric striae about the growth point of each scale; these are more marked on the costals and marginals than on the vertebrals. Similar striae sometimes are in evidence upon the plastral scutes, but usually these are worn off, leaving the plastron smooth. Head rather small, scaly, the dorsal surface covered by a tightly drawn skin. Upper jaw strongly hooked, and with a distinct median notch. Limbs strongly scaled, the scales larger and more prominent on the front limbs. Digits of front limb five, each with a strong, straight claw; digits of hind limb also five (though the fifth is exceedingly rudimentary), the four larger with slender, somewhat curved claws, the innermost being very small and weak. All digits without distinct webbing. Tail short, slender. Osteological features: zygomatic arch entirely absent; quadrato-jugal absent; postorbital arch very slender. Phalanges in fore limb 2-2-2-2-2; in hind limb 2-3-3-3-1.



TEXT-FIGURE 14.—Skull of *Terrapene ornata* (for comparison with Text-fig. 11).

Coloration.—*Terrapene ornata* does not show nearly as much variation in either color or pattern as does *T. carolina carolina.* The carapace is usually a chocolate brown, with local tendencies toward a reddish brown. Each scute of the vertebral and costal series is marked with dashes and lines of bright yellow, which tend to radiate from the growth center. There is a tendency to form a mid-vertebral yellow line, but this is ordinarily somewhat broken up into a series of long yellow dashes. The lateral portion of the marginals bears a yellow patch of irregular shape and of variable size. The plastron is yellow, highly and conspicuously mottled in an elaborate, asymmetrical design of red-brown. Head and neck dark brown, spotted with pale yellow, especially on the

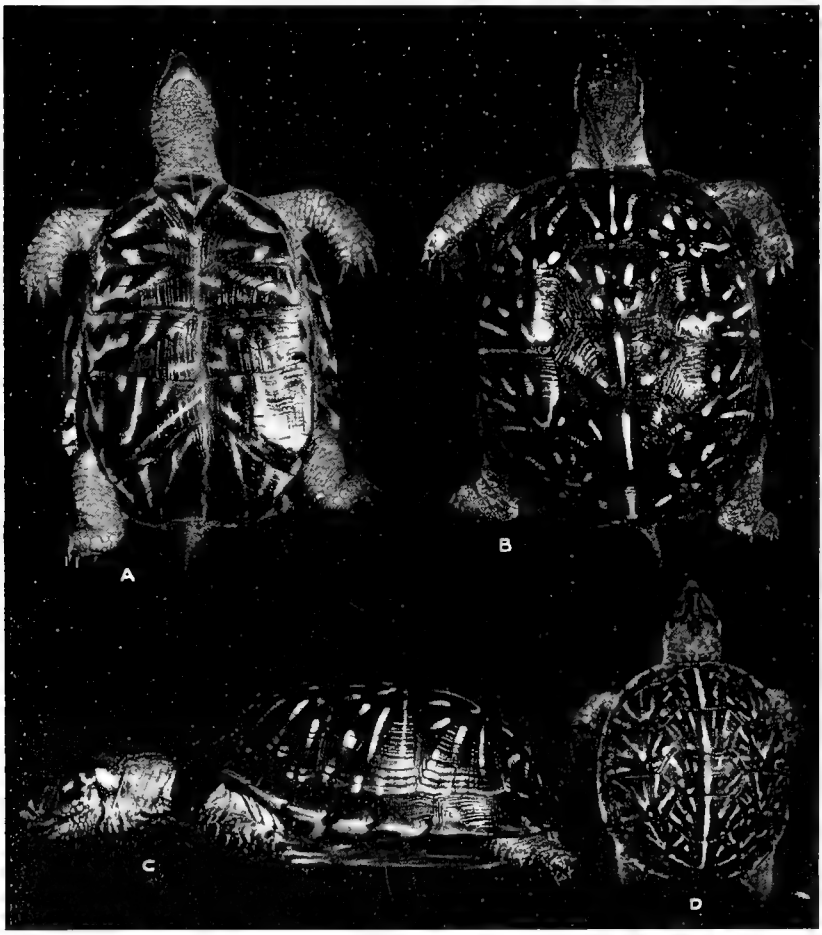


Plate 13.—*Terrapene ornata: A,* Adult, ventral view. *B,* Adult, dorsal view. *C,* Adult, lateral view. *D,* Immature individual, two and a quarter inches long.

top and sides. Each scale of the fore limbs bears a conspicuous yellow dot on a dark brown background. Tail with a pale yellow mid-dorsal line.

YOUNG.—I have been entirely unable to locate a newly hatched specimen of *Terrapene ornata,* and there is no description of the young in literature. Agassiz figures the young, but unfortunately in such a position as to make description of it impossible. It appears to have a light (yellow?) blotch on the costal scutes, and a mid-dorsal light (yellow?) vertebral stripe. The fact that the young are without a trace of a vertebral keel is mentioned by several authors.

SEX DIFFERENTIATION.—The females have short tails, the males long tails, the difference lying in the fact that the anus of the male is beyond the carapace, while in the female it is located under the edge of the carapace; the difference in length lies between the anus and the tip: this distance is less in the female than in the male. Males have the claw on the first digit of the hind foot turned abruptly forward. The males cannot be distinguished, as can those of *T. carolina carolina,* by either the depression in the center of the plastron (which does not occur in *T. ornata*) or by the color of the iris of the eye.

COMPARISON OF SPECIES OF TERRAPENE.—Many people seem to have considerable difficulty in distinguishing between the two species of box turtles, *T. carolina carolina* and *T. ornata,* found in Illinois. In an effort to point out the most marked differences, the following comparison is offered:

1. Carapace of *carolina* is arched, or domed.
   Carapace of *ornata* is flattened on top, or depressed.
2. Vertebral scutes of *carolina* with a median keel.
   Vertebral scutes of *ornata* without a keel.
3. Plastron of *carolina* is widest across the femorals.
   Plastron of *ornata* is widest across the abdominals.
4. Plastron of *carolina* without a bridge.
   Plastron of *ornata* with a short but distinct bridge.
5. In *carolina* the axillary element is absent or rudimentary.
   In *ornata* the axillary element is well developed.
6. Plastron of *carolina* completely closes the aperture.
   Plastron of *ornata* is a bit too short to close it completely.
7. Upper jaw of *carolina* is not notched at the tip.
   Upper jaw of *ornata* is notched at the tip.
8. In *carolina* the length of the plastron very rarely equals that of the carapace.
   In *ornata* the length of the plastron ordinarily exceeds that of the carapace.
9. When fully grown, *carolina* is a considerably larger turtle than is *ornata.*

Osteological differences:

10. Postorbital arch of *carolina* is stout.
    Postorbital arch of *ornata* is very slender.
11. Quadrato-jugal of *carolina* is present but rudimentary.
    Quadrato-jugal of *ornata* is absent.

Geographic Distribution.—According to Stejneger and Barbour (1923) the range of *Terrapene ornata* is: "Indiana, Illinois and the territory between the Missouri and Mississippi rivers and the Rocky Mountains from the Yellowstone River in the north to the Gulf of Mexico in the south, southern New Mexico, Arizona and northern Mexico." In general terms, *T. ornata* may be said to be a western form which reaches its eastern limit of distribution in eastern Illinois, while *T. carolina carolina* is an eastern form which extends westward approximately to the Mississippi River. Ellis and Henderson (1913) report it from Colorado; it is reported by various authors from Wyoming, Kansas, Oklahoma, Nebraska, Arkansas, New Mexico, and Texas. In the southern United States it does not occur east of Texas. Hurter (1911) reports it generally distributed over Missouri. Hay does not list it in either of his reports on Indiana. Evermann and Clark (1930), however, report *T. ornata* as established in the Lake Maxinkuckee region of northern Indiana since about 1923. For Wisconsin, Higley (1889) records it from Walworth County, while Hoy (1883) reports it from Grant County; Pope and Dickinson (1928) add a specimen from Columbia County, and give its range in the state as "apparently only southern Wisconsin." Blanchard (1922 reports it as very rare in Dickinson County, Iowa.

Map 9.—*Terrapene ornata.*

Illinois Records.—There are relatively few records for Illinois for this species of box turtle. Garman (1892) records it only from Fairfield, as does Hay (1892); as a matter of fact, both of these reports are the Yarrow (1882) record, U. S. National Museum #9937, 9938, 9940. Hurter (1911) reports it from Baldwin, Randolph County, and from Addieville, Washington County. Taylor (1895) had a specimen from Kankakee, and another specimen (U. S. National Museum 7542) sent in by Kennicott from "Illinois." Vestal (1913) found it in Mason

County, and Blanchard (1924) at Rosebud, Monroe County. An error occurs in the report of Gaige (1914); in this report of specimens from Richland County, *T. carolina* should read *T. ornata,* according to a personal letter from Dr. Gaige to the writer. In this county, *T. ornata* is reported to be very abundant. The writer has examined specimens from Fairfield, Centralia, Addieville, Pinkneyville, Robinson, and Litchfield; in the latter region this species of box turtle is very abundant. On November 4, 1930, a deluge of box turtles was mysteriously let loose on Michigan Avenue, Chicago. Eventually over 500 specimens were collected, consisting mostly of *Terrapene ornata,* with only a few specimens of *T. carolina triunguis* mixed in. Of these, about 500 specimens of *T. ornata* (no *triunguis*) were finally liberated by Dr. Karl P. Schmidt of the Field Museum, in the sandy area around Waukegan. Dr. Schmidt writes me under date of March 8, 1932: "Only a few of these survived the winter, and I doubt if the species 'takes.' All were marked with drill holes in the posterior rim of the shell." The fact of this planting should be noted, however, in case of the eventual appearance of the species around Waukegan. Where these turtles came from or how they got there is unknown, but it is believed that they were the chief performers in the thrilling sport of turtle racing, probably belonging to a "stable" the owner of which went broke.

Habitat.—Whereas *Terrapene carolina carolina* is distinctly an inhabitant of the deciduous woods environment, *Terrapene ornata* is a prairie species. It is found out in the open prairies or in sandy areas, wandering among the short grasses, and is very rare indeed in association with trees or heavy ground cover. Around Litchfield, Illinois, where the species is really very common, these box turtles are picked up in the open fields and pastures. While both *T. carolina* and *T. ornata* are abundant in this region, their environmental preferences keep them remarkably apart in their distribution.

Habits.—In general the habits of *T. ornata* are very similar to those of *T. carolina* which we have already discussed in some detail; hence we will be brief in our discussion of this species. Certain points of contrast in behavior should be considered. In our discussion of *T. carolina* we noted certain very marked tendencies toward an aquatic habit. Such tendencies seem to be entirely absent in *T. ornata.* We have seen that certain individuals of *T. carolina* took up a decided and definite home in the puddle of water at one end of the outdoor pen in which they were confined. While there were seventeen specimens of *T. ornata* in the same pen and these had the same range as *carolina,* not one was ever seen to enter the water. If one was placed in the water, it scrambled out as fast as it could and headed for the other end of the pen. One half of the pen is grown in herbaceous ground cover and bushes; the other end

is open and sandy. While *T. carolina* occasionally wandered, naturally, into the open end, the turtles of this species spent by far the greater part of their time around the "wooded" portion, and the reverse of this is equally true of *T. ornata.*

In disposition there is also quite a noticeable contrast. While *T. carolina* is of a quiet and peaceful nature, yet it will snap on occasion. I have never seen *T. ornata* exhibit any defense reaction of this sort; in fact I have never been able to provoke it to the point where it would snap. It seems to have complete and absolute control of its temper and to have developed a completely fatalistic attitude. Its movements are more rapid than those of *T. carolina,* and its rate of progression is quite a bit faster. This may well be due to its lesser bulk, for it is a smaller turtle.

I was able to compare the hibernation of these two box turtles in my outdoor pen. *T. ornata* goes into hibernation earlier than does *T. carolina,* for every specimen of this species had disappeared fully two weeks before the first of *T. carolina* showed a desire to hibernate. Once *T. ornata* has dug into the ground, it does not again emerge until spring. Like *carolina,* they start a few inches under the surface of the ground in October, and work their way deeper and deeper into the earth as the temperature of the soil drops. Whereas *T. carolina* ceases its descent at 19 inches, *T. ornata* went down to a depth of 22½ inches. This greater depth of hibernation is sufficient to account for the fact that the period of inactivity is greater, and *ornata* does not emerge until a week or two after *carolina* has thawed out and become active. Thus it remains in hibernation nearly a month longer than *carolina.*

Whether this species enters into temporary periods of aestivation or not is not clear, but there is a hint of it in a sentence by Ortenburger (1930): "In some instances they had burrowed partially into the mud of the river bank." This at least hints strongly at the very similar but perhaps more definitely developed aestivation habit of *T. carolina* during the hotter parts of the summer.

Nesting Habits and Eggs.—I have no information at hand as to the breeding habits of *T. ornata.* While the females which I placed in my outdoor pen had (as seen in the dissection of certain individuals) large eggs in the ovaries, yet I find no young turtles. Either the turtles did not lay, or else the eggs failed for some reason to hatch. Perhaps this might be due to an insufficiency of direct sunlight in the pen. One specimen dissected had hard-shelled eggs in the oviduct. Most of the specimens of *T. ornata,* however, had the large eggs for that season's laying still in the ovary at the time that all the females of *T. carolina* had hard-shelled eggs in the oviduct, indicating a somewhat later laying season. Since the rate of development in *carolina* is so slow (about three months) it is quite possible that, if the incubation period of *ornata* is

approximately the same, eggs laid in my pen may have been caught by the cool weather of the fall and hence not have hatched. It is quite certain that under normal and natural conditions, the eggs of *ornata,* laid in more open and exposed places, will receive a proportionately greater heat increment, and hence should perhaps have a shorter incubation period to compensate for their later laying habit. The average size of the six hard-shelled eggs removed from the oviduct was 35 mm by 23 mm. Data would seem to indicate that four to six eggs compose the usual clutch.

Food Habits.—The stomachs of five specimens examined by me from Litchfield, Illinois, showed a purely vegetable diet. The mass of partially digested vegetable matter was beyond the possibility of identification, but no trace of insect remains or of other animal matter was discernible. On the other hand, Ortenburger (1930) has an interesting observation on the food habits of the species in Oklahoma: "These turtles feed to a considerable extent on the grasshoppers of the region. Some of the queerest sights seen were the attempts, often successful, of these supposedly slow-moving animals to catch grasshoppers. The movements are surprisingly quick and agile. On one occasion one turtle was seen to catch a large lubber grasshopper 'on the wing' by stretching the neck and literally jumping at the flying insect. Others were seen eating green caterpillars and robber flies."

Economic Importance.—This turtle is not sufficiently abundant in the state to have any definite economic importance. Since, however, it has been shown to be an insect eater, whatever it does in this direction must be regarded by man as an asset.

Table 9.—Measurements of Illinois Specimens of *Terrapene ornata*
(Measurements in millimeters; weight in grams)

Specimen No.	Carapace		Plastron			Head	Tail		Weight	Sex
	Length	Width	Length	Width	Depth		Total	A-T		
1	112	91	111	73	52	19	25	22	308	♀
2	103	85	103	66	49	18	24	22	219	♀
3	96	77	99	78	52	16	20	18	203	♀
4	96	83	98	71	48	17	32	20	202	♂
5	99	85	102	...	48	17	30	18	210	♂
6	105	89	106	68	51	19	22	17	320	♀
7	83	71	85	54	41	14	21	16	120	♀
8	109	96	110	69	58	16	25	19	295	♀
9	99	89	101	65	50	17	21	16	231	♀

Genus Graptemys Agassiz

Emys (part) Duméril 1806
Clemmys (part) Wagner 1830
Terrapene (part) Bonaparte 1830
Malaclemys Gray 1844
Graptemys Agassiz 1857
Malacoclemmys Agassiz 1857

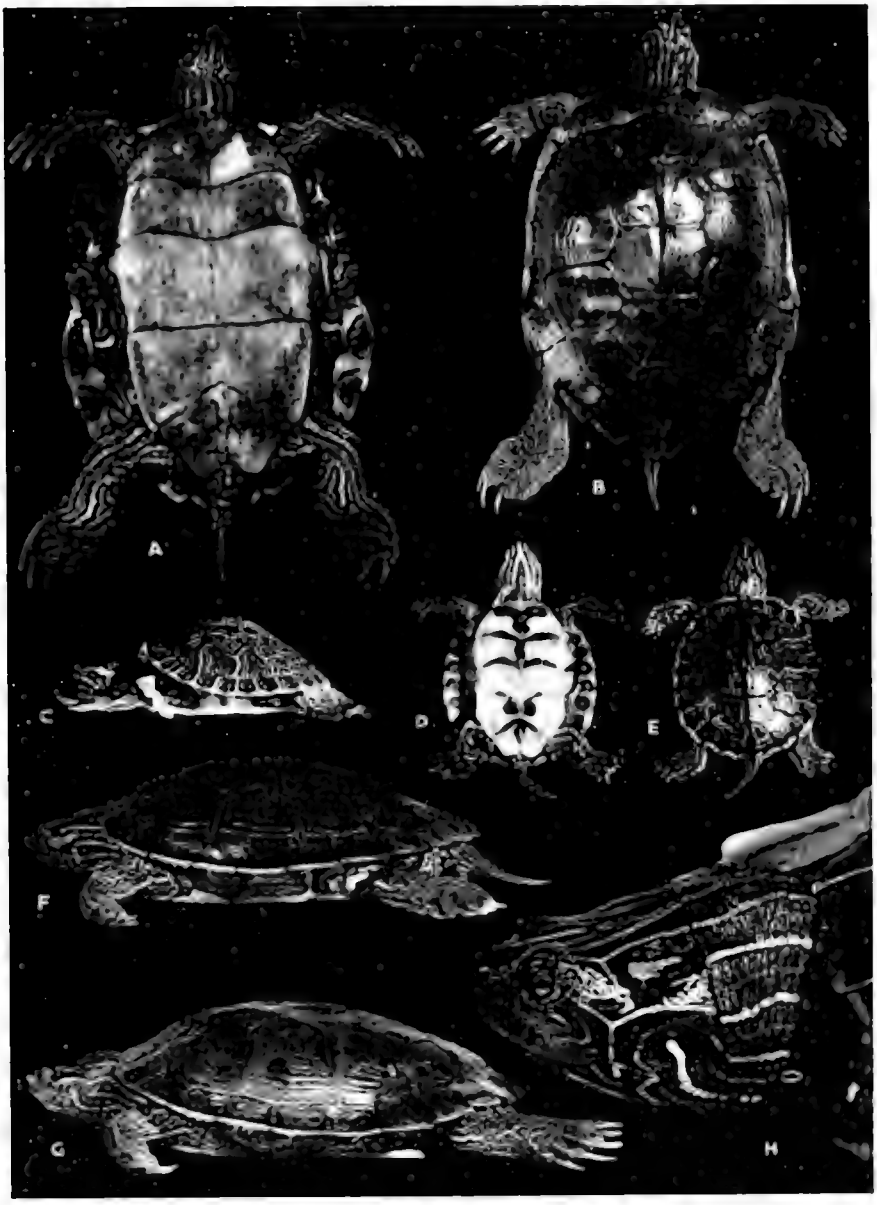


PLATE 14.—*Graptemys geographica: A,* Adult female, ventral view. *B,* Adult female, dorsal view. *C,* Newly hatched young, lateral view. *D,* Newly hatched young, ventral view. *E,* Newly hatched young, dorsal view. *F,* Immature female, lateral view. *G,* Adult female, lateral view. *H,* Head study of an adult.

Shell depressed, but with a distinct and conspicuous tuberculate keel. Bridge wide, with the axillary and inguinal elements well developed; inguinal anchylosed to the fifth costal scute. Top of head covered with a tightly drawn, smooth skin. Upper jaw without a median notch. Alveolar surfaces of the jaws very wide, but without a median ridge, the right and left sides separated from each other by a deep, narrow channel. Carapace strongly serrated posteriorly. Digits fully webbed. Tail relatively short. Choanae behind the level of the eyes. Skull with a bony temporal arch. The entoplastron lies wholly anterior to the humero-pectoral suture.

Graptemys geographica (LeSueur)

(Geographic turtle; map turtle; ridge-back; slider; terrapin)

Testudo geographica LeSueur 1817
Emys geographica Say 1825
Terrapene geographica Bonaparte 1830
Emys megacephala Holbrook 1844
Emys labyrinthica Duméril 1851
Graptemys geographica Agassiz 1857
Clemmys geographica Strauch 1862
Malacoclemmys geographica Cope 1875
Malacoclemmys geographicus Davis & Rice 1883

DESCRIPTION.—Shell oval, somewhat depressed, highest in the middle, but more elevated anteriorly than posteriorly and wider behind than in front of the middle; posterior margin serrated. Scutes of vertebral series all rather large. First vertebral weakly hexagonal, almost square, the anterior margins meeting in a wide median angle. Second and third vertebrals hexagonal, wider than long. Fourth vertebral hexagonal, the posterior margin about one-half of the anterior. Fifth vertebral pentagonal and of good size. There is a mid-dorsal vertebral keel which is persistent throughout life, but which is much more pronounced in the young and partially grown individuals than in the large adults. This keel is blunt and tends to rise to a posterior tubercle which is inconspicuous in the adult; the curvature of the keel on each scute is uniform and regularly convex in front of the tubercle. Costal scutes large. First costal roughly trapezial, large; second the largest of the series, pentagonal, the median lateral margins encroaching between the second and third vertebrals; third costal similar to the second, but smaller, not as wide; fourth the smallest of the plastral elements (excluding marginals) and approaching square. There is a tendency for the scutes, particularly the costals, to exhibit longitudinal ridges in the form of obscure roughenings; this feature is highly variable. Nuchal small, triangular, the posterior margin notched to receive the apex of the first vertebral. Marginals all large and wide, and with an even edge through the sixth. The seventh marginal increases in size posteriorly and the remaining five are notably larger than the anterior series, the eighth and ninth being the largest. Marginals serrated posteriorly from the eighth to the caudals, and there

is a conspicuous notch between these latter scutes. Posterior marginals flaring, but the caudals with a vertical tendency particularly at their median contact. The carapace is widest across the seventh and eighth marginals. Plastron large, truncate anteriorly, deeply and widely notched posteriorly. Gulars rather small, triangular, the anterior lateral angles slightly produced. Humerals trapezial, with the interhumeral suture the shortest of the mid-plastral contacts. Pectorals rectangular, the posterior lateral portion drawn out posteriorly to help form the bridge. Abdominals the largest of the series, square. Femorals the second largest of the plastral scutes, the lateral margin equalling the length of the abdominals, but the median contact shorter. Anals large, with a long interanal suture. Bridge wide, but rising only slightly toward the carapace, formed mostly by the prolongation of the abdominal and the posterior prolongation of the pectorals. Axillary and inguinal elements large. Head large and massive and with a blunt snout. Both jaws with a smooth cutting edge, the margin of the upper jaw being somewhat sinuate and *without* a median notch. Alveolar surfaces of the jaws very wide, the inner edges almost meeting, and without a median ridge. Posterior articular surface of lower jaw expanded into a spoon-like dilation. Lower jaw flat, not hooked at the tip. Limbs large, strong, with the short digits fully webbed. Hind feet very large. Five digits of fore feet with a strong claw each; four digits of the hind foot with claws, the three inner being long and somewhat curved. Fore limbs covered with a series of large, sharp-edged scales; hind limbs with scattered scales, partially on the inner surface. Tail long.

Coloration.—The coloration of *Graptemys geographica* is highly variable; not only do adults show much variability, but individuals of different ages (sizes) have conspicuously different markings. The large adult has the carapace dark olive-brown. There is a dark brown spot, almost black, at the posterior tubercle of each vertebral, and each of the costal elements is blotched irregularly with similar dark marks. There is a strong tendency toward a blotch on the sutures. Each dark blotch is encircled by a complicated pattern of pale yellow-green lines, these becoming very obscure in large specimens and increasingly conspicuous in younger individuals. Dorsally, each marginal has a dark blotch on the intermarginal suture, surrounded by the pattern of yellow-green lines. Plastron yellow, each suture lined in black. The wings of the pectorals and abdominals, together with the axillaries and inguinals, marked with black, irregular lines. The under surface of the marginals yellow, with a dark brown blotch on the intermarginal sutures, this blotch broken by enclosed irregular yellow lines. The blotches are more conspicuous and simpler from the seventh marginal backward; in front of the seventh the pattern becomes very complicated and general over the scute. Head, neck,

and limbs dark green, almost black, with lines and streaks of pale greenish-yellow. Typical head markings as follows: A conspicuous greenish-yellow, comma-shaped dash behind the eye. A straight line extends from the tip of the snout to a point behind the eye, ending abruptly. A stripe starts at the anterior median margin of the orbit as a very thin line, widening behind the eye into a conspicuous stripe which extends down the neck. Numerous other longitudinal stripes parallel this one along the neck. A conspicuous vertical stripe crosses the tympanum, then turns abruptly to extend down the neck as a ventral lateral stripe. A straight median stripe starts at the symphysis of the lower jaw and ends abruptly at a point just posterior to the angle of the jaw. Horny portion of the jaws brownish. The entire ventral surface of the neck is covered with a series of longitudinal yellow stripes that tend to parallel each other. Limbs striped, the stripes more numerous ventrally, hence the limbs darker above than below. Remaining soft parts mottled in an intricate pattern. Iris golden green.

Young.—Specimen 35 mm carapace length: Carapace almost round, the length equalling the width. Shell highly arched, the posterior slope greater than the anterior. Vertebral keel prominent, particularly on the second and third vertebrals. Color dark green, with an elaborate pattern of yellow lines some of which are conspicuous and surround lines of lesser brightness. Marginals with a yellow circle at each intermarginal suture, this enclosing two (sometimes only one) yellow spots; each marginal with a vertical median yellow line and edged laterally with yellow, thus forming a yellow "T." Plastron yellow, with irregularly placed and highly variable black spots and blotches. Under side of marginals yellow, with an intermarginal black spot containing a yellow center. Color markings of head, limbs, and soft parts typical of adult.

Specimen 70 mm carapace length: The elaborate network of yellow lines on the carapace has increased in conspicuousness; ground color olive brown; markings on marginals in younger specimen. Plastral spots now becoming vague and poorly defined, blurred, fading. Keel on vertebrals prominent, tuberculate.

Specimen 140 mm carapace length: Yellow reticulations of carapace becoming weaker, while the dark brown blotches are beginning to appear; dark blotches on tubercles of the keel now well defined. Posterior serrations of marginals now deeper and very pronounced. Plastral markings practically obliterated, the dark lines along the sutures well established.

Sex Differentiation.—The head of the male is much smaller than that of the female, this character applying particularly to adults rather than to immature individuals. The tail of the male is much longer than that of the female, while the female attains a much greater total size than does the male.

Geographic Distribution.—*Graptemys geographica* has a distribution encompassing most of the Mississippi Valley from Canada, Iowa, and Wisconsin southward to Oklahoma, Louisiana, and northeastern Texas. Eastward it extends through Pennsylvania to New York. Babcock (1919) finds it only along the eastern shore of Lake Champlain in New York, and notes its occurrence in Vermont. Surface (1908) gives numerous records for Pennsylvania, but points out that it is very local in its distribution. Morse (1904) says that it is common in Ohio in the larger rivers flowing into Lake Erie and into the Ohio River. In Indiana, Hay (1892) reports it generally over most of the state, and Evermann and Clark (1920) report it as by far the most abundant turtle in Lake Maxinkuckee in the northern part of that state. Ruthven *et al* (1928) report it from southern Michigan. For Wisconsin, Higley (1889) found it quite common in the southern part of the state, while Pope and Dickinson (1928) limit it to the southern and western portions of the state, but Cahn (1929) did not find it in Waukesha County of southern Wisconsin. It is probably less common in that state than formerly. Hurter (1911) records it from three widely separated points in Missouri, while Strecker and Hurter (1909) report it from Missouri and Texas, and mention its occurrence in the rivers of eastern Oklahoma. For Texas, Strecker (1915) reports it from the eastern half of the state. Patch (1925) extends the hitherto known northward range of the species into Canada with the report of specimens from Norway Bay, just west of Ottawa, Quebec, Guelph, and Point Pelee, Ontario.

Map 10.—*Graptemys geographica.*

Illinois Records.—*Graptemys geographica* has a general distribution over the entire state, but is confined to the larger rivers. Yarrow (1882) records five specimens from Mt. Carmel. Davis and Rice (1883) say that it is found throughout the state, and H. Garman (1889) says that this species, together with *G. pseudogeographica,* constitutes more than half the turtles

of the Quincy region. McLain (1889) reports a specimen (1227) in the Stanford University collection from Plano, Kendall County. Garman (1892) reports it from Nippersink Lake, Green River in Henry County, Ogle County, Quincy, Peoria, Cairo, Pekin, the Little Wabash River, St. Francisville, and the Little Fox River at Phillipstown. Along the Mississippi, Hurter (1911) finds it in Madison, St. Clair, and Monroe counties. The Field Museum has a series of specimens from Havana (97, 334, 476-80, 1767, 2193) and one from Jackson Park, Chicago (2925). The writer has examined specimens from the following localities: Mt. Carmel, Chester, Peoria, Metropolis, Havana, Pekin, Meredosia, Sterling, Rock Island, Quincy, the Kankakee River at Kankakee, Bureau, Beardstown, Fox Lake, Okawville, Vandalia, Murphysboro, and Horseshoe Lake in Alexander county.

Habitat.—An abundant turtle throughout the state, frequenting most commonly the lakes and larger rivers, this species is less often found in the smaller streams. In over-flow ponds along the courses of the rivers they often occur in large numbers, but they leave these for the rivers themselves if the ponds begin to dry up. Garman (1892) says that "half the individuals which one may see perched on logs during a day's boating in August would prove to be of this species." The present writer believes that this species is less numerous than formerly, yet distinctly more common than the next, closely related, species. These turtles prefer water in which grows an abundance of such vegetation as Chara and Nitella, and this is utilized to the utmost for concealment in time of danger and affords the hunting grounds for their food supply. They are seldom found in clear water and very rarely indeed in swift flowing streams, unless it be during temporary periods of flood or high water. Large, swift rivers, like the Mississippi and the Illinois, and especially the backwaters of these, with soft bottoms, afford an ideal environment, and in such places the species finds its optimum.

Habits.—*Graptemys geographica* is highly aquatic in its habits. Its strongly webbed feet afford it excellent propellors, but the bulk and weight of the shell are such that it is not a fast swimmer. The hind feet are particularly large and drive the turtle at a reasonable speed. On land the turtle is slow, awkward, and evidently ill at ease. It is found on land only during the breeding season and under such unusual circumstances as may drive it from one pond or river to another. If caught on land, the head is withdrawn with a hissing sound caused by the expulsion of air from the lungs accompanying the withdrawal of the head and neck within the shell. If provoked it emits an occasional hiss as the head is withdrawn farther and farther into the protective position. Wary and cautious while in the water, on land the turtle is timid and very inoffen-

sive despite the power and strong cutting edges of the jaws. Both the structure of the jaws and the powerful musculature thereto attached would enable it to do serious damage were its disposition less retiring.

These turtles are among the earliest to make their appearance in the spring. The coldest months of the winter may be spent in the mud at the bottom of the river or in the soft banks; occasionally muskrat runways are utilized, the turtles either burying themselves in the soft floor of the passage or remaining half concealed in the runway itself. Shortly after the ice goes out they are found basking on the shore at the very edge of the water. Those which hibernate in shallow lagoons or ponds come out first, for here the water warms up earlier than in the bed of the larger rivers. At this time they are slow and sluggish and may be easily caught. They love the sunshine, and spend hour after hour lying motionless as they absorb the heat. With the first chill of later afternoon they disappear into the water, but as April wears on they remain out longer and longer. They are highly gregarious and usually found in close association with their own kind. This gregariousness makes them difficult to approach, for when one becomes frightened and slides into the water, all promptly become panic stricken and disappear likewise. During the long summer days they bask luxuriously upon logs well out in the water, lying with the hind legs outstretched. Through field glasses they may be seen snapping at passing insects, many of which they succeed in catching. With the approach of fall their basking periods are shortened, though these turtles are among the very last to go into hibernation. There is some evidence that occasional individuals do not hibernate at all, but remain slightly active on the river bottom all winter. Along the banks of the Illinois River I have found dozens of young specimens that fell victim to this disinclination to hibernate. They had remained out of water too long: numbed with the cold, they were unable to regain the water; stranded, they froze to death.

Nesting Habits.—Late in May, and from then until mid-June, the females come out to lay their eggs. Their timid disposition leads them to come out very early in the morning, for they prefer solitude, and daylight finds the turtle well on its journey. The female comes out of the water slowly but there is an air of stolid determination about her. She wanders about in a zigzag path for some time, often getting far from water in her search for the exactly suitable nesting site. The moist sand of the shoreline interests her not in the least. One may sometimes follow her tracks if the ground is suitable, and the aimlessness of her wandering is quite evident from the great irregularity of her course. Here she pauses to dig: a small rock interferes, so she goes on. Here she tries again, but a small root is in the way, so she gives it up and wanders on. Here she digs again, but some undefinable thing does not suit her—

perhaps the soil was not just right—so she goes on again. After hours of search and many efforts at digging, the right spot is found and the nest is dug. This is a symmetrical flask-shaped cavity of a diameter sufficient to admit her, dug with the hind feet only, the front feet being used as a brace. The length of the neck and the size of the flask depend upon the character of the soil selected and the number of eggs to be produced. I have seen dozens of nests of this species but never yet one that was not well filled, nor one that was over full. Once the digging has begun in earnest, the female is determined to go on with it to the end; if disturbed, she watches the intruder for a time, but does not retreat, and when things quiet down she resumes her work. The eggs are laid in a double layer in the body of the flask, often with a thin layer of dirt between the eggs. In the neck of the flask are deposited the last two or three eggs, the last egg laid being very close to the surface. The loose dirt is then scraped into and over the hole and the surface smoothed by dragging the plastron over the small area disturbed so as to erase the least trace of the disturbance.

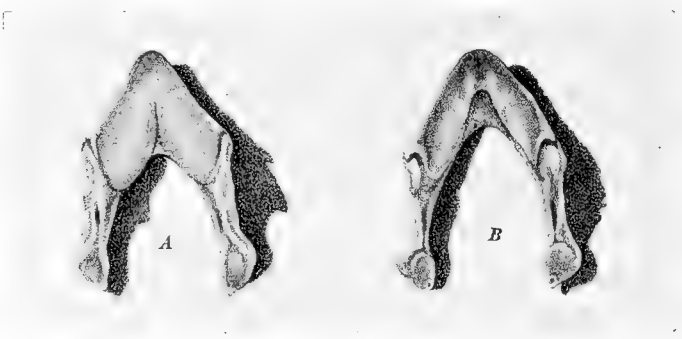
Eggs.—The number of eggs deposited varies from ten to sixteen, depending upon the size and age of the turtle, with twelve to fourteen by far the commonest number. They are white and elliptical, with a soft, leathery shell which may be very easily indented. They average 32 mm by 21 mm. The rate of development is slow, the young hatching usually about mid-August or shortly thereafter. The young dig themselves out, coming up through that position of the ground occupied by the nest, this affording them the least resistance. Once at the surface they blink the dirt out of their eyes and head straight for the nearest water, even though it be a quarter of a mile or more away and may take a week to reach. Newman (1906) reports newly hatched young in May, and explains it in reference to unusual females found laying in late July, saying that the "well advanced embryos must pass the winter in a condition of dormancy analogous to that observed in hibernating adults." I have in my collection several newly hatched young taken in the vicinity of Meredosia on the Illinois in early July. There seems to be no reason why a well developed embryo should not live over the winter within the egg; the dropping of the temperature slows up the rate of development and the embryo remains *in status quo* until the warmth of spring penetrates to the eggs, whereupon it resumes its development. Furthermore, turtles are poikilothermous. Whether those eggs in the neck of the nest, only an inch or two beneath the surface, hatch after a thorough freezing is undetermined.

Food Habits.—The great width of the masticatory surfaces of the jaws are admirably suited for cracking mollusks, and stomach examinations show a very large percentage of these animals in the diet. Snails,

and an occasional insect or larva, are the main items of food taken. So badly crushed are molluscan remains that identification is almost impossible. Besides this fact, the hard parts of the shell are scratched out of the mouth by means of the claws of the front feet. Newman (1906) makes an interesting observation: "Two methods of feeding prevail. The favorite method seems to be to capture the mollusc when the foot and gills are well out of the shell, to bite off the soft parts and leave the hard shell. To do this the final closure of the jaws must be quite sudden. If they fail to secure the body of the snail in this way, they adopt the crushing method." I have frequently watched this species prowling slowly about amid the vegetation looking for snails, and thick beds of aquatic

TABLE 10.—MEASUREMENTS OF ILLINOIS SPECIMENS OF *Graptemys geographica*
(Measurements in millimeters; weight in grams)

Specimen No.	Carapace		Plastron			Head	Tail	Weight	Sex
	Length	Width	Length	Width	Depth				
1.....	227	170	196	103	84	33	86	...	♀
2.....	203	181	213	141	85	34	79	1687	♀
3.....	203	158	183	113	72	31	60	1055	♀
4.....	190	141	169	118	66	29	71	780	♀
5.....	186	140	168	110	63	33	68	740	♀
6.....	151	126	142	96	53	26	61	498	..
7.....	133	98	115	57	41	19	71	...	♂
8.....	118	97	106	54	42	17	40	...	♀
9.....	116	87	101	48	37	17	65	...	♂
10.....	113	86	98	47	36	16	63	...	♂
11.....	106	82	90	43	35	15	62	...	♂
12.....	70	62	61	32	27	13	22	...	♀
13.....	38	32	35	21	16	9	19	...	♂



TEXT-FIGURE 15.—Drawings of lower jaws, showing difference in alveolar surfaces. *A—Graptemys geographica; B—Graptemys pseudogeographica pseudogeographica.*

plants are often thoroughly tunneled by pathways made by these turtles in search of their food. In the laboratory they refuse every kind of food except snails and clams, showing almost a total lack of the scavenger habit so often found among turtles.

Economic Importance.—*Graptemys geographica* is caught in great numbers by net fishermen, but does not often reach the public market, probably because it seldom reaches a size sufficiently large to warrant shipment. The larger specimens, however, are excellent for the table. The flesh is entirely palatable, and except for the size there is no reason why they should not be used as food.

Graptemys pseudogeographica pseudogeographica (Gray)

(Ridge-back; map turtle; saw-back; slider; "terrapene"; river terrapin)

Emys lesueurii Gray 1831
Emys pseudogeographica Gray 1835
Emys geographica (part) Duméril & Bibron 1835
Graptemys lesueurii Agassiz 1857
Graptemys pseudogeographica Gray 1863
Clemmys pseudogeographica Strauch 1865
Malacoclemmys pseudogeographicus Cope 1875
Malacoclemmys lesueuri True (in Yarrow 1882)
Malaclemys pseudo-geographica Hay 1892
Graptemys pseudogeographicus Paulmier 1902
Graptemys pseudogeographica pseudogeographica Stejneger & Barbour 1923

Description.—Shell oval, somewhat depressed, rather flat-topped in fully grown specimens, highest in the middle, emarginate posteriorly. Carapace with a conspicuous persistent vertebral ridge rising to a prominent posterior tubercle which is well developed upon the second and third scutes. Vertebrals five, the first the smallest of the series. Second and fourth vertebral scutes of approximately the same size, hexagonal; the anterior margin of the second is shorter than the posterior and this is reversed in the fourth scute. The third is the largest of the series, hexagonal, the anterior and posterior margins about equal. The fifth vertebral is variable in form, sometimes being rather "maple-leaf"-shaped, the total length, however, about equalling the maximum width of the scute; this maximum width is attained by wing-like lateral projections which intrude deeply between the fourth and fifth costals—if a fifth is present. If but four costals are present the fifth vertebral is pentagonal and wider than long. The keel is low and inconspicuous on the first vertebral. On the second it begins to rise at about the middle of the scute and reaches a sharp posterior tubercle at the very posterior edge of the scale. On the anterior portion of the third vertebral a low ridge drops from the apex of the anterior tubercle toward the middle of the scute and rises again to a conspicuous tubercle at the posterior margin,

giving a *concave* profile to the keel which is particularly obvious on the third (and much less so on the second) vertebral scute. The number of costals shows some variation; the usual number is four, but occasionally five are present. If five, the fifth vertebral is drawn in, as described above, in order to make room for it. Costals large. First costal large,

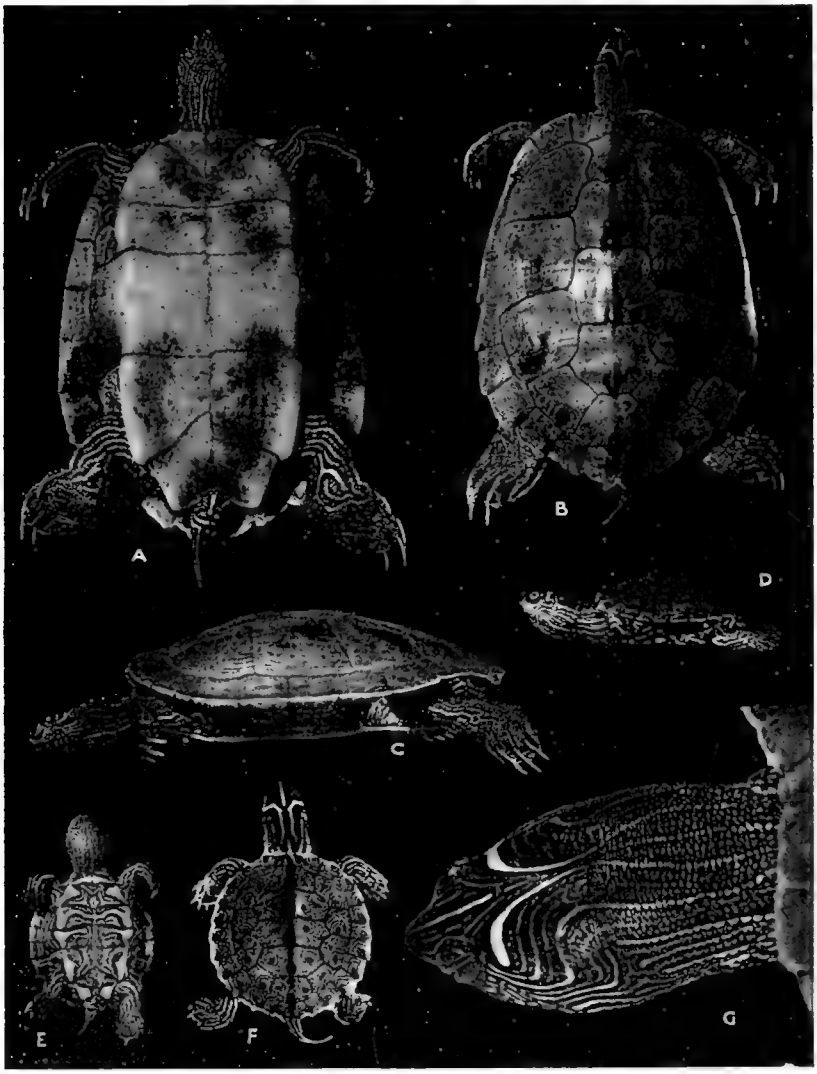


PLATE 15.—*Graptemys pseudogeographica pseudogeographica: A,* Adult, ventral view. *B,* Adult, dorsal view. *C,* Adult, lateral view. *D,* Newly hatched young, lateral view. *E,* Newly hatched young, ventral view. *F,* Newly hatched young, dorsal view. *G,* Head study of an adult.

roughly triangular. The second is the largest of the series and is wider than long; the third is of the same shape and proportions as the second, but somewhat smaller. The fourth is roughly rectangular if a fifth is present, but approaching square if only four are present. If a fifth is present it is by far the smallest of the series. Nuchal with a posterior notch to accommodate the anterior angle of the first vertebral. Thirteen pairs of marginals. First marginals with the median border much shorter than the lateral, giving the appearance of a "bow tie" to them and the enclosed nuchal. There is a slight serration associated with the first two anterior scutes. The marginals begin to flare widely at the eighth, from which point the edge of the carapace becomes increasingly more serrated posteriorly. Caudals rise sharply toward their median symphysis and contain a sharp, deep posterior notch. Plastron large and strong, the anterior and posterior lobes being of approximately the same length and width, truncate anteriorly and widely emarginate posteriorly. Gulars triangular, the length equalling the width. Humerals with the interhumeral angle the shortest of the plastral sutures. Pectorals rectangular. Abdominals nearly square, the largest of the ventral elements. Femorals next to the abdominals in size, the lateral margin equalling the length of the abdominals but with the median contact shorter. Anals large, the interanal suture longer than the interfemoral; the anal notch is wide and generally rounded. The bridge is wide and flat, rising but little toward the carapace. Axillary and inguinal elements large and well developed. Head medium to large, depending upon the sex of the specimen; snout not protruding. The cutting edge of the upper jaw is smooth and slightly convex and without a notch; lower jaw with the cutting edge slightly convex and without a hook. Alveolar surfaces moderately wide, wholly separated in front by soft skin. The limbs are well developed, the hind limbs being particularly strong and well developed. Digits fully webbed to the base of the claws. Five digits on fore limb, each with a claw; four digits only of the hind foot with claws, the fifth lacking a claw. Tail rather short, pointed.

Coloration.—In fully adult specimens the carapace is olive green, sometimes with a brownish cast. Each costal and many of the marginals exhibit a dark brown, almost black posterior blotch; there is a tendency for each blotch to be encircled by a yellowish or greenish line. The vertebral keel is dark brown, darkest at the tubercle. Scutes of the carapace with irregular network of yellowish or greenish reticulations or tracings; these reticulations are often rather obscure in large (old) specimens. The plastron of the large adult is yellow, with a varying amount of vague, dusky discoloration which may be totally absent; younger specimens show a bilateral pattern of dark areas enclosing yellow markings within, reminding one somewhat of *Chrysemys picta*

bellii. Bridge marked with dusky, tending toward longitudinal lines. Axillaries and inguinals either lined or blotched with dusky discolorations. Marginals irregularly marked with a dusky color on the ventral surface. Head dark olive green, elaborately marked with yellow lines. Behind the eye is a conspicuous yellow transverse streak which, medially, turns posteriorly to extend down the head and neck parallel to the streak from the opposite side. On the head it has the appearance of a boomerang. Sometimes this mark is carried down below the eye. A straight yellow line extends from the tip of the snout to well behind the posterior margin of the eyes, terminating between the angles of the boomerang. Below the eye is a small yellow spot. The remaining portions of the head with fine yellow lines, many of which extend down the neck parallel to each other. Jaws mottled with yellow. There is a yellow spot at the symphysis of the lower jaw. Limbs, tail, and the remaining soft parts olive green, elaborately lined with yellow.

Young.—In very young individuals (32 mm) the shell is almost perfectly round. Carapace very high, with a steep lateral slope; anterior slope abrupt; posterior slope more gradual. Keel very conspicuous, particularly on the second and third scutes, but without any trace of the concave profile. Marginals all more or less in line with the general curvature of the carapace. Posterior marginals not only with an intermarginal notch but with a strong tendency toward a second notch in the middle of the edge of each scute, giving the border a very "saw-toothed" appearance. Color bright green, with conspicuous yellow tracings; the dark mark upon the keel of the vertebrals conspicuous. Plastron with a bilateral dusky pattern on yellow, with numerous yellow inclusions. Surface of the carapace finely granular. As the turtles grow larger the shape and pattern tend toward that of the adult. In a larger specimen (102 mm) the dark blotches on the costals and marginals are beginning to appear, the color is now brownish and the yellow tracings still conspicuous, especially about the forming dark blotches. There is still a faint trace of the toothing of the anterior marginals, but the tooth in the middle of the border is growing very weak. The concave profile of the keel is now plainly evident. Bilateral plastral markings still plain but fainter than in the newly hatched young.

Sex Differentiation.—The head of the male is relatively smaller than that of the female, which is quite massive. The tail of the male is longer than that of the female, thus extending the anus beyond the posterior margin of the carapace.

Comparison of the Two Species of Graptemys.—Although to the uninitiated there seems to be considerable difficulty in separating *Graptemys geographica* from *Graptemys pseudogeographica pseudogeographica,* there are certain differences which usually will make the distinction

less difficult. These differences have been ably discussed by Garman (1890). We may summarize them as follows:

1. *Head.*—Large, massive in *G. geographica,* contained about 4.6 times in the length of the carapace; small to medium in *G. pseudogeographica,* contained in the carapace about 6.4 times.

2. *Jaws.*—Alveolar surfaces of *G. geographica* greatly expanded, while this is not the case in *G. pseudogeographica* (see Text-fig. 15).

3. *Vertebral Ridge.*—In *G. geographica* the median vertebral ridge is obscure, flattened, and in profile a simple curve and not of the tuberculate type; in *G. pseudogeographica* this ridge is very prominent, tuberculate, and exhibiting a concave profile on at least the third scute.

4. *Spot Behind Eye.*—In *G. geographica* this spot is not comma-shaped; it is isolated and is directed longitudinally. In *G. pseudogeographica* it is comma-shaped or like a boomerang, not isolated, being continued as a fine stripe down the neck.

5. *Mandibular Spot.*—There is a yellow stripe on the symphysis of the mandible of *G. geographica,* while this mark is in the form of a yellow spot in *G. pseudogeographica.*

6. *Supraoccipital Spine.*—Though purely an osteological character, *G. geographica* has an enlarged, thickened supraoccipital spine, while *G. pseudogeographica* shows a small, unthickened spine.

Geographic Distribution.—*Graptemys pseudogeographica pseudogeographica* is distributed over the Mississippi Valley from Wisconsin and northern Iowa southward, and from eastern Kansas and Oklahoma eastward to Ohio and Alabama. Thus it is seen to have a more circumscribed range than *Graptemys geographica.* To the east of Illinois it is reported from Columbus, Ohio, by Yarrow (1882), though it is not included in the state list by Morse (1904). It is not listed by Ruthven *et al* (1928) from Michigan. Blatchley (1891) lists it from Indiana, while Hay (1892) reports it from several localities in that state. The type locality is the Wabash River at New Harmony, Indiana, which is just across the river from Illinois. In Wisconsin, Hoy (1883) reports it as not rare, while Higley (1889) says it is quite common in the southern half of the state; Cahn (1929) did not find it in Waukesha County. Pope and Dickinson (1928) refer it to the western part of Wisconsin. In Missouri, Hurter (1911) gives numerous records, while in South Dakota, Over (1923) reports it only from the Missouri River, which it no doubt ascends from the Missouri region. Yarrow (1882) gives a single record for Kansas, as does Burt (1927) for that state. In the south its place is taken by two sub-species, *G. pseudogeographica kohnii* and *G. pseudogeographica oculifera.*

Illinois Records.—For Illinois, Garman (1892) says: "Throughout the state, but less common north," and gives records from Quincy, Jersey County, the Wabash Valley, the Ohio River, and Cairo. In his paper dealing with the Quincy region (1888) he says that the two species

of Graptemys constitute about half the turtles seen, while in his short notes (1892) he reports it as "very abundant in all our rivers." It is not mentioned by Hankinson (1917) for the Charleston region, while Davis and Rice (1883) say that it is found in all parts of the state. With the records mapped, it appears that Garman's statement of 1892 is nearest correct at the present time. The Field Museum has specimens from Havana (#95, 331, 475, 1759, 1773), McHenry (#2670), and Maeys (#3464, 3465). Hurter (1911) reports it from Madison, St. Clair, Monroe, and Randolph counties. The writer has examined specimens from the following places: Chester, Havana, Meredosia, Quincy, Grafton, Carlyle, Okawville, Murphysboro, Metropolis, Mt. Carmel, Elizabethtown, Horseshoe Lake in Alexander County, and Carmi, which is only a few miles from the type locality.

MAP 11.—*Graptemys pseudogeographica pseudogeographica.*

HABITAT.—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 is absent from lakes lacking this dense vegetation, or at least from those regions of the lake in which the vegetation is absent, and is not found with any frequency in rivers with any considerable current. This environmental preference perhaps explains in part the distinctly southern distribution of the species in Illinois, for in the southern portion of the state these aquatic conditions, congenial to *G. pseudogeographica,* are of more frequent occurrence. It would appear, also, that the species is more delicately attuned in its environmental preferences than the preceding species, for it is less hardy and distinctly shorter lived under adverse conditions.

HABITS.—The entire structural make-up of this turtle seems to emphasize its highly aquatic nature. The feet, especially the hind feet, are large and powerful, and the toes are fully webbed, making excellent structures of propulsion. The shell is large and relatively quite heavy, making the turtle rather awkward when out of its preferred element. In the water it is wary and secretive, disappearing from view at the least sign of danger, and remaining beneath the surface amid the protection of the dense vegetation for a long period before reappearing. These turtles are very gregarious and are often seen basking lazily in the hot sun. Basking places well away from the shore are best liked, and a protruding dead-head or a stranded log is ideal from their point of view. If such a site is not available, they will line up on half submerged logs along the shore, but under such conditions the turtles are more than ordinarily wary and on the alert, seeming to sense the added dangers which proximity to the shore brings. At the least sign of disturbance every turtle slides into the water, and this characteristic action has given to them the local name of "sliders." If caught on shore they behave much as do the turtles of the preceding species, withdrawing within their bulky shell and remaining stubbornly retracted. After having poked around for a few minutes at one I once caught on shore, I left it high and dry on the bank; returning about an hour later, the turtle was still in the same spot and had only reached the stage of renewed hope which permitted it to have its legs relaxed and its nose out about half an inch.

In the northern part of the state this species goes into hibernation during October and remains inactive until after the ice has gone out. The turtles bury themselves to a depth of from four inches to a foot or more in the soft mud of the bottom, or crawl into the under-water entrances of muskrat houses and there bury themselves. In the southern part of the state the turtles do not go into hibernation at all, but remain active, though but sluggishly so, throughout the coldest months of the winter. There is a hint that during this time they do not feed, or at least feed sparingly, for such turtles taken in the winter have invariably had the stomach empty. With the warming of the water in the spring, the turtles, as *G. geographica,* come out and sun themselves during the brightest hours of the day. The first chill of the afternoon sends them back into the water, yet occasionally an individual is found in which the reaction time to the change in temperature was too slow to get it back into the protection of the water before paralyzed by the cold. Such an individual seems always to die with one night's exposure. Such incidents are perhaps more common prior to hibernation in the fall than in the spring following it, though both have been observed.

NESTING HABITS.—The literature is strangely silent regarding the breeding habits of this turtle, the frequently cited reference being to

Agassiz (1857): "The time of the year at which they [turtles] lay is the same for both the northern and the southern species, without reference to physical differences, such as temperature, moisture, etc., of climate in general. Graptemys LeSueurii [*G. pseudogeographica*], which lays as early as the first of June, gives the earliest instance of incubation in the year." The standard reference to laying on June 1 at Natchez, Mississippi, follows as the stock example. This statement, widely quoted as it is, seems hardly to hold as a set rule; certainly it does not hold for the observations made at Meredosia in the summer of 1931. At that time, with many turtles of other species laying throughout June, it was not until July 6 that *G. pseudogeographica* began to lay. From June 13 on, females of the species with eggs mature but without the shell were found, but not a trace of evidence exists that the species laid prior to the July date. On July 6, then, a female with a carapace length of 218 mm was watched during her nesting progress. From the field notes I read: "The nesting site was in the middle of an old road, between the ruts made by the wagon wheels. The road runs about thirty feet from the river on one side and along a ditch about twenty feet away on the other. The soil is black and fairly solid. The turtle had a heavy growth of algae on her shell, and may well have come out of the ditch which is full of algae. She had apparently started digging but a few minutes before, judging from the rapidity with which the rest of the nest was dug. During the observed digging of the nest, which lasted five minutes (probably not over ten minutes was required for the entire excavation) the turtle worked with great rapidity, standing in one position. The hole was dug with the hind feet only, by scratching vigorously with legs alternating. As soon as a little pile of loose dirt accumulated, she pushed it out behind her, using both legs together to shove it out of the hole, the dirt coming in contact with the soles of the feet. The hole descended forward at an angle of 60° under her position, the sloping floor of the hole being the inclined plane up which she pushed the loose dirt. As she started to lay she slowly rotated her position to the right, pausing periodically to lay an egg or two, after which she rotated again. With all the eggs laid she was back almost where she started from, having rotated through about 350°. From this position, then, she reached back with one hind leg after the other and, using the anterior (top) of the feet, she raked the loose dirt piled immediately behind her into the hole and filled it completely. For a few moments she patted the dirt down with the soles of her hind feet, then headed back toward the ditch, and was captured. The actual time occupied in laying, as represented by the rotation through 350°, was just seven minutes. The hole was then carefully opened. The nest was 5½ inches deep, with a 2-inch opening at the

surface, and terminated in a rounded chamber at the bottom 3 inches in diameter. It contained eleven eggs."

Eggs.—The number of eggs laid varies from seven to thirteen, with nine or ten being the most common number. They are white, elliptical in shape, and covered with a soft, leathery shell of fine texture. The eleven eggs laid by the female whose nesting has been described above, measured as follows (in millimeters): 30 x 20, 32 x 21, 30 x 21, 32 x 20, 33 x 23, 33 x 21, 33 x 22, 31 x 21, 34 x 23, 29 x 20, 32 x 20. This set averages a trifle smaller than other sets on hand; the average of 71 eggs representing 7 complete egg complements, is 32.7 x 22.5 mm. I have no information in regard to the incubation period, but young of the species, certainly not very long out of the egg, have been taken in late August and early September.

Food Habits.—Unlike many other species of turtles, *G. pseudogeographica* is almost exclusively a vegetarian when adult, therein showing a very striking difference when compared with the closely related *G. geographica*. The young turtles are both carnivorous and herbivorous in habits, but when they reach a carapace length of 120-130 mm, the carnivorous tendencies diminish and soon disappear. The young feed largely if not exclusively upon small mollusks, principally thin-shelled gastropods, with an occasional worm or insect larva thrown in. Stomach examinations of ten adult specimens showed quantities of chewed-up aquatic grasses, succulent stems and bulbous roots, with no trace whatever of animal matter. The bulbs of a sedge have been frequently identified. As has been noted, *G. geographica* is largely a mollusk eater, and although both species show similar habitat preferences and are found often in close association, the masticatory apparatus of the two species clearly indicates their divergent gastronomic preferences. The alveolar surfaces of *G. pseudogeographica* are not expanded or especially adapted for the crushing of mollusks, and the turtles attempt no such action except when young and then only upon small "paper-shelled" species. The species is not scavenger. Surface (1908) says, "little is known concerning the food and feeding habits of this turtle, excepting that it is said to feed upon very small fish, reptiles, etc." The writer has no evidence that would bear out this surmise. Although dozens of specimens have been kept alive in the laboratory, they would never touch meat of any kind in any form, but ate lettuce and greens sparingly. They fed only when submerged and could never be induced to eat while out of water.

Economic Importance.—Along the Illinois River, the chief source of turtles that "go to market" from the state, the most prized and sought for species are the snapper and the soft-shells, because of their large

size. Next to these follows *G. pseudogeographica,* with *Pseudemys elegans* fourth. The fact that these turtles reach a reasonably large size when compared to other species of "terrapins" explains its presence in the turtle markets. Clark and Southall (1920) say: "the terrapin [*G. pseudogeographica*] were used as a substitute, or partial substitute, for the diamond-backs, and that for this purpose the males were not desired. What was wanted was the egg-bearing or 'queen' terrapin. . . . . During the summer of 1918 'queen' terrapin were being quoted at that place [the Illinois River] at $1 each." They reach a weight of from two to three pounds frequently, and are exceedingly good for eating.

TABLE 11.—MEASUREMENTS OF ILLINOIS SPECIMENS OF *Graptemys pseudogeographica pseudogeographica*
(Measurements in millimeters; weight in grams)

Specimen No.	Carapace		Plastron			Head	Tail	Weight	Sex
	Length	Width	Length	Width	Depth				
1.....	220	163	198	93	76	28	70	1721	♀
2.....	203	152	185	85	65	31	69	1119	♂
3.....	195	149	181	83	63	27	55	984	♀
4.....	192	148	179	85	66	29	71	968	..
5.....	185	153	179	80	67	28	50	788	♂
6.....	178	135	170	72	69	25	50	540	♀
7.....	116	86	101	63	38	17	65	158	♂
8.....	101	84	94	63	39	17	61	127	♂
9.....	95	75	82	56	34	16	30	103	♂
10.....	92	72	80	53	32	14	52	95	♂

GENUS CHRYSEMYS GRAY

Emys (part) Duméril 1806
Terrapene (part) Bonaparte 1830
Chrysemys Gray 1844
Clemmys (part) Wagler 1862

Alveolar surface of the jaws narrow, but slightly wider posteriorly; median ridge inconspicuous and the alveolar groove poorly defined in the anterior part of the jaw. Upper jaw with a median notch, lateral to which is a small tooth-like projection; lower jaw with a small tooth-like projection which fits into the upper median notch. Shell wide, much depressed; usually smooth, but in some cases with concentric rugae; no keel is present. Toes strong and fully webbed; hind feet large, spreading; claws strong, curved. Carapace and plastron united by a suture and supported by a strongly developed axillary and inguinal element; inguinal united to the fifth costal plate. Entoplastron anterior to the humero-pectoral suture. Skull with a well developed temporal arch; choanae between the eyes. Dorsal surface of the head covered with plain, tightly drawn skin.

The Chrysemys Problem

From the point of view of the genus Chrysemys, Illinois is a region of great interest and still greater complexity because of the overlapping of the range of the several subspecies. *Chrysemys picta* was described by Schneider in 1783, and was characterized by the transverse arrangement of the costal and vertebral scutes plus the clear yellow plastron. In 1831 Gray described *Chrysemys bellii,* characterized, as are all the members of the group other than *picta,* by the alternate arrangement of costals and vertebrals, and by the great development of the dark area of the plastron. In 1857 Agassiz described *Chrysemys marginata,* characterized by the greatly restricted dark area of the plastron, and *Chrysemys dorsalis,* with an immaculate yellow plastron and a conspicuous median dorsal red stripe down the vertebrals. The last of the genus to be described is *Chrysemys treleasei,* which Hurter described in 1911, distinguished from the other species by the red color of the plastron. Subsequently *bellii, dorsalis,* and *treleasei* were reduced to subspecies of *marginata, Chrysemys picta* remaining the second species of the genus. In their review of the genus Chrysemys, Bishop and Schmidt in 1931 established what they term the "intergradation" of *Chrysemys picta* of the Atlantic states with what was designated as *Chrysemys marginata marginata* whose range extended from New York to the Mississippi. Babcock (1933) points out the eastern extension of the intergrading of *Chrysemys picta marginata* with *C. p. picta* "through New England to the Atlantic coast." He gives intergrade records from Massachusetts (including Pasque Isle and Nantucket), Vermont, New Hampshire, and Maine. Since *picta* is the older name, the eastern species becomes *Chrysemys picta picta,* and the original *marginata* now becomes *picta marginata* because of these intermediate forms. Stejneger and Barbour, however, do not accept this in their 1933 revision of their *Check List;* nevertheless, the present writer proposes to follow them in their terminology. Bishop and Schmidt show the intergradation of the aligned vertebral and costal scutes of *picta picta* to the alternate arrangement found in *picta marginata,* as well as the development of the plastral markings. These writers also call attention to the intermediate conditions found in the Chrysemys from northern and central Illinois, where the subspecies *marginata* and *bellii* overlap, and mention a possible intergradation of these with *picta dorsalis* "somewhere to the south of the Ohio River."

Before discussing the Chrysemys problem in Illinois it is well to eliminate those forms which do not occur within the state. Garman (1892) includes *Chrysemys picta picta* in his list of Illinois turtles, stating that it is "very rare, if it occurs at all." It can be quite definitely stated at this time that this form does *not* occur in the state, and in the

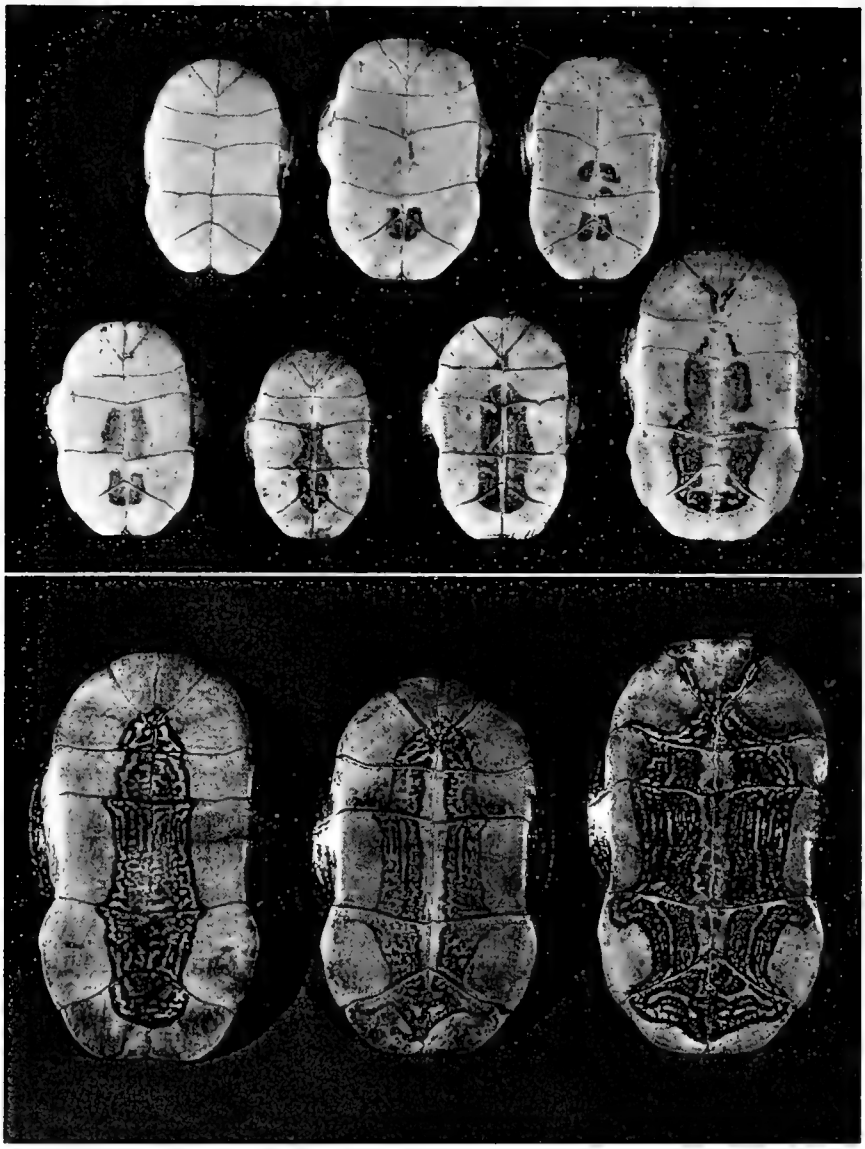


PLATE 16.—The Chrysemys Problem: (*Above*)—A series of plastra of *Chrysemys picta dorsalis*, taken at Horseshoe Lake and vicinity, arranged to show variations in markings. The upper left specimen is typical of *dorsalis*. (*Below*)—Plastra of Chrysemys taken in one drag of a net at Meredosia on the Illinois River. The left-hand specimen is typical of *marginata;* the right-hand specimen is typical of *bellii;* the middle specimen is intermediate between the two.

present paper it is dropped from the state list. As to *Chrysemys marginata treleasei* of Hurter, Bishop and Schmidt have shown that the red coloring of the plastron is due to a superficial deposit of red pigment, presumably an iron oxide, that similar deposits are to be found on other turtles of the same genus, and that there is no correlation whatever between the presence of the red color and the geographic range of the turtles. They therefore reduce the original *treleasei* to synonomy with *Chrysemys picta bellii* because of the approach to the typical *bellii* in all matters other than the red coloring of the plastron which, being a superficial deposit, has no bearing on the case. Thus we find three subspecies of the genus Chrysemys occurring in Illinois: *Chrysemys picta marginata, Chrysemys picta bellii,* and *Chrysemys picta dorsalis.* The latter is reported in this paper for the first time in the state.

Chrysemys picta marginata is an eastern form, extending from eastern New York westward through Indiana into eastern Illinois. *Chrysemys picta bellii* is a western form whose range extends from the Rocky Mountains to western Illinois. In Illinois, therefore, the ranges of these two turtles meet and overlap, and over a great part of the state an intermediate form is found coincident with the overlap. In Indiana, typical *marginata* is found; in eastern Illinois typical *marginata* is also found, but along with it are found a number of turtles in which the narrow dark plastral area shows a tendency to enlarge and creep out along the sutures, especially along the femoro-anal and gulo-humeral unions. In central Illinois, particularly in the region of the Illinois River, this tendency for the plastral mark to enlarge and spread increases, and the size of that area becomes larger, tending toward the *bellii* characteristic. In a series of 212 turtles of the genus Chrysemys taken at Meredosia on the Illinois River, 12 specimens were typical *marginata,* 33 were typical *bellii,* and the remaining 170 were intermediate between the two, extending through every degree and variation of plastral markings. Of this 170, 32 were more similar to *marginata* than to *bellii,* 46 were more similar to *bellii* than to *marginata,* and the remaining 92 showed such intermediate markings that it would be difficult to say which of the two forms they resembled unless one became arbitrary in the matter. These intermediate forms are what Bishop and Schmidt call "intergrades."

Chrysemys picta dorsalis is a southern form, extending westward into Louisiana, Arkansas, and Texas, and northward into the extreme southern tip of Illinois. Thus it is seen that somewhere in the southwest the ranges of *dorsalis* and *bellii* meet, while the ranges of *dorsalis* and *marginata* meet, almost as indicated by Bishop and Schmidt, "somewhere to the south of the Ohio River." From Cairo and Metropolis the writer has collected typical specimens of *dorsalis,* with the very characteristic

dorsal band and the immaculate plastron. He has also collected from southern Illinois and from the extreme western tip of Kentucky and northwestern Tennessee a full and complete set of forms entirely intermediate between *dorsalis* and *bellii,* both as to the development of the vertebral band and the development of the dark area on the plastron, with typical *dorsalis* and typical *bellii* at opposite ends of the series, and with *marginata* in the middle. (This series is shown in Pl. 16.) The question is, then: What are we going to do with these intermediate forms? What are we going to call them?

If the plastral markings of *marginata* and *bellii,* and the lack of plastral markings of *dorsalis,* are definite genetic characters—as they appear to be since they are practically constant and consistent over the great range of the forms, then, where the ranges of the two subspecies meet and overlap, the intermediate forms found there may well be considered as *hybrids* between them, hybrids showing incomplete dominance. This is on the understanding of a hybrid as being a cross between two distinct species or subspecies, or between individuals having distinctive differences, and without reference to any question of fecundity. In the eastern part of the country we find only *marginata;* in the western part only *bellii.* Where the ranges of these two overlap (Illinois) we find the hybrids, plus occasional typical examples of each, and we find the hybrids in far greater abundance than either of the parent stocks. The same is true where the range of southern *dorsalis* overlaps that of *bellii* and *marginata.* Since there is no physical barrier of any kind between *marginata* and *bellii,* or between *dorsalis* and either *marginata* or *bellii* in the area in which the hybrid forms occur, and since every possible variation exists between the typical parent forms within this area, it is not to be supposed that the hybrids comprise an additional subspecies.

Since the primary distinction between *marginata* and *bellii* lies in the size and distribution of the dark plastral area, it is perhaps well to delineate as definitely as possible between the two subspecies. Bishop and Schmidt (1931) have reduced this matter to a mathematical basis comparing the maximum width of the dark plastral figure to the width of the plastron as measured from the lateral margins of the abdominals where they meet the marginals in the bridge:

Chrysemys picta marginata:
Dark area occupies from 13 per cent to 67 per cent of the plastral width. Average: 36 per cent. (7 specimens out of 51 exceed 50 per cent.)

Chrysemys picta bellii:
Dark area occupies from 56 per cent to 85 per cent of the plastral width. Average: 74 per cent. (5 specimens out of 44 fall below 70 per cent.)

Chrysemys intergrades:
Dark area occupies from 15 per cent to 78 per cent of the plastral width. Average: 55 per cent.

From the above figures it is seen that the hybrids extend through almost the entire range from minimum *marginata* to maximum *bellii*. The writer has checked these figures on something over 600 turtles of the genus from within Illinois, and is quite in agreement with Bishop and Schmidt. Certain points, however, have been brought out by his study.

Since Bishop and Schmidt have shown that out of 51 specimens of *marginata* only 7 exceeded 50 per cent, and out of 44 *bellii* only 5 fall below 70 per cent, I have quite arbitrarily taken 60 per cent (instead of their 55 per cent) as the dividing line, and say that any turtles between 50 per cent and 60 per cent show "*marginata* tendencies," while any between 70 per cent and 60 per cent show "*bellii* tendencies." Otherwise, since the intergradation is so complete and is illustrated by such a great assortment of percentages, it would be quite impossible to designate which way the hybrids are tending. While I have taken typical *marginata* from many localities in southeastern Illinois, this form does not extend its range far into the state before the hybrid forms begin to appear, and these fall into the group showing definite *marginata* tendencies. Such hybrids from the upper Embarrass, the Little Wabash, and the Upper Kaskaskia average 58 per cent. On the other hand, turtles from the lower Illinois River and its tributaries show the *bellii* tendencies, averaging 66 per cent. There is a third series of localities, as the lower Sangamon and certain regions on the upper Illinois River, where the variation covers almost the entire range of the hybrid scale and one cannot definitely state which way the hybrids are tending: they are wholly intermediate. The accompanying map illustrates the distribution of hybrid Chrysemys according to their "tendencies" in localities where twenty or more specimens were available for study. From this map one will note that apparently the drainage basin of the Illinois River and its

MAP 12.—Intermediate Chrysemys.

major tributaries is the zone of maximum transition between these two subspecies. While typical *Chrysemys picta dorsalis* has been taken in the extreme southern tip of Illinois, it is distinctly rare, and is associated with transition hybrid forms tending toward the *marginata* type. Similar specimens showing *dorsalis* tendencies have been taken southward to and including Reelfoot Lake, Tennessee, where, however, typical *dorsalis* is the abundant and dominant form found.

The facts of the Chrysemys problem line up as follows: (1) The most striking difference between the three subspecies occurring in Illinois is the plastral marking. (2) In one part of the country we find one expression of plastral markings (*marginata*); in another part a second expression (*bellii*); in a third part still another expression (*dorsalis*). In these areas the turtles breed typical expressions of the character. (3) Where these areas overlap (Illinois) we find turtles in which the character is expressed through a series of variations which show tendencies toward one or the other of the typical character expressions, or else so intermediate between the two as to give no indication as to which of the parent expressions they tend toward. (4) In these areas of overlapping, the number of individuals which exhibit the typical expression of the character concerned is far less than the number of the individuals showing variations or intergradations.

It seems to the present writer that there are two possible explanations that might be offered to account for these facts. Both of these are offered herewith merely tentatively, for the writer realizes fully that the only way in which the truth of the matter can eventually be ascertained is by careful and prolonged breeding experiments, a series which would require years to complete, and which he is in no position to undertake. (1) We are dealing with three distinct subspecies, *marginata, bellii,* and *dorsalis,* each being a separate form. Where the ranges of these touch and overlap, we have a hybridization between those whose ranges join, with all sorts of variations resulting. This would be termed "interspecific hybridization." (2) We are dealing with but one single species or subspecies, in which we have three expressions of *genetic* characters. This might well be called "intraspecific hybridization."

This latter idea has not yet been expressed, so far as the writer knows, and a word further might be in order. If the plastral markings of the three typical subspecies are the result of the expression of different genetic complexes, the following facts would be true: (1) Within the limits of distribution of each subspecies, each subspecies would breed true. (2) Where the limits join or overlap we have a series of expressions which differ from either parent and do not resemble either exactly, which may show a *tendency* to resemble one of the parents. (3) The number of individuals showing the expression of variation between the

two parents will far outnumber those individuals which exactly resemble the parents. These facts (2 and 3) are illustrated in the area in which hybridization occurs. If *marginata* and *bellii* and *dorsalis* are pure lines, where these pure lines come together in the overlapping range of what we are calling the typical subspecies, we would expect *quantitative variation* between the pure lines. On the surface, at least, this seems to be true.

Chrysemys picta marginata (Agassiz)

(Painted turtle; red-legged turtle; mud turtle; pond turtle)

Testudo cinerea Bonnaterre 1789
Emys cinerea Schweigger 1814
Emys picta Gravenhorst 1829
Chrysemys picta (var. 2) Gray 1855
Chrysemys marginata Agassiz 1857
Clemmys picta (var. 2) Strauch 1865
Chrysemys pulchra (part) Gray 1873
Chrysemys cinerea Boulenger 1889
Chrysemys marginata marginata Stejneger & Barbour 1923
Chrysemys bellii marginata Ruthven 1924
Chrysemys picta bellii Bishop and Schmidt 1931

Description.—Shell wide, depressed, broadest at about the eighth marginal scute; rather uniformly convex, highest in the middle. The posterior lateral marginals flaring. Surface smooth for the most part, but sometimes with weak concentric rugae near the lateral margins of the costal scutes and extending to the median margins of the contiguous marginals; unkeeled even in the young individuals. Vertebral scutes wider than long, and about equal to the costals in width. The anterior margin of the first vertebral greatly exceeding the posterior margin. Second, third, and fourth vertebrals hexagonal, the anterior and posterior margins of the second and third being approximately equal, while the anterior margin of the fourth is greater than its posterior margin. The fifth vertebral is somewhat the smallest of the series and tends to be pentagonal; in some specimens it shows a tendency to divide along the mid-dorsal line. The vertebrals alternate with the costals. Costal scutes somewhat larger than the vertebrals. The first costal is trapezoidal, its maximum length and width being about equal. Second and third costals wider than long, the second being a trifle wider than the third but having nearly the same length. The fourth costal is the smallest of this series, and approaches a square in shape. The nuchal is long, narrow, and with a definite median notch anteriorly; this may or may not be bordered on each side by a series of serrations extending on to the adjacent marginals, and these serrations may be very small or highly conspicuous. The marginals number 24. Posteriorly the marginals begin to flare at about the seventh scute, and there is a slight caudal notch. The plastron is broad and flat, truncate anteriorly and posteriorly. Gulars finely serrated along the anterior margin and with the anterior lateral angle prolonged into a blunt "tooth." Interhumeral and interfemoral sutures usu-

ally about equal, and both a trifle shorter than the interpectoral suture. Pectoral scutes transverse, about half the length of the abdominals. Interanal suture about equalling the interabdominal suture. The bridge is wide, rising rapidly to the marginals. The inguinal is larger than the axillary element, and both are triangular. The head is moderate in size, and distinctly flattened dorsally. Upper jaw with a distinct median notch

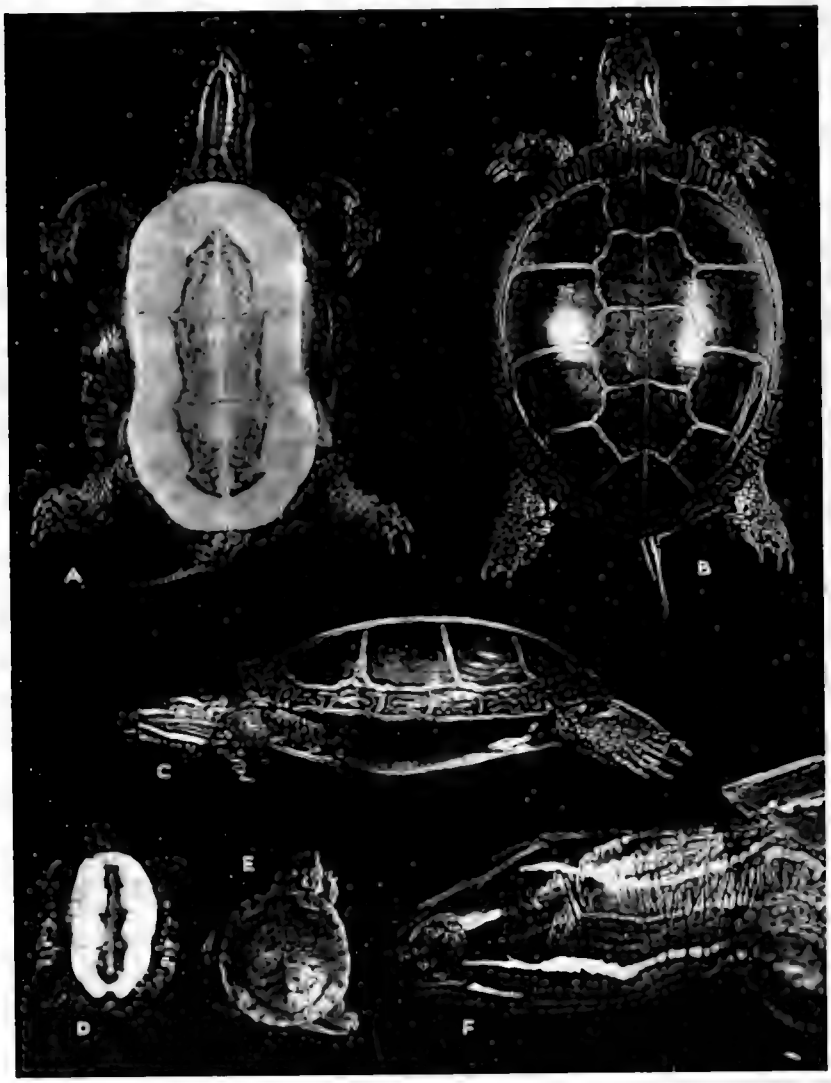


PLATE 17.—*Chrysemys picta marginata: A,* Adult, ventral view. *B,* Adult, dorsal view. *C,* Adult, lateral view. *D,* Newly hatched young, ventral view. *E,* Newly hatched young, dorsal view. *F,* Head study of an adult.

which is bordered on each side by a distinct "tooth." Snout short, not projecting far; nostrils anterior, terminal, and close together. Alveolar ridge weak. Lower jaw but little upturned and with a small median tooth. Limbs well developed, the posterior the larger. Anterior limbs with rows of transverse imbricated scales; digits 5, claws 5, these being strong and curved. Hind limbs flattened and expanded; digits 5, claws 4, the fifth toe represented by a tough marginal projection and without a claw. Claws on the hind limbs shorter than on the fore. Hind feet large. All digits fully webbed to the base of the claws.

Coloration.—The general plan of the color pattern of *Chrysemys picta marginata* is quite stable, but the fine details prove to be highly variable. The carapace is dark olive green. A *very* narrow black-bordered red or yellowish line extends from the anterior margin of the nuchal to the notch of the caudals; in some cases this line is almost indistinguishable. The margins of the scutes are yellow, which clearly outlines each scute. The posterior margin of the costal and vertebral scutes is bordered by a narrow black line; the anterior border of these scutes shows a wider line of yellow (sometimes orange, sometimes approaching red), lying against the preceding black line. Vertebrals and costals often with yellow or red lines, dots or blotches, these usually rimmed with black. Marginals with the dorsal surface decorated with lines and spots of yellow and bright red, usually tending toward a concentric pattern around a brilliant red spot near the center of the lateral margin of the scute. This red spot is prolonged down the middle of the ventral surface of the marginals, forming a striking color contrast against the almost black background. The plastron is bright yellow or straw color, often covered with a superficial layer of brown or reddish deposit; it bears a dusky or black-mottled central area extending from the posterior angle of the gulars to about the middle of the anals. This dark area shows no tendency to produce lateral branches along the sutures, especially not along the gular-humeral articulation. The axillary and inguinal elements are largely black, blotched with bright red or orange-yellow. The distal margins of the pectorals and abdominals, which form the bridge, are bordered with black. The more conspicuous of the head and neck markings, all of which show much variation, are usually as follows: On each occipital region is a large yellow blotch, nearly the size of the eye, prolonged backward as a narrower yellow line along the neck; a short, wide dash behind the eye often connects with the previously mentioned spot; a stripe extends from the mid-ventral margin of the orbit downward and backward along the anterior ventral margin of the tympanum, where it meets a short line from the lateral angle of the lower jaw, and together they run as a conspicuous ventro-lateral line down the neck; a short median yellow line begins at the "tooth" of the lower jaw, but

bifurcates to extend down the neck. Between these major lines are many fine lines of yellow. The top of the head is usually mottled, and shows a median line from the nostrils to a point just behind the eyes. The iris is golden brown. Two bright red stripes on the anterior surface of the fore limbs, and three on the under surface of the hind limbs. Tail with yellow or orange stripes. Other soft parts mottled with red and yellow.

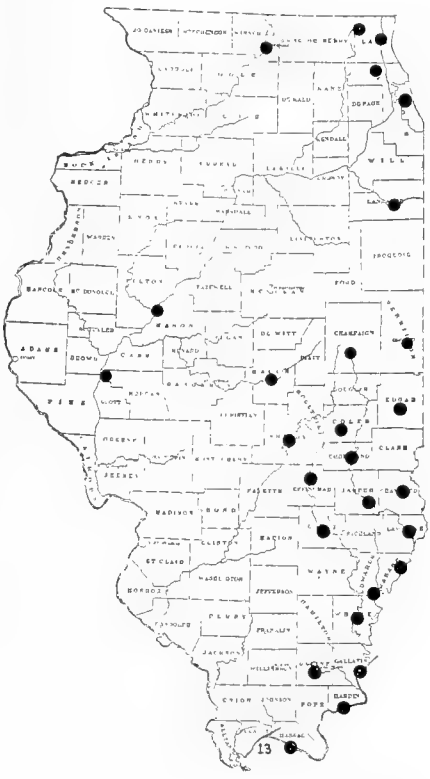
Young.—The newly hatched young are readily recognizable by their resemblance in general form and coloration to the adult. However, the head, instead of being flat dorsally, is convex and highly domed above. The snout is very short; eyes large in proportion to the head. The carapace is nearly circular in outline and very flat and without a keel. Nuchal scute nearly square, the anterior median notch usually not visible. The mid-dorsal stripe is quite clear but is always very narrow, being merely a line. The plastral markings are almost solid black, but of the same shape and form as in the adult.

Sex Differentiation.—The sexes may be distinguished externally by the fact that in the male the claws of the front feet are long, slender, and curved; those of the female are short and stout and but slightly curved. The vent of the male lies beyond the margin of the carapace, of the female, beneath it. The females are larger than the males when fully developed.

Geographic Distribution.—The recent work of Bishop and Schmidt (1931) on the genus Chrysemys enables us to outline the geographic distribution of the various species of the genus with greater clarity than was possible some years ago. *Chrysemys picta marginata* occurs throughout the great territory of eastern United States, extending from eastern New York westward through western Pennsylvania, Ohio, Indiana, southern Michigan, and into eastern Illinois and Wisconsin. The northern and southern limits are very uncertain due to the confusion of names existing in the literature and cannot be accurately defined until a great deal of field work has been done. As an example, *Chrysemys picta* is reported as abundant over the province of Ontario by Nash (1906), and no mention is made of *marginata,* which is probably what he has called *picta* over most of that region. It is not mentioned as an inhabitant of New England by Babcock (1919). Surface (1908) quotes *marginata* from several localities in northwestern Pennsylvania, and incidentally says that "intergrading forms [between *picta* and *marginata*] are rather common," a reference to this matter which Bishop and Schmidt have apparently overlooked. Morse (1904) reports it as one of the commonest turtles in Ohio, and it is reported by Ruthven (1912) from the southern half of lower Michigan. Hay (1892) reports it as "everywhere" in Indiana, and gives its range as the "northern states of the Mississippi

Valley from Ohio to Kansas and north to Lake Superior"—which is both too much and not enough! When we come to Wisconsin, we find Pope and Dickinson (1928) reporting *marginata* as "statewide," with records from the extreme north to the extreme south, and as far west as Grant County on the Mississippi; Hoy (1883) gives it as "abundant everywhere," while Higley (1889) reports it as very common; Cahn (1929) has typical specimens from southeastern Wisconsin, but failed to distinguish the hybrid forms. Since Wisconsin, or part of it at least, lies in the area of overlap of ranges, it is in need of a thorough going over.

Illinois Records.—When we come to Illinois, it is very difficult to know what to do with the published records which cannot be verified by a re-examination of the original material. Since most of the writers did not recognize the hybridization between *marginata* and *bellii* it is extremely difficult to determine just what they were dealing with. We can guess at probabilities, but prefer not to do so. Yarrow (1882) reports *marginata* from Mt. Carmel. Garman (1892) records it "throughout the state; common . . . ." with records from Lake County, Nippersink Lake, Oregon, Normal, Peoria, Phillipstown and Mt. Carmel; Garman (1888) says that it does not occur in the Mississippi bottoms near Quincy, which statement is quite correct. Davis and Rice (1883) do not list *marginata* at all from Illinois, but record *picta* as "abundant throughout the state," which is quite incorrect. Hankinson (1917) is quite frank about his Chrysemys around Charleston, calling them "*Chrysemys* (species?)," though he probably had mostly *marginata* with some hybrids as well. Bishop and Schmidt (1931) report pure *marginata* from southeastern Illinois, but cite no localities. The writer has examined specimens unquestionably *Chrysemys picta marginata* from the following Illinois localities: Paradise Lake at Mattoon, Urbana, Rockford, Havana, Danville, Arlington Heights, Fox Lake, Robinson, Meredosia,



Map 13.—*Chrysemys picta marginata.*

Lawrenceville, Mt. Carmel, Carmi, Louisville, Shawneetown, Harrisburg, Shelbyville, Sims, Metropolis, Effingham, Kankakee, Elizabethtown, Paris, Greenup, and Newton. In preparing the map of distribution of the form, only the above localities where typical *marginata* were examined have been listed. It must be borne in mind, also, that at some localities, as Meredosia, Havana, etc., as well as in the northern counties, hybrids were also present.

HABITAT.—*Chrysemys picta marginata* is a common inhabitant of the smaller lakes, ditches, temporary ponds, and sluggish waters of the eastern and southeastern portion of the state. Its habitat preference is distinctly for shallow, soft-bottomed, weedy lakes, and it distinctly avoids fast water and both rocky and gravelly environments. Almost any muddy ditch or the backwater of a stream or river is likely to have its population of this turtle in surprising numbers. It is associated almost always with an abundant growth of aquatic vegetation, and often the carapace is found to be overgrown with masses of algae. Whether it is the vegetation or the soft bottom accompanying vegetation which is the major attraction would be hard to say, but the combination, usually inseparable, affords the turtle the abundance of food and highly adequate protection in which it finds its optimum environmental requirements. Masses of Vallisneria, Potamogeton, Elodea, and the intertwining nets of algae are likely to shelter great numbers of these turtles.

HABITS.—There is considerable diversity of individual habits exhibited among these turtles, some being highly aquatic, others showing a tendency toward a terrestrial habit. During the summer and fall in particular I have frequently found specimens wandering about in fields and woods nearly half a mile from water, their wanderings having no connection with age, sex, breeding, or hibernation. Such land-journeying specimens are distinctly less timid than the more aquatic ones and, while they mildly resent being disturbed, they quickly recover their equanimity and proceed with their wanderings. Those turtles which show aquatic preferences are very wary and difficult to approach. They spend hours floating at the surface of the water, the head protruding while the body lies partially concealed by the protecting bed of vegetation which they dare not forsake. At the first sign of danger they disappear amid a tiny swirl caused by the sudden action of the hind legs, and are very slow and cautious about again venturing to the surface. As a whole, the species enjoys basking in the sunshine, and the turtles may be seen lined up on partially submerged logs or along the sloping banks of the pond, lazily absorbing the warmth. They lie with their hind legs fully outstretched and entirely relaxed, and with the eyes closed they give the observer the impression of sleeping. But notwithstanding their complete relaxation, the least approach of danger startles them into activity, and they plunge

from their log or scramble down the bank into the water where they bury themselves in the mud at the bottom. Their return to the basking place is slow and cautious, and they do not emerge until the neighborhood has been carefully scanned and inspected.

As swimmers they are fast and powerful when speed is necessary, the flattened hind limbs and the wide webbing of the digits giving them excellent organs of propulsion. When not frightened, however, they walk slowly and cautiously along the bottom, peering to the right and left among the dense vegetation in search of possible food. Again, they may lie for a long period entirely motionless on the bottom, the legs half drawn up, the head just protruding beyond the shell, resting.

When disturbed and handled, the turtles snap vigorously for a time and then seem to take a philosophical attitude and make the best of the situation. Their bite is quite harmless due to the weakness of the jaws, but they are fast in their actions and sure of their aim. In captivity they quickly adjust themselves to their surroundings and in a few days will begin to eat and behave naturally. They can be kept for months or years in a suitable aquarium; they become very tame and eat from the hand within a few weeks after capture.

As the summer wears on and the chill of autumn pervades the air, they become more and more sluggish in their reactions and finally forsake entirely their basking activities. After mid-October, unless the weather conditions are unusual, they are not seen at the surface, and hibernation begins at about this time. They hibernate in the mud at the bottom of the pond, or in the runways of muskrat burrows, or in "cave-ins" along the bank. In the southern portion of the state the hibernation is less marked, and even in the vicinity of Danville the turtles may sometimes be seen crawling slowly and sluggishly along on the bottom during the winter. They reappear shortly after the ice goes out and by mid-April their heads are to be seen poking above the surface, though they do not come out to bask until the air has warmed up to a considerable degree.

Breeding Habits.—Long before the nesting season begins, the turtles become increasingly active, often traveling in pairs, with the male following or chasing the female. Sometimes two or even more males are to be seen thus occupied pursuing a single female; always it is the female that is in the lead. On one occasion I saw the male catch up with the female; he climbed on top of her carapace and seemed to be clawing at her head and neck. However, she quickly evaded him, and when last seen he was again in pursuit. No notes on copulation are available. The nesting habits of the turtles of the genus Chrysemys have been described by Babcock (1919) who quotes observations of Thoreau and others relative to *picta*, while Stromsten (1910) describes the process for *bellii*. That *marginata* is similar to these, the following transcription from my field notes will

bear out. (In one respect at least, the turtles of the genus Chrysemys differ from other species found in the state: they lay in the late afternoon and early evening instead of in the early morning. Thus it happens that the turtle described herewith is a bit unusual only in that it was found digging its nest at 4:10 in the afternoon; it is usually done later.) "The nest was in compact, black soil along the edge of a road, within fifteen feet of a vegetation-choked pond from which her tracks led straight to the point where she was at work. When discovered, the turtle had dug a hole about half an inch deep. She paused for a few minutes, standing motionless while I sat down a yard away, watched me closely, then resumed her digging and paid me no further attention during the process, though I moved considerably in order to watch the performance. Her front feet were firmly planted and were not moved from their position; the digging was done entirely with the hind feet. She scratched several times with one foot; then cupping the foot by drawing the digits together, she carefully scooped the loosened dirt out of the hole and deposited it on the opposite side of the hole behind her. This was then repeated with the opposite foot. As each load was removed, she discharged a stream of water through the cloacal apperture directly into the hole, softening the dirt prior to the scratching that followed. She worked briskly and without pause, one foot after the other removing a pinch of dirt to the growing pile behind her. When she had dug down about two inches, the bottom of the hole was very muddy; from then on no more water was discharged, and this mud was dug out and pushed back. At three and a quarter inches (subsequent measurement) she began to enlarge the bottom of the hole a bit, making a sort of oval chamber, the longer axis parallel with her position. The digging that was watched required sixty-four minutes to complete; then the first egg was laid. In laying, she pulled her head entirely within the shell and, apparently without any effort, deposited the egg in the hole, reaching in with the right hind leg to shove the egg over to one side and to lay it horizontally. The seven eggs that followed were laid at intervals of about one minute, and each was rearranged with the right hind foot after laying. The eighth egg deposited, she remained motionless for about three minutes, then began to fill in the hole. She reached back with one leg after the other and raked small quantities of dirt into the hole, tamping it down with the sole of the foot and occasionally discharging water on it and then tamping it down still more. With the hole almost filled, she seemed to switch from the sole of the foot to the dorsal surface, kneading the dirt into place instead of tamping it down. When the hole was completely filled she watered the spot thoroughly, then repeatedly drew the flat surface of the plastron over it, smoothing the surface. Finally, the front feet still in position, she reached out and drew over the nest an accumulation of

débris, leaves, twigs, dead grass, etc., concealing the last trace of the disturbance. Without looking around to inspect her work, she headed for the pond and disappeared." The entire process under observation required an hour and fifty-two minutes. Regarding the age at which Chrysemys breeds, Agassiz (1857) says that *picta* does not breed until its eleventh summer.

Eggs.—The number of eggs varies from four to ten, with six or seven being the average number deposited. When laid, the eggs are translucent and almost flesh-colored, but as the shell dries out it becomes pure white, opaque and rather brittle. The measurements (in millimeters) of the eight eggs in the set dug from the nest described above are as follows: 30 x 18, 31 x 17, 30 x 17, 30 x 17, 30 x 18, 31 x 18, 31 x 17, 30 x 18; average: 30.3 x 17.6. There is no information available to the writer regarding the incubation period, but young turtles, evidently but newly hatched, have been taken in late August and early September as well as in late June, which inclines the writer to agree with Newman's suggestion (1906) that "forced hibernation of embryos" results when turtles lay late in the season. In spite of the careful effort of the turtle to hide her nesting site, the eggs are very frequently dug up by skunks and raccoons, both of which are experts at discovering these choice delicacies.

A recent note by Wilcox (1933) on the incubation period of the painted turtle (presumably *Chrysemys picta picta*) in New York, is of interest. On June 26 he observed a female digging her nest; on September 8, Wilcox dug down to the nest and found the young turtles just coming out of the shell. They measured almost exactly one inch in length. This gives an incubation period of nine and a half weeks. Nichols (1933) remarks that the above brood was probably unusually advanced for the region and reports eggs laid on July 17, 1925, hatched April 3, 1926, and eggs laid June 25, 1928, hatched October 28 of the same year.

Food Habits.—Hay (1893) reports the food of *marginata* as being "insects, tadpoles and other feeble and small animals." An examination of ten stomachs from specimens from southeastern Illinois leads the writer to make the statement that they are omnivorous, with a strong tendency toward vegetarianism. These stomachs showed the remains of aquatic larvae such as Chironomous and other dipterous forms, nymphs of dragonflies, mayflies and stoneflies, aquatic beetles, gastropods, fingernail shells, small crayfish, tadpoles, ants, flies, and honey bees; only one small, unidentifiable minnow was found. Vegetable matter predominated, being in the form of chewed-up masses of aquatic plants, algae, rootlets, leaves, stems, and grass. Three specimens showed evidence of the scavenger habit; there is no question of the fact that if dead matter is

available, this turtle shows well developed scavenger instincts. When eating anything too large to be swallowed entire, the morsel is held firmly in the mouth and is then ripped to tatters by the claws of the front feet, these feet acting either separately or together.

Economic Importance.—In spite of the abundance of turtles of this genus everywhere throughout the state, their small size makes them undesirable for human consumption, in spite of the fact that the flesh is firm and of excellent flavor. Their scavenger habit makes them a valuable asset in the destruction of animal matter. While they do not ordinarily destroy living fish or fish eggs, it is conceivable that in such places as fish breeding pens these turtles might be a serious annoyance and cause considerable loss.

Table 12.—Measurements of Illinois Specimens of *Chrysemys picta marginata* (Measurements in millimeters; weight in grams)

Specimen No.	Carapace		Plastron			Head	Tail		Weight	Sex
	Length	Width	Length	Width	Depth		Total	A-T		
1	162	116	148	93	58	24	57	42	484	♀
2	143	110	133	88	52	22	45	40	321	♀
3	138	101	129	81	50	22	47	39	368	♀
4	133	103	125	81	52	21	40	38	363	♀
5	133	98	120	81	43	20	45	39	283	♂
6	133	98	117	77	43	20	51	32	308	♂
7	125	94	116	77	45	19	44	39	266	♀
8	123	96	115	76	43	18	50	37	254	♂
9	122	90	111	70	38	18	55	40	241	♂
10	118	85	102	75	35	17	50	35	176	♂
11	115	87	106	68	42	18	35	32	213	♀
12	82	68	75	65	32	14	44	35	96	♂
13	30	28	28	21	13	8	16	14	6	..
14	27	27	26	20	11	7	12	11	5	..

Chrysemys picta bellii (Gray)

(Western painted turtle; red-legged turtle; mud turtle; pond turtle)

Emys bellii Gray 1831
Emys oregoniensis Harlan 1837
Chrysemys oregoniensis Holbrook 1842
Chrysemys bellii Gray 1855
Chrysemys nuttalii Agassiz 1857
Clemmys oregoniensis Strauch 1862
Chrysemys picta (part) Gray 1863
Clemmys picta (var. b and c) Strauch 1865
Chrysemys pulchra (part) Gray 1873
Chrysemys bellii True 1883
Chrysemys cinerea bellii Boulenger 1889
Chrysemys marginata bellii Stejneger & Barbour 1917
Chrysemys bellii bellii Ruthven 1924
Chrysemys picta bellii Bishop and Schmidt 1931

Description.—Shell broadly ovate, widest posteriorly; depressed and unkeeled; uniformly convex. The posterior lateral marginals flaring. Surface smooth except for occasional longitudinal rugae near the lateral margin of the costal scutes, and extending onto the median of the

marginals. Costal scutes alternating with the vertebrals. Anterior margin of the first vertebral approximately twice the length of the posterior margin and about a quarter greater than the length of the scute. Second and third vertebrals almost equal in size as well as in width; hexagonal; the anterior and posterior borders about equal to the length of the scute. Fourth vertebral wider than long in most of the specimens, and also hexagonal. Fifth vertebral somewhat smaller than the fourth. Costal scutes large, about equalling the width of the vertebrals. First costal trapezoidal, its length and width about equal. Second and third costals wider than long, tending toward rectangular in shape, the third smaller than the second. Fourth costal the smallest of the series, almost square. Nuchal scute elongate but quite wide in most specimens—usually wider than in *marginata;* its anterior margin is usually weakly serrated and the serrations more often than not do not extend to the adjacent marginals. Marginals number 24, with a shallow caudal notch. The marginals follow the slope of the carapace up to the seventh scute, from which region they begin to flare. The plastron is broad and flat and is truncate both anteriorly and posteriorly, the anterior margin finely serrated. Gulars triangular, their anterior lateral angle protruded forward into a weak, blunt "tooth." Interhumeral and interfemoral sutures approximately equal, and the shortest of the median articulations. The interpectoral suture only a trifle longer than either of the preceding sutures. Pectoral scutes transverse, about half the length to the abdominals, which are by far the largest of the plastral elements. Anals large, triangular, the interanal suture but slightly shorter than the interabdominal. The bridge is wide and strong. Inguinal scute larger than the axillary, both irregular in shape. Head moderate and distinctly flat on the dorsal surface and covered with plain, tightly drawn skin. Snout short, not projecting; nostrils anterior, terminal, and set close together. Upper jaw with a distinct median notch which is bordered on each side by a short but definite tooth. The alveolar ridge is weak and poorly developed. Lower jaw only slightly upturned and with a median point which fits into the median notch of the upper jaw. Limbs strong and well developed, especially the posterior pair. Front legs with rows of transverse imbricated scales; digits 5, claws 5. Hind limbs flattened and expanded; digits 5, claws 4, the claw absent on the fifth (posterior) digit. Claws strong, pointed, curved. Toes fully webbed to the base of the claws. Tail slender and attenuated.

Coloration.—The carapace is dark olive green, each scute with a narrow buff margin along its anterior articulation. Other than this, the markings are extremely variable. There is a tendency for each costal scute to show evidence of a diagonal line of buff, or a few irregular transverse lines of red or yellow, and occasionally a few dots. There

is a very narrow mid-vertebral streak of buff or red, often, however, very inconspicuous or almost wanting. The marginals tend to have three transverse streaks, the outer two small and inconspicuous and often buff

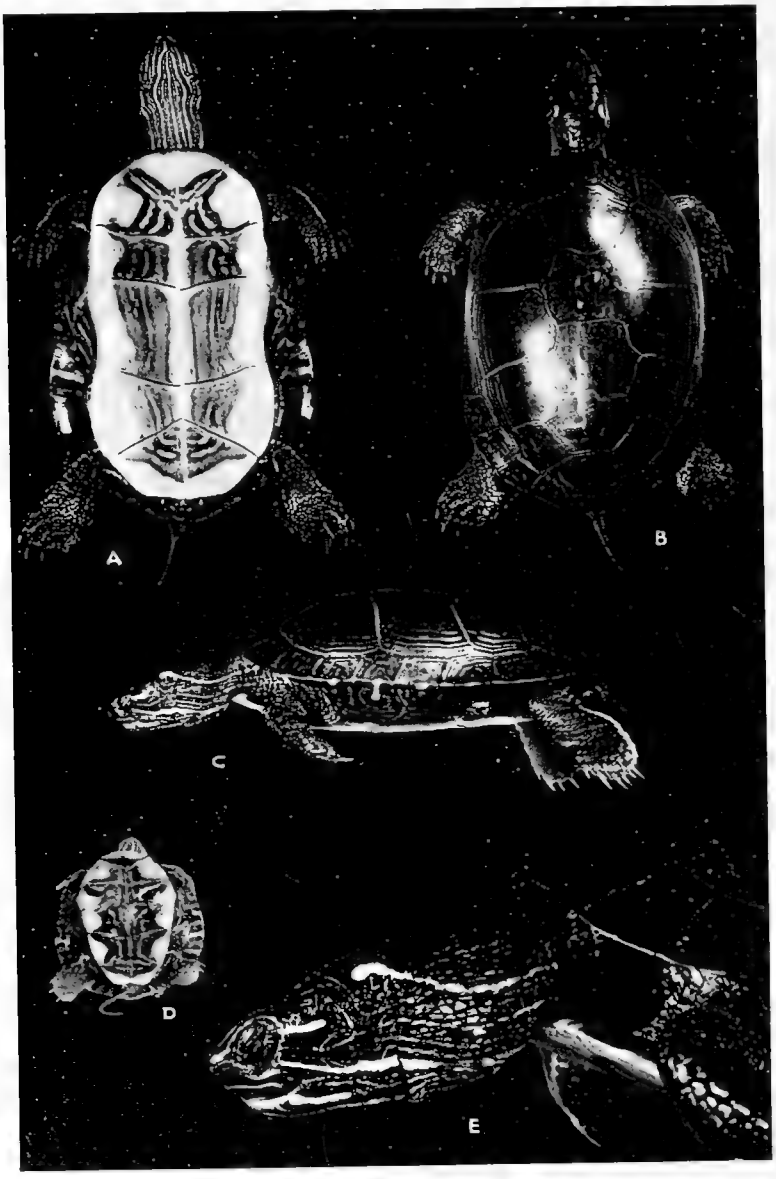


PLATE 18.—*Chrysemys picta bellii: A,* Adult, ventral view. *B,* Adult, dorsal view. *C,* Adult, lateral view. *D,* Newly hatched young, ventral view. *E,* Head study of an adult.

in color, the central one reaching to the lateral margin and blood red in color, terminating in a more or less distinct blotch. Ventrally this red spot is continuous with a brilliant red band, and the marginal scute shows streaks or blotches of buff and red on each side of this band. The bridge is traversed longitudinally by bars, lines, or blotches of red, orange, or buff on a dark olive background, these markings extending over the inguinal and axillary scutes. Inguinal usually with a blood red spot at its posterior lateral angle. The plastron is yellow, sometimes overcast with a brownish or reddish superficial deposit. The central region is marbled with black in a complicated, lyriform, bilateral design. This figure flows out along the sutures and occupies upward of 60 per cent of the area of the plastron. There usually is a clear, longitudinal area within this design, following the mid-ventral suture. The coloration of the fleshy parts is elaborate. The head and neck are striped with blood red and lemon yellow as follows: a yellow stripe from below the nostril to the posterior end of the jaw; two yellow stripes, joined at the nostril, pass through the orbit and terminate dorsal and ventral to the tympanum. Three orange or yellow stripes run along the neck, one starting at the tympanus, one at the corner of the mouth, and one on the occiput. On the ventral surface, a bifurcating yellow stripe starts at the symphysis of the lower jaw and extends back to the body, with a third stripe between these two. Besides these major stripes, many fine yellow longitudinal lines cover the sides and ventral surface of the head and neck. The anterior surface of the fore limbs show two, three, or four broken lines, red on the limb and tending to yellow on each digit; the webbing tends toward a greenish yellow. The posterior limb usually shows three broken red or orange bands, the median the most conspicuous; this one extends onward to the ventral tip of the tail where it unites with its mate from the opposite side. The tail also shows two red lines dorsally which become yellow posteriorly as they unite to extend as a single stripe to the tip of the tail. The vent is usually set in a red spot.

Young.—The young show all of the typical markings of the adult, and, so far as the writer can determine, the markings on the plastron, though blacker and more solid than in the adult, yet retain the same outline and relative proportion throughout life. The young are much more round than the adult, being almost circular in outline. The head is domed above and the eyes are large in proportion to the size of the head. There is never a trace of a keel in the young. The vertebral streak is perhaps a bit more clear in young individuals, but it is always very narrow, a mere line.

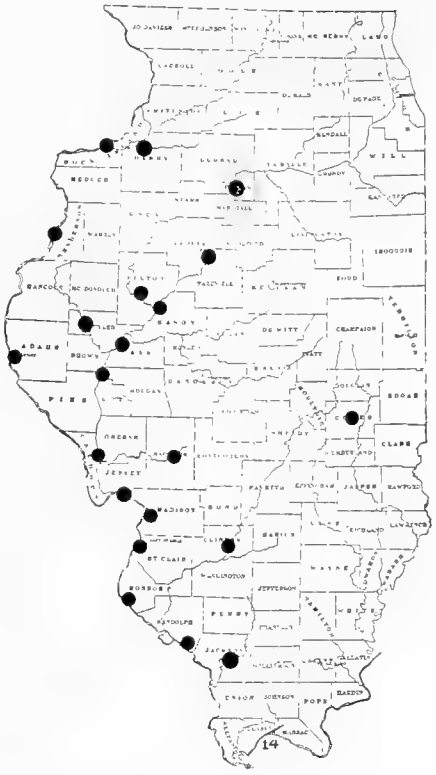
Sex Differentiation.—The sexes may be determined externally by the long claws on the front feet of the male, these being three or four times the length of the claws on the hind foot. They are slender and

curved. In the male the vent lies beyond the margin of the carapace. Fully grown females are larger than fully grown males.

Geographic Distribution.—*Chrysemys picta bellii* is a western painted turtle, with a range extending from the Cascade Mountains eastward to the Mississippi River. Storer (1932) gives the status of the species in the far west as follows: "There is thus no definite basis for ascribing *Chrysemys picta bellii* to the region west of the Cascade Mountains. It is a species of the interior, definitely recorded from the Mississippi drainage, Colorado (New Mexico?), and eastern Washington. Like many other vertebrates it evidently circles the northern margin of the Great Basin to reach its limit of range east of the Cascade system." From these mountains, then, the range extends eastward. Blanchard (1922) records it from northwestern Iowa, where he found it to be abundant, and records its breeding. Strecker (1915) reports it from El Paso, Texas. For South Dakota it is reported to be common by Over (1923); Burt and Burt (1929) report it from Nebraska and from Colorado; Burt (1927) records it from eastern Kansas. From Missouri, Hurter (1911) records it for the entire width of the state, and Agassiz (1857) mentions its occurrence at Osage River and St. Louis. Crossing the Mississippi, we are a bit in doubt as to whether all the records of *bellii* deal with this form or with the hybrids, since the eastern limits of the range north of Illinois have not been definitely worked out. Be that as it may, it is reported from Wisconsin by Pope and Dickinson (1928) as "state-wide" in distribution, and by Pearse (1923), who remarks that *Chrysemys bellii* and *C. cinerea* appear to intergrade in the Madison region, "but a majority of the individuals resemble the former." Bishop and Schmidt (1931) record it only from northwestern Wisconsin. In Michigan it is reported only from the western portion of the northern peninsula by Ruthven (1912). In Canada it is recorded for the Lake Nipigon region by Logier (1928). In discussing the distribution of this turtle, Bishop and Schmidt say: "This extension of what is in the main a plains species through the heavily forested area of Wisconsin, Michigan and Ontario seems explainable in part by the highway for dispersal supplied by the valley of the St. Croix and by Lake Superior itself."

Illinois Records.—Here again we have difficulty in sorting out what we may consider records of typical *bellii*. Hurter (1911) records it from Randolph, Monroe, St. Clair, Madison, and Adams counties, all on the Mississippi River, which records are entirely correct. Davis and Rice (1883) do not mention it, but record *picta* as throughout the state, which is certainly entirely incorrect. Garman (1889) reports it from the Quincy region as "rather common in the sloughs, but not seen elsewhere," which is correct. Again in 1892 he reports it from Quincy as very common, in the bottom-lands, but not taken elsewhere in the state. In his inter-

mediate report (1890) he says it is ". . . . closely related to *C. marginata,* but I have not seen in many hundred painted turtles examined during eight years' collecting, an intermediate example." The writer has examined typical specimens from the following Illinois localities: Meredosia, Mattoon, Quincy, Peoria, Havana, Clinton, Hardin, Carlinville, the region directly across the Mississippi River from Burlington, Iowa, Beardstown, Rock Island, Murphysboro, Grafton, Lewiston, Geneseo, and Senachwine Lake in Putnam County.



MAP 14.—*Chrysemys picta bellii.*

HABITAT.—*Chrysemys picta bellii* shows a decided preference for the sloughs and shallow backwaters of rivers. It is associated with shallow water, usually of a warm temperature, as well as with soft bottom and an abundance of vegetation. In Illinois, at least, it seems to prefer ponds to rivers, and generally avoids current.

HABITS.—Its habits are so similar in detail to those reported for the preceding species that it would be largely repetition to reprint them here, and the reader is referred to this section under *Chrysemys picta marginata.*

NESTING HABITS.—The nesting of *bellii* has been well described by Stromsten (1910). Field notes made while watching the nesting of this turtle at Meredosia in 1931 check almost exactly with this published description, and since they are so similar to those reported for *marginata,* it seems unnecessary to repeat them. Like *marginata, bellii* digs with the hind legs while the front feet are fixed in position; it applies copious water from the cloaca to the material to be dug from the hole, and finally, during the laying of the eggs, it uses the hind foot to arrange the eggs in position within the nest.

EGGS.—The number of eggs laid varies from four to ten, with six or seven being the normal number. When laid the eggs are flesh color and

translucent, and the shell dries white and opaque. A typical set of eggs measures as follows (in millimeters): 36 x 18, 35 x 18, 36 x 18, 36 x 18, 34 x 18, 34 x 17, 34 x 18, 34 x 18; the average size of 41 eggs composing seven complements is 34.7 x 17.8. They tend apparently to be a trifle larger than those laid by *marginata*. The young usually hatch in August or early September, but newly hatched individuals in June indicate again the possibility of embryonic hibernation.

Growth.—The only recent paper dealing with the growth of any of our common turtles is that of Pearse (1923), who worked on Chrysemys at Madison, Wisconsin. Pearse recognized the "intergrade" condition of the Chrysemys of that region and says that the Madison turtles resemble *bellii* more than *marginata*. Therefore, while he was probably studying largely hybrid turtles, his results are interesting and probably approximate very closely the condition in either pure *bellii* or *marginata*. He captured his turtles, measured and tagged them, and turned them back to be recaptured at a later date. Table 13 is taken directly from his paper. His conclusions, based on this table are that "a turtle nearly doubles its length and weight during the second year of its life. After twelve years it would be about 135 mm long, and the growth rate would have decreased to about one-thirtieth of that during the first two years. An ordinary adult turtle measuring 150 mm in length is, using the data here presented as a basis for computation, about twenty-five years of age." Unfortunately, Pearse does not state clearly what his criterion for age determination of turtles is; nor does Agassiz (1857) make it much clearer when he deals with *picta* and records its age-length relationship as follows: 1st year 26.5 mm; 2nd year 42 mm; 3rd year 51 mm; 4th year 54 mm; 5th year 59 mm; 6th year 66 mm; 7th year 72 mm; 8th year 74 mm; 9th year 77 mm; 10th year 80 mm; 13th year 92 mm;

Table 13.—Growth of Turtles of Different Lengths

Length: mm.	No. of records	Av. rate of growth: mm. per year	Estimated av. weight: grams	Estimated av. wt. increase: gms. per year	Percentage increase
40-50	2	32.7	19	13.8	73.0
50-60	10	17.0	36	11.1	31.0
60-70	12	16.7	50	12.7	25.0
70-80	8	19.0	68	15.9	25.0
80-90	3	4.2	106	5.2	5.0
90-100	11	6.0	134	8.5	6.0
100-110	13	3.5	170	5.7	3.3
110-120	8	3.1	233	6.3	2.7
120-130	6	4.2	243	8.2	3.4
130-140	8	1.5	310	3.4	2.4
140-150	6	1.6	362	3.9	2.7

24th year 121 mm. Agassiz further reports for *Chrysemys picta* that "up to their seventh year the ovary contains only eggs of very small size, not distinguishable into sets; but that with every succeeding year there appears in that organ a larger and larger set of eggs, each set made up of the usual average number of eggs which this species lays, so that specimens eleven years old, for the first time, contain mature eggs, ready to be laid in the spring." He further reports that fecundation occurs in the fall prior to hibernation, and that the act is repeated in the spring, starting with the seventh year of the turtle's life. Just what the significance of this is has never been determined, but Agassiz believes that "fecundation does not appear to be an instantaneous act, resulting from one successful connection of the sexes, as it is with most animals. The facts related above show, on the contrary, that, in turtles, a repetition of the act, twice every year, for four successive years, is necessary to determine the final development of a new individual . . . ." There are some very interesting and somewhat difficult research problems involved in these ideas of Professor Agassiz! To these facts the writer would add that females from Paradise Lake at Mattoon measuring 106 mm in length contained tiny embryonic eggs while females 160 mm long contained at the same time eggs about to be laid.

TABLE 14.—MEASUREMENTS OF ILLINOIS SPECIMENS OF *Chrysemys picta bellii*
(Measurements in millimeters; weight in grams)

Specimen No.	Carapace		Plastron			Head	Tail		Weight	Sex
	Length	Width	Length	Width	Depth		Total	A-T		
1	179	133	166	115	63	26	55	45	720	♀
2	160	115	148	102	59	24	48	40	540	♀
3	158	121	146	98	51	23	49	39	510	♀
4	145	115	142	94	52	21	50	40	429	♀
5	114	103	130	87	44	22	60	41	359	♂
6	113	72	107	94	36	18	..	..	187	♂

Chrysemys picta dorsalis (Agassiz)

(Southern painted turtle; red-legged turtle; mud turtle; pond turtle)

Chrysemys dorsalis Agassiz 1857
Chrysemys picta (part) Gray 1863
Clemmys picta (var. d) Strauch 1865
Chrysemys cinerea dorsalis Boulenger 1889
Clemmys cinerea (part) Strauch 1890
Chrysemys marginata dorsalis Stejneger and Barbour 1923
Chrysemys picta dorsalis Bishop and Schmidt 1931

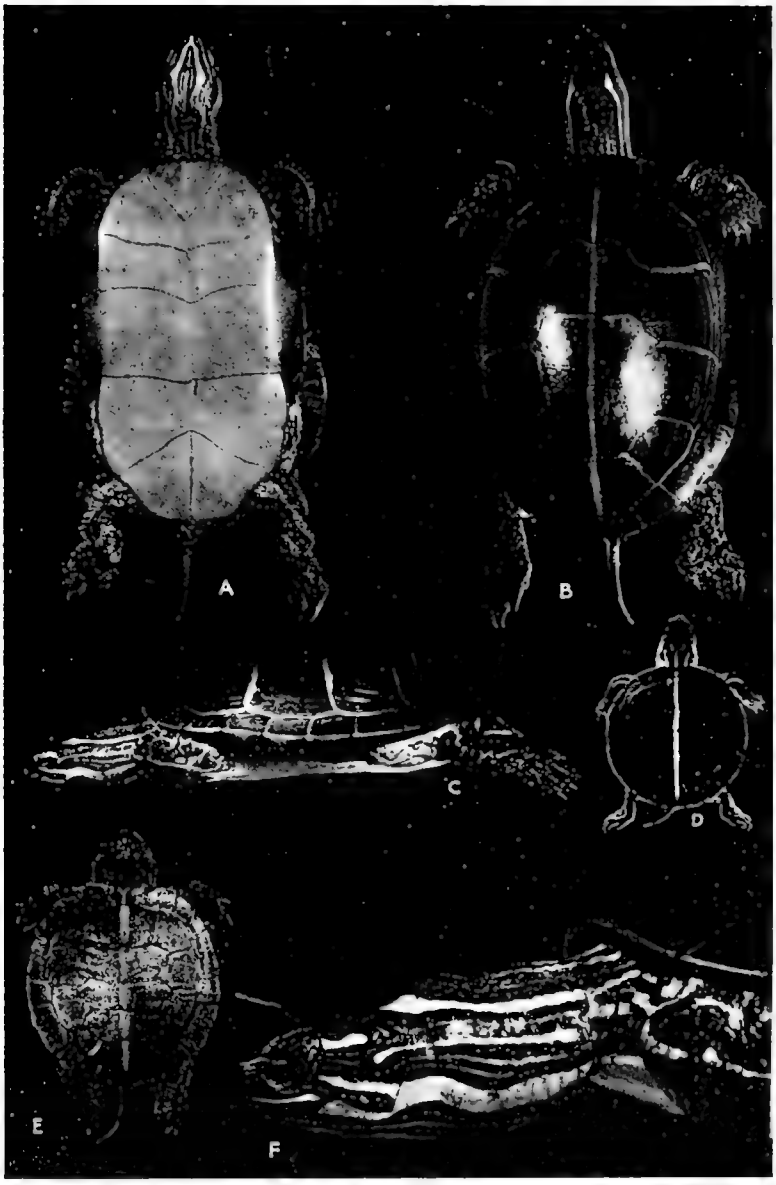


PLATE 19.—*Chrysemys picta dorsalis: A,* Adult, ventral view. *B,* Adult, dorsal view. *C,* Adult, lateral view. *D,* Newly hatched young, dorsal view. *E,* Newly hatched young, photographed to bring out the granular surface of the scutes. *F,* Head study of an adult.

DESCRIPTION.—Shell elliptical in outline, occasionally tending toward broadly oval; depressed and without a trace of a dorsal keel. The outline of the shell tends to be wider than in either *marginata* or *bellii,* and to be slightly less depressed. Marginals flaring posterior laterally, the curvature of the rest of the shell being gradual and uniform. The vertebral series of scutes is very wide, much wider than in either *marginata* or *bellii,* the width of these scales considerably exceeding the width of the costal scutes. First vertebral trapezoidal, about the length of the second, but distinctly narrower; its anterior margin greatly exceeds its posterior margin. Second, third, and fourth vertebrals broader than long, and broader than the costals, with the anterior lateral borders approximately equal to the posterior lateral borders. The middle three costals nearly equal in size, the fifth being much smaller and the shortest of the series. Nuchal long and narrow, usually with a very small median notch. Anterior border of the first marginal often but not necessarily finely denticulate. Posterior margin of the carapace either weakly serrated or unserrated, and with a very small median (caudal) notch. Plastron very large and wide, fully equalling the opening of the shell, exceeding in this respect the plastron of both *marginata* and *bellii;* both anterior and posterior lobes truncate. Length of the posterior plastral lobe approximately one-half the width of the plastron, about equalling the total width of an abdominal scute at the point of the bridge. Gulars with a finely denticulate anterior margin, and with the anterior lateral angles slightly prolonged into a small knob. Pectoral scutes narrow. The interanal suture is usually the longest, but in some cases is equalled, and in a few exceeded, by the interabdominal suture. The interhumeral and interfemoral sutures are the shortest and are usually approximately equal, though either may be a bit shorter than the other. In only one specimen on hand the interhumeral is shorter than the interfemoral suture. Inguinal large, axillary small. Head moderate in size. Snout short and bluntly pointed; nostrils anterior, terminal, and close together. Upper jaw with a small median notch and with a very small cusp on each side of it; the cutting edge is practically smooth, but sometimes with very faint denticulations. Alveolar surface narrow, with poorly developed median ridge. The limbs are strong; digits fully webbed to the base of the claws; claws 5-4, short in females, long in males. Tail slender, its proportions varying with the sex of the individual.

COLORATION.—Carapace much less highly decorated than in either of the preceding species. Carapace dark brownish olive to nearly black. The mid-dorsal line is usually wide and very conspicuous; it starts at the tip of the nuchal and extends through or onto the caudals, sometimes bifurcating on the latter. It varies from yellow to blood red; often it is

vermillion. Anterior and anterior-lateral margins of the second, third, and sometimes the fourth vertebral scutes bordered with straw-color or yellow. Anterior margins of the second, third, and fourth costal scutes bordered with the same color. Individuals show a great variation in the width and conspicuousness of these color bands, but they are much more pronounced than in *marginata* or *bellii*. The marginals show little red dorsally, the area being confined usually to a single short, transverse line or a spot at the margin; the remaining marks consist of lines, comas, U- and S-shaped marks of straw yellow. Plastron uniformly yellow (Hurter (1911): "deep red in spring;" a condition the writer has never seen in spring specimens). Ventral surface of the marginals with bright red median area, bordered toward the sutures with black or dark olive, which dark areas contain irregular yellow mottlings. Axillary and inguinal scutes marked with red and yellow on the same dark ground color. Usually a dusky longitudinal area across the suture between the marginals and the lateral edge of the wing of the pectoral and abdominal scutes on the bridge. Soft parts dark olive, almost black, striped with yellow and red, those markings on the head and neck showing much variation but usually as follows: a yellow band from under the nostrils to the angle of the upper jaw; a yellow line from the dorsal margin of the nostril, running through the orbit and stopping shortly beyond it; two yellow bands, often quite broad, start above and below the angle of the jaw, shortly unite and extend as a broad band down the neck, grading into vermillion about half-way down the neck; a yellow line starts on the tympanum and extends down the neck; a broad yellow band starts at the posterior lateral dorsal portion of the occiput and extends down the dorsal lateral side of the neck, grading into vermillion and branching near the body to send a posterior branch toward the front leg. On the ventral surface, a yellow line starts at the symphysis of the lower jaw and quickly bifurcates, enclosing an olive area with yellow lines within it; these yellow lines grade into vermillion and fuse again into a single red line near the base of the neck. Between these more conspicuous lines are many faint and irregular lines of straw yellow. The top of the head is mottled and lined with the same color. Fore limbs with two conspicuous yellow-bordered red bands and irregular yellow lines. Hind limbs lined and dotted with yellow-margined red areas. Flesh of the axillary and inguinal regions of a similar color. Tail with two dorsal lateral yellow lines.

YOUNG.—Nearly circular in shape. The carapace of newly hatched individuals tends to be a trifle less depressed than in the other turtles of the genus, and as the vertebrals have quite a slope, the median line is quite sharp, giving a hint of a very slight keel. The surface of the carapace is finely granular in these newly hatched individuals, but this

granulation disappears at an early date. The mid-vertebral stripe is wide, brilliant, and very conspicuous, but the yellow edges of the vertebral and costal scutes are entirely absent (28-mm specimen). The dorsal surface of the marginals shows a conspicuous lateral marginal spot of red, and the remaining dorsal surface of these scutes is finely reticulate. The ventral marginals show a red area near the anterior suture, with a black area toward the posterior margin, this dark area with a median yellow line. The major color lines described above are usually clearly indicated.

Sex Differentiation.—Males with claws on the second, third, and fourth digits of the fore limb; long, slender, and curved. Tail of the male is just short of being half the length of the plastron, and less than a third that of the plastral length in the female. In the male the anus opens well beyond the posterior margin of the carapace.

Geographic Distribution.—*Chrysemys picta dorsalis* is distinctly of southern and southwestern distribution, the exact limits of whose range cannot at the present time be stated with accuracy. Hurter (1911) gives its range as "from the Gulf of Mexico up the Mississippi River to the southeastern part of Missouri." Siebenrock (1909) reports it from Mississippi and Louisiana, while Yarrow (1882) records it only from Mississippi. Hurter and Strecker (1909) record it from northeastern Arkansas. Hurter (1911) reports it from the extreme southeastern corner of Missouri, to which Blanchard (1924) adds another record for the same region. In Louisiana, Beyer (1899) reports it as of general distribution in the state west of the Mississippi, but not common. It is not recognized at all by Davis and Rice (1883). The writer has taken it commonly at Reelfoot Lake, Tennessee. Apparently, then, the range is limited to the lower Mississippi Valley, and for the most part to the region west of the river.

Map 15.—*Chrysemys picta dorsalis.*

Illinois Records.—There is no published record of the occurrence of this turtle in Illinois. The writer first became acquainted with the species in the Reelfoot Lake country, where it is very common. Subsequent search in southern Illinois brought some thirty specimens from Cairo, Metropolis, Chester, and Horseshoe Lake in Alexander County. In all of these localities typical *dorsalis* was found, as well as a number of the hybrid forms previously discussed. It is not, however, common in the state. We must say, then, that *dorsalis* is confined to the extreme southern tip of Illinois, with a slight extension of its range up the Mississippi River to Chester.

Habitat.—*Chrysemys picta dorsalis* is distinctly more of a pond turtle than an inhabitant of rivers or streams, and shows more decided preferences in this direction than either of the preceding two members of the genus. In the southern tip of the state it is found in shallow weed-choked or rush-grown ponds, often temporary in nature, and often in water but a foot or less in depth. In consequence of the shallow nature of these ponds, the water therein has a higher temperature than is found in the deeper neighboring bodies of water at the same time of the year. It is often found in the over-flow ponds and backwaters of the Mississippi and Ohio rivers, as well as in the more permanent lakes.

Habits.—So far as the writer has observed, *dorsalis* is very similar in its habits to *marginata* and *bellii,* except that it is perhaps a trifle more aquatic. It is most frequently seen with its head out of water, but cannot possibly be identified when thus placed unless one knows it to be the only Chrysemys in the region. During the warm days of spring and all through the hot summer, these turtles enjoy basking on exposed logs, lying relaxed as is common to the members of this genus. They are very timid, and scurry into the water when the least suspicious of danger. I have watched them thus sunning themselves in Horseshoe Lake and note that once disturbed, they are very slow about reappearing in their basking places. They are strong swimmers when necessity demands, but when undisturbed they may be seen walking slowly over the bottom in search of their food. They can remain under water for a long time, as observed in the laboratory, but in nature the duration of their submergence is very difficult to determine because of the numbers of the turtles generally present and the density of the aquatic vegetation which may effectively conceal their inconspicuous heads when poked to the surface. Except during the breeding season when they search for a nesting site, and in the event of the evaporation of their secluded pond when they are forced to migrate, the turtles rarely leave the water, though they are capable of easy and rapid locomotion on land. That they leave their aquatic environment reluctantly is illustrated by the fact that when Horseshoe Lake dried up in 1930, hundreds of shells of these turtles were found

scattered over the lake bed, though the turtles would not have needed to migrate far to have found water. Might one guess that because the drying up of Horseshoe Lake was a new experience to the turtles living in it their migratory "mechanism" failed to function as it does in turtles living in ponds that regularly go dry? I noticed the same condition during the 1930 "low level" record of Reelfoot Lake in Tennessee: a pond, not connected by water to the lake, which under normal conditions would have measured some hundred yards in each direction, had dried up completely, and in the bed of this "dead" pond I found 116 dead *dorsalis,* with no other species of turtle represented. Yet in similar ponds half a mile away which had not dried up, I found *dorsalis* associated with many *Pseudemys elegans, P. concinna,* and *P. troostii.* There is no evidence either way on the subject of hibernation of this turtle in Illinois, but the writer doubts, because of the relative mildness of the climate in the region inhabited by the turtle, that the species goes into any prolonged period of winter inactivity, if, indeed, it hibernates at all.

Nesting Habits.—I have not been fortunate enough to have seen *dorsalis* digging its nest, and no description of the process exists in literature. Yet at Horseshoe Lake I came close to it in June, 1930, when I caught a female just as she had finished her nest and was departing for the water. The nest was typical of that constructed by the other Chrysemys species, and contained six eggs. The nest was dug out, and it was noted that the soil was wetter than in the surrounding undisturbed area, indicating again the discharge of water from the cloaca during the process of nesting.

Eggs.—The six eggs referred to above constitute the only set of eggs of the species the writer has been able to obtain. The eggs are

Table 15.—Measurements of Illinois Specimens of *Chrsyemys picta dorsalis*
(Measurements in millimeters; weight in grams)

Specimen No.	Carapace		Plastron			Head	Tail		Weight	Sex
	Length	Width	Length	Width	Depth		Total	A-T		
1	132	105	125	89	46	19	41	36	307	♀
2	132	104	125	88	46	20	40	32	300	♀
3	127	100	119	87	47	20	41	32	274	♀
4	128	98	123	83	42	20	42	34	249	♀
5	126	100	119	81	45	19	42	35	265	♀
6	125	102	120	89	51	20	40	30	304	♀
7	122	100	116	91	41	18	35	26	252	♀
8	114	91	107	76	42	18	43	31	200	♀
9	104	88	98	75	40	17	39	30	172	♀
10	100	83	92	71	35	17	35	26	131	♀
11	99	75	80	60	29	14	40	25	91	♂
12	87	70	80	60	33	15	30	22	103	♀
13	81	66	72	55	28	13	42	29	74	♂
14	81	66	71	55	26	14	37	22	60	♂
15	83	68	78	55	30	14	36	21	79	♂
16	27	28	25	21	11	8	16	13	5	Im.

indistinguishable in size and texture from those of the other species of the genus, and it is very doubtful whether it would be possible to tell the eggs of *marginata, bellii,* and *dorsalis* apart by any means other than hatching. These eggs measure as follows (in millimeters): 31 x 19, 31 x 19, 30 x 20, 32 x 19, 33 x 18, 31 x 18, with an average of 31.3 x 18.8. No information as to the incubation period is available, but young turtles, evidently but recently hatched, have been sent to the writer from Cairo and Metropolis in both June and September.

Food Habits.—The food habits of *dorsalis* are very similar to those of the preceding species of the genus, being distinctly omnivorous, with about an equal mixture of animal and vegetable matter usually found in the stomach. Of animal life, the following has been found: tadpoles, small crayfish, phyllopod crustaceans, gastropods, and an assortment of the larger aquatic insects and larvae, diving beetles (Dytiscus), Corydalis larvae, mayfly and dragonfly nymphs, Notonecta and caddis worms. Of vegetable matter, the chewed-up remains of grass, rootlets, and a variety of unidentifiable aquatic plants are almost always present. The scavenger habit is well developed and is indulged in when opportunity permits.

Genus Pseudemys Gray

Pseudemys Gray 1855
Ptychemys Agassiz 1857
Trachemys Agassiz 1857
Nectemys Agassiz 1857
Callichelys Gray 1863
Redamia Gray 1870
Chrysemys (part) Boulenger 1889

Shell somewhat depressed, but not as much so as in the genus Chrysemys; posterior margin of the carapace serrated. Plastron truncate anteriorly, emarginate posteriorly. Abdominal and pectoral elements with well developed wings; axillary and inguinal elements approximately equal in size and relatively large. Alveolar surface of the jaws wide, and with a median ridge extending parallel to the margins. Digits fully webbed; 5-4 in number. Anterior digits long, with curved claws; fifth digit on the hind foot without a claw and in the form of a projection on the posterior margin of the foot. Fore limbs with rows of scales. Young with a distinct keel which may or may not persist in the adult stage.

Pseudemys concinna (LeConte)

Testudo concinna LeConte 1830
Terrapene concinna Bonaparte 1830
Emys annulifera Gray 1831
Emys concinna Duméril & Bibron 1835
Emys labyrinthica LeSueur (Duméril 1851)
Pseudemys concinna Gray 1855
Ptychemys concinna Agassiz 1857
Malacoclemmys geographica (part) Agassiz 1857
Clemmys concinna Strauch 1865
Emys orthonyx Wied 1865
Trachemys annulifera Gray 1873
Chrysemys concinna Boulenger 1889
Chrysemys labyrinthica Hay 1892
Pseudemys labyrinthica Baur 1893
Pseudemys vioscana Brimley 1928

DESCRIPTION.—Shell moderately depressed; carapace oval in outline, the point of maximum width varying with age, but in adults this region is usually in the immediate vicinity of the eighth marginal scute. Sides

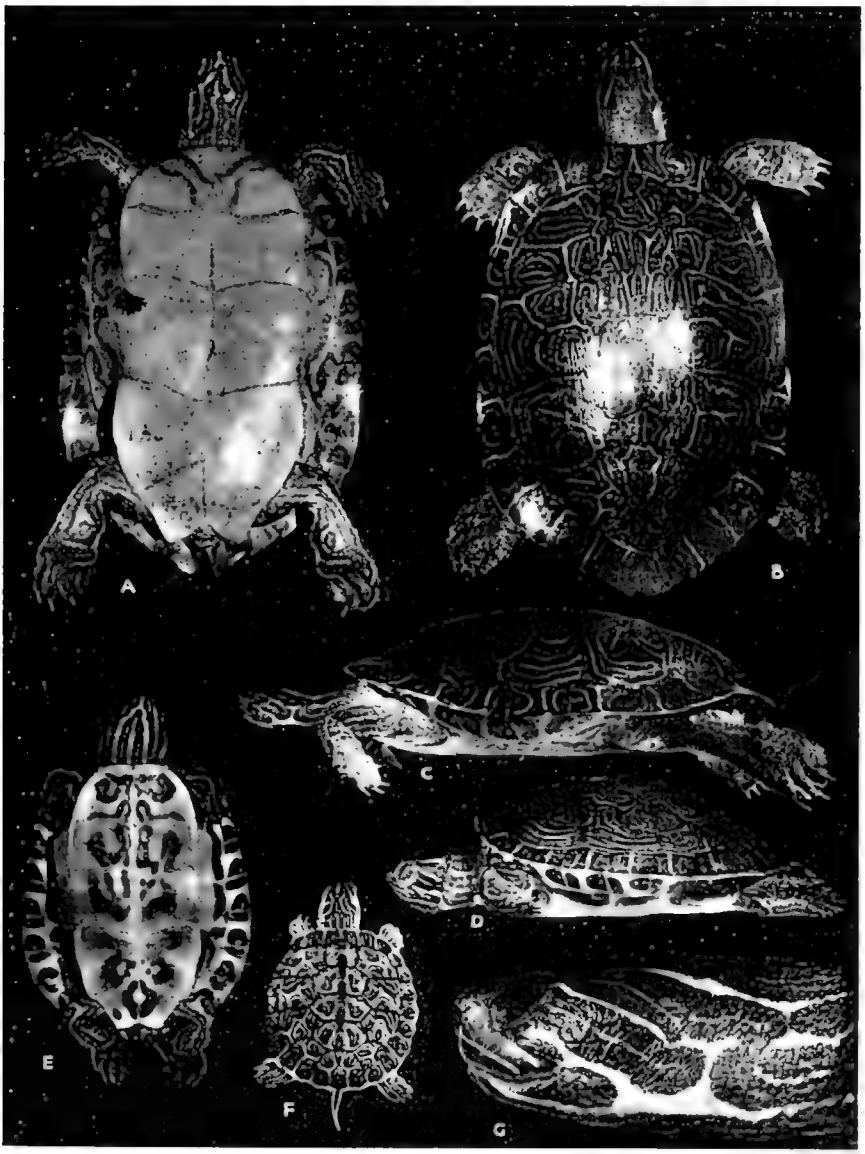


PLATE 20.—*Pseudemys concinna: A,* Adult, ventral view. *B,* Adult, dorsal view. *C,* Adult, lateral view. *D,* Immature individual, lateral view; length, six inches. *E,* Same immature individual, ventral view. *F,* Newly hatched young, dorsal view. *G,* Head study of an adult.

with uniform slope, but with a distinct posterior flare involving the marginals from the seventh backward; anterior flare less marked. First vertebral scute urn-shaped, its lateral borders sinuous; second, third, and fourth vertebrals approximately as wide as long, and narrower than the costals; fifth vertebral wider than long, approaching trapezoidal. Costal scutes with more or less conspicuous lateral, longitudinal rugae. Anterior three costals very large, all three wider than long; fourth costal much smaller and with its length and width about equal. The first costal is triangular; the remaining elements of the series quadrangular. Nuchal elongate, nearly twice as long as wide, its anterior margin straight. Anterior margin of the carapace with a shallow, rounded emargination involving the first pair of marginals and the nuchal. Posterior marginals with their posterior angles produced to form a serrated edge, beginning usually at the ninth scute and ending with an acute median posterior notch between the caudals. Plastron large. Gular with a bluntly rounded anterior-lateral angle. Pectoral scutes much wider than long. Abdominals very large. Posterior margin of the plastron with a deep median notch. The interabdominal suture is the longest; the interhumeral the shortest. Axillary and inguinal elements large, the latter protruding forward so as to cut off the greater part of the wing of the abdominal from contact with the marginals. Bridge wide, the angle of slope toward the carapace varying with the size (age) of the individual, being most abrupt in young specimens. Head moderate in size, the snout short and blunt. Upper jaw without a median notch or hook, the cutting edge entirely smooth, not serrate; alveolar ridge strongly tuberculate and wide throughout. Lower jaw very flat and with a median tooth; cutting edge serrated. Limbs strong, the digits fully webbed; claws 5-4. Tail short and stocky.

Coloration.—Carapace with the ground color varying from brownish to olive green, with a superimposed complicated design of yellowish lines. In a general way these lines tend to run longitudinally upon the vertebral scutes and transversely upon the costals. On the costals these lines tend to form into concentric areas of indefinite shape, bordering on circles. In some specimens the costals bear a transverse yellow bar as conspicuous as that found in *Pseudemys elegans*. Marginals with a transverse yellow bar near the middle. On each side of this is a thinner yellow crescent, opening toward the adjacent suture, within which crescent is a poorly defined yellow spot; the crescents of adjoining scutes thus tend to form a circle containing two yellow spots. The plastron is uniformly yellow or straw color, or with a few dusky spots or symmetrical dusky areas on the gulars and humerals. The amount and placement of these darker areas exhibit great variation. Bridge, axillaries, and inguinals with dusky longitudinal areas. Ventral surface of the marginals yellow, with large crescent-shaped dusky areas containing one

or more yellow spots. Head and neck dark olive, striped with yellow or yellow-green. A straight line extends from the snout to a point just posterior to the orbit. Another line starts at the orbit, extends backward and widens on the neck. A third stripe starts at the posterior angle of the orbit and extends backward and downward, joining by a vertical branch, which passes the anterior margin of the ear, a fourth stripe which starts at the mid-ventral margin of the orbit. This fourth stripe is very wide and conspicuous. At the posterior angle of the mouth this stripe is joined by a conspicuous band from the mid-lateral margin of the lower jaw, thus forming a large "Y" around the posterior angle of the mouth. From the symphysis of the lower jaw a stripe starts backward, to bifurcate and extend as two irregular stripes down the neck. Often another stripe is to be found between these bifurcations. The upper jaw is lined with yellow. Tail, limbs, and feet with conspicuous yellow lines. The skin in the inguinal region is white, immaculate.

Young.—The young possess a distinct median keel, which disappears in individuals about half-grown, leaving no trace in the fully adult specimens. This keel is most marked on the posterior part of the second, on the third, and on the anterior part of the fourth vertebral scutes. The plastron shows considerable dusky color, arranged in symmetrical design which is usually more pronounced on the anterior elements, and faint traces of portions of this pattern may remain even in very large, mature individuals. There are usually two black spots on the bridge. The snout is very short and blunt; the eyes are prominent. Young specimens tend to have their maximum width near the middle of the carapace, this shifting posteriorly with age.

Sex Differentiation.—Males with claws of second, third, and fourth digits of the fore feet exceedingly long, at least three times the length of the other claws. The tail is longer in the male than in the female, and the anus lies beyond the rim of the carapace in male individuals.

Geographic Distribution.—*Pseudemys concinna* is a southern turtle which, for some reason or other, is hardly mentioned in lists or in literature dealing with regional herpetology. Siebenrock (1909) records it as from the southern states, from Missouri and North Carolina to the Gulf of Mexico, excluding Florida; Boulenger (1889) gives a similar range, but does not exclude Florida. Loennberg (1894) reports it as the commonest "cooter" in Florida! Stejneger and Barbour (1923) locate the range as "the eastern rivers from Georgia to southern Maryland." For Louisiana, Beyer (1899) reports it as common in the southern portions but rarer inland except near large bodies of water; Strecker and Hurter (1909) say that specimens from Arkansas previously reported as *P. concinna* are in fact *P. texana,* a western close relative. Strecker (1915)

corrects Yarrow (1882) in the report of *P. concinna* from Texas, saying these are probably *P. mobilensis* Holbrook, and he further points out the hopeless confusion in Texas records of *texana* and *mobilensis*. Hay (1892) includes it in his Indiana list on the basis of the report of Garman (1892) from the Wabash River, though he has no further records to add. Rhoades (1895) records it from Tennessee, and the writer has taken exceedingly fine, large specimens in abundance from Reelfoot Lake in that state. It is not recorded from Alabama by Haltom (1931). The writer has a suspicion that the two new species of the genus Pseudemys described by Brimley (1929) under the names of *P. vioscana* (Louisiana) and *P. elonae* (North Carolina) are synonymous to *P. concinna,* or at best, subspecies of it.

Map 16.—*Pseudemys concinna.*

Illinois Records.—The only published Illinois record for *Pseudemys concinna* seems to be that of Garman (1890; 1892) of a specimen sent him by Dr. Shenck from Mt. Carmel, on the Wabash River, for it is not mentioned by Davis and Rice (1883). The writer has specimens from the following localities: Mt. Carmel, Chester, Metropolis, Cairo, Elizabethtown, Murphysboro, Union County, and Horseshoe Lake in Alexander County.

Habitat.—In the southern portions of its range, in which it is an abundant species, *Pseudemys concinna* apparently frequents brackish water, according to True (1884). In the northern limits of its range, however, the turtle is found only in the larger rivers and lakes, avoiding the smaller streams and temporary ponds. It is abundant among the cypresses of Reelfoot Lake, Tennessee, where the relatively warm, shallow water and the abundance of aquatic vegetation seem to afford it a most congenial environment, for specimens reaching a length of 375 mm and a weight of over 4000 grams are not at all rare there. The shallow water of Horseshoe Lake in southern Illinois affords it a congenial

habitat, but here the specimens do not attain nearly so great a size. In this lake the species was exterminated when the lake went dry in the late summer of 1930; it will be interesting to note whether the species rehabilitates itself there. It has not done so to date (1933). When associated with the larger rivers, the turtles are most frequently met with in the backwaters and in the sluggish bays, seldom out in the main channel. Quiet, shallow, warm water, and an abundance of vegetation on a soft bottom seem to be their environmental requirements.

Habits.—In 1892 Hay wrote that "not much appears to be known about the habits of this terrapin," and the same can truthfully be written after a lapse of forty years. It has been sadly neglected and should be thoroughly investigated in the south where it reaches its optimum; it is too rare in Illinois to do much with except over a long period of time. The observations herein recorded were made at Reelfoot Lake, and from notes and material submitted to the writer from this lake and from Horseshoe Lake in Alexander County, Illinois, by field workers.

Pseudemys concinna is decidedly aquatic in its habits. It seldom leaves the water except to lay its eggs, spending most of its time in water from two to five feet deep. It spends a large part of the time submerged, either resting on the bottom or walking slowly about in quest of food, coming to the surface periodically for air. When at the surface, only the head protrudes, the shell remaining at an angle of about 45°, completely hidden. In this position the turtles remain for a long period, apparently motionless, but this surface drifting is only done when the water is smooth; if there are any waves at all they get their air immediately and submerge again. They are fond of basking, and crawl out on submerged logs or up on cypress knees, and remain for hours enjoying the warmth of the sun. I have seen logs lined with an assortment of *P. concinna, P. elegans, P. troostii,* and *Chrysemys picta dorsalis,* so thickly that sometimes they are piled up two deep. *Pseudemys concinna,* however, is very timid and wary; constantly on the lookout for danger, the least suspicious movement sends them off into the water, and once frightened, they are very careful for hours afterward. I have spent hours trying to capture specimens with a long handled dip net from a silently paddled boat, almost always without success. While they utilize every possible basking space available out in the water, I have never seen one basking on shore.

On land they are rather slow and awkward, due to the bulk and weight of the shell, and among the tangle of cypress knees they have great difficulty in traveling on shore. When the fishermen take in their fish nets they frequently have many of these turtles in their catch. If they throw them ashore into the woods, as they frequently do, a great many of them never succeed in regaining the water, as witnessed by the

numerous skeletons I have found about the lake. The large turtles get penned up by the cypress knees and cannot climb over them or apparently find their way out of the maze. They show little intelligence in solving the problem and the result is often fatal. If taken from the water and placed on land, the turtles show no offense whatever, neither attempting to escape nor to bite. The head and neck are drawn in as far as possible, and the legs pulled up under the shell, and thus they are likely to remain for hours. Once they get under way their progress is quite slow, while in the water their movements are powerful and rapid. They are excellent swimmers.

Nesting Habits.—The building of the nest has never been described so far as the writer knows, and he has no data to offer other than that they nest in sandy localities not far removed from the water. The season of nesting is reported as early June for the Reelfoot Lake country, and this would seem, from the condition of the eggs taken from females by dissection, to be about correct. While the writer has several sets of eggs dug from nests, no nest so far discovered has been more than about 100 feet from water.

Eggs.—A large female of *Pseudemys concinna,* sent to the writer from Reelfoot Lake in late May, 1931, had nine eggs in the oviduct, with the shell already deposited. The eggs were all ready to be laid, and are typical of the eggs of the species. They were elliptical and are covered with a hard, white shell of fairly coarse, granular structure. They measure as follows (in millimeters): 40 x 28, 42 x 26, 38 x 26, 37 x 22, 36 x 26, 35 x 25, 35 x 26, 40 x 25, 36 x 26; average: 37.6 x 26.1. There are no data on the period of incubation. The smallest specimen which the writer has is an individual with a carapace length of 39 mm, which was caught and sent in from Reelfoot Lake in late September, 1931, and was undoubtedly a very recently hatched individual.

Food Habits.—This species is largely carnivorous in its diet, feeding upon almost any animal matter that is available. From the stomachs of specimens examined in the field the following items have been noted: crayfish, tadpoles, small fish, gastropods, dragonfly nymphs, Corydalis larvae, water beetles, and an assortment of forms obviously picked from the surface, including grasshoppers, crickets, caterpillars, and various dipterous and hymenopterous insects. The scavenger habit is well developed and I have observed the turtles feeding upon dead fish floating at the surface. They do not, however, practice this scavenger habit along the shore. Some vegetable matter is usually present in the digestive system, this representing aquatic sedges, algae, and numerous shallow-water plant species. In Florida, Loennberg (1894) reports that they feed largely upon vegetable matter.

ECONOMIC IMPORTANCE.—*Pseudemys concinna* is far too rare in Illinois to be of any economic importance. To the southward, however, where it is abundant and where it reaches a large size, it is undoubtedly an item of human consumption, though it is not mentioned by Clark and Southall in this connection. Loennberg says that the meat is white and very palatable.

TABLE 16.—MEASUREMENTS OF ILLINOIS SPECIMENS OF *Pseudemys concinna*
(Measurements in millimeters; weight in grams)

Specimen No.	Carapace		Plastron			Tail		Head	Weight	Sex
	Length	Width	Length	Width	Depth	Total	A-T			
1	330	216	293	171	107	61	45	38	3794	♀
2	326	232	300	181	113	55	45	41	3772	♀
3	219	156	194	119	66	87	40	26	966	♂
4	213	153	192	116	67	80	40	25	936	♂
5	75	63	72	47	31	12	10	13	64	Im.

The Pseudemys elegans-troostii Problem

When the writer first began collecting material for this monograph he was rather puzzled at first by the difficulties encountered in obtaining females, eggs, and young of *Pseudemys troostii,* a rather common species in the state. A search of the literature yielded nothing on the life history of the species, and, more confusing still, a search of the larger or more opportunely placed museums failed to unearth any of these specimens. An abundance of material was available from Illinois, and many dozens of specimens passed through the laboratory for study and examination. However, every good example of *troostii* proved to be a male. It was not long, furthermore, before a gradation between males of *troostii* and *elegans* was noted, and an entire and complete series of intergradations between typical *elegans* on the one hand and typical *troostii* on the other was obtained. This series showed the increasing darkening of the carapace toward the *troostii* end, the gradual obliteration of the transverse yellow bar on each costal scute, the increasing amount of dark mottling on the plastron, and the gradual obliteration of the bright red postorbital band on the head through various deepening shades of brown and olive. While this series was being built up, correspondence with Mr. Percy Viosca at New Orleans brought out the fact that he had long believed that *troostii* was merely a melanistic male *elegans.* An opportunity to examine a fine lot of both *elegans* and *troostii* confirmed him in this view, and he published the results of his findings (1933). Knowing, then, of Mr. Viosca's findings, the writer skeletonized his series of *elegans-troostii* intergrades, and made a careful study of the skulls,

leg bones, and vertebrae. The results of this study only confirm the idea that *elegans* and *troostii* are inseparable; he can find no osteological character that will differentiate between them. Therefore, since there are, apparently, no *troostii* females, no *troostii* eggs or young, since a complete intergradation between *elegans* and *troostii* males has been demonstrated, and since there seems to be no anatomical or osteological character upon which they can be separated, he concurs with Mr. Viosca's views. And since *troostii* is the older name (*Emys troostii* Holbrook 1836; *Emys elegans* Wied 1839), *Pseudemys elegans* now becomes a synonym for *Pseudemys troostii,* which is most unfortunate in view of the fact that ex-*troostii* is only the melanistic *male* of the much more familiar ex-*elegans!* Such are, however, the laws of priority. In order to simplify matters and so as not to add unnecessarily to the confusion of names, these melanistic males will be discussed separately at the end of this section.

Pseudemys troostii (Holbrook)

(Red-head; painted turtle; pond terrapin)

(Synonomy for what has heretofore been called *P. elegans*)

Emys troostii Holbrook 1836
Emys elegans Wied 1839
Emys cumberlandensis Holbrook 1842
Emys holbrookii Gray 1855
Emys sanguinolenta Gray 1855
Trachemys elegans Agassiz 1857
Clemmys elegans Strauch 1865
Trachemys holbrookii Gray 1873
Trachemys lineata Gray 1873
Pseudemys elegans Cope 1875
Chrysemys scripta elegans Boulenger 1889
Chrysemys elegans Hay 1892
Pseudemys troostii Viosca 1933

Description.—Shell broad, depressed; uniformly convex both toward the sides and along the anterior-posterior axis, this median axis with but the faintest trace of a keel in the adult if, indeed, any trace is present; if present, this trace is more conspicuous toward the posterior end of the carapace. Carapace emarginate posteriorly, with a notch between the scutes and a second notch within the boundary on the scute at a point about one-third the distance from the posterior margin. These serrations begin faintly on the eighth (occasionally on the seventh) marginal. The vertebral scutes are all of very nearly equal length. The first vertebral approaches a square, being approximately as long as wide, and is slightly urn-shaped. The second, third, fourth, and fifth vertebrals are wider than long, the second and third being the largest of the series, though the fifth is usually almost as wide but is distinctly shorter. The anterior margin of the third and fourth vertebrals is longer than the posterior margin, while the anterior margin of the second and fifth is shorter than the posterior. The costals are large and are arranged in a series decreasing in size posteriorly; the second and third are rectangular, the fourth

approaches the square. The nuchal is triangular, narrow, and usually has a weak median notch. There is a notch near the middle of the border of the first marginal. The marginals flare posterior-laterally beginning with the eighth scute, though the caudal marginals do not flare, carrying out as they do the posterior curvature of the carapace. There is a deep caudal notch. The surface of the carapace is more or less wrinkled, with

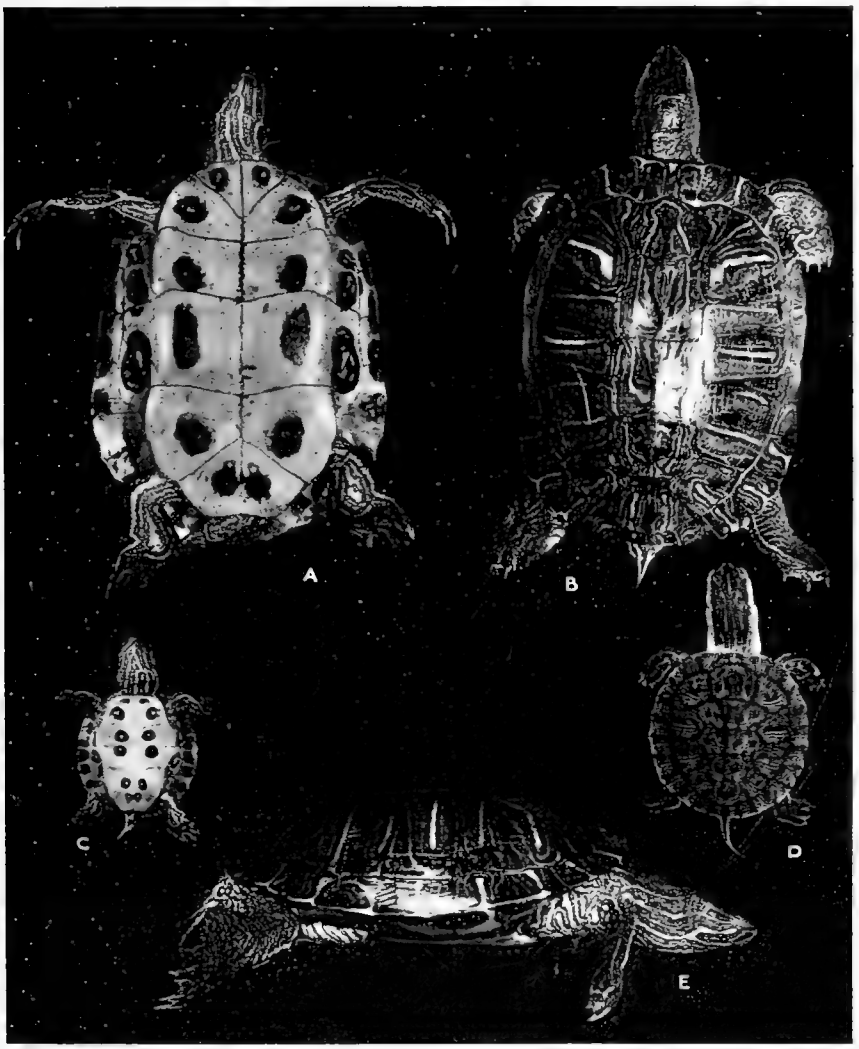


PLATE 21.—*Pseudemys troostii: A,* Adult male, ventral view. *B,* Adult female, dorsal view. *C,* Newly hatched young, ventral view. *D,* Newly hatched young, dorsal view. *E,* Adult, lateral view. (This is the form previously known as *Pseudemys elegans.*)

interrupted longitudinal rugae on the costal scutes especially. The conspicuousness of these rugae varies greatly in different specimens. The plastron is very slightly rounded anteriorly, and shows a broad, shallow emargination posteriorly. The posterior lobe of the plastron is narrower than the anterior lobe, and approximately two-thirds the width of the carapace. Gular scutes triangular, the anterior-lateral angle slightly and bluntly protruded. Abdominal scutes longer than wide if the bridge is excluded, and are the longest of the plastral elements, with the longest suture. Interfemoral suture about equalling the interhumeral suture. Anal scutes trapezial, with a long interanal suture. The bridge is wide and rises rapidly and evenly to the marginals. Axillary and inguinal scutes present and well developed, the inguinal the larger of the two. The head is of moderate size, with the snout very short and blunt. The edge of the upper jaw is convex along the posterior margin and there is a shallow but distinct median notch. The tip of the lower jaw curves upward to fit into this notch. Alveolar surface of the upper jaw with a low, very finely serrated ridge. Limbs well developed and the feet fully webbed. There are five claws anteriorly and 4 posteriorly. Tail moderate, projecting beyond the carapace.

Coloration.—The carapace is olive brown, with a complicated pattern of yellow lines and black stripes. On the first two vertebral scutes the lines tend to run longitudinally, becoming irregular and wavy on the posterior scutes. A yellow band of varying width and intensity extends transversely down the middle of the costal scutes, with other bands of black and yellow roughly paralleling it. There are two conspicuous wide black bands on each of these scutes. The marginals, both above and below, show a black spot on the intermarginal sutures, this surrounded by vague concentric circles of yellow and black. The black spot is large and very conspicuous on the ventral side. The plastron is yellow with, typically, a conspicuous black blotch on each scute, and more or less of a black mottling down the mid-ventral suture. Occasionally the plastron is almost entirely black. The bridge often has black spots confluent into a longitudinal band; sometimes this mark is absent. The axillary and inguinal plates are marked with black. The head shows many stripes of yellow or orange, fine dorsally and coarser ventrally and laterally. A very conspicuous blood red or orange red stripe starts at the posterior margin of the eye and extends backward upon the neck, becoming narrow posteriorly, and affords an excellent field mark for the identification of the species. A broad yellow stripe starts under the eye and extends backward along the neck, passing between the tympanum and the jaw, to be met by a stripe from the middle of the jaw at the angle of the mouth. On the under side of the head, a mid-ventral yellow line starts at the mandibular tooth, sending two diverging lines along the neck; a second

broad stripe starts about mid-way between the symphysis and the angle of the jaw and extends toward the stripe starting below the eye, and may or may not reach it. The stripe which in *Pseudemys concinna* starts above the eye and extends to the neck, is missing. The legs are striped with yellow, as is the tail; the fore limbs show two very conspicuous parallel yellow bands on the anterior margin.

YOUNG.—The young show the typical markings and coloration of the non-melanistic adult, but the vertebral keel is high and conspicuous, becoming more and more obscure with advancing age and increasing size of the individual. The concentric nature of the blotches is more pronounced, especially in the marginal and plastral elements. Description of a 30-mm individual: carapace: bright green, all scutes marked with fine parallel black lines arranged either in bands or in concentric figures; also true of the marginals. The yellow stripes of the adult show clearly on the costals; marginals edged with yellow from which edge a yellow mark extends toward the costals, forming a "T." Plastron yellow, each scute with a black spot formed by alternating concentric areas of black and yellow, usually with a light center. Ventral side of the marginals with a similar spot formed by a series of concentric black rings overlapping the intermarginal sutures. Similar spots are on the wings of the abdominals and on both the inguinal and axillary plates in typically marked specimens. Head and soft parts elaborately marked with bands of yellow, green, and black. Of these the most conspicuous is a Y-shaped band starting ventro-laterally on the neck and forking behind and below the mouth, one arm terminating at the margin of the lower jaw. A second Y-shaped band starts at the symphysis of the lower jaw, forking almost at once to send the arms of the "Y" down the ventral side of the neck. The crimson area behind the orbit is fully developed and conspicuous, blending into a pale green stripe which runs back along the side of the neck. Limbs and tail green, streaked with bright yellow.

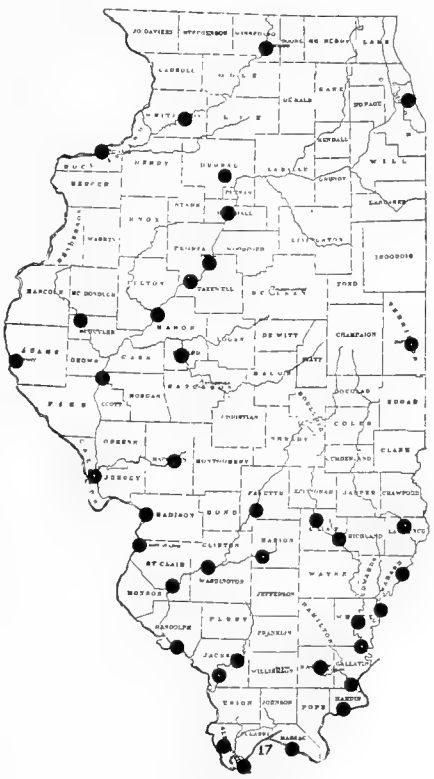
SEX DIFFERENTIATION.—The tail is much longer in the female than in the male. In the female the anal opening lies beyond the posterior edge of the carapace, while in the male this opening lies below the carapace. The red band of the male is likely to be brighter than that of the female, especially in the early spring and during the breeding season. The claws of the front feet of males are very long, slender, curved; those of the female are short and stout, and hence more practical for digging the nest.

GEOGRAPHIC DISTRIBUTION.—*Pseudemys troostii* is distributed over the lower two-thirds of the Mississippi Valley, from northern Illinois, Indiana, and Ohio southward to the Gulf of Mexico. It is not listed as occurring in Ohio by Smith (1882), or by Morse (1904), though that state is included within the range of the species by Stejneger and Barbour (1923). It is not recorded from Michigan by Ruthven *et al* (1928).

PLATE 22.—*Pseudemys troostii: (Above)*—Sex differentiation as illustrated by the claws of the fore feet—*left,* female; *right,* male. *(Below)*—Variations in plastral markings of melanistic males; *left,* markings nearly typical of the non-melanistic individuals; *right,* practically the extreme exhibited in melanistic individuals.

Hay (1892) reports it from Indiana, but very sparingly; it is recorded from Vigo County, Indiana, by Blatchley, and Evermann and Clark (1920) report it as the rarest turtle in Lake Maxinkuckee. It has not been recorded from Wisconsin, though it occurs in Illinois very close to the Wisconsin line, so that the writer might venture a guess that it might be found in Lake Koshkonong. Blanchard (1922) records it from western Tennessee, and the writer has found it very abundant in Reelfoot Lake in that region. It is one of the commonest turtles of Louisiana (Beyer, 1899), but apparently does not extend far eastward. Haltom (1931) reports it for but one region in Alabama. Strecker (1915) reports it from the entire length and width of Texas; Hurter and Strecker (1909) have one record from northeastern Arkansas, and Hurter (1911) has numerous records from Missouri. Yarrow (1882) records it from Mexico, Kansas, Tennessee, Louisiana, Missouri, and from the Yellowstone River; his report of the species from South Carolina is based on a specimen of *Pseudemys scabra.*

Illinois Records.—For Illinois, the species is reported as from the southern part of the state by Davis and Rice (1883). For the Quincy region, Garman (1888) records it as frequent in sloughs; in his later report (1892) he records it from the larger streams in the southern two-thirds of the state, and gives Quincy, Henry, Peoria, Pekin, Havana, and Mt. Carmel as specific localities. Hurter (1911) reports it from St. Clair and Madison counties, and Hay (1893) from Mt. Carmel. The Field Museum has specimens from Liverpool, Maeys, Olive Branch, and Mt. Carmel. The writer has examined specimens from the following localities: Havana, Chester, Meredosia, Danville, Sterling, Carlysle, Louisville, Cairo, Horseshoe Lake in Alexander County, Camden, Mt. Carmel, Peoria, Quincy, Shawneetown, Metropolis, New Haven, Carmi, Clay City, Lawrenceville,



Map 17.—*Pseudemys troostii.*

Centralia, Murphysboro, DeSoto, New Athens, Vandalia, Carlinville, Hardin, Bureau, Harrisburg, and Petersburg. The turtle is common in the Illinois River, increasingly so toward the south, and is much more adundant in the southern part of the state than in the northern portion.

HABITAT.—*Pseudemys troostii* is found most commonly in large, quiet waters, and only rarely in fast water. Thus it is an abundant species in the wide reaches of the larger rivers of the state—the Mississippi and Illinois—as well as in the over-flow lakes along the Mississippi and Illinois bottoms. Toward the headwaters of the various rivers in which it occurs, the species becomes increasingly rare, and never does it reach beyond the region where the rivers are wide and slow-flowing. Soft bottom, such as silt or mud, seems to be the most congenial, and a considerable growth of aquatic vegetation is highly desired by the turtles. In the spring, when the larger streams grow into flood conditions, if the turtles are out of hibernation they escape the turbulent conditions of mid-stream, and enter the flooded bays and ponds, where they remain until the recession of the water drives them back to the river. Those ponds which are permanent will likely have a permanent *troostii* population. Again, it is more of a pond than a river species; hence the local name of "pond terrapin."

HABITS.—Distinctly aquatic in its habits, *Pseudemys troostii* is seldom found on land except during the nesting season or when traveling from pond to pond or from pond to river. It is a quick, active species, which indeed is very much at home in the water, though its movements are not as rapid as those of the soft-shelled turtles or, for that matter, as the turtles of the genus Chrysemys. This is probably due to the bulk and weight of the shell. If great beds of aquatic vegetation are available, the turtles wander around, in and out, among the thickest of the growth, their perambulations often wearing open pathways or tunnels through it. As a result of their selection of quiet, vegetated regions they are, like turtles of the genus Chrysemys, frequently found with dense growths of algae on the carapace, and little growths of the colonial protozoan *Epistylis articulata* are often found upon the plastron. If logs are available out in mid-stream, the turtles pile up on them two and three deep, and spend the hotter hours of the mid-summer days sunning themselves in the security of their island retreat. If logs are not available, their heads may be seen poked out above the surface, just beneath which the turtles lie at rest for long periods at a time, apparently quite as relaxed as if they were upon a more secure footing. Always watchful, the least sign of anything dangerous sends them below the surface like a flash, and once frightened, they are more cautious than ever. Refuge is sought at once in the heart of the densest of the vegetation, to the very bottom of which they burrow immediately, remaining motionless until the fright

reaction wears off. The sloping bank of the water's edge is seldom utilized and one rarely sees a turtle of this species basking in such a location. If cornered on land, the turtle withdraws completely within its shell, the withdrawal of the head being accompanied by a hissing sound as the air is expelled from the lungs to accommodate the incoming bulk of the head and neck. If bothered too much, it shows a reluctant inclination to snap, a sort of half-hearted attempt that is but a poor offense at best. In captivity it refuses to eat for a week or two after its capture and is very timid, but once it becomes used to its surroundings, it grows very tame and will eat from the hand offering food, and follow it all over the aquarium. Agassiz (1857) reports that he has heard turtles of this species "emit a piping note." The writer was astonished one night to hear a distinctly whistled note arise from one of his turtle pens, repeated over and over again at irregular intervals. Quiet watching finally located the sound as coming from a half-grown turtle of this species, which periodically raised its head to the fullest extent of the neck and then "whistled," the note coming as the air was expelled from the lungs. For three days the turtle "whistled," and then suddenly died. Dissection showed a small foreign obstruction lodged in the trachea, and the writer was able to reproduce the whistled note by blowing through the trachea with a blow pipe.

Nesting Habits.—*Pseudemys troostii* nests in clear sandy areas not far removed from the water. The egg laying usually begins during the third or fourth week of June and is completed by the end of the first week of July. While there is considerable variation in the time of day at which nest digging and oviposition occurs, by far the greater number lay early in the morning, while a few lay late in the afternoon; it is rare to find this turtle laying during the day between eight in the morning and four in the afternoon. The female leaves the water slowly and cautiously; one glance at her will show that she has something quite definite on her mind even though she wanders up the bank in a leisurely, casual manner, her head well out, looking from side to side with considerable care. Now and again she pauses to scratch prospectively, but not being satisfied with the soil conditions, she goes on until she finds exactly the right spot. Here she begins to dig, using the hind feet in the process, the front feet remaining more or less fixed in their position. She digs steadily, throwing the loosened sand out behind her, pausing now and again to stare fixedly at some suspicious object she had not noticed before. The digging is not hurried, but gives one the impression of determination rather than haste. The hole is dug to a depth of between four and six inches, depending upon the ground conditions and the size of the turtle, and requires approximately thirty minutes for completion. The eggs are deposited one at a time as soon as the nest is finished, and

are laid at the rate of one about every 40 seconds until the complement is complete. If the female is disturbed while laying she usually shows no offensive reaction, but retires passively into her shell and waits. It takes considerable disturbance and actual physical violence to cause her to forsake the hole while the laying is in progress, but the actual oviposition is suspended without great cause. When the last egg has been deposited, the dirt is raked into the hole and the eggs covered even with the surface, the hind legs dragging in the sand scattered during the digging process. With the location of the nest thus concealed, the turtle returns directly to the water, usually at a greater speed than she showed on leaving it. From an examination of the ovaries it has been ascertained that females become sexually mature and lay for the first time when they attain a carapace length of 7 to 7½ inches.

Eggs.—The eggs of this turtle are oval, with well and equally rounded ends, white, and of a rather coarse and granular shell texture. The number varies considerably, depending upon the size and age of the turtle. A large complement contains 20 eggs, and I once found a set containing 23. The average number of eggs is between 15 and 18, and small clutches of 6 or 8 eggs usually represent the first efforts of a young female. In size they average 37 x 22 mm, varying from 34 x 21 mm to 38.5 x 23.5 mm; these figures are from seven different sets of eggs taken at Meredosia, numbering 121 eggs. Great numbers of nests of this turtle are found dug out, the old eggshells giving mute evidence of the activity of raccoons and skunks, which animals delight in turtle eggs. In the vicinity of Meredosia, on the Illinois River, the young hatch toward the end of August or early in September. Immediately after hatching they go directly to the nearest water and remain in the vegetation-choked shallows.

Food.—*Pseudemys troostii* is largely a carnivorous species, but is able to subsist for long periods on a strictly vegetable diet, as the writer has shown in the laboratory. In nature the food consists of tadpoles, crayfish, mollusks (mostly gastropods), the larger larvae and nymphs of aquatic insects, and small fish, of which the following species have been identified: *Notropis hudsonius selene, Umbra limi, Apomotis cyanellus, Heliop erca macrochira,* and *Perca flavescens.* Usually a quantity of well-masticated vegetable matter is to be found in the digestive system, this consisting of the various aquatic plants of the region apparently without much discrimination as to species. In the laboratory it will eat chopped meat with avidity, and will also subsist on lettuce, apples, and to some extent on bananas. It has a strong scavenger tendency, and will be found feeding upon dead fish, amphibia, and even small mammals which find a watery grave. It will not, however, leave the water to feed upon dead matter upon the shore.

Economic Importance.—The three most important "food" turtles outside of the snapper (Chelydra) and the soft-shells (Amyda) are: *Pseudemys troostii, Graptemys geographica,* and *Graptemys pseudogeographica pseudogeographica.* Of these, *troostii* is the most common, but since it does not attain a size equal to that of the snapping turtle or the soft-shelled species, it is not used extensively for table purposes. However, Clark and Southall (1920) report that *troostii* (i.e. *elegans* of these writers) appears commonly in the fish markets of Chicago, and they are sometimes shipped as far as Philadelphia and Washington from the Illinois River. The price of these turtles now ranges around 20 cents each. The meat is of high quality and delicious flavor.

Table 17.—Measurements of Illinois Specimens of *Pseudemys troostii*
(Measurements in millimeters; weight in grams)

Specimen No.	Carapace		Plastron			Head	Tail		Weight	Sex
	Length	Width	Length	Width	Depth		Total	A-T		
1	243	181	206	147	95	36	68	40	2035	♀
2	233	178	216	147	94	35	54	35	2050	♀
3	230	175	224	139	88	37	53	33	2006	♀
4	215	159	199	130	87	31	40	33	1320	♀
5	200	154	185	120	73	28	73	38	1005	♀
6	196	145	188	109	76	31	50	40	1083	♂
7	195	152	186	120	72	28	50	39	1094	♂
8	192	151	184	126	73	28	50	36	1021	♀
9	189	154	178	78	65	27	50	..	996	♀
10	185	131	168	95	60	26	60	40	740	♀
11	170	132	157	100	58	25	70	34	637	♂
12	166	129	161	117	58	24	55	34	644	♀
13	156	122	151	100	55	25	46	..	545	♂
14	112	92	103	74	44	20	43	30	223	♂
15	110	85	102	66	40	19	30	..	185	♀
16	86	75	81	57	32	16	27	..	101	♂

Parasites.—This turtle, being an abundant species, is a good form for a study of turtle parasites, and affords a good collecting subject for class study in parasitology as it usually is rather heavily infested with a variety of forms. The writer has taken the following from this species: *Neoechinorhynchos emydis* (Acanthocephala), *Allassostoma magnum* and *Polystomoides microcotyle* (Trematoda), and *Ophiotaenia testudo* (Cestoda), this being the second record of this Magath species.

Melanistic Males of Pseudemys troostii

(Black-headed turtle)

(Synonomy of what has heretofore been called *Pseudemys troostii*)

Emys troostii Holbrook 1836
Trachemys troostii Agassiz 1857
Pseudemys troostii Cope 1875
Chrysemys troostii Boulenger 1889

DESCRIPTION.—These melanistic males, representing what, in the literature of herpetology to date, has been the original *Pseudemys troostii,* show the physical and structural characteristics of scute conformation as already described for the non-melanistic forms, and hence

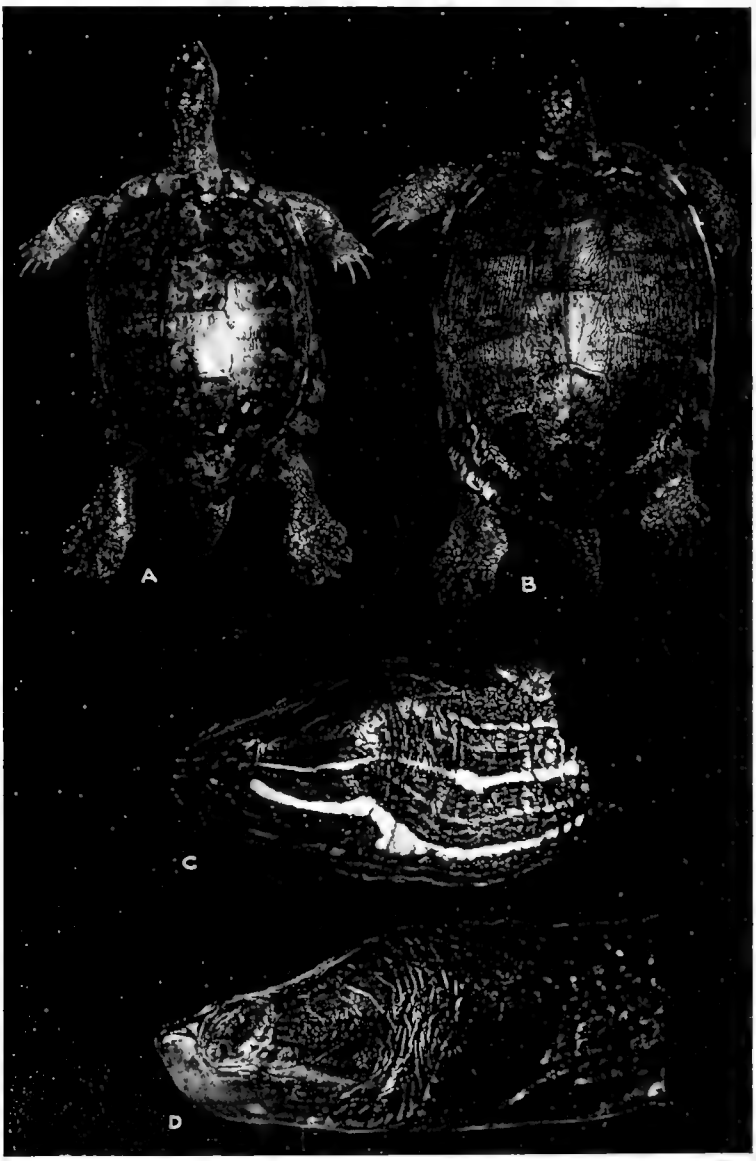


PLATE 23.—*Pseudemys troostii,* melanistic males: *A,* typical adult with a smooth carapace. *B,* Adult; shell with many fine rugae. *C,* Head study of a typical adult non-melanistic male. *D,* Head study of a typical adult melanistic male.

need not be repeated. There is but one feature which, while not at all constant, appears much more frequently in these turtles than in the typically colored forms; this is a rugous condition of the dorsal scutes, especially of the costals. These small ridges tend to follow the general outline of the carapace, and in extreme development may be a highly conspicuous characteristic of the specimen; again, they may be absent.

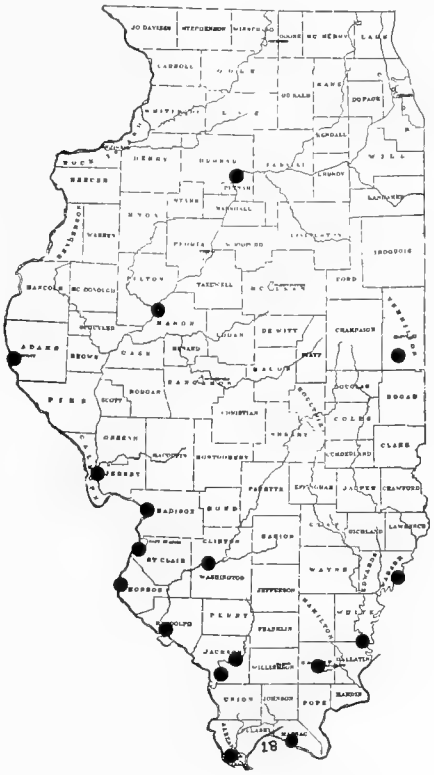
Coloration.—Carapace: dark olive to dark grayish brown, without any trace of light color markings. The sutures between most (if not all) of the scutes of the carapace are covered with black or very dark chocolate brown in an irregular pattern. The olive green ground color is often brightest on the three anterior marginals; on the ventral surface of the marginals, yellow replaces the olive green. In a fully melanistic specimen the entire carapace has the appearance of being dull and indefinite as to color markings. The plastron is pale yellow or straw, with a varying amount of black markings. On the anterior two-thirds of the plastron these black markings appear as streaks which follow the sutures for the most part, with the dark central area expanding posteriorly so as to cover most of the surface of the femorals and anals. In many cases one can observe traces of the last vestiges of the dark blotches so characteristic of the plastron of non-melanistic individuals. Occasionally there are black lateral patches on the abdominals. The bridge shows black patches along the sutures. The under side of the marginals shows a black patch or spot, the center of each spot falling upon a suture; hence a yellow bar reaching to the margin of each marginal scute, this representing the ground color. Head, neck, and limbs of the same dead tone as the carapace, the head olive green, finely and inconspicuously striped with black. An inconspicuous dark olive-brown band extends backward from the posterior margin of the eye, replacing the brilliant red band of the typical non-melanistic individuals. Behind the eye it widens, to reach its maximum width dorsal and posterior to the ear, beyond which it again becomes narrow. The jaws are dark, spotted and lined with black. A short median stripe of yellow begins at the symphysis of the lower jaw and branches at once to send two conspicuous stripes down the under surface of the neck. The angle of the jaw lies between two brown bands, one arising from the posterior median margin of the orbit, the other arising from near the posterior lateral margin of the lower jaw. These bands unite posterior and ventral to the ear and extend as a single inconspicuous line down the neck. Both limbs and tail show only very faint color markings; the tail tends to exhibit a yellowish lateral stripe and a median dorsal brown stripe. All variations between the brightly colored typical individuals and the very dark, fully melanistic individuals may be found, but only in the males of the species.

While dealing with the question of coloration, it is interesting to note

TABLE 18.—GEOGRAPHIC DISTRIBUTION OF P. "ELEGANS" AND P. "TROOSTII"

State	Authority	P. "elegans"	P. "troostii"
Wisconsin	Pope, Dickinson	No	No
Ohio	Morse	No	No
	Stejneger, Barbour	Yes	No
Indiana	Hay (1893)	Rare	Rare: 1 record
	Blatchley	Rare	No
	Evermann, Clark	Rarest species	No
Tennessee	Blanchard (1922)	Western: very common	No (?)
	Cahn	Reelfoot: abundant	Common
Louisiana	Beyer	Abundant	Common
Alabama	Haltom	Present	No
Texas	Strecker	Statewide: common	Southeast: 1 record
Arkansas	Hurter, Strecker	Northeastern	Northeast: 1 record
Missouri	Hurter	Common	Common
	Blanchard (1924)	Southeastern	No
Kansas	Yarrow	1 record	No
Oklahoma	Ortenburger, Freeman	Scattered	No
Illinois	Garman (1892)	Common: southern ⅔	Very rare

what Hay (1892) has to say: "This is a very beautiful and a characteristically marked species. It may readily be distinguished from *C. elegans* by the brown borders of all the scutes, and the absence of yellow stripes on the carapace. Both have a blood-red stripe along the neck." It is obvious from this last sentence that Hay either did not have fully melanistic "troostii" or that he has made a composite description from several specimens; for the melanistic form, when fully developed so as to have lost all trace of the transverse yellow costal bars, does not have the blood-red stripe behind the eye, which stripe is characteristic only of "elegans."



MAP 18.—*Pseudemys troostii*—melanistic males.

DISTRIBUTION.—In order to bring out more conveniently the geographic distribution of the melanistic males as compared to the non-melanistic individuals, as revealed in the published literature, the writer wishes to revert for the purpose of this discussion only, to the old nomenclature used in this literature in which the melanistic form is treated as a distinct species, by calling the non-melanistic forms "elegans" and the melanistic males "troostii." A comparison of the distribution of these two forms is most easily made according to states as shown in Table 18. As to the distribution within Illinois, a glance at the two maps, showing the distribution of *Pseudemys troostii* (Map 17) and of the melanistic males (Map 18), will show that these melanistic individuals are more common in the southern part of the state than in the northern.

From the foregoing information, certain generalized statements may be drawn, though until a more systematic and careful series of collections is made throughout the Mississippi Valley we cannot delimit with any exactness the range of these melanistic *troostii*. It is fairly obvious, however, that where "elegans" is common, there, too, we find "troostii"; (how Blanchard missed it around Reelfoot Lake, Tennessee, is a puzzle,

for here it is a very common species); that at no place is it as common as "elegans," which is perhaps not surprising, as only one sex is involved; that it is not found outside of the range of "elegans"; and that it is much more common in the southern part of the Mississippi Valley than elsewhere. Since it is not found throughout the range of "elegans," and since it *is* found most abundantly in the southern part of the range of that form, are we to infer that there is a temperature factor involved in the production of these melanistic individuals? Although we cannot say for certain that all adult male "elegans" *do not* become melanistic in old age, this would seem to be the case. A series of measurements made on both "elegans" males and "troostii" follows. Carapace length in mm:

"troostii": 217, 212, 210, 202, 200, 196, 193, 191, 177, 172.
"elegans": 196, 195, 192, 189, 185, 180, 166, 156, 112, 110, 86.

The writer has found no example of melanistic "troostii" smaller than 172 mm, which might be considered as typical of the form, though intermediate, intergrading forms with "elegans" characters still visible have frequently been found below this size. Nor has he found any male "elegans" that equals in size the largest of the "troostii." This might lead one to infer that "troostii' is the very old male "elegans," but such a statement is not permissible until a further study has been made, for the largest "elegans," measuring well up into the "troostii" series, show no signs of any melanistic tendency.

So far as habitat selection is concerned, the melanistic "troostii" are always associated with the non-melanistic individuals: both are caught in the same net at the same time, though, as we have said, in fewer numbers. In only one point of behavior could one note anything like a characteristic not pronounced in both. The non-melanistic "elegans" is a rather quiet, inoffensive, peaceful species, not given especially to snapping or pugnacious qualities in either sex; the melanistic "troostii," on the other hand, frequently exhibits decided pugnacity.

TABLE 19.—MEASUREMENTS OF ILLINOIS SPECIMENS OF MELANISTIC MALES OF *Pseudemys troostii*

(Measurements in millimeters; weight in grams)

Specimen No.	Carapace		Plastron			Head	Tail		Weight
	Length	Width	Length	Width	Depth		Total	A-T	
1.....	217	155	193	113	70	29	65	45	1214
2.....	212	151	188	117	72	28	75	39	1190
3.....	202	147	185	114	63	28	75	42	1039
4.....	200	146	186	112	69	27	66	41	1002
5.....	191	148	171	81	66	28	70	40	965
6.....	177	143	161	80	62	27	70	41	872
7.....	172	126	152	91	55	26	72	39	720

FAMILY TRIONYCHIDAE

Trionycidae Gray 1825
Trionychidae Bell 1828
Steganopodes (part) Wagler 1830
Potamites Duméril & Bibron 1835
Trionychida Strauch 1862
Chitradae Gray 1870
Emydinadae Gray 1870

External Features.—Body extremely flattened, nearly circular in outline, both carapace and plastron without any epidermal skeleton composed of scutes, the dermal skeleton covered with a continuous leathery skin which is somewhat cartilaginous along the margin. Snout projected into a flexible fleshy proboscis, with terminal nostrils. Jaws partially concealed beneath fleshy lips; the ear is hidden. Head and neck completely retractile within the shell along a sigmoid curve. Digits 5-5, claws 3-3, only the three inner digits with claws, the unclawed digits concealed within the web.

Osteological Features.—Dermal skeleton not completely ossified. Epiplastra separated from the hyoplastra by a T-shaped entoplastron; marginal bones absent or at best forming only an incomplete series, not connected by ribs. Cervical vertebrae without transverse processes; the articulation between the last cervical and first dorsal vertebrae by the zygopophyses only. Mandible with articulary concavities. The outer border of the tympanic cavity is notched. Pterygoids not narrowed posteriorly and separated from each other. Basisphenoid joining the palatines. Pelvis is not anchylosed to the carapace or to the plastron.

Genus Amyda Oken

Amyda Oken 1816
Aspidonectes Wagler 1830
Gymnopus Duméril & Bibron 1835
Platypeltis Fitzinger 1835
Pelodiscus Fitzinger 1835
Potamochelys Fitzinger 1843
Chitra Gray 1844
Tyrse Gray 1844
Trionyx Gray 1844
Dogania Gray 1855
Rafetus Gray 1864
Aspilus Gray 1864
Pelochelys Gray 1864
Landemania Gray 1869
Sarbieria Gray 1869
Fordia Gray 1869
Callinia Gray 1869
Isola Gray 1873
Oscaria Gray 1873
Nilssonia Gray 1873
Ida Gray 1873
Yuen Heude 1880
Psilognathus Heude 1880
Temnognathus Heude 1880
Gomphopelta Heude 1880
Coelognathus Heude 1880
Tortisternum Heude 1880
Ceramopelta Heude 1880
Coptopelta Heude 1880
Cinctisternum Heude 1880
Aspidertes Hay 1903

External Features.—Body extremely depressed, nearly circular in outline. Carapace and plastron without epidermal scutes and covered by a continuous thick, leathery skin which is somewhat cartilaginous at the flexible margins of the carapace. Head long and pointed, with a

tubular snout prolonged into a fleshy proboscis with nostrils terminal. Fleshy lips concealing the horny coverings of the jaws. The ear is completely hidden. Head and neck completely retractile within the shell; limbs exposed. Feet large; digits 5-5; claws 3-3, the fourth and fifth digits clawless.

Osteological Characters.—Carapace not completely ossified. Outer extremities of the nuchal plate overlie the second dorsal rib; the neural plates are well developed. The hypoplastron is distinct from the hyoplastron. Plastron with not more than five callosities. Bony choanae between the orbits; postorbital arch narrower than the diameter of the orbit. Posterior border of the pterygoids free and without an ascending process.

Amyda mutica (LeSueur)

(Spineless soft-shell; queen turtle; leatherback; soft-shell)

Trionyx muticus LeSueur 1827
Gymnopus muticus Duméril & Bibron 1835
Amyda mutica Agassiz 1857
Potamochelys microcephala Gray 1864
Callinia microcephala Gray 1869
Aspidonectes muticus Baur 1888

Description.—Body greatly depressed, broadly oval approaching circular in outline, covered with a thick, leathery skin and without scales, the carapace flexible at the margins, being largely cartilaginous. Carapace smooth, occasionally slightly granular. Anterior margin smooth, without a trace of the row of tubercles which adorn this region in *A. spinifera,* and other North American members of the genus. The edge of the carapace is entire, without serrations. The plastron is placed anterior, leaving the posterior limbs exposed and non-retractible within the shell. Like the carapace, the plastron is largely cartilaginous. The entoplastron has a single callosity, the epiplastra each a small callosity, these being best developed in the adult, and better developed in males than in females. The head is small, slender, long and pointed, sloping rapidly anterior to the eyes into a short, fleshy proboscis. This proboscis terminates obliquely, so that the nostrils, while terminal, tend to be somewhat inferior in position; they are circular and show no trace of a ridge projecting into them from the side of the septum. The margins of the jaws are slightly concave; the horny covering of the upper jaw has a keen cutting edge which is deepest toward the anterior symphysis and bluntly toothed toward the posterior articulation. Lower jaw with a sharp cutting edge, and both jaws with a narrow alveolar surface. The horny covering of the jaws is at least partially concealed beneath the fleshy lips. The limbs are well developed, strong; the feet are fully webbed with both marginal and interdigital webbing. The anterior limbs have a few transverse scales on their dorsal surface, and the posterior

limbs usually have a single larger scale. Digits 5-5, the claws 3-3, the two outer digits being concealed in the web and being without claws. Tail strong, conical, fleshy, pointed.

COLORATION.—The dorsal surface of the carapace, head, neck, and limbs are brown to olive-brown. The carapace may be unicolored or marked with small, obscure blackish spots or blotches, and short, slender

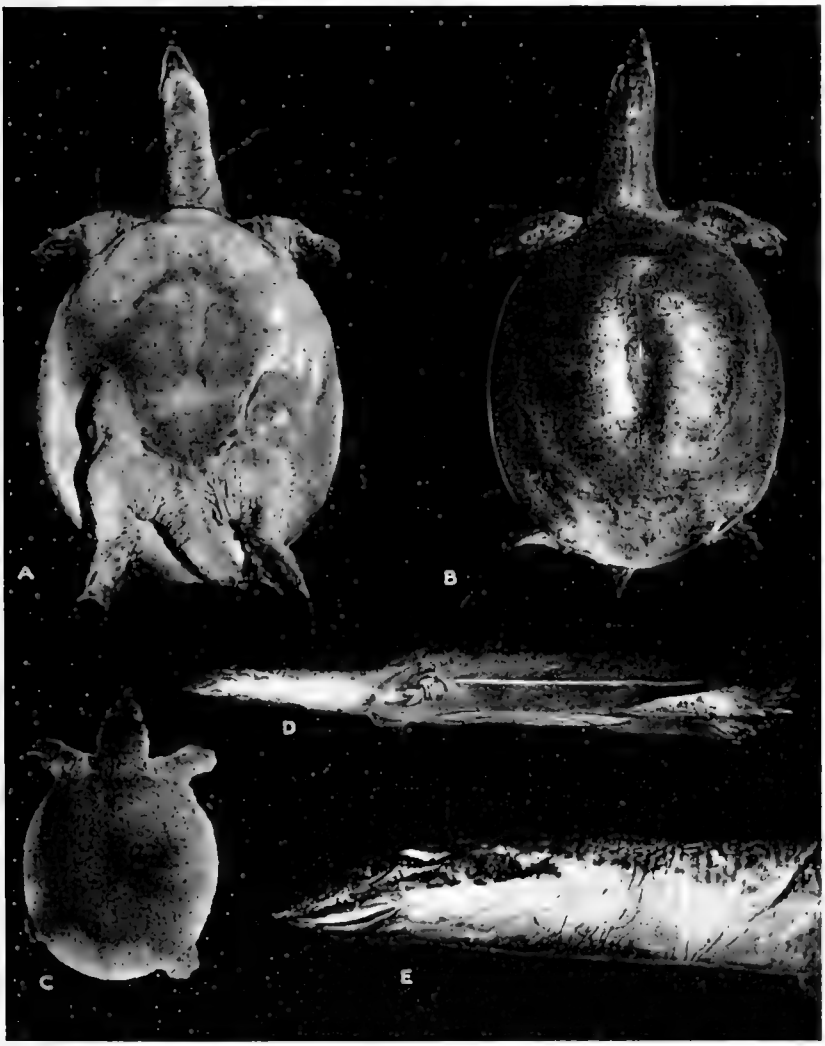


PLATE 24.—*Amyda mutica: A,* Adult female, ventral view. *B,* Adult female, dorsal view. *C,* Newly hatched young, dorsal view. *D,* Adult, lateral view. *E,* Head study of an adult.

lines. There is a light, yellowish margin to the carapace, this preceded mesially by a black line. These markings vary considerably both with the individual and with the age of the specimen, becoming obscure in fully adult animals. The plastron is pearly white, somewhat translucent; the under sides of the head, neck, and limbs are whitish and are unmarked. Soles of the feet bluish gray, unmottled. A pale, black-bordered stripe extends from the snout to the eye, posterior to which it is continued along the sides of the neck.

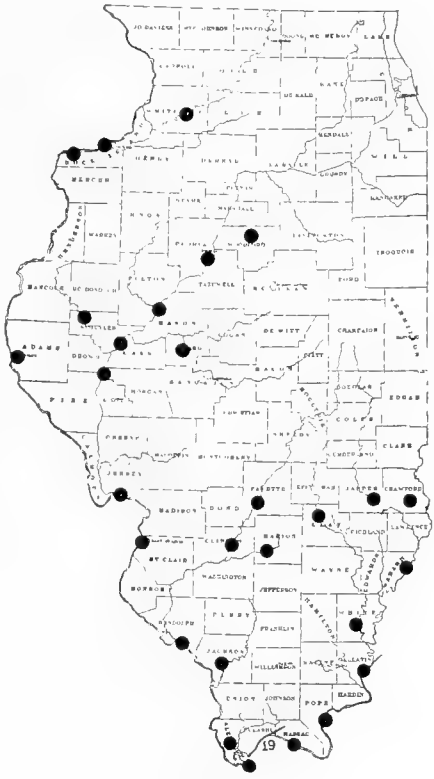
Young.—The young resemble the adult in all structural features, but differ considerably from them in color pattern. The most frequent coloration shows the carapace sprinkled with many fine, bacilliform dashes of darker brown on the otherwise unicolored carapace. The lateral and posterior margin of the carapace is bordered with yellow, this preceded by a black mesial line. With age these bacilliform markings seem to spread and tend to become amoeboid in shape and finally either become obscure or disappear entirely.

Sex Differentiation.—The tail of the male is much longer than that of the female, and projects farther beyond the edge of the carapace. The callosities of the male are somewhat more pronounced than are those of the female. The female usually has long claws on the hind feet, the male long claws on the fore feet. Fully adult males are much smaller than similar females.

Geographic Distribution.—*Amyda mutica* is found to range from the St. Lawrence River southward to Florida, and westward through the plains. From the north it is reported by Nash (1906) as very rare for the Ontario side of Lake Erie. It is recorded in the fauna of Pennsylvania by Surface (1908) because of this record of Nash, but no locality records are given for that state; it is not listed for New England by Babcock (1919). Morse (1904) states definitely that it has not been found in Ohio, though Smith (1882) records it from Lake Erie and from the Ohio River, which agrees with the range given by Davis and Rice (1883) as "north of the Ohio River." Blatchley (1891) reports it from Western Indiana, and Hay (1892) has records extending from northwestern to southeastern Indiana, though Evermann and Clark (1920) do not record it in Lake Maxinkuckee. The type was collected from the Wabash River at New Harmony, Indiana, about due east of Carmi, Illinois. Ruthven *et al* (1928) do not report its occurrence in Michigan. For Wisconsin it is reported from the western half of the state by Higley (1889), who says it is more common there than is *A. spinifera*. Hoy (1883) had previously reported it from "all the tributaries of the Mississippi River." In contradistinction to this, Pope and Dickinson (1928) refer to the meager records of the species in the state

as indicating its presence is "rather unusual." Over (1923) reports it from the Missouri River in South Dakota, but as an uncommon species. Burt (1927) records it from northeastern Kansas. Hurter (1911) reports it from the rivers in Missouri, and Hurter and Strecker (1909) mention it from Arkansas, as does Yarrow (1882) who adds a questionable Florida record. Blanchard (1922) reports it from western Tennessee, and the writer has taken many specimens from Reelfoot Lake in that region. Halton (1931) does not record it for Alabama, and it is not reported from Texas. Ortenburger and Freeman (1930) report it from western Oklahoma.

Illinois Records.—Yarrow (1882) has several records of *Amyda mutica* from Mt. Carmel, Illinois, collected by Ridgway, and an "Illinois" record of Kennicott. Davis and Rice (1883) record it from the Mississippi and "other rivers of the state." For the region about Quincy, Garman (1888) says that *A. mutica* is abundant in the Mississippi River, and less abundant in the sloughs. In his later report (1892) covering the state, he reports it from running water throughout the state, with specific records from Mackinaw Creek in Woodford County, Peoria, Quincy, Mt. Carmel (the Wabash River; this is close to the type locality, New Harmony, Indiana), and from the Ohio River at Cairo. Hurter (1911) does not report it from the Illinois side of the Mississippi. Muller (1921) reports it from Illinois, across the Mississippi River from Freeport, Iowa, and records its breeding there. The Field Museum has specimens from Meredosia and from Golconda. The writer has examined specimens from the following localities: Rock Island, Meredosia, Havana, Crooked Creek in Schuyler County, Robinson, Shawneetown, Carmi, Horseshoe Lake in Alexander County, Chester, Murphysboro, Centralia, Grafton, Carlysle, Vandalia, Louisville, Newton, Beardstown, Petersburg, Sterling, and East St. Louis.



Map 19.—*Amyda mutica.*

HABITAT.—The spineless soft-shelled turtle apparently is quite typical of rivers and streams in general, irrespective of their size, providing these afford a clear bottom of sand or silt. Rock areas are distinctly avoided, as are stagnant ponds and overflow areas. Vegetation does not attract this turtle as it does most of the hard-shelled species. Current means little that is disadvantageous to it, for the great paddle-like feet are powerful enough to drive the turtle against a considerable current. Since *Amyda mutica* prefers running water, it is found more often in rivers than in lakes.

HABITS.—As is the case with all of the soft-shelled turtles, *A. mutica* is highly aquatic; it is even more aquatic than *A. spinifera* for it almost never leaves the water and but seldom climbs up on logs to bask in the sunshine. On land it seems to feel clumsy and awkward (which in reality it is not), and hence never goes far from the edge of the water, excepting perhaps at the breeding season. If one would search for this turtle one should seek a river with clear water, considerable current, and a sandy bottom free from rocks and plant growth. In such a stream there are likely to be windfalls and piles of half-submerged drift-wood along the shores, or perhaps a tree lying half on the shore and half in the water. About such places one is most likely to encounter *A. mutica,* for it browses around, as it were, among the tangle of brush, seeking food amid the partial concealment of the branches of the drift. During the warmest days of mid-summer, these turtles sometimes come to the water's edge, and lie upon the flat bank a few inches from the water, as if afraid to adventure further inland. Here they bask in the sun, legs drawn up under the cover of the drooping edge of the carapace, instantly ready for the necessary scramble back into the water. The neck is usually protruded to the fullest extent, and lies flat on the ground, the turtle being fully relaxed. But even though relaxed, the ever-watchful eye is never closed, and the turtle is constantly alert for possible dangers. If anything suspicious occurs, there is a frantic scramble for the water, the claws digging into the soft ground for firmer hold. The progression appears awkward, but is surprisingly swift for an animal whose legs are so far apart and set so nearly parallel to the ground. Over a level, unobstructed sand beach one of these turtles can outrun a man. Once they hit the water they disappear beneath the surface with a swirl like that made by a fish, as the powerful strokes of their propellers begin to get in their action. These feet are not only very large but are fully webbed, as in all of the members of the genus, and give the turtle great speed under water.

When at rest under water, the turtles select a shallow-water environment, free from any vegetation, and here in the sandy bottom they proceed to bury themselves. This is done by flipping up the loose sand and permitting it to settle down again upon the carapace, until the entire

shell is buried from sight and only the head is out. This head, being colored so nearly like the sand, is almost invisible. Thus concealed, the turtles lie motionless for hours at a time, being able to obtain sufficient oxygen for respiration from the water through their pharyngeal method of respiration (as will be mentioned in the section dealing with the closely related *A. spinifera,* p. 190). The writer has repeatedly demonstrated this pharyngeal respiration in *Amyda mutica* in the laboratory by inserting grains of carmine in the water close to the nostrils and observing their sudden dive into the nasal passage as the hyoid apparatus drops. A similar phenomenon has also been demonstrated about the anus, indicating that there is an anal respiration associated with the posterior wall of the gut. Some such accessory respiratory mechanism is certainly of great advantage to a highly aquatic species of air-breathing animal, for the rigid construction of the shell of turtles offers no opportunity for excessive lung expansion or of air storage. Agassiz (1857) long ago measured the lung capacity of turtles in relation to their weight and in association with their habits. He found that in *Amyda ferox,* which is as aquatic as *mutica,* the lung capacity was to the body weight as 1:17; in *Cinosternon pennsylvanicum* (*K. subrubrum*), also exceedingly aquatic, it was as 1:16; in *Cistudo* (*Terrapene*) *triunguis,* highly terrestrial, it was almost as 1:1. Hence it would seem that the aquatic turtles have proportionately much less lung capacity than terrestrial species. The highly vascular development of the mucous lining of these regions, then, enables the turtles to remain under water for long periods, and explains their ability to remain so long submerged. It also makes clear the method of respiration during the long periods of hibernation (and perhaps also of aestivation in some species). The writer has demonstrated a similar pharyngeal respiration for various hard-shelled turtles as well (Chrysemys, Pseudemys, Sternotherus), and finds that the rate of pharyngeal movement increases as the temperature of the water rises. While lying, then, concealed in the sand of the river bottom, the turtles are able to obtain a sufficient oxygen supply without coming to the surface. If they desire more air, they extend their necks upward until the nostrils break the surface of the water; hence the selection of a shallow-water burial place. This pharyngeal and anal respiration is, however, insufficient for the turtles if they are active, which explains why soft-shelled turtles die so readily when caught in nets.

Amyda mutica is an expert swimmer. Very fast, it is able to capture fish with ease, its very extensible neck giving it a great advantage in this regard. In a large tank I once watched this turtle capture a small brook trout (*Salvelinus fontinalis fontinalis*), one of the fastest and most agile of our fish. The turtle approached with great rapidity behind the darting fish until its victim was within reach of its snake-like neck; then

there was a lightning-like movement of the head, which shot out like a dart, and the trout was caught. *Amyda mutica* is much less vicious than is *Amyda spinifera,* but its disposition is by no means docile. If cornered, it snaps viciously at any offending object, the head shooting forward for all the world like that of a snake. It is this fact of relative tempers of the two species which has won for the milder *mutica* the local name of "queen" turtle, while its more voracious relative is known as the "king" turtle. The edges of the jaws are as keen as a knife, and the jaws themselves are powerful enough to inflict a painful injury.

As already mentioned, *A. mutica* is a river species. It is able to swim against a strong current, and that this is often and consistently done is indicated by the fact that, as Garman (1892) has pointed out, it is found abundantly below the various dams on the Illinois River, these dams impeding possible further progress upstream. If it habitually traveled down stream, it would be found abundantly above the dams, where in fact it is rare. Since the species is so very aquatic, the dams form efficient barriers to its progress.

Nesting Habits.—There is little information about the nesting habits of this turtle available, and the writer has only once, and then imperfectly, seen the nest digging, which is apparently very similar to that of *A. spinifera.* When leaving the water, the female is extremely cautious and very alert for possible danger. The head is held high and the vicinity is carefully inspected for possible dangers. The female does not go far from the water if suitable nesting grounds are available close by; most nests the writer has found have been within fifty feet of the water's edge. Open sand bars in the larger rivers, or the sandy shore of an island free of vegetation are most desired, but the turtles come to the mainland if no such isolated spot is available. The nest is usually dug in clear sand. I have on occasion dug up the eggs of this turtle in very loose sandy loam, but never in a tight-packing soil, through which the young could not escape. It is believed that the hole is dug with the hind feet, though I have never been able to get close enough to this species to be certain of the fact, the fore feet remaining in place during the operation. Oftentimes several holes were started, but for some reason best known to the digger, each proved unsatisfactory and was abandoned until just the right spot was located—sand neither too hard nor too soft, neither too wet nor too dry. After laying, the turtle fills in the hole and, with the hind feet, rakes sand over the eggs, so as to leave but little trace in the disturbed area. Then the female scurries for the water. In the vicinity of Meredosia, on the Illinois River, all indications point to early July as the nesting season, for after about July 10 no females were secured with eggs in the oviducts ready for deposit.

Eggs.—The eggs of *A. mutica* are round and white, and are smaller than those of *A. spinifera* which they so closely resemble. The normal number laid by a female is from 18 to 22; the largest number the writer has obtained from a single nest is 31, while Muller (1921) reports 33. The number of eggs laid is proportional to the size (age) of the female, the young individuals laying fewer eggs than the old ones. This accounts for clutches of 5 or 6 eggs as are occasionally found. The average size of 116 eggs measured by the writer is 22.6 mm, as compared with 28.3 mm for *spinifera*. Incubation lasts approximately 70 days and, as pointed out by Muller, varies with conditions of heat and moisture; excessive moisture kills the embryo, while excessive drought simply retards the development. Describing the embryo in the egg, Muller says: "The carapace is folded down around the young turtle, and the arms are extended in front of the head. The forepaws are thrust through the shell first in hatching, and this opening enlarged to allow egress for the rest of the body. Although the young have an egg tooth below the flexible proboscis, it does not seem to be used in escape from the egg, and is dropped a week after hatching. They always hatched during the night or early morning." On hatching the young turtle is almost perfectly circular, about 34.5 by 33 mm.

Food Habits.—*Amyda mutica* is distinctly a carnivorous turtle, though vegetable matter does play a minor rôle in the diet. The food consists principally of crayfish, fish, frogs, tadpoles, the larger insect larvae and nymphs, and aquatic mollusks. The fish eaten are for the most part minnows, the large shiners *Notropis heterolepis heterolepis* and *N. whipplii spilopterus* frequently appearing in stomach examinations; other species of fish identified are: *Notropis hudsonius selene, Helioperca macrochira, Lepibema chrysops, Perca flavescens, Catostomus commersonii commersonii, Hepentelium nigricans.* The mollusks eaten are both gastropods and bivalves, the latter being thin-shelled species of small size, but there is seldom sufficient evidence of the shell left to afford identification. Over (1923) reports "young fowl" as an item of diet; Agassiz (1857) reports the larvae of neuropterous insects; Von Wied (1865) reports LeSueur's record of worms, snails, fruits, and even hard nuts; Hay (1892) reports this species as very fond of potato stems. It is only to a slight extent a scavenger.

Enemies.—Great numbers of the eggs of this turtle, as well as of *A. spinifera,* are dug out of their sand nests by skunks and raccoons, and the empty shells strewn around the ravaged nesting site bespeak a not inconsiderable havoc wrought by these nocturnal marauders. The adult turtle is so capable of caring for itself that it has but few enemies other than man himself. One might expect ectoparasites, such as leeches (*Placobdella parasitica*), would find the exposed soft parts of these soft-

shelled turtles an ideal feasting ground, but, since *A. mutica,* at least, shuns vegetation and quiet water where leeches are most abundant, it is but seldom attacked by these animals.

Economic Importance.—Like *A. spinifera, mutica* is a most palatable turtle and is highly desired for table purposes. It is inferior to *spinifera* only because of its somewhat smaller size. Despite this fact, the soft-shelled turtles are seldom found in the markets of the larger cities. Clark and Southall (1920) report: "None was seen in the Washington market nor in Chicago, where it was reported that 'they could not be given away, much less sold.' And yet, where well known, the soft-shell is regarded as the most delicious of turtles. It is, indeed, a species of soft-shell turtle which is raised in Japan much as the diamond-back terrapin is beginning to be raised in this country."

Amyda spinifera (LeSueur)

(Spiny soft-shell; king turtle; leatherback; soft-shell)

Trionyx spiniferus LeSueur 1827
Trionyx ferox (part) LeConte 1830
Platypeltis spinifera Fitzinger 1835
Gymnopus spiniferus (part) Duméril & Bibron 1835
Trionyx ferox Dekay 1842
Tyrse argus Gray 1846
Trionyx argus Gray 1855
Aspidonectes spinifer Agassiz 1857
Gymnopus olivaceus Wied 1865
Callinia spinifera Gray 1869
Trionyx spinifer Boulenger 1889
Aspidonectes spiniferus Rhoades 1895
Amyda spinifer Hurter 1911

Description.—Seen from above, the carapace is broadly and bluntly ovate. It is covered with a soft, leathery skin, the horny scutes being entirely absent. The ossification of the carapace is incomplete, the ribs extending beyond the periphery of the costal plates; the marginal plates are entirely absent, permitting the edge of the carapace to droop over the limbs and head. The shell is greatly depressed, and nearly flat. There are no emarginations of any kind, the margin being entire. The dorsal surface of the carapace is often finely granular, like fine sandpaper, and there is a series of conical tubercles along the anterior margin. The plastron is likewise incompletely ossified, the elements being loosely associated and reduced in size. The plastron is anterior in position, its anterior margin being in a vertical line with that of the carapace, while the posterior limits are only about two-thirds the distance back when compared to the carapace. It is so placed as to afford complete protection to the withdrawn head, neck, and fore limbs, but none whatsoever to the hind limbs and tail, which are at all times fully exposed. The neck is extremely long and is capable of extension to nearly three-fourths the length of the carapace. The head is small and pointed, the skull depressed. The snout is prolonged forward into a soft, slender, tube-like proboscis with terminal nostrils. These nostrils are concentric, or reni-

form, and show a lateral ridge on each side of the nasal septum. The jaws are powerful and possess a sharp cutting edge, but are concealed laterally by fleshy lip-like flaps. The limbs are large and powerful, the feet large and fully webbed. Digits 5-5; claws 3-3, the three inner digits on each foot being supplied with well-developed claws, the remaining being without claws and concealed in the webbing. The tail is large and fleshy anterior to the anus, and much attenuated posterior to it; it projects beyond the edge of the carapace, with the anus close to the tip.

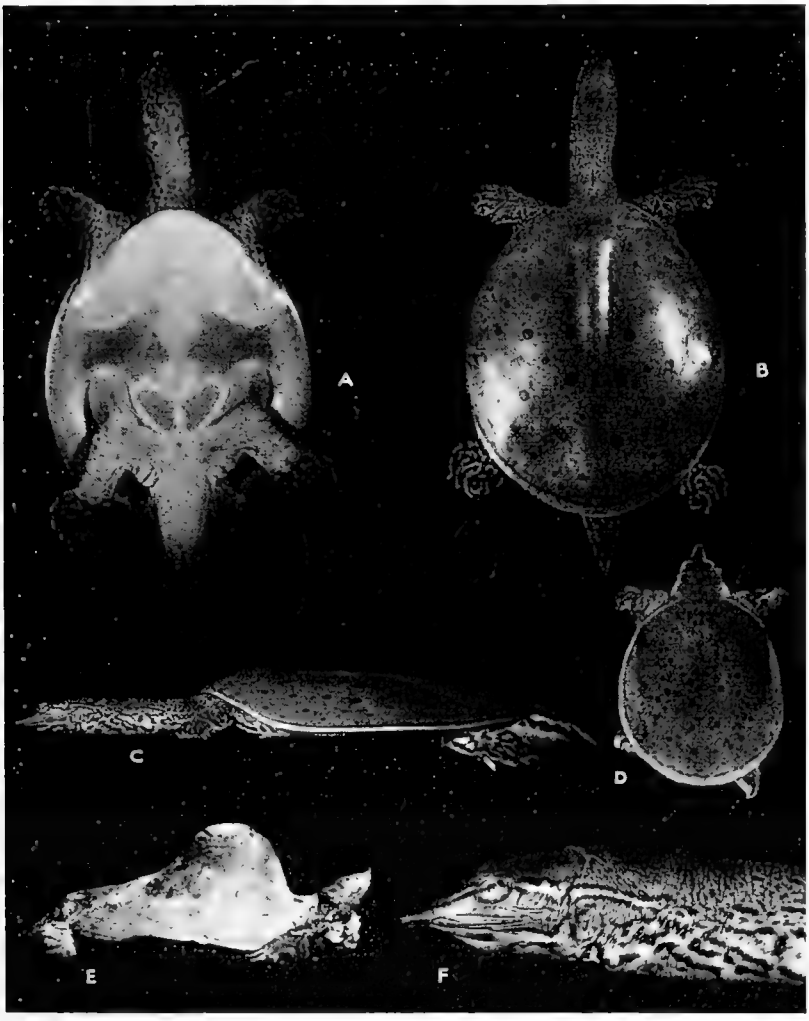


PLATE 25.—*Amyda spinifera: A,* Adult male, ventral view. *B,* Adult male, dorsal view. *C,* Lateral view. *D,* Young, dorsal view. *E,* A congenital deformity in a sexually mature female. *F,* Head study of an adult.

Coloration.—Carapace olive green or light brown, margined with yellow. This margin is widest along the posterior border, becoming narrower anteriorly. Between the yellow margin and the body of the carapace is an interrupted, wavy black line. The carapace is dotted with numerous dark brown spots, those nearest the margin being smallest and darkest. Toward the mid-dorsal line these spots become larger and each is surrounded with a black ring. The nature of these ocellated spots varies greatly with the age of the individual; they are regular and very conspicuous in the younger turtles, becoming irregular in outline, larger in size, and less bright in mature specimens, finally fading into irregular blotches, with little if any symmetry. The plastron and under surface of the carapace is immaculate, white, or ivory in color, and the plastral elements tend to show through as a purplish discoloration. The head and neck are olive. A pale yellow stripe edged with black extends along the neck, passing through the eye and on to the snout where, at the tip, it is joined by its fellow from the opposite side; a similar stripe extends backward from the angle of the jaw. The legs and feet are olive, mottled with black, the legs dorsally, the feet both above and below. The anterior

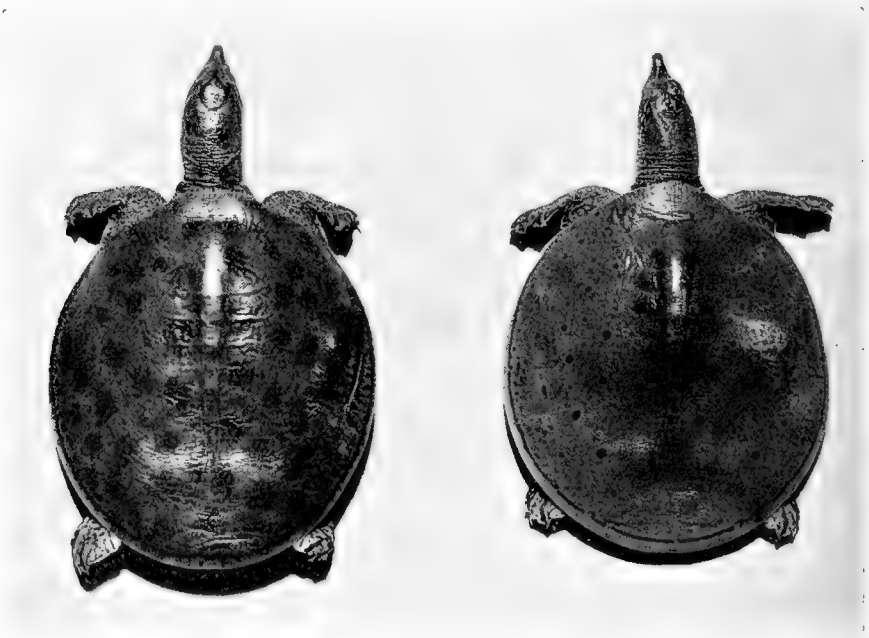


Plate 26.—*Amyda spinifera: (Left)*—An immature individual, six and a half inches long, which lacks the typical spotted markings, having instead lichen-like patches of dark pigment. *(Right)*—A typically marked immature individual of nearly the same size.

limbs bear a series of transverse scales dorsally; the posterior limbs bear a single transverse scale. The tail is olive, with a black-bordered yellow lateral stripe.

YOUNG.—The young resemble the adults in all essential details of form and coloration. In the young specimens the ocellate spots are bright, regular, and conspicuous, these dimming and becoming irregular in older individuals. The granular surface of the carapace is more pronounced in the younger specimens.

SEX DIFFERENTIATION.—The tail of the male is much longer than that of the female, and projects farther beyond the posterior edge of the carapace; it is also heavier and fleshier. The granular finish of the surface of the carapace is more pronounced in the female than in the male, and the tubercles on the shield are larger and more numerous on the female than on the male.

GEOGRAPHIC DISTRIBUTION.—"Mississippi River and tributaries, west to Colorado, north to Montana; St. Lawrence River and tributaries; east to Vermont, western New York and Pennsylvania" is the range as given by Stejneger and Barbour (1923). Babcock (1919) records the species for Vermont from Lake Champlain, the only New England record, and Surface (1908) records it from rivers in Pennsylvania. Morse (1904) says that it is found in every stream in Ohio, and Ruthven *et al* (1928) report it from the southern half of lower Michigan. Hay (1892) reports it as the commonest soft-shelled turtle in Indiana, occurring throughout the state; it is interesting to note that the type locality is New Harmony, on the Wabash River. Swinging southward we find Blanchard (1922) recording it from western Tennessee, where I have found it abundant in Reelfoot Lake; Haltom (1931) records it for Alabama. The writer has specimens from Louisiana, where Beyer (1900) reports it as abundant inland; apparently it does not occur in Florida. It is not recorded from Texas, where Strecker (1915) reports only *A. ferox* and *A. emoryi*. In western Oklahoma only *A. mutica* is reported by Ortenburger and Freeman (1930), and only *mutica* is recorded from Arkansas by Hurter and Strecker (1909). Hurter (1911) reports it from numerous rivers in Missouri, and Burt (1927) records that *spinifera* is more common in Kansas than is *mutica*. Ellis and Henderson (1913) record it as being common in Colorado, making no mention of *mutica*, yet Over (1923) reports only *mutica* from South Dakota. Blanchard (1922) reports *spinifera* from Iowa. Higley (1889) says it is found in southern and western Wisconsin, and Pope and Dickinson (1928) report it as "statewide" in Wisconsin; Cahn (1929) records it from southern Wisconsin. To the north Nash (1906) says that it is "distributed in all marshy waters of western Ontario, not common anywhere."

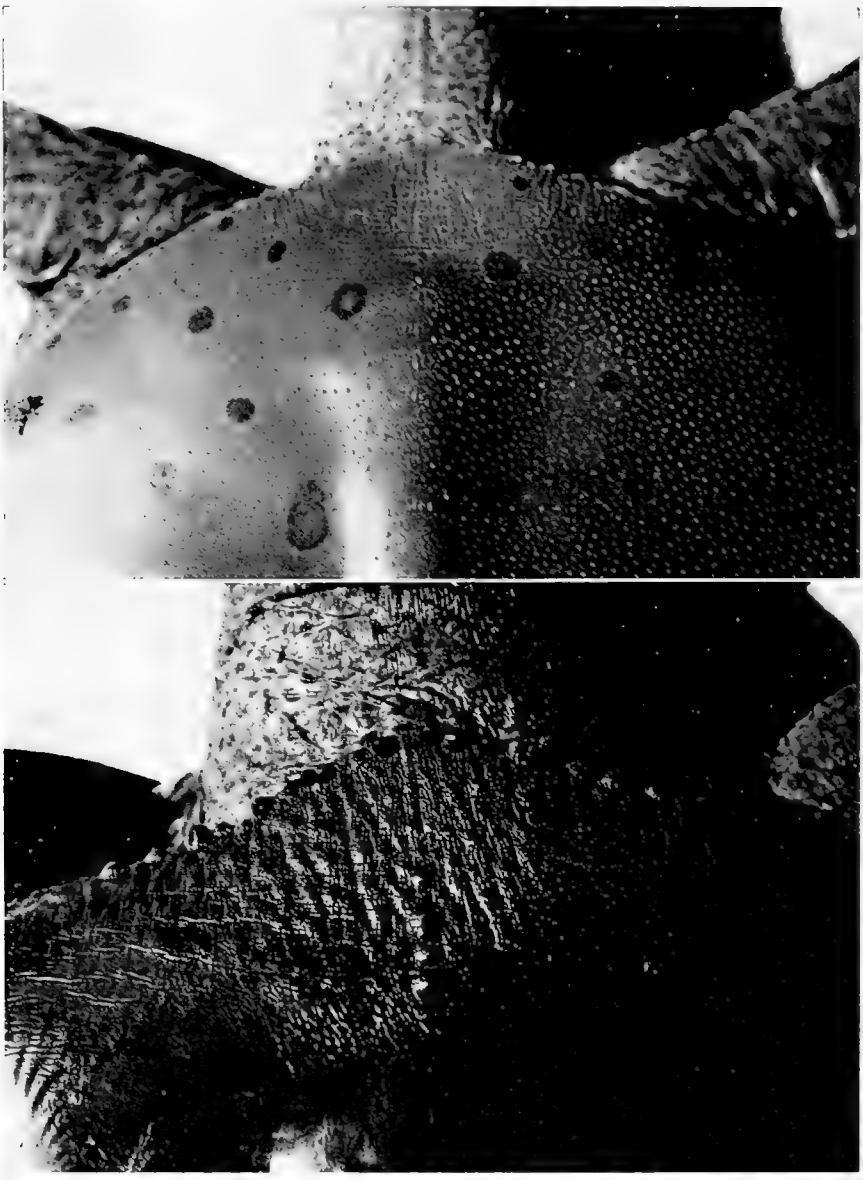
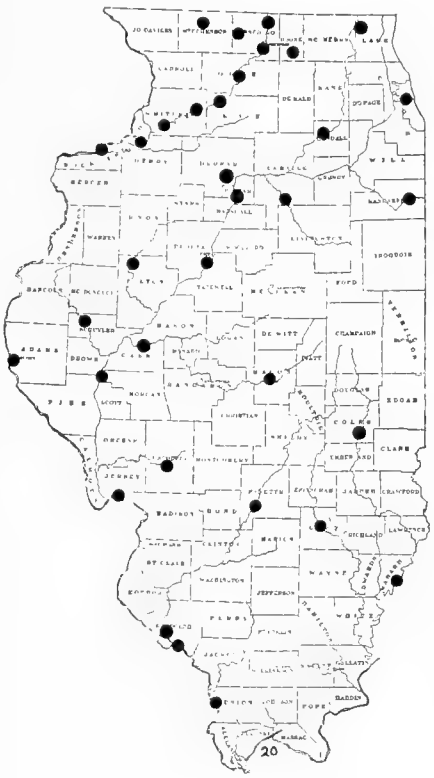


PLATE 27.—*Amyda spinifera: (Above)*—Study of the surface of the carapace to show the highly granular surface. *(Below)*—Study of the anterior margin of the carapace to show the terminal marginal row of tubercles characteristic of the species.

Illinois Records.—*Amyda spinifera* is distributed throughout the state of Illinois, and is an abundant species. Davis and Rice (1883) record it from Lake Michigan and as abundant in the rivers of the state. Garman (1888) reports it as abundant in the Quincy region, and in his state report (1892) gives records of it from Rock Creek in Plano County, Oregon, Quincy, Peoria, Bluff Lake in Union County, and Mt. Carmel. Hankinson (1917) found it in the Embarrass River at Charleston, and Weed (1923) reports it from Meredosia. The Field Museum has specimens from Momence, Jackson Park in Chicago, Havana, Meredosia, and Grafton. The writer has examined specimens from the following localities: Meredosia, Havana, Bureau, Chester, Peoria, Crooked Creek in Schuyler County, Rock Island, Barstow, Hillsdale, Sterling, Rockton, Freeport, Belvidere, Fox Lake, Decatur, Vandalia, Louisville, Chandlerville, Carlinville, Ellisville, the Kaskaskia River at Reilly Lake, and Streator.



Map 20.—*Amyda spinifera.*

Habitat.—The spiny softshelled turtle is preëminently a shallow-water species, inhabiting lakes, ponds, and rivers which have a soft sandy or muddy bottom, and avoiding those waters having much current or rock and gravel bottoms. It is less dependent upon aquatic vegetation than are other species of pond turtles, for it depends upon its ability to bury itself in the soft bottom when concealment is necessary rather than upon hiding among aquatic plants. Its swimming power enables it to cope with the current of even the largest rivers.

Habits.—This turtle is exceedingly aquatic, spending by far the greater part of its life in the water and leaving this congenial environment only for some extraordinary reason and to lay its eggs. In the soft mud or sand at the bottom of a shallow lake or river this species buries itself with great rapidity by flipping the light silt over its back until it is

wholly concealed from view. Usually only the tip of the snout projects from the dirt covering. This burial usually takes place in water so shallow that the turtle can extend its long neck sufficiently to protrude its nostrils enough above the surface to breathe, all this without uncovering or disturbing its body. Thus it may lie concealed, at rest, for hours. The position of the body is always horizontal, and the covering is only a thin film of sediment. The ability of these turtles to remain for long periods—many hours—beneath the surface without reaching air has been demonstrated by Gage (1886), who showed a true aquatic form of respiration for both *spinifera* and *mutica*. He showed that there is a rhythmic movement of the hyoid apparatus at the rate of 16 movements per minute. By the raising and lowering of this structure the mouth and pharynx are filled with water and then emptied. The mucous membrane of the pharynx is highly vascular, the capillaries lying in filamentous villi-like processes, and these function as gills. Further, an analysis of the water in which the turtle was confined for hours without access to air showed that the oxygen supply was greatly depleted and that the water contained a large excess of carbonic acid.

Being thus so highly aquatic, it is not surprising to find this species a remarkably fine swimmer, capable of extremely rapid movement. In fact the entire creature is adapted to just this type of life, and to a higher degree than is found in any other fresh-water turtle. The excessively depressed body, the thin and flexible cutting edge of the carapace, the placing of the limbs in such a position that they propel the animal from a point beyond the hindrance of the carapace, the great webbing of the feet, all unite in making the soft-shells the fastest moving and most agile of our turtles. In swimming, the neck is extended forward in a straight line; the limbs strike out horizontally left and right, alternating in their action. So great is their speed that they are able to capture the fastest of our fishes. Whey they crawl leisurely on the bottom, we find the limbs are attached in such a position that only the inner two toes can touch the ground, and so buoyant are the turtles that they are incapable of rapid walking when submerged. On land their locomotion appears awkward, yet here they are capable of getting up surprising speed. When one is in full retreat you must "trot along right smart" if you would keep up with it or capture it.

When disturbed the turtle withdraws within its shell with remarkable completeness. Agassiz (1857) thus describes the performance:

> The neck and head are withdrawn entirely within the shield, the skin rolling off from the greater part of the neck and allowing it to protrude naked among the viscera. The legs are withdrawn horizontally and the skin slips off so far that it does not surround them, except below the knees and elbows. When thus withdrawn, the humerus is carried round into or before the widespread scapular arch, the elbow being placed very near the head or neck; the fore leg and foot are

turned back upon the humerus, the flat surface of the foot being nearly horizontal, so that its outer edge rests against the femur, and the foot again turned somewhat forward, its flat surface being nearly horizontal.

The long, supple, snake-like neck is a great asset to the turtle in capturing its prey. So long is the neck that the creature can almost reach your fingers when you hold it by its tail. Yet one would never suspect its extensibility when the turtle is behaving quietly. Its disposition is pugnacious and irritable and it strikes forward or laterally with lightning speed and perfect accuracy. The jaws are powerful and the bite extremely painful, for the jaws very easily cut deep into the flesh.

Amyda spinifera goes into hibernation toward the end of October, burying itself to a depth of about two to four inches in the mud or sand at the bottom of the lake or river. The burial is accomplished by flicking at the sand with the feet and permitting it to settle over the carapace. It emerges again in May or, if the season is a warm one, toward the end of April. In the southern part of the state there is evidence pointing to the conclusion that the species does not go into complete hibernation, remaining sluggishly active all winter.

Nesting Habits.—As the time for egg laying approaches, this turtle shows signs of forsaking its normal aquatic habits and may sometimes be seen basking in the sun close to the water's edge, completely out of water. At such times the turtles lie flat upon the plastron, with all four legs fully extended and the toes widely spread, completely relaxed. The hind feet rest upon the inner toe, the soles directed upward and inward. The least disturbance, however, is sufficient to send them plunging back into the water and they then show a marked timidity about returning to their sun bath.

When the female comes out to lay, so cautious and alert is she that it is almost impossible to observe her activities from a point sufficiently close to see what is actually going on. This difficulty Mr. Combs overcame by sitting up in a tree for hours at a time, observing the turtles through powerful binoculars. The nesting performance is as follows: A female about twelve inches long left the water at 11:15 on the morning of July 11, 1931. She progressed only about four feet from the water when she turned and went back into the river, entering, however, only the shallows. A few minutes later she repeated the performance and returned again to the water. A third time she came out some five feet up stream, at a point where the willow brush was less dense and the sand more abundant. She held her neck erect and very stiff, and advanced with extreme caution. After traveling 18 feet from the water, a distance which it required about 15 minutes to cover, she came to rest and remained entirely motionless, neck fully extended, for two minutes. Then, very deliberately, she planted her fore feet firmly in the sand, and began

scratching slowly with her hind feet. From the time she planted her front feet until the eggs were laid and the nest covered, she never moved the fore feet from this spot. In digging the hole she made two or three slow, heavy scratches with one hind foot; this was followed by a sudden, violent kick which sent the dirt flying four or five feet behind her. Scratching then began with the opposite foot in exactly the same manner. Thus for 16 minutes she dug, alternating in the use of her hind feet, every third or fourth stroke shooting out the loose dirt which the preceding scratchings had loosened, building up a pile of dirt immediately behind her. During all the digging she held her head high, carefully watching.

As soon as the digging ceased, she drew in her neck and remained very quiet for 8 minutes, during which time the subsequent examination of the nest showed she laid 12 eggs. Then, her front feet still in their original position, she began filling in the nest. This she accomplished by extending her hind feet backward and raking into the hole the loose sand her excavating had piled up. With the front feet acting as a fixed pivot, she rotated her body and hind legs through an arc of about 90°, dragging in all the loose sand within reach. As soon as this was completed to her satisfaction, she wheeled quickly about and without a glance behind her at the nest which she never saw, hurried back into the water.

Then the nest was examined. It was found to consist of a hole descending at an angle of about 60°, the opening at the surface lying under what was approximately the middle of the plastron while the animal was digging. Thus the eggs when laid were deposited upon an inclined plane down which, being spherical, they rolled. It could not be determined from the point of observation whether or not the hind legs were used in lowering the eggs into the hole. A second interesting fact was that the sand which surrounded the eggs was very much wetter than the surrounding material. From this the obvious conclusion must be drawn that the female, as she packed in the sand around the eggs while filling up the hole, wetted it down, undoubtedly with water stored in the cloacal region. The utilization of water in this manner has been observed in the case of other turtles. The sand at the surface was so neatly packed down that the nest site was almost invisible.

As we have mentioned, the eggs are spherical, and each is covered with a thick, strong, and rather brittle calcareous shell which is less flexible than the shell of many other turtle eggs. In this respect the eggs of the family Trionychidae, Chelydridae, and Kinosternidae differ from those of all the rest of our inland turtles, though the last-named group does not lay spherical eggs. Beneath this shell lies a very tough membrane. The shell is pearl white in color, quite smooth and unglazed. Agassiz (1857) reports the number of eggs laid as "from twelve to

twenty or more," while Surface (1908) and others report the number as "about 60." I doubt if any *A. spinifera* lays this number of eggs in a season, and assume that the authorities for these high numbers include in the count all of the larger eggs found in the ovaries as well as the shell-covered eggs about to be laid which are in the horns of the uterus, the counts having been made from dissected females rather than from dug-out nests. This is obviously unfair, for the larger embryonic eggs are retained *in situ* for laying the following spring. My experience shows that the number of eggs laid by females in Illinois is as follows: 9, 12, 13, 15, 17, 19, 19, 21, 22, 22, 23, 25, with the average of this series as 18. The eggs are large, measuring 28.3 mm as the average for 217 eggs, with the largest measuring 29.3 mm. An examination of the ovaries inclines me to the belief that this species must attain a carapace length of about 24 cm before the females become sexually mature.

There are no data available as to the exact duration of incubation and no doubt this period, whatever it may be, is varied considerably both ways from a mean by climatic and soil conditions: by the type of soil in its relation to heat and moisture retention, by temperature and by rainfall which cools off the soil and hence may slow up the rate of development. Most of the Illinois turtles of this species lay in June or early July: earlier in the southern part of the state, later in the northern portion, and young-of-the-year are taken in late August and September. Further, there is no information at hand or available dealing with the rate of growth after hatching. The only material of this nature to which we can refer is offered by Mitsukuri (1905) for *Amyda japonica* (*sinensis* ?), a closely allied species, as follows:

Age	*Length in cm*	*Width in cm*	*Weight in gms*
Just hatched	2.7	2.5	...
First year	4.5	4.2	23
Second year	10.5	8.8	169
Third year	12.2	10.5	300
Fourth year	16.0	13.5	563
Fifth year	17.5	15.1	750

Food Habits.—*Amyda spinifera* is conspicuously carnivorous in its diet. The commonest items of food found in stomach examinations are: crayfish (*Cambarus* spp.), minnows, fry of larger fish, frogs, tadpoles, earthworms, insects (often beetles), and mollusca (*Piscidium, Planorbus, Vivipara,* etc.), in the order named. Sometimes aquatic vegetation is found, but this is not common. Among the fish that have been identifiable I note: *Notropis heterodon, N. heterolepis heterolepis, N. hudsonius selene, Catostomus commersonii commersonii, Allotis humilis, Helioperca macrochira, Semotilus atromaculatus atromaculatus, Abramis crysoleucas,*

Umbra limi, and *Aplites salmoides.* In Wisconsin I found the remains of brook trout (*Salvelinus fontinalis fontinalis*) six inches long in the stomach of a 13-inch turtle, attesting the speed and agility of the species in capturing its food. It is also a scavenger, picking up a lot of débris from the shallow water.

Economic Importance.—According to Clark and Southall (1920) this turtle seldom finds its way into the large market centers of the city and certainly it is far more seldom seen there than the snapper. This is due no doubt to at least two important factors. First and foremost is the fact that the river fishermen who capture these turtles recognize their delicious table qualities, and they are disposed of at the local markets near the point of capture without the necessity of shipment to distant markets. In the second place they are far more delicate than the hardier snapper and consequently they do not stand shipment as well. Be that as it may, the spiny soft-shell is a delightful table delicacy, the very nature of its food supply insuring its meat of a palatable flavor. Along the Illinois, Rock, and Mississippi rivers particularly, thousands of pounds of these turtles are captured annually and bring a good price on the local markets. Hence the species must be regarded as of considerable economic importance. This fact the state recognizes and has placed a minimum size limit of 7 inches on all of the species of soft-shelled turtles.

Table 20.—Measurements of Illinois Specimens of *Amyda spinifera*
(Measurements in millimeters)

Specimen No.	Carapace		Plastron			Tail	
	Length	Width	Length	Width	Depth	Total	A-T
1.....	168	142	110	55	35	76	8
2.....	159	132	119	59	36	75	8
3.....	172	149	126	57	34	86	9
4.....	176	153	130	61	37	86	10
5.....	141	119	100	61	29	63	5
6.....	124	104	88	39	22	43	5

HYPOTHETICAL LIST

After a careful study of the turtles now found within the state of Illinois, and a careful review of the literature bearing on all of these forms, it has become necessary to designate certain species as hypothetical within the state. By this term is meant (1) that the form is no longer to be found within the state, if it ever actually did occur there; (2) that it is no longer a valid species; or (3) though not taken in the state, its occurrence there is possible. The task of evaluating early records when the

original material is no longer available is very difficult at all times; it is made more difficult still by the fact that the early investigators did not distinguish between subspecies and they did not clearly see the relations between closely allied forms in the light in which we do now. There are some species reported from Illinois which the writer cannot verify. In view of this fact it has been considered advisable to segregate them out of the main body of the paper, yet, since they appear in the literature, the student is entitled to know what has become of them, and why. In this list, then, we attempt to explain why certain forms have been deleted from the state list, and to point out certain other species which, for one reason or another, may possibly be found within the state by future investigators.

Of the six species placed in this list, three are apparently errors in previous identifications: *Sternotherus carinatus, Chrysemys picta,* and *Amyda ferox;* one is considered as being no longer valid: *Chrysemys treleasei;* one is believed to be of exceedingly doubtful occurrence: *Pseudemys hieroglyphica;* and the remaining species, *Clemmys insculpta,* while never taken in Illinois, has been captured within eleven miles of the boundary of the state and hence may be taken in the state at some future time.

Sternotherus carinatus (Gray)

Aromachelys carinata Gray 1855
Goniochelys triquetra Agassiz 1857
Cinosternum carinatum Boulenger 1889
Sternotherus carinatus Stejneger 1923
Kinosternon carinatum Stejneger & Barbour 1917

Description.—Carapace elongatedly oval, rather narrower at the posterior end than at the anterior; very high and massively domed; in profile steeper behind than in front. A prominent, sharp keel becomes particularly evident on the second vertebral scute, and increasingly prominent from here backward, the nearly flat sides forming a straight slope from keel to marginals. The scales are all highly imbricated; the posterior margin of each scute overlaps the anterior margin of the succeeding scute as do shingles. The vertebral scutes are all very nearly the same in length. The first vertebral is triangular, the apex directed posteriorly, and much longer than its anterior width. The second and third vertebrals are rhomboidal, their length closely approximating their width. Fourth vertebral usually longer than wide; the fifth vertebral is the smallest of the series. The median keel arises gradually from the vertebrals and appears as a continuous sharp median ridge. The costal scutes are all very large, the first being by far the largest of the series. Second and third costals highly rectangular; fourth costal irregular in shape. The posterior three costals are pentagonal; the anterior roughly rhomboidal. Nuchal very small and insignificant. Lateral marginals rectangular; the tenth and eleventh (the latter the supracaudalia) are much higher than

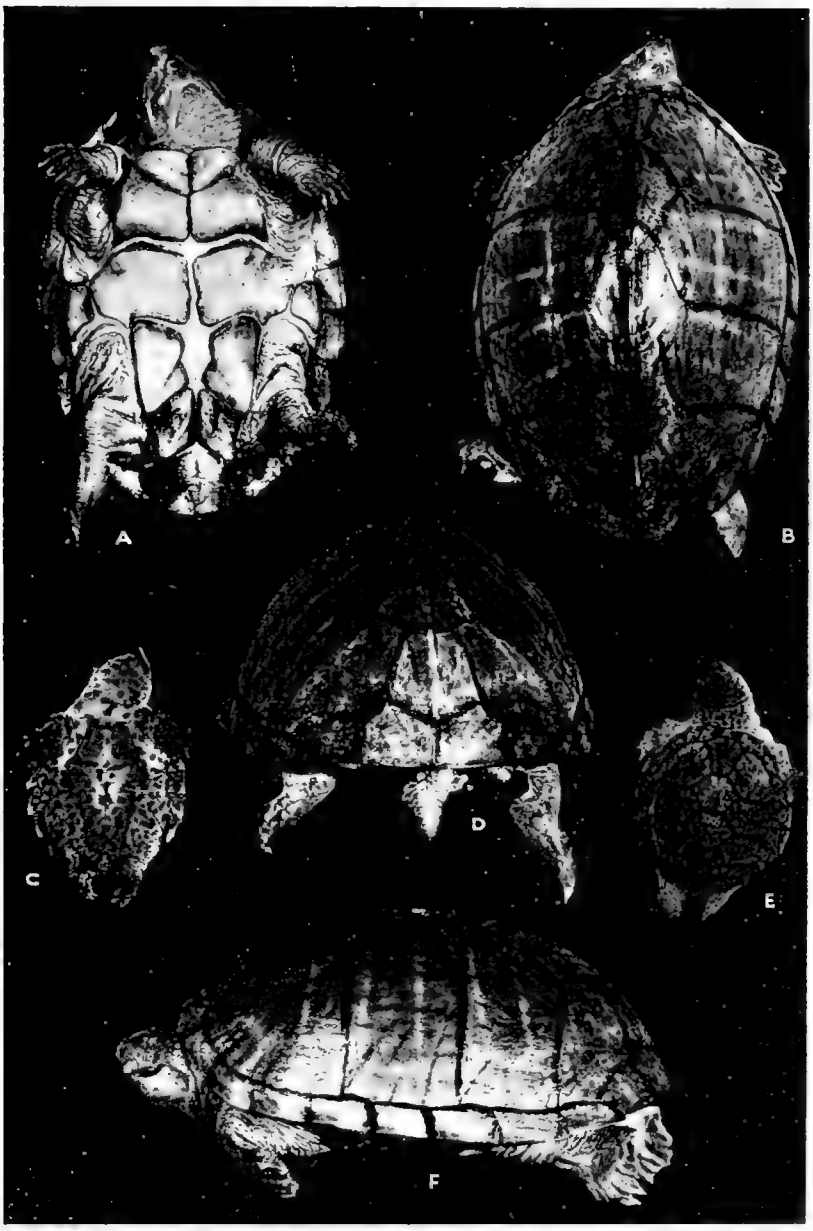


PLATE 28.—*Sternotherus carinatus: A,* Adult, ventral view. *B,* Adult, dorsal view. *C,* Newly hatched young, ventral view. *D,* Posterior view of the carapace to show the arrangement, relative size and shape of the posterior marginal scutes. *E,* Newly hatched young, dorsal view. *F,* Adult, lateral view.

the rest of the series, the eleventh being higher than the tenth. The highest point of the eleventh marginal is toward the anterior margin. The plastron is small, tending toward cruciform, and does not nearly close the aperture of the shell. The anterior lobe is truncate along its forward border, and is wider than long. The posterior lobe is longer than wide, is approximately one-half as wide as the aperture in that region, and has a wide, shallow posterior emargination. The front lobe is about two-thirds the length of the hind lobe, but longer than the intermediate portion. The gular is absent in most specimens, so that the humerals form the anterior termination of the plastron. The humerals are roughly triangular, the interhumeral suture being shorter than the humeral-pectoral suture. Pectorals larger than the humerals, rhomboidal. Abdominals the largest of the plastral elements. The femorals are much longer than wide and tend toward the triangular in general form. The anal scutes are rhomboidal, terminating posteriorly in a sharp projecting angle, the lateral tip of the posterior emargination. The inguinal and axillary elements touch at their proximal ends and form the major part of the bridge, completely separating the short wings of the abdominal from the marginals. The axillary is triangular and is smaller than the rhomboidal inguinal. Head large, massive; snout rather short but pointed. The nasal plate is strongly forked. Jaws strong, with sharp cutting edges. Gular barbels two; well developed. Legs and feet strong; toes webbed. Digits of fore limb all with small claws; fifth digit of the hind foot without a claw, and the anterior (first) digit with only a tiny one. Fleshy parts posterior to the hind legs covered with small fleshy tubercles tending to arrange themselves in lines along the tail. No terminal claw or nail present on the tail.

Coloration.—Carapace varies in color around olive green. Each scute is mottled with chocolate brown spots and dashes which sometimes tend to extend into radiating lines, the number, conspicuousness, and extent of these varying enormously but usually plainly in evidence. The posterior margin of each scute, where it overlies the succeeding posterior scute, is bordered by a conspicuous but narrow black line. Dorsally the marginals bear the same black border along each overlapping suture. Plastron is horn color to yellowish, unmarked in most specimens, but occasionally exhibiting a very few short brown dashes. There is a large amount of cartilaginous material along the interabdominal, pectoral-abdominal, and interfemoral sutures, the amount varying with the sex of the animal. This material is usually pinkish in color. Head olive, covered with numerous small, dark brown flecks and spots both dorsally and laterally; there is no stripe back of the eye. Neck and chin pinkish gray, also spotted, the spots lacking ventrally. Jaws horn color, with

transverse brown stripes, which are sometimes very faint. The rest of the soft parts are grayish in tone and without markings.

Young.—The young resemble very closely indeed the young of equal size of *Sternotherus odoratus,* and might well be very confusing. In the young specimens there is usually a keel in evidence on both series of costal scutes, this keel becoming more and more obscure with age. The young *S. carinatus* lack the light stripes so conspicuous below and behind the eye in young and adult *S. odoratus.*

Sex Differentiation.—In the male the "stridulating organs" are well developed on the hind legs as a series of scale-like roughenings. Usually the transverse brown stripes on the jaws are much more intense in the males than in the females. The amount of cartilage between the plastral elements is much greater in the males than in the females.

Geographical Distribution.—*Sternotherus carinatus* is distinctly a southern species. It inhabits the lower part of the Mississippi River Valley, the range covering Georgia, Mississippi, Florida, Louisiana, and westward to about the eastern third of Texas.

Illinois Records.—The only record of this species for Illinois is to be found in the list of Davis and Rice (1883) who state simply: "Has been taken as far north as Lake County." This Illinois record is taken seriously by Hay (1892) who quotes it in view of the possibility of finding the species in Indiana. Again, Garman (1896) quotes the same record and includes the species in his herpetological report of Illinois, mentioning, however, that he has not taken it in the state, and putting the responsibility for the record upon Davis and Rice. In view of the fact that a careful combing of the state during the last three years has brought to light not the slightest trace of the species, and because of the great distance which Lake County, Illinois, lies north of its known range, the present writer rejects it from the Illinois fauna. Yet, in view of the case of *Kinosternon flavescens,* he does so gently but firmly, and places it in the hypothetical list until positive evidence in the form of a specimen taken in the state comes to hand. The Davis and Rice material is not available for study. The writer is inclined to follow Siebenrock (1907, p. 552), who believes that Davis and Rice (he quotes, however, only the Garman citation) had *Sternotherus odoratus* and not *S. carinatus.* In view of the tendency of *S. odoratus* toward keels in the immature stages, this seems altogether likely.

Since the present writer is quite confident that *Sternotherus carinatus* does not occur in Illinois, and that the only published record for it within the state is in error, a further discussion of the species will be omitted. To those who are interested in the taxonomy of this species and of *Sternotherus minor* with which it has been badly confused, reference is made here to a paper by Stejneger (1906).

Chrysemys picta Schneider

Testudo picta Schneider 1783
Testudo cinerea Schneider 1792
Emys picta Schweigger 1814
Terrapene picta Bonaparte 1830
Chrysemys picta Gray 1856
Clemmys picta Strauch 1862
Chrysemys picta picta Bishop and Schmidt 1931

The last authority, in point of time, to include this eastern species in a list of the turtles of the state is Garman (1892), who says as follows: "Under the name of *C. picta,* this and the closely allied *C. marginata* are included by good authorities as varieties of one species, and as the former name has the right of priority, it has come to be commonly applied by students to the individuals of the genus taken in Illinois. It is probable, however, that *C. picta* will be found to be very rare in this State, if it occurs at all." He gives one locality record. Previous to the Garman list, it had been included in the Cook County, Illinois, list by Kennicott (1855), in which list the author says that it is "very abundant; exists throughout the state." However, previous to this time the validity of these two species *(picta* and *marginata)* was not understood, as Garman indicates, and when Kennicott reports *picta* as an abundant species there can be little doubt but that he referred to what we now understand as *marginata,* believing that *picta* and *marginata* were one and the same species. Garman refers to a specimen taken at Mt. Carmel, Illinois, probably using as his data the published record of this specimen in the Yarrow (1882) list. This record shows U. S. National Museum specimen #9559 to be *Chrysemys picta,* taken in 1878 by Shenck. The writer wrote to Dr. Stejneger in regard to this record, and through his kindness has learned that the specimen referred to under this number by Yarrow is in reality *Chrysemys marginata.* Hence the Yarrow record is eliminated, as is also the Garman record. The distribution of *Chrysemys picta* is given by Stejneger and Barbour (1933) as follows: "Eastern North America from New Brunswick to Florida."

Amyda ferox (Schneider)

Testudo ferox Schneider 1783
Testudo verrucosa Schoepff 1792
Testudo bartrami Daudin 1802
Trionyx carinatus Geoffroy 1809
Trionyx georgicus Geoffroy 1809
Trionyx brongnartii Schweigger 1814
Amyda ferox Oken 1816
Gymnopus spiniferus (part) Duméril & Bibron 1835
Platypeltis ferox Agassiz 1857
Gymnopus spiniferus Wied 1865
Platypeltis agassiz Baur 1888
Trionyx ferox Boulenger 1889
Trionyx agassiz Baur 1893
Aspidonectes agassiz Baur 1893
Pelodiscus agassiz Baur 1893
Trionyx agassizii Hay 1892

This southern soft-shelled turtle has been recorded but once for Illinois, and it is extremely doubtful whether it occurs within the state. This Illinois record is that of Kennicott (1855), who records this species as

"common in Lake Michigan and throughout the State." There can be little doubt but that Kennicott is in error here, for he makes no mention in his list of the turtles of Cook County of either *spinifera* or *mutica;* hence we must assume that he did not distinguish between the various species of the soft-shelled turtle. And if this is the case, we cannot possibly accept his identification of *ferox* as *the* common species of Illinois. Again, Yarrow (1882) records a specimen (#8359) in the National Museum, from Madison, Indiana, and this record constitutes the sole basis for the inclusion of this species in the list of turtles of Indiana as published by Hay (1892) under the name *Trionyx agassizii.* As to including it in the hypothetical list of Illinois: outside of the Kennicott record the only justification is to be found in the fact that Madison, Indiana, is on the Ohio River. Since *Amyda ferox* is, like the other species of the genus a highly aquatic species, and since it is a southern turtle, the most plausible route this specimen could have taken would be up the Mississippi to the mouth of the Ohio, and up the Ohio to Madison, Indiana. Hence, if the Indiana record is correct, it is just possible that sometime a stray specimen may again attempt a similar journey and be taken *en route* in southern or southeastern Illinois.

Chrysemys treleasei Hurter

Chrysemys treleasei Hurter 1911
Chrysemys marginata treleasei Stejneger & Barbour 1917

This species was described by Hurter in 1911 from specimens taken by him in Madison, St. Clair, and Monroe counties along the Mississippi River in Illinois. The description of the form is similar to that of the other species of the genus *(marginata, bellii),* and the basis for the founding of a new species lies in the coloration of the plastron. "The plastron is uniformly blood red in the adults, which color partly fades away in alcoholic specimens. When the red has faded the plastron sometimes shows a faint long and wide blackish mark. In the young of the first year the red plastron is divided into squarish fields by the proportionately wide yellow sutures." Bishop and Schmidt (1931), in reviewing the status of *treleasei,* give as their opinion that the red color of the plastron is due to a superficial deposit of inorganic red pigment (an oxide of iron), and point out that this is true of specimens in the Field Museum from the same locality which likewise show the red plastron. They further point out that the yellow sutures of the young individuals represent new growth of the horny shields, on which the superficial red deposit has as yet had insufficient time to become deposited. The writer has examined two specimens from Monroe county which were typical of Hurter's description of *treleasei,* and in both cases scraping with a knife revealed the red color of the plastron to be merely a superficial

deposit, with the normal yellow color underlying it. Hurter's statement that, on fading, the plastron sometimes "shows a faint long *and wide* blackish mark" indicates the true *bellii* affinities of the specimens he describes as *treleasei*. Those specimens examined by the writer were typical *bellii* when the red deposit had been removed. Bishop and Schmidt accordingly place *Chrysemys treleasei* Hurter as a synonym of *Chrysemys picta bellii*. With this view the present writer is quite in accord. Stejneger and Barbour (1933) have likewise placed *treleasei* in synonymy with *bellii*. Hence *Chrysemys treleasei* is deleted from the list of species found in Illinois on the ground of being an invalid species.

Pseudemys hieroglyphica (Holbrook)

Emys hieroglyphica Holbrook 1836
Ptychemys hieroglyphica Agassiz 1857
Clemmys hieroglyphica Strauch 1865
Chrysemys hieroglyphica Boulenger 1889
Pseudemys hieroglyphica Garman 1892
Pseudemys elonae Brimley 1928 (?)

The following description is taken from Hay (1892): "Head unusually small; snout somewhat projecting; upper jaw slightly notched in front; both upper and lower jaws smooth or slightly denticulated. Shell greatly depressed, and in large specimens without trace of keel. In specimens five inches long there is a slight keel. Shell sometimes smooth, occasionally longitudinally wrinkled. At its border, especially behind the thighs, the shell flares outward excessively, in some cases producing an actual concavity in the shell above. Hinder margin deeply serrated. The bridge is narrow from front to back, the width being contained in the length of the plastron about three times or more. It rises little toward the carapace, and this contributes to the apparent flatness of the shell. Hinder border of the plastron with a deep notch. Longest suture that between the abdominals; the shortest, that between the humerals. Digits all strongly webbed. Hind feet very large and flat.

"The ground color of the carapace varies from olive to dark brown. This is variegated with numerous lines and stripes of yellow. On the vertebrals the lines tend to run longitudinally. On the costals broad yellow bands divide each scute into three or four areas, inside of each of which are narrow concentric lines of the same color. The marginals are marked with yellow and brown. The plastron is yellow, with some splotches of brown on the bridge. The head, neck, feet, and tail are all dark green, with numerous longitudinal bands of yellow. The length of the shell of large specimens is 12 inches." Baur (1893) characterizes *hieroglyphica* by its elongated, narrow shell and its very small head; by the presence of yellow stripes and dots on the head which are much more distinct than in *P. concinna*, which it most nearly resembles.

The only records, apparently, for the occurrence of this species in Illinois are those of Garman (1892) and Hay (1892). Garman gives no locality records of any kind, and no mention is made of a single speci-

men having been taken or examined by him in Illinois. He merely says: "The species has been observed only in the Wabash River." For a turtle so nearly resembling another species *(P. concinna),* this can hardly be accepted as a record or as a proof of its occurrence in the state. Turning to Hay, we find little satisfactory information. He says: "Two shells of this species are in the State collection, which were sent in from Mt. Carmel, Illinois, on the Wabash River. No doubt it will be found along the whole lower course of the Wabash." The writer has been unable to locate these two "shells"; correspondence with Mr. Verne Patty, the curator of this museum, indicates that *if* the turtles are still in this museum they are packed up and hence not available for study. So we must simply take Hay's statement and weigh it. In the first place, one would like to know what is meant by "shells." Presumably carapace and plastron. If so, one would like to know whether the coloration and scutellation was sufficiently distinct to distinguish it from the very closely similar *P. concinna.* Is one to assume that by referring to "shells" Dr. Hay wished to designate that no skull was present? Yet the best diagnostic feature to distinguish *hieroglyphica* from *concinna* is the smooth cutting edge of *both* jaws in *hieroglyphica* and the *serrate* edge of the *lower* jaw of *concinna.* Finally, Dr. Hay's prediction that the species would "no doubt" be found along the "whole lower course of the Wabash" has not been verified during the last forty-one years, for no further specimens have come to light. The writer has taken *P. concinna* from this Mt. Carmel region, but an especially vigorous search for *P. hieroglyphica* in that locality has yielded nothing. Stejneger and Barbour (1933) give the range of *hieroglyphica* as "the rivers of the southern Appalachians." Hence it would appear that Illinois is very far from the normal range of the species. There is in the Field Museum a specimen of this species (#6300), bearing the data: "Kankakee river at Kankakee." Correspondence from Dr. Karl P. Schmidt, of the Field Museum, states in regard to this specimen: "The *Pseudemys hieroglyphica* appears to be correctly identified, but the locality is quite untrustworthy as it is an aquarium specimen received from F. S. Young, but not collected by him. Any statement of this record should carry this notation. The occurrence of this turtle in the Kankakee requires confirmation." The only other nearby record is that of Levette (1876), who reports it, strangely enough, from the Kankakee River in northern Indiana! Therefore, since the writer has been unable to verify these old records, and since he has been unable to obtain a single specimen from the state, he feels that the species should be placed in the hypothetical list. If these old records are ever verified, and if in the meantime no new specimens are obtained, we may then assume that *Pseudemys hieroglyphica* has been exterminated within the state.

Clemmys insculpta (LeConte)
(Wood turtle)

Testudo insculpta LeConte 1830
Emys speciosa Gray 1831
Emys insculpta Harlan 1835
Clemmys insculpta Fitzinger 1835
Geoclemmys pulchella Gray 1865
Glyptemys insculpta Agassiz 1857
Glyptemys pulchella Gray 1870
Chelopus insculptus Cope 1875

DESCRIPTION.—Carapace ovate, approaching retangular, widest posteriorly across the eighth marginal scutes; depressed; flattened dorsally; serrate posteriorly. Scutes of the carapace very rough, sculptured. First and fifth vertebral with length and width about equal; remaining vertebrals wider than long and of almost identical size and proportions. First and second costals the largest of the series but only slightly larger than the third; fourth costal the smallest of the scutes of the carapace. Marginals vary in number, but usually show 24 plus the nuchal. (For a study of this variation, see Parker 1901). Nuchal elongate, narrow, deeply notched posteriorly where the anterior margin of the first vertebral projects sharply into it. Marginals all flaring, lying almost horizontal in position. Each scute of the carapace bears toward its posterior margin a "focal point," from which a few weak ridges radiate. From each focal point a series of fine, raised, concentric ridges radiate toward the margin of the scute, giving the shell a highly sculptured surface. The focal points on the vertebral and costal scutes are raised and form the apex of a flattened pyramid. A weak longitudinal keel is present on the vertebrals, most developed posteriorly. Plastron ovate, flat. Gulars triangular, their anterior lateral margins projecting into a blunt, rounded knob, their anterior margins rounded and emarginate. Anals trapezial, with a deep notch between them, the posterior angles rounded. Anterior margin of the anals less than the posterior margin of the femorals; hence the posterior lateral angle of the femorals forms a rounded protruding angle; posterior margin of the femorals deeply concave. Anterior lateral angle of the femorals extends into the posterior lateral margin of the abdominals, which "flows" around it to form the base of the bridge. Each scute of the plastron with a posterior lateral focal point which is, however, not raised, and with a series of concentric angular rugae extending from it. Axillary and inguinal elements small, the axillary triangular. Head flat or slightly dished dorsally, compressed, wider above than below; upper jaw projecting downward like a bill and notched at the tip. Edge of lower jaw straight except at the tip, which is highly arched upward. Alveolar surface of both jaws narrow. Soft parts (except head) covered with rough scales or blunt, wart-like protuberances.

COLORATION.—Carapace a dull brown, with very faint yellow and black radiating and concentric lines which become very obscure in adult individuals. Plastron yellow, with a squarish black blot on the posterior

lateral margin of each scute except the gulars, on which the spot is anterior lateral. Dorsal surface of the gulars yellow, with black anterior area. Ventral marginals yellow, with a black posterior lateral blotch.

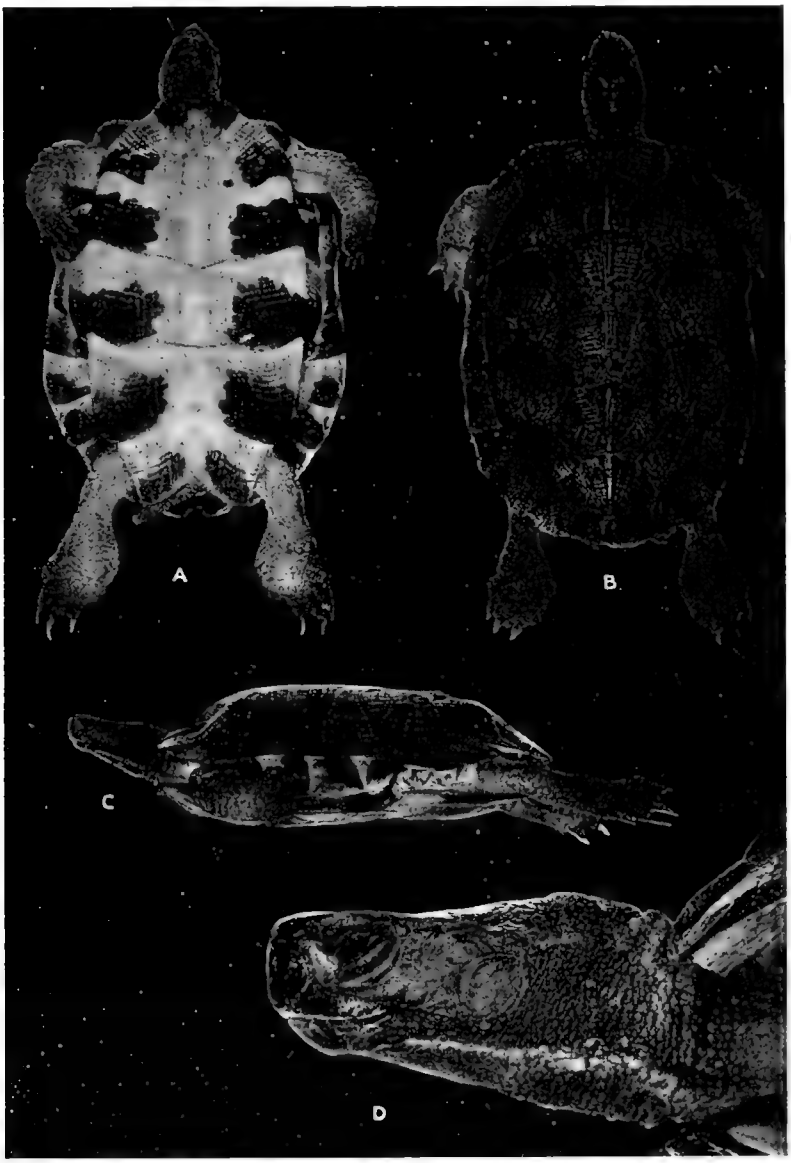


PLATE 29.—*Clemmys insculpta: A,* Adult, ventral view. *B,* Adult, dorsal view. *C,* Adult, lateral view. *D,* Head study of an adult. This specimen is from Wisconsin, close to the Illinois state line.

Soft parts yellow, orange, or red, with the dorsal surfaces dark olive green. Top of head and neck dark olive, blending into yellow on the sides of the neck.

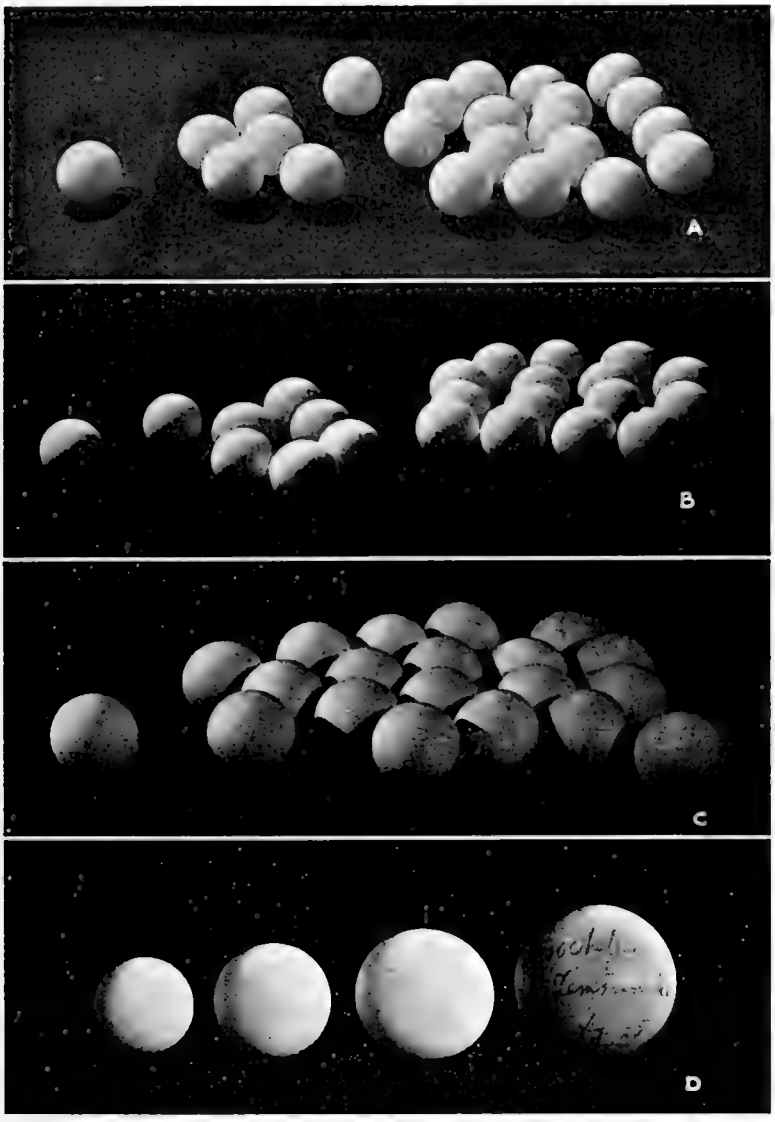


PLATE 30.—Turtle Eggs: The Round Eggs. *A, Amyda mutica. B, Amyda spinifera. C, Chelydra serpentina. D,* Left to right, to show relative sizes: *Amyda mutica, Amyda spinifera, Chelydra serpentina, Macrochelys temminckii.* (The last specimen is the original Agassiz specimen, loaned by the Museum of Comparative Zoology.)

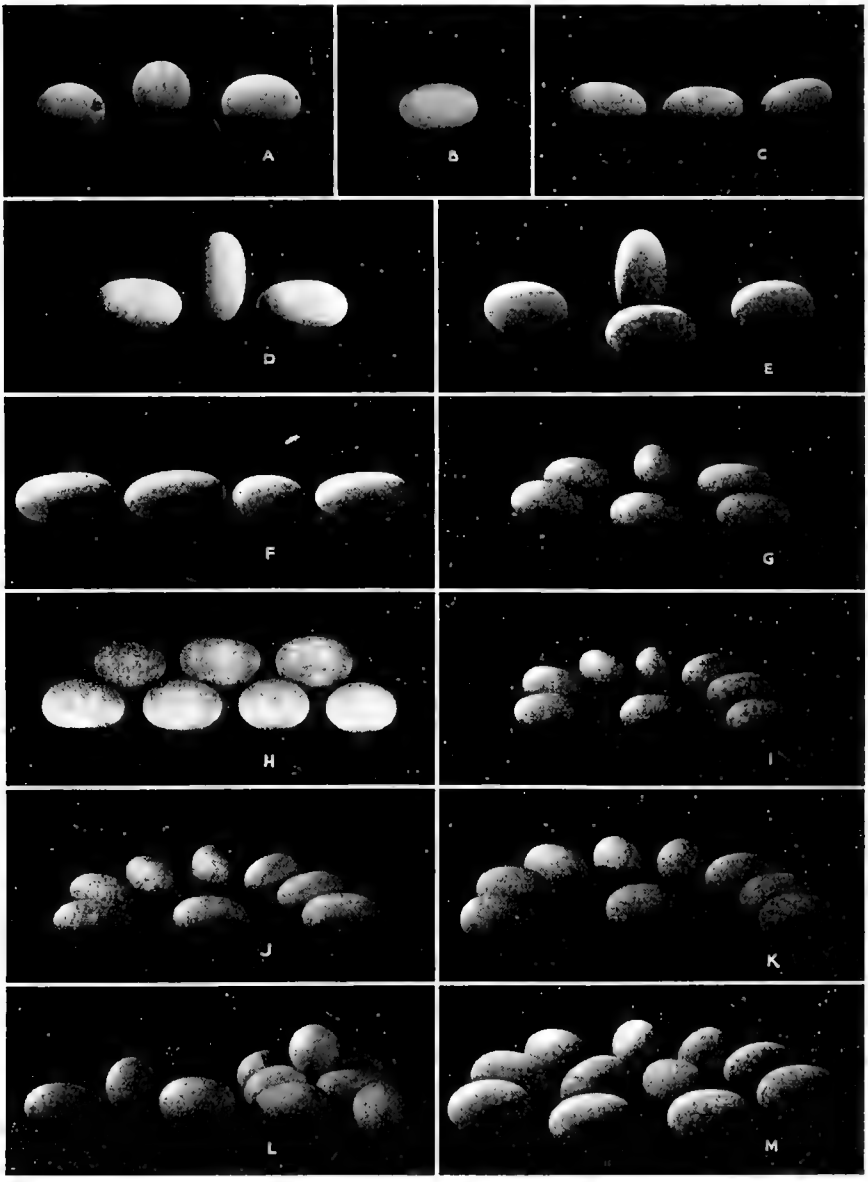


PLATE 31.—Turtle Eggs: The Ovate Eggs. *A, Emys blandingii B, Kinosternon subrubrum subrubrum. C, Clemmys guttata. D, Sternotherus odoratus. E, Terrapene ornata F, Chrysemys picta dorsalis G, Terrapene carolina carolina. H, Pseudemys concinna I, Chrysemys picta marginata. J, Chrysemys picta bellii. K, Graptemys pseudogeographica pseudogeographica. L, Graptemys geographica. M, Pseudemys troostii*

SEX DIFFERENTIATION.—In the male the tail is longer than in the female; the scales on the front legs are coarser and the claws are heavier than in the females. In the adult male the central area of the plastron is concave; in the female this region is either flat or slightly convex, as it is in immature specimens of both sexes.

The wood turtle has never been recorded from Illinois so far as the writer is aware. It is a northern species, which extends in distribution from Maine to Virginia in the east and south, westward to Michigan and Wisconsin and northward into Canada. Ruthven, Thompson, and Gaige (1928) record it from the northern half of southern Michigan. In Wisconsin it is not reported by either Hoy (1883) or Higley (1889), but Pope and Dickinson (1928) report it as "probably state-wide" in distribution, with records from Shawano County (northeastern Wisconsin), Polk County (northwestern), Waupaca County (east central), the upper Wisconsin River (north central), and Waukesha County (extreme south central). It is included in this hypothetical list of Illinois species only on the basis of a specimen taken in the summer of 1933 in Rock County, Wisconsin, by Mr. C. R. Naeser, who presented the specimen to the writer. This turtle was taken from the Rock River south of Janesville, Wisconsin, eleven miles north of the Illinois state line, and is probably a transport. While *Clemmys insculpta* is undoubtedly very rare in southern Wisconsin, if it occurs there at all, the capture of a typical specimen so close to the Illinois line would indicate at least the possibility of its eventually being found in this state. It is one of the very few species that future investigators may perhaps add to the list of native Illinois species.

BIBLIOGRAPHY

Illinois References

Baker, F. C.
1930. The Use of Animal Life by the Moundbuilding Indians of Illinois. Trans. Ill. St. Acad. Sci., XXII:41-64.

Bishop, S. C., and Schmidt, F. J. W.
1931. The Painted Turtles of the Genus Chrysemys. Field Mus. Nat. Hist., Zool. Ser., XVIII:123-139.

Blanchard, F. N.
1924. A Collection of Amphibians and Reptiles from Southeastern Missouri and Southern Illinois. Papers Mich. Acad. Sci., Arts, and Letters, IV:533-541.

Cahn, A. R.
1931. Kinosternon flavescens, a Surprising Turtle Record from Illinois. Copeia, 1931:120-132.

Cahn, A. R., and Conder, E.
1932. Mating of Box Turtles. Copeia, 1932:86-88.

Clark, H. W., and Southall, J. B.
1920. Fresh-water Turtles: A Source of Meat Supply. U. S. Bur. Fish., Doc. 889:3-20.

Cope, E. D.
1875. Check-list of North American Batrachia and Reptilia. U. S. Nat. Mus. Bull., I:1-104.

Davis, N. S., and Rice, F. L.
1883a. North American Batrachia and Reptilia Found East of the Mississippi River. Bull. Ill. St. Lab. Nat. Hist., I:5:3-64.
1883b. List of the Batrachia and Reptilia of Illinois. Bull. Chicago Acad. Sci., I:25-32.

Evermann, B. W., and Clark, H. W.
1930. The Painted Box Turtle, Terrapene ornata, in Indiana. Copeia, 1930: 40-41.

Gaige, H. T.
1914. A List of the Amphibians and Reptiles Observed in Richland County, Illinois, in May, 1913. Copeia, 1914:11.

Garman, H.
1889. A Preliminary Report on the Animals of the Waters of the Mississippi Bottoms, Near Quincy, Illinois in August, 1888. Bull. Ill. St. Lab. Nat. Hist., III:123-184.
1890. Notes on Illinois Reptiles and Amphibians, Including Several Species not before Recorded from the Northern States. Bull. Ill. St. Lab. Nat. Hist., III:185-190.
1892. A Synopsis of the Reptiles and Amphibians of Illinois. Bull. Ill. St. Lab. Nat. Hist., III:215-385.

Garman, S.
1884. The North American Reptiles and Batrachians. Bull. Essex Inst., XVI:3-64.

Hankinson, T. L.
1915. The Vertebrate Life of Certain Prairie and Forest Regions Near Charleston, Illinois. Bull. Ill. St. Lab. Nat. Hist., XI:281-303.
1917. Amphibians and Reptiles of the Charleston Region. Trans. Ill. Acad. Sci., X:322-328.

HAY, O. P.
1892. The Batrachians and Reptiles of the State of Indiana. An. Rept. Dept. Geol. Nat. Res. Indiana, 17:409-602.
1911. Herpetology of Missouri. Trans. Acad. Sci. St. Louis, XX:59-274.
KENNICOTT, R.
1855. Catalogue of Animals Observed in Cook County, Illinois. Trans. Ill. St. Agr. Soc., I:577.
KOFOID, C. A.
1903. Plankton of the Illinois River. Bull. Ill. St. Lab. Nat. Hist., VI:562.
MCLAIN, R. B.
1889. Notes on a Collection of Reptiles from Ft. Smith, Arkansas, with Remarks on other Eastern Reptiles. Wheeling, W. Virginia.
MULLER, J. F.
1921. Notes on the Habits of the Soft-shelled Turtle, Amyda mutica. Am. Midland Nat., VII:6.
STEJNEGER, L.
1923. Rehabilitation of a Hitherto Overlooked Species of Musk Turtle of the Southern States. Proc. U. S. Nat. Mus., 62:6.
STEJNEGER, L., and BARBOUR, T.
1917, 1923, 1933. Check List of North American Amphibians and Reptiles. Harvard University Press.
TAYLOR, W. E.
1895. The Box Tortoises of North America. Proc. U. S. Nat. Mus., XVIII: 573-588.
VANCLEAVE, H. J.
1931. Some of the Biological Effects of Drought. Sci. Monthly, XXXIII:301.
VESTAL, A. G.
1913. An Associational Study of Illinois Sand Prairie. Bull. Ill. St. Lab. Nat. Hist., X:I:1-96.
WEED, A. C.
1922. Reptile Notes. Copeia, 1922:112.
1923. Notes on Reptiles and Batrachians of Central Illinois. Copeia, 116:45-50.
YARROW, H. C.
1882. Check-list of North American Reptiles and Batrachia. Bull. U. S. Nat. Mus., 24:1-249.

GENERAL REFERENCES

The following are particularly valuable to the student of turtles, but though quoted do not contain references directly to Illinois.

AGASSIZ, L.
1857. Contributions to the Natural History of the United States, I-II. Boston.
BABCOCK, H. L.
1919. The Turtles of New England. Monog. Boston Nat. Hist. Soc., VIII: 327-431. (Fine colored plates).
1933. The Eastern Limit of the Range of Chrysemys picta marginata. Copeia, 2:101.
BAUR, G.
1887. Ueber die Stellung der Trionychidae zu den übrigen Testudinata. Zool. Anz., X:96.
1890. On the Classification of the Testudinata. Am. Nat., XXIV:530-536.
1891. American Box Tortoises. Science, (1) XVII:426:190-191.

1893a. Notes on the Classification of the Cryptodira. Am Nat., XXVII:319.
1893b. Further Notes on American Box Tortoises. Am. Nat., XXVII:677.
1893c. Notes on the American Trionychidae. Am. Nat., XXVII:1121.

Blake, S. F.
1921. Sexual Differences in Coloration in the Spotted Turtle, Clemmys guttata. Proc. U. S. Nat. Mus., 59:463-470.

Boulenger, G. A.
1889. Catalogue of the Chelonians, Rynchocephalians, and Crocodiles in the British Museum. London.

Brimley, C. S.
1903. Notes on the Reproduction of Certain Reptiles. Am. Nat., XXXVII: 261-266.
1904. The Box Tortoises of Southeastern North America. Journ. Elisha Mitchell Sci. Soc., XX:1:27-34.
1907. Notes on Some Turtles of the Genus Pseudemys. Journ. Elisha Mitchell Sci. Soc., XXIII:76-84.

Burt, C. E.
1927. An Annotated List of the Amphibians and Reptiles of Riley County, Kansas. Occ. Papers Mus. Zool., Univ. Mich., 189.

Burt, C. E., and Burt, M. D.
1929. Field Notes and Locality Records on a Collection of Amphibians and Reptiles Chiefly from the Western Half of the United States. Journ. Wash. Acad. Sci., XIX:20:448.

Coker, R. E.
1910. Diversity in the Scutes of Chelonia. Journ. Morph., XXI:43-44.

Davis, W. T.
1887. Color of the Eyes as a Sexual Characteristic in Cistudo carolina. Am. Nat., XXI:88.

DeSola, C. R.
1931. The Turtles of the Northeastern States. Bull. N. Y. Zool. Soc., XXIV: 5:131-160.

Ditmars, R. I.
1908. The Reptile Book.

Eigenmann, C. H.
1896. The Inhabitants of Turkey Lake (Indiana). Testudinata. Proc. Ind. Acad. Sci., V:262.

Ellis, M. M., and Henderson, J.
1913. The Amphibians and Reptiles of Colorado. University of Colorado Studies, 10:39-129.

Engelhardt, G. P.
1916. Burrowing Habits of the Box Turtle. Copeia, 31:42.

Evermann, B. W., and Clark, H. W.
1920. Lake Maxinkuckee. Indiana Dept. Conserv., Vol. I.

Ewing, H. E.
1933. Reproduction in the Eastern Box Turtle Terrapene carolina carolina. Copeia, 1933:95.

Gadow, H.
1901. Amphibia and Reptiles. Cambr. Nat. Hist., VIII.

Gage, S. H.
1884. Pharyngeal Respiration in the Soft-shelled Turtle (Aspidonectes spinifer). Proc. Am. Assoc. Adv. Sci., XXXII:316.

GAGE, S. H., and GAGE, S. P.
1886. A Contribution to the Physiology of Respiration in Vertebrates. Pro. Am. Assoc. Adv. Sci., XXXIV:316.
GARMAN, H.
1890. The Differences Between the Geographic Turtles. Bull. Essex Inst., XII:1-14.
GOODRICH, E. S.
1930. Studies on the Structure and Development of Vertebrates. New York.
HALLOWELL, E.
1856. [Remarks on living Sternotherus.] Proc. Acad. Nat. Sci. Phil., VII: 106-108.
HALTOM, W. L.
1931. Alabama Reptiles. Geol. Surv. Ala., Mus. Paper XL.
HAY, O. P.
1891. Some Observations on the Turtles of the Genus Malaclemys. Proc. Ind. Acad. Sci., 120-126.
1903. On the Existing Genera of the Trionychidae. Proc. Am. Phil. Soc., XLII:268.
HOLBROOK, J. E.
1838. North American Herpetology. Ed. I, Vol. 3.
JORDAN, D. S.
1929. Manual of the Vertebrate Animals . . . . 13th ed.
LATHAM, R.
1916. Notes on Cistudo carolina from Orient, Long Island. Copeia, 34:64-67.
LEVETTE, G. M.
1876. The Lakes of Northern Indiana. 7th An. Rept. Geol. Surv. Indiana.
LOENNBERG, E.
1894. Notes on Reptiles and Batrachians Collected in Florida in 1892 and 1893. Proc. U. S. Nat. Mus., XVII:317.
LOGIER, E. B. S.
1928. The Amphibians and Reptiles of the Lake Nipigon Region. Trans. Roy. Can. Inst., XVI:290.
MITSUKURI, K.
1905. The Cultivation of Marine and Fresh-water Animals in Japan. Bull. U. S. Bur. Fish. for 1904, XXIV:259-290.
NASH, C. W.
1906. Batrachians and Reptiles of Ontario. Dept. Educ., Toronto.
NETTING, M. G.
1932. Blanding's Turtle, Emys blandingii, in Pennsylvania. Copeia, 1932:173.
NEWMAN, H. H.
1906. The Habits of Certain Tortoises. Journ. Comp. Neur. and Psych., XVI:126-152.
NICHOLS, J. T.
1933. Further Notes on Painted Turtles. Copeia, 1:41.
ORTENBURGER, A. I., and FREEMAN, B.
1930. Notes on Some Reptiles and Amphibians from Western Oklahoma. Pub. Univ. Okla., Biol. Surv., II:175-188.
OVER, W. H.
1923. Amphibians and Reptiles of South Dakota. S. D. Geol. and Nat. Hist. Surv., Bull. 12.
OVERTON, F.
1916. Aquatic Habits of the Box Turtle. Copeia, 26:4.

PARKER, G. H.
1901. Correlated Abnormalities in the Scutes and Bony Plates of the Carapace of the Sculptured Tortoise. Am. Nat., XXXV:17.
PATCH, C. L.
1925. Graptemys geographica in Canada. Copeia, 149:95.
PEARSE, A. S.
1923. The Growth of the Painted Turtle. Biol. Bull., XLV:145.
RISLEY, P. L.
1929. Anatomical Differences in the Sexes of the Musk Turtle, Sternotherus odoratus. Papers Mich. Acad. Sci., Arts, and Letters, XI:445-464.
1933. Observations on the Natural History of the Common Musk Turtle, Sternotherus odoratus. Pap. Mich. Acad. Sci., Arts, and Letters, XVII:683-711.
SHENCK, J.
1886. Longevity of Turtles. Am. Nat., XX:897.
SIEBENROCK, F.
1907. Die Schildkrötenfamilie Cinosternidae. Sitz. Ber. Akad. Wiss. Wien (math.-nat.), 116, Abt. 1, pp. 527-599.
1909. Synopsis der rezenten Schildkröten, mit Berücksichtigung der in historischer Zeit ausgestorbenen Arten. Zool. Jahrb. Suppl., X:427-618.
STORER, T. I.
1932. The Western Limit of Range of Chrysemys picta bellii. Copeia, 1:9-11.
STRECKER, J. K.
1915. Reptiles and Amphibians of Texas. Baylor Bull., XVIII:4:3-82.
STRECKER, J. K., and HURTER, J.
1909. The Amphibians and Reptiles of Arkansas. Trans. Acad. Sci. St. Louis, XVIII:11-27.
STEWART, N. H.
1928. Some Rare Vertebrates of the Susquehanna Valley, Pennsylvania. Proc. Penn. Acad. Sci., II:24.
STROMSTEN, F. A.
1910. Nest Digging and Egg Laying Habits of Bell's Turtle. Univ. Iowa Stud. Nat. Hist., X :67.
SURFACE, H. A.
1908. Economic Features of Turtles of Pennsylvania. Zool. Bull. Div. Zool., Penn. Dept. Agr., VI:106-195.
VIOSCA, P.
1931. Amphibians and Reptiles of Louisiana. Southern Biological Supply Co., New Orleans.
1933. The Pseudemys troostii-elegans Complex; A Case of Sexual Dimorphism. Copeia, 1933:208-210.
WILCOX, L.
1933. Incubation of Painted Turtle Eggs. Copeia, 1:41.
YERKES, R. M.
1904. Space Perception of Tortoises. Journ. Comp. Neur. and Physiol., XIV:16-26.
1905. The Color Pattern of Nanemys guttata. Science, N. S., 21:386.

REFERENCES FOR STATES ADJACENT TO ILLINOIS

The following few titles are intended to afford the student a starting point for references to the turtles of the adjacent states.

Wisconsin

CAHN, A. R.
1929. The Herpetology of Waukesha County, Wisconsin. Copeia, 170:4-8.

HIGLEY, W. K.
1889. Reptilia and Batrachia of Wisconsin. Trans. Wis. Acad. Sci., Arts, and Letters, VII:155-176.

HOY, P. R.
1883. Catalogue of the Cold-blooded Vertebrates of Wisconsin. Geol. of Wisconsin, I:422-426.

POPE, T. E. B., and DICKINSON, W. E.
1928. The Amphibians and Reptiles of Wisconsin. Bull. Pub. Mus. City Milwaukee, VIII:1-138.

Indiana

BLANCHARD, F. N.
1925. A Collection of Amphibians and Reptiles from Southern Indiana and Adjacent Kentucky. Papers Mich. Acad. Sci., Arts, and Letters, V:367-388.

BLATCHLEY, W. S.
1891. Notes on the Batrachians and Reptiles of Vigo County, Indiana. Journ. Cinc. Soc. N. H., XIV:22-35.

EVERMANN, B. W., and CLARK, H. W.
1920. Lake Maxinkuckee. Indiana Dept. Conservation, Pub. 7, Vol. 1.

HAY, O. P.
1892. The Batrachians and Reptiles of the State of Indiana. An. Rept. Dept. Geol. Nat. Res. Indiana, 17:406-610.

MYERS, G. S.
1925. A Synopsis for the Identification of the Amphibians and Reptiles of Indiana. Proc. Ind. Acad. Sci., XXXV:277-294.
1926. Notes on Indiana Amphibians and Reptiles. Proc. Ind. Acad. Sci., XXXVI:337-340.

Missouri

HURTER, J.
1903. Second Contribution to the Herpetology of Missouri. Trans. Acad. Sci. St. Louis, XIII:77-86.
1911. Herpetology of Missouri. Trans. Acad. Sci. St. Louis, XX:59-274.

Iowa

BLANCHARD, F. N.
1922. The Amphibians and Reptiles of Dickinson County, Iowa. Univ. Iowa Stud. Nat. Hist., X:19-26.

RUTHVEN, A. G.
1910. Contributions to the Herpetology of Iowa. Proc. Iowa Acad. Sci., 19:198-209.

Ohio

MORSE, M.
1904. Batrachians and Reptiles of Ohio. Proc. Ohio. St. Acad. Sci., IV: 91-144.

SMITH, W. H.
1882. Report on the Reptiles and Amphibians of Ohio. Rept. Geol. Surv. Ohio., IV:633-734.

Michigan

Ruthven, A. G., Thompson, C., and Gaige, H. T.
1928. The Herpetology of Michigan. Univ. Mus., Univ. Mich., Mich. Handbook Ser., No. 3.

Smith, W. H.
1879. Catalogue of the Reptiles and Amphibians of Michigan. Suppl. Sci. News, i-viii.

Tennessee

Blanchard, F. N.
1922. The Amphibians and Reptiles of Western Tennessee. Occ. Pap. Mus. Zool., Univ. Mich., 117:1-18.

Rhoades, S. N.
1895. Contributions to the Zoology of Tennessee. Proc. Acad. Nat. Sci. Phil., 376-407.

References for Synonymy

The following list includes works referred to in the synonymy of the genera and species, except those already given in the preceding sections of this bibliography.

Baur, G.
1893. Notes on the Classification and Taxonomy of the Testudinata. Proc. Am. Philos. Soc., 31:210-225.

Bell, T.
1826. A Monograph of the Tortoises having a Movable Sternum, with remarks on their arrangement and affinities. Zool. Journ., 2:299-310.

Bonaparte, C. L.
1830. Osservazione sulla seconda edizione del Regno Animale del Barone Cuvier. Bologna.

Bonnaterre, [M. l'Abbé]
1789. Tableau Encyclopédique et Méthodique des Trois Règnes de la Nature. Erpétologie. Paris.

Brimley, C. S.
1928. Two new Terrapins of the Genus Pseudemys from the Southern States. Journ. Elisha Mitchell Soc., 44:66-69.

Cope, E. D.
1872. Synopsis of the species of Chelydrinae. Proc. Acad. Nat. Sci. Phila., 1872:22-29.
1895. Taylor on Box Tortoises. Am. Nat., 29:756-757.

Cragin, F. W.
1894. Herpetological Notes from Kansas and Texas. Colorado College Studies, 5:37-39.

Daudin, F. M.
1802. Histoire Naturelle des Reptiles, 2:1-326. Paris.

De Kay, J. E.
1842. Zoology of New York, or the New York Fauna. Part III. Reptiles and Amphibia. Albany.

Ditmars, R. L.
1936. The Reptiles of North America. New York

Duméril, A.
1851. Catalogue Méthodique de la Collection des Reptiles du Muséum d'Histoire Naturelle de Paris. Paris.

Duméril, A. M. C., and Bibron, G.
1834-35. Erpétologie Générale, 1(1834):345-439; 2(1835):1-570. Paris.

ECKEL, E. C., and PAULMIER, F. C.
1902. Catalogue of New York Reptiles and Batrachians. Bull. N. Y. State Mus., 51:355-414.
FITZINGER, L. J.
1835. Entwurf einer Systematischen Anordnung der Schildkröten nach den Grundsätzen der Natürlichen Methode. Ann. Wien. Mus., 1:103-128.
FLEMMING, J.
1822. Philosophy of Zoology. London.
FOWLER, H. W.
1906. The Amphibians and Reptiles of New Jersey. Rep. N. J. State Mus., 1906:23-376.
GMELIN, J. F.
1789. Systema Naturae, 1:1036-1046.
GRAVENHORST
1829. Reptilia Musei Zoologica Vratislavensis Fasciculus Primus. Leipzig.
GRAY, J. E.
1831. Synopsis Reptilium, or Short Descriptions of the Species of Reptiles. London.
1844. Catalogue of the Tortoises, Crocodiles, and Amphisbaenians in the Collection of the British Museum. London.
1855. Catalogue of the Shield Reptiles in the British Museum. London.
1869. Notes on the Families and Genera of Tortoises (Testudinata) and on the characters afforded by the study of their skulls. Proc. Zool. Soc. London, 1869:165-225.
1870. Supplement to the Catalogue of Shield Reptiles in the British Museum. London.
1872. Appendix to the Catalogue of Shield Reptiles in the British Museum. London.
1873. Hand-list of Specimens of Shield Reptiles in the British Museum. London.
HARLAN, R.
1826. Genera of North American Reptiles and a Synopsis of the Species. Journ. Acad. Nat. Sci. Phila., 5:317-372; 6:7-37.
1837. Description of a new species of Fresh Water Tortoise, Inhabiting the Columbia River. Am. Journ. Sci. Arts, 31:382-383.
HAY, O. P.
1903. Existing Genera of the Trionychidae. Proc. Am. Philos. Soc., 42:268-274.
HEUDE, M.
1880. Memoire sur les Trionyx. Mem. Hist. Nat. Emp. Chinois, 1(pt. 1): v-viii + 1-38.
HOLBROOK, J. E.
1842. North American Herpetology, 1:1-152; 2:1-47. (2nd Ed.). Philadelphia.
LACÉPÈDE, (COMPTE DE)
1788. Histoire Naturelle des Quadrupèdes Ovipares et des Serpents, 1:54-175. Paris.
LE CONTE, J.
1830. Description of the species of North American Tortoises. Ann. Lyc. Nat. Hist. N. Y., 3:91-131.
LE SUEUR, C. A.
1817. An Account of an American Species of Tortoise, not noticed in the Systems. Journ. Acad. Sci. Phila., 1:86-88.
1827. Note sur deux Espèces de Tortues du genre Trionyx Gffr. St. H. Mem. Mus. Hist. Nat. Paris, 15:257-268.

Linnaeus, C.
1758. Systema Naturae. Stockholm.
Lindholm, W. A.
1929. Revidiertes Verzeichnis der Gattungen der rezenten Schildkröten nebst Notizen zur Nomenklatur einiger Arten. Zool. Anz., 81:275-295.
Maximilian, Prince zu Wied-Neuwied
1865. Verzeichnis der Reptilien, welche auf einer Reise im nördlichen Amerika beobachtet wurden. Nova Acta Acad. Leop. Carol., 32:viii + 141.
Merrem, B.
1820. Versuch eines Systems der Amphibien. Marburg.
Oken, L.
1816. Lehrbuch der Zoologie. Jena.
Rafinesque, C. S.
1832. Atlantic Journal, 1:64.
Ritgen.
1828. Nova Acta Acad. Leop. Carol., 4:1:272.
Ruthven, A. G.
1924. A Check List of North American Amphibians and Reptiles. [Review.] Science, 59:339-340.
Say, T.
1825. On the Fresh Water and Land Tortoises of the United States. Journ. Acad. Sci. Phila., 4:203-219.
Schneider, J. G.
1792. Beschreibung und Abbildung einer neuen Art von Wasserschildkröte. Schriften Ges. Naturf. Freunde Berlin, 10:259-283.
Schoepff, J. D.
1792. Historia Testudinum. Erlangen.
Schweigger, A. F.
1812. Prodromus Monographiae Cheloniorum. Königsberg.
1814. Prodromi Monographiae Cheloniorum. Königsberg.
Sonnini, C. S., and Latreille, P. A.
1802. Histoire Naturelle des Reptiles, 1:12-172. (Pagination of new edition.) Paris.
Stejneger, L.
1923. Rehabilitation of a Hitherto Overlooked Species of Musk Turtle of the Southern States. Proc. U. S. Nat. Mus., 62(Art. 6):1-3.
Stone, W.
1903. A Collection of Reptiles and Batrachians from Arkansas, Indian Territory, and Western Texas. Proc. Acad. Nat. Sci. Phila., 55:538-542.
Strauch, A.
1862. Chelonologische Studien. Mem. Acad. Sci. St. Petérsbourg, (7) 5:1-196.
1865. Die Verteilung der Schildkröten über den Erdball, *Ibid.*, (7) 8:1-207.
Vaillant, L.
1894. Essai sur la Classification générale des Cheloniens. Ann. Soc. Sci. Nat. Zool., (7) 16:331-345.
Wagler, J.
1830. Naturliches System der Amphibien. Munich.
Yarrow, H. C.
1882. Check List of North American Reptilia and Batrachia, with Catalogue of Specimens in the United States National Museum. Bull. U. S. Nat. Mus., 24:1-249.

GLOSSARY

Abdominal scutes: From the anterior end, the fourth pair of scales of the plastron.
Alveolar surface: The flat masticatory surface of the jaws, lying just inside the cutting edge.
Amphycoelous: A condition of the body (centrum) of the vertebra in which both ends are concave.
Anal plates: The most posterior pair of scutes of the plastron.
Anchylose: A fixed (fused) joint.
Axillary plate: A small plate inserted in the anterior (axillary) margin of the bridge.
Barbel: A short process of skin about the mouth, neck, or chin.
Bridge: The lateral prolongation of the plastron, together with other elements, which meets the carapace.
Callosity: A patch of hard skin on the plastron of soft-shelled turtles.
Carapace: The upper (dorsal) portion of the shell of a turtle.
Carinate: Keeled, or with a sharp ridge.
Choana: The internal opening of the nostrils.
Costal: Pertaining to the ribs; hence: the paired lateral scutes of the carapace.
Costiform: Rib-like.
Cruciform: Shaped like a cross.
Dermal skeleton: The bony skeleton of the shell.
Emarginate: With a broad, shallow notch.
Entoplastron: The only unpaired bony element of the dermal skeleton of the plastron.
Epidermal skeleton: The scale-like shields or scutes which cover the dermal skeleton of most turtles.
Epiplastra: The most anterior, paired bony elements of the dermal skeleton.
Femoral scutes: From the anterior end, the fifth pair of scales of the plastron.
Gulars: The most anterior pair of scutes of the plastron.
Hinge: A ligamentous, flexible joint in the plastron.
Humerals: The second most anterior pair of scutes of the plastron.
Hyoplastra: From the anterior end, the second pair of bony elements of the dermal skeleton.
Hypoplastra: The third most anterior pair of bony elements of the dermal skeleton.
Inframarginals: Secondary scutes lying below (ventral) the marginals.
Inguinal: A small plate inserted in the posterior (inguinal) margin of the bridge.
Intergular: An unpaired element located anterior to the gular scutes in a few turtles.
Keel: A well-defined ridge.
Lobe: The region of the plastron anterior or posterior to the bridge.
Marginals: Scutes forming the lateral margin of the carapace.
Neurals: The middle (unpaired) series of bony elements of the dermal skeleton of the carapace.
Notch: A sharp V-shaped indentation.
Nuchal: The most anterior, unpaired, median marginal scute.
Opisthocoelous: The condition in the body (centrum) of the vertebra in which the anterior face is convex, the posterior face concave.
Papilla: A small fold of the mucous membrane within the nose.
Pectoral scutes: From the anterior end, the third, paired, set of scutes of the plastron.

Plate: A scute; usually designating a heavy scale.
Plastron: The ventral portion of the shell of a turtle.
Procoelous: The condition in the body (centrum) of a vertebra in which the anterior face is concave, the posterior convex.
Pygals: The scutes above the tail; supracaudals; caudal marginals.
Reniform: Kidney-shaped.
Reticulate: Net-like.
Rugae: Small folds; wrinkles.
Scute: A scale; one of the component elements of the epidermal skeleton.
Serrate: Toothed; saw-edge.
Shield: A scute.
Submarginal: Below the marginal scutes.
Supracaudal: Above the tail; the most posterior pair of marginal scutes; caudal marginals; pygals.
Supramarginals: Accessory marginal scutes located above the marginals.
Symphysis: The fixed union along the midline between paired bones.
Temporal arch: A bony bar extending from the quadrate to the upper jaw.
Truncate: Having a square or even edge.
Tubercle: A short, knob-like protuberance.
Vertebral: The median, unpaired scutes of the carapace.
Wing: The lateral prolongation of the elements of the plastron which aid in forming the bridge.
Xiphiplastra: The most posterior paired bony elements of the dermal skeleton of the plastron.