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# VARIATION IN GROWTH RATES IN THREE POPULATIONS OF THE PAINTED TURTLE, *CHRYSEMYS PICTA*[1]

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Some species of turtles are excellent organisms for studies of growth because both age (from scale annuli) and size (by measurement of plastron length) can be accurately determined.

Numerous references have been made concerning growth in turtles. Most of these have been observations of single individuals, though a few studies on a population level have been undertaken (Pearse, 1923; Hildebrand, 1932; Risley, 1933; Sergeev, 1937 (from Cagle, 1946); and Cagle, 1946).

Hildebrand (1932) noted that individual *Malaclemmys centrata* of similar age and size varied greatly in growth rate. Cagle (1946) pointed out that individuals of *Pseudemys scripta* from three different localities in Illinois varied in growth rates and size depending upon which population they were from. He thought these differences resulted from differences in age, water temperature, and abundance of food.

Three populations of *Chrysemys picta* from southwestern Michigan were examined in the present study to determine what factors might be responsible for the differences in growth rate and maximum size of individuals from each population.

The Department of Zoology and the W. K. Kellogg Biological Station of Michigan State University provided materials and laboratory space used in the study. I thank Mr. Don L. McGregor for field assistance and for reading the manuscript. Dr. W. E. Cooper was consulted for statistical advice. Dr. Allen W. Knight helped collect the turtles from the Kalamazoo River. The study was assisted by a Sigma Xi Grant-in-Aid of Research. Manuscript preparation was

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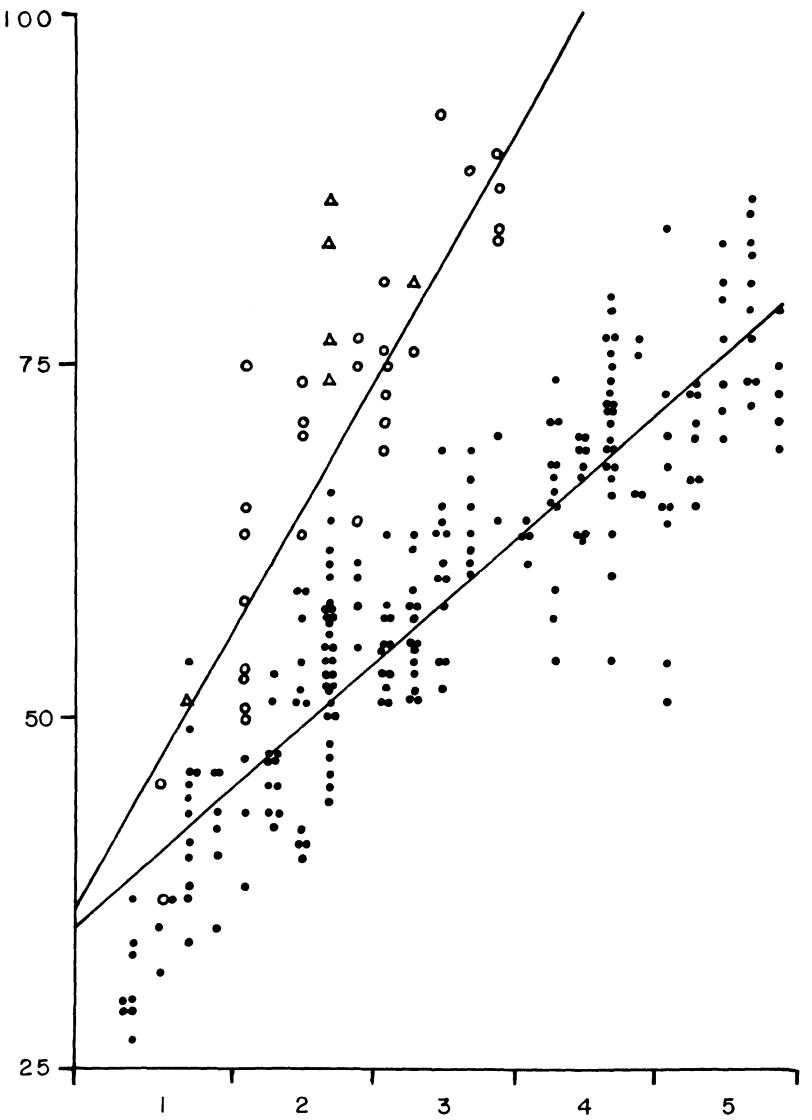


FIG. 1.—Relationship between age and plastron length of juvenile *Chrysemys picta* from the Kalamazoo River (triangles), Wintergreen Lake (open circles), and Sherriff's Marsh (closed circles). Individuals are included throughout the growing season at which most males in the particular population reach maturity. Regression equation for Wintergreen Lake (upper line) is $y = 36.4 + 3.55x$. Regression equation for Sherriff's Marsh (lower line) is $y = 35.2 + 1.77x$.

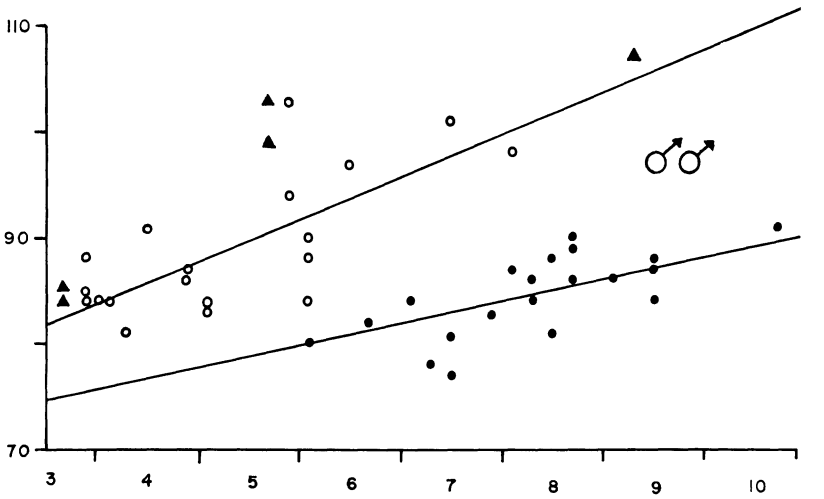


FIG. 2.—Relationship between age and plastron length in mature male *Chrysemys picta* from the Kalamazoo River (triangles), Wintergreen Lake (open circles), and Sherriff's Marsh (closed circles). Regression equation for Wintergreen Lake (upper line) is $y = 82.9 + .76x$. Regression equation for Sherriff's Marsh (lower line) is $y = 75.0 + .40x$.

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## PROCEDURE

From July 1964 to November 1966 ecological studies were made on populations of the painted turtle, *Chrysemys picta*, from three distinctive habitats in southwestern Michigan.

The first habitat, Sherriff's Marsh, is composed of several hundred acres of a grass-sedge association surrounding ten acres of open water consisting of a winding channel and an adjoining lake. During the summer months the channel is filled with aquatic plants. The bottom sediment is highly enriched with organic matter. Dominant aquatic plants are coontail (*Ceratophyllum*), duckweeds (*Lemna* and *Spirodela*), and lily pads (*Nymphaea* and *Nuphar*).

The second habitat, Wintergreen Lake, is two miles from the marsh and is about 20 acres in surface area. It is highly eutrophic with organic bottom sediments. Aquatic plants are abundant around the periphery, the dominant submergents being *Ceratophyllum* and *Potamageton*. *Nymphaea* and *Nuphar* are also present.

The third locality is a highly polluted stretch of the Kalamazoo River near Otsego, Michigan. Most of the turtles from this habitat were taken from a mud flat where aquatic vegetation is sparse, although duckweeds and filamentous algae are present. The bottom is predominantly silt and clay.

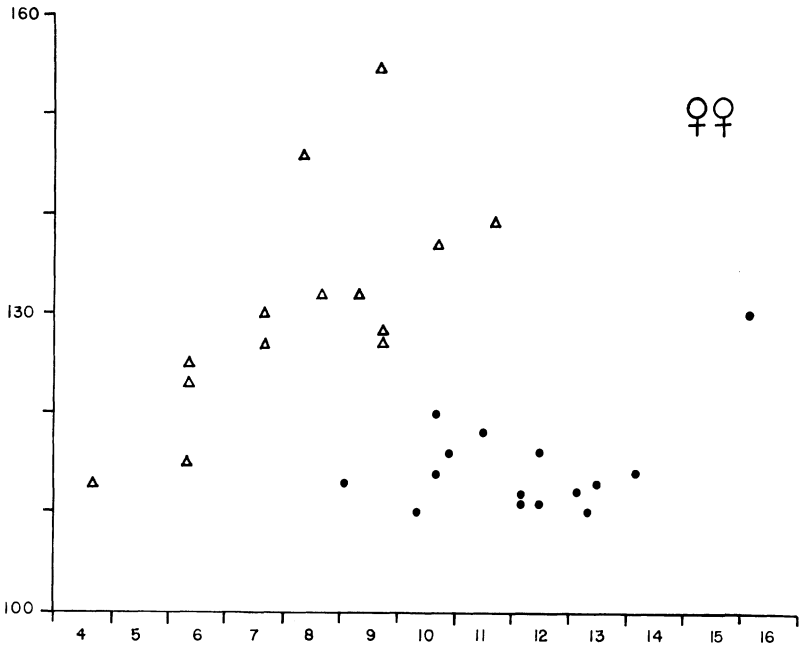


FIG. 3.—Relationship between age and plastron length of mature female *Chrysemys picta* from the Kalamazoo River (open circles) and Sherriff's Marsh (closed circles).

When possible, age, sex, and plastron length were taken for each animal captured. Age was determined by counting plastral annuli. Sex of turtles from the river and lake populations was determined by dissection. Mature males from the marsh were recognized by their long claws and mature females by their large size and short claws. Length was determined by straight-line measurement of the plastron with a millimeter rule. These observations were made on 308 *Chrysemys* from Sherriff's Marsh, 61 from Wintergreen Lake, and 28 from the Kalamazoo River.

Because growth rates of mature males and females and of immature animals are different, these classes were separated in each sample before comparison. Immature females larger than the size at which males reach maturity were not considered. Maturity in this region is attained when males reach a plastron length of about 80 mm and females about 115 mm.

Sexton (1965) considered that most of the growth in painted turtles from southeastern Michigan occurred from June through August. Mark-recapture studies in Sherriff's Marsh have shown that at least some growth occurs during May and September in this population. Therefore, for the present report, the growing season for

individuals from the study populations is considered as being from May through September.

## Results

Figure 1 shows the relationship between age and plastron length of immature male and female *Chrysemys picta* from three populations in southwestern Michigan. Regressive equations were determined for the lake and marsh populations. Too few specimens were available in this size class from the Kalamazoo River for statistical comparison; however, the six observations are shown. The 95% confidence interval for the regression coefficient of the lake population is 3.55 ± 0.69; that for the marsh population is 1.77 ± 0.12. The growth rate is about 18–26 mm/year for the lake turtles and 10–12 mm/year for those from the marsh.

Growth of mature males from each of the populations is shown in Fig. 1. Again, the regression equations were determined only for the lake and marsh populations since only five specimens were available from the river. The 95% confidence intervals for the lake and marsh populations respectively are 0.76 ± 0.37 and 0.40 ± 0.24. The growth rate in turtles from the lake is approximately 2–6 mm/year, whereas that in the marsh population is about 1–3 mm/year.

Growth curves for mature females were not determined statistically. However, a comparison between the river and marsh populations indicates more rapid growth in the turtles from the Kalamazoo River (Fig. 3). Mature females from Wintergreen Lake are not indicated on the diagram but were intermediate between the other two populations.

Maximum size of individuals is also different in each population, as indicated in Fig. 4. Both males and females from the Kalamazoo River population exhibit a slightly higher maximum size than those from Wintergreen Lake; individuals of both sexes from Sherriff's Marsh have a smaller maximum size than turtles from either of the other populations.

All turtles observed in the marsh were feeding on aquatic vegetation, primarily duckweed. Five dissected specimens had full stomachs containing more than 95% plant materials of several species. The only animal matter was small invertebrates which may have been eaten inadvertently with the vegetation.

Animal matter was found in more than 50 specimens from Wintergreen Lake which were examined qualitatively for stomach contents. Earthworms, fish remains, and snails were often present, though aquatic plants were most abundant.

The Kalamazoo River turtles displayed the most striking food habits. In June and August of 1966, stomachs of 47 *Chrysemys* were examined quantitatively. Invertebrates made up more than 75% of

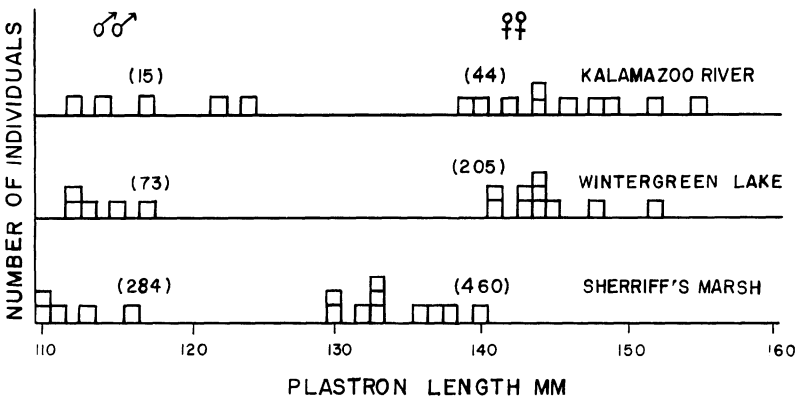


FIG. 4.—Five largest males and ten largest females from each of three populations of *Chrysemys picta*. Numbers in parentheses represent sample sizes from which selections were made.

the stomach contents. Most of the stomachs contained little or no plant material. Midges made up the bulk of the diet in June and cladocerans were the most abundant form in August (Knight and Gibbons, in preparation).

## DISCUSSION

Growth rates and maximum sizes of *Chrysemys picta* are different in different populations. Turtles from the Kalamazoo River show the greatest maximum size and rate of growth. *Chrysemys* from Sherriff's Marsh have a relatively slow growth rate and small maximum size. Turtles from Wintergreen Lake are intermediate between the other two populations in growth rate and size but most closely approach the Kalamazoo River turtles in these aspects.

Cagle (1946) noted different growth rates in *Pseudemys* populations in Illinois. He attributed the rapid growth in one population to an abundant food supply and high water temperature which increased metabolic rate. The difference in water temperature probably does not play a significant role in determining growth in the *Chrysemys* populations of the present study, since annual temperature regimes are similar for all three habitats. Abundance of food does not guarantee a rapid growth rate either, since the slowest growing population (Sherriff's Marsh) had a tremendous amount of available food in the form of aquatic vegetation.

However, food quality might be the cause for such variation between these geographically adjacent populations. The Kalamazoo River turtles are primarily carnivorous; those from Sherriff's Marsh are herbivorous; the Wintergreen Lake population is omnivorous. Growth rates in these three populations increase progressively as

the diet becomes more carnivorous. The actual growth rates of individuals within each population are in accord with these food habits: it is more efficient to eat animal than plant food.

Cagle (1946) stated that individual *Pseudemys* from one population were larger because of their faster growth rate and also because of their being from an older population. I feel that population age had little bearing on average or maximum size of individual *Chrysemys* in the study areas. The best evidence for this is that two individuals less than ten years old from the Kalamazoo River exceeded the maximum plastron length of any of the Sherriff's Marsh turtles. Since many turtles from the marsh are over ten years old, population age is not necessarily a factor in the size attained by the river turtles.

A possible explanation for the individual size differences which exist among the three populations is that growth rate slows down considerably within a few years after the animals reach maturity so that the fastest growing turtles gain a size superiority during the initial growth and retain it in the subsequent years of negligible growth.

A change in diet could cause such a cessation in growth in some populations. Marchand (1942) found that stomachs of immature *Chrysemys* from Reelfoot Lake, Tennessee, contained mostly animal matter whereas the adults had eaten mostly plants. He suggested the possibility that *Chrysemys* are carnivorous by preference but that the larger adults become primarily herbivorous since animal food "can no longer be obtained in sufficient quantity to meet the normal requirements. . . ." This idea is feasible since the energy expended in capturing prey in thick vegetation might not be compensated for by the prey alone and would need to be supplemented by a plant diet.

The *Chrysemys* from the Kalamazoo River eat an abundance of animal food even as adults. Correspondingly, many large individuals show rapid growth (Fig. 3). It is suggested, therefore, that the type of food is an important factor influencing the rate of growth in *Chrysemys picta* even after attainment of maturity.

Food differences could create variations in growth rates between mature individuals from different populations, though not to the extent that has been observed in younger turtles. This aspect is presently under investigation.

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## THE OCCURRENCE OF *THAMNOPHIS SIRTALIS* AND *T. RADIX* IN THE PRAIRIE–FOREST ECOTONE WEST OF ITASCA STATE PARK, MINNESOTA

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The distribution of the Common Garter Snake (*Thamnophis sirtalis*) is reported by Schmidt and Davis (1941) and Conant (1958) to be limited mainly to the eastern United States. However, Fitch and Maslin (1961) point out that various subspecific forms of this serpent range from the Atlantic to the Pacific coast and from southeastern Alaska into northern Mexico, perhaps giving it the greatest geographic range of any North American reptile. Within its range, *T. sirtalis* commonly inhabits forested regions which are interspersed with open areas. It may even frequent vacant city lots and heavily populated regions.

The range of the Plains Garter Snake (*Thamnophis radix*) is more limited and appears restricted chiefly to the prairie regions of the central United States. Schmidt and Davis (1941) indicate that this species occurs from eastern Illinois westward and northward throughout the grasslands, and southward into Missouri and eastern Kansas. Conant (1958) reports this snake from as far east as central Ohio. Breckenridge (1958) suggests that, in Minnesota, *T. sirtalis* occurs only in the eastern portion of the state whereas, the range of *T. radix* and the prairies coincide in the west.

In Minnesota, little was known about the area of range overlap for these two species. This study was concerned with their occurrence within the prairie–forest ecotone, or transition zone, of Mahnomen County, approximately 40 miles west of Itasca State Park.

In Mahnomen County, the prairie–forest ecotone is characterized by the westward extension of the forests, which terminate roughly along the Big Stone Moraine. Scattered areas of relict prairie, how-