

Society for the Study of Amphibians and Reptiles

Geographic Variation in the Seasonal Activity Cycle of Spotted Turtles, *Clemmys guttata*

Author(s): Jeffrey E. Lovich

Reviewed work(s):

Source: *Journal of Herpetology*, Vol. 22, No. 4 (Dec., 1988), pp. 482-485

Published by: [Society for the Study of Amphibians and Reptiles](#)

Stable URL: <http://www.jstor.org/stable/1564346>

Accessed: 15/11/2012 20:19

Your use of the JSTOR archive indicates your acceptance of the Terms & Conditions of Use, available at <http://www.jstor.org/page/info/about/policies/terms.jsp>

JSTOR is a not-for-profit service that helps scholars, researchers, and students discover, use, and build upon a wide range of content in a trusted digital archive. We use information technology and tools to increase productivity and facilitate new forms of scholarship. For more information about JSTOR, please contact support@jstor.org.



Society for the Study of Amphibians and Reptiles is collaborating with JSTOR to digitize, preserve and extend access to *Journal of Herpetology*.

<http://www.jstor.org>

- FRAZER, N. B., AND L. M. EHRHART. 1985. Preliminary growth models for green, *Chelonia mydas*, and loggerhead, *Caretta caretta*, turtles in the wild. *Copeia* 1985:73-79.
- LIMPUS, C. J. 1979. Notes on growth rates of wild turtles. *Marine Turtle Newsl.* 10:3-5.
- . 1985. A study of the loggerhead sea turtle, *Caretta caretta*, in eastern Australia. Ph.D. Dissertation, Univ. Queensland, Australia. 481 pp.
- MENDONCA, M. T. 1981. Comparative growth rates of wild immature *Chelonia mydas* and *Caretta caretta* in Florida. *J. Herpetol.* 15:447-451.

Accepted: 29 April 1987.

Journal of Herpetology, Vol. 22, No. 4, pp. 482-485, 1988
Copyright 1988 Society for the Study of Amphibians and Reptiles

Geographic Variation in the Seasonal Activity Cycle of Spotted Turtles, *Clemmys guttata*

JEFFREY E. LOVICH, *Savannah River Ecology Laboratory, Drawer E, Aiken, South Carolina 29801, USA.*

The spotted turtle (*Clemmys guttata*) is a small semi-aquatic species that typically inhabits shallow wetlands (Ernst and Barbour, 1972). They are widely distributed in suitable habitats from southern Ontario to northern Florida, and west through Pennsylvania and the lower Great Lakes region to northeastern Illinois (Ernst, 1972). Previous investigators have noted that northern populations of *C. guttata* are active primarily during the spring (Conant, 1951; Nemuras, 1966; Ernst, 1976), and appear to shun high environmental temperatures (Ward et al., 1976; Ernst, 1982). However, there are no published accounts regarding the seasonal activity cycle of this essentially northern species in the southern part of its range. If aversion to high temperature is consistent in the species, then turtles at lower latitudes should initiate their activity cycle earlier than populations at higher latitudes. The objective of this study was to compare the seasonal activity cycles of *C. guttata* from various geographic regions.

Previously published seasonal activity cycles for *C. guttata* (Ohio—Conant, 1951; Maryland—Nemuras, 1966; Pennsylvania—Ernst, 1976) were compared, along with unpublished records for South Carolina. Records for South Carolina were based on live animals captured on or near the Savannah River Plant in Aiken and Barnwell Counties, and data associated with preserved specimens in the Charleston Museum from other sites in the state. Seasonal activity in each state was measured by the number of captures per month. Data for each state are based on collecting activities spanning two or more years. Frequencies between states were compared using contingency table analysis (Zar, 1984) under the null hypothesis that levels in any time interval were independent with respect to geographic region, assuming no collector

bias or significant year-to-year variation. Multiple comparisons of all possible pairs of states were then made using Gabriel's (1966) simultaneous test procedures. The resulting log likelihood ratio statistics, $2l (=G)$, were compared with critical values of χ^2 at an alpha level of 0.10 due to the conservative nature of the test. Confidence intervals of the binomial parameter π were plotted for significant comparisons, using graphical procedures proposed by Snee (1974), to determine which time intervals contributed most of the observed heterogeneity between populations.

Climatological data for the period 1951-80 were obtained from tables published by the National Climatic Data Center (Publication No. 81 [by state]). Mean monthly and annual normal air temperatures (AT) reported in this paper for Maryland and Pennsylvania populations were taken from the recording station nearest to the study sites of Nemuras (1966) and Ernst (1976): Owing's Ferry Landing, Maryland; and Landisville, Pennsylvania, respectively. In Ohio and South Carolina these values were calculated as the mean of all recording stations within the statewide distribution of the species, since *C. guttata* activity data for these states were obtained from numerous widely scattered localities. Predicted cloacal temperatures (CT) were calculated using the formula

$$CT = 5.20 + 0.82(AT)$$

reported by Ernst (1982) for feeding *C. guttata* where AT is the mean monthly air temperature discussed above.

Levels of spotted turtle activity as measured by frequency of capture were highest in the spring for all states (Fig. 1). In Maryland, 74% of all activity occurs from March to May, inclusive. During the same period in Pennsylvania and Ohio, the frequencies are 68% and 93%, respectively. In South Carolina, over 50% of yearly captures were made in February and March. Activity peaks occurred in May for all populations sampled except South Carolina which reached a maximum in March. Activity levels decline in June for all populations except South Carolina which begins to decline in April.

An overall test of independence revealed significant heterogeneity ($P < 0.10$) among the various activity cycles suggesting that levels of activity are strongly dependent on geographic locality. In addition, all pairwise comparisons between states were significant except for Pennsylvania vs. Maryland (Table 1). Most of the heterogeneity observed between South Carolina and other states is due to comparatively low levels of activity from April-July in the former (Fig. 2). Low levels of activity in Ohio during June and July contrast significantly with those observed in Maryland and Pennsylvania.

Activity levels peak when the mean monthly air temperature (AT) is between 13.1°-18.0°C ($\bar{x} = 15.5$) (Table 2), which is at least two months earlier than the month with highest mean AT. Levels of activity begin to decline when the mean monthly AT is between 17.8°-22.3°C ($\bar{x} = 20.3$), and then approach or reach a minimal level during the month with highest mean AT.

The thermal ecology and seasonal activity cycle of

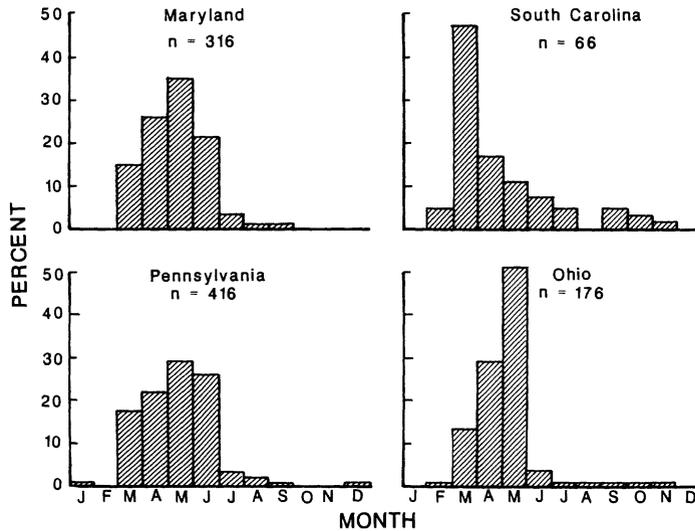


FIG. 1. Seasonal activity cycles for spotted turtles as measured by the number of captures/records per month. Refer to text for details.

C. guttata has received considerable attention in the literature. Ernst (1967) observed mating pairs in southeastern Pennsylvania in March with CTs equal to or below the minimum voluntary temperatures reported for other aquatic turtles by Brattstrom (1965). Later in the year, when shallow ponds exceeded 30°C, spotted turtles began aestivation in muskrat (*Ondatra zibethica*) burrows and lodges, and the soft bottoms of small streams (Ernst, 1982). The highest CT observed by Ernst (1982), 32°C, was far below the mean critical thermal maximum reported for the species (41.98°C) by Hutchison et al. (1966). Seasonally consistent microhabitat selection and activity was reported by Ward et al. (1976) for a Maryland population. Ninety-two percent of all captures were made from March through May. From June through December, *C. guttata* alternated between aestivating in terrestrial habitats and feeding in flooded areas. Hibernation occurred during January and February in puddles. Terrestrial activity was also reported by Netting (1936) and Cahn (1937). The relatively low evaporative water loss gradient reported for this species (Ernst, 1968) is probably an adaptation to the observed semi-aquatic existence.

The results of my study demonstrate that the seasonal activity of *C. guttata*, while consistently highest in the spring, varies considerably between some localities. Populations in South Carolina reach a high level of activity much earlier in the year, and for a shorter period of time, relative to the northern counterparts examined. This behavior is presumably the result of higher average temperatures in the South (Table 2). Populations in eastern Maryland and southeastern Pennsylvania exhibit similar seasonal activity cycles, probably due to their geographic proximity and similar climates. Farther to the west at the same latitudes in Ohio, the climate is more typically "continental" with relatively colder winters. This may ex-

plain why turtles in Ohio are less conspicuous in March relative to those in Pennsylvania.

Differences observed between the states are consistent with the thermal preferences previously reported for *C. guttata*. For example, Ernst (1982) found that spotted turtles began feeding when CTs reached 15°C. The activity peaks observed for each state occur during or just after the month when predicted CTs first exceed 15°C (Table 2). Thus it appears that these peaks may be a result of increased feeding activity. The mean air temperature near aestivating *C. guttata* was reported by Ernst (1982) as 22.61°C. Fig. 1 and Table 2 indicate that the lowest levels of activity in each state occur during or near the month when mean normal AT first exceeds 22.61°C. In spite of favorable temperatures later in the year, spotted turtles do not become active in large numbers until the following spring, presumably due to a decreased food supply (Ward et al., 1976).

In summary, *C. guttata*, as a species, appears to be capable of adapting to a wide variety of climatic regimes by predictably modifying the annual cycle of

TABLE 1. Values of the log likelihood ratio statistic (2l) for all pairwise comparisons of spotted turtle activity cycles. Value for overall test = 128.73 ($P < 0.10$), using seasonal intervals shown in Fig. 2.

State	State		
	Ohio	Maryland	South Carolina
Pennsylvania	67.93*	7.74	44.03*
Ohio	—	43.06*	62.49*
Maryland	—	—	56.93*

* $P < 0.10$, $\chi^2_{0.10,12} = 18.55$.

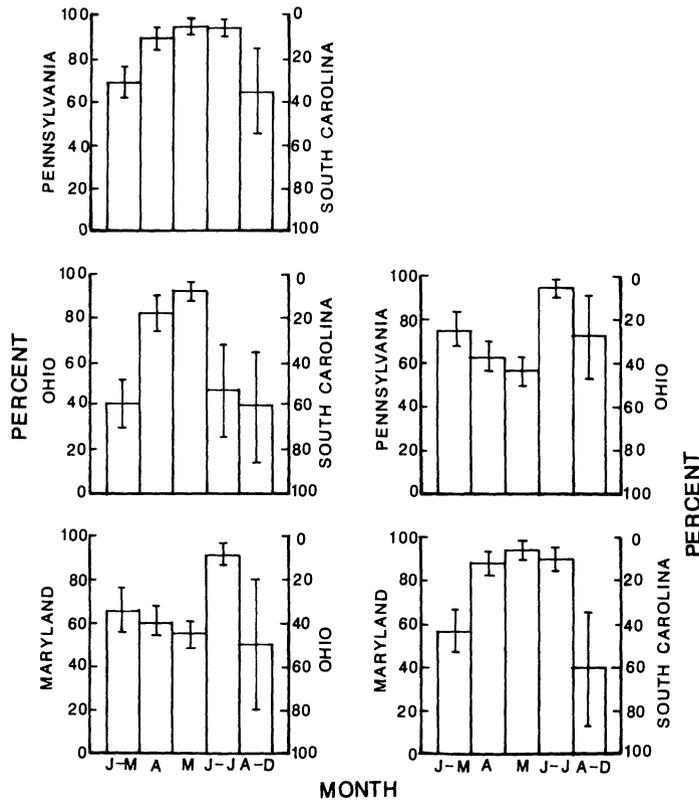


FIG. 2. Ninety percent binomial confidence intervals for significant pairwise comparisons of spotted turtle activity cycles. Significant contributions to the test statistic ($2I$ values in Table 1) are indicated by nonoverlapping confidence intervals. For example, most of the observed heterogeneity between Maryland and Ohio is due to differences in June and July. This is because 90% of the turtles in this time interval were from Maryland as opposed to only 10% in Ohio. Activity levels for these two populations were not significantly different from January–May and August–December. Seasonal intervals were selected to maintain appropriate cell frequencies under criteria proposed by Cochran (1954).

TABLE 2. Mean monthly and annual normal air temperatures for states of interest, and predicted cloacal temperatures of feeding *Clemmys guttata*. All temperatures in °C. Refer to text for computational details.

State/ tem- pera- ture	Month												Annual
	J	F	M	A	M	J	J	A	S	O	N	D	
Maryland													
Air	—	—	7.0	13.0	18.0	22.3	24.6	23.9	20.4	—	—	—	13.3
Cloaca	—	—	10.9	15.9	20.0	23.5	25.4	24.8	21.9	—	—	—	—
South Carolina													
Air	—	9.1	13.1	17.8	22.0	25.1	26.8	26.5	23.8	18.1	13.0	—	17.7
Cloaca	—	12.7	15.9	19.8	23.2	25.8	27.2	26.9	24.7	20.8	15.9	—	—
Pennsylvania													
Air	-2.3	—	4.2	10.2	15.6	20.6	23.0	22.2	18.4	—	—	0.1	10.7
Cloaca	3.3	—	8.6	13.6	18.0	22.1	24.1	23.4	20.3	—	—	5.3	—
Ohio													
Air	—	-2.5	2.8	9.5	15.2	20.3	22.3	21.5	17.9	11.6	5.0	—	9.9
Cloaca	—	3.2	7.5	13.0	17.7	21.8	23.5	22.8	19.9	14.7	9.3	—	—

activity. Others have previously noted variable activity patterns in response to changing temperatures. Ernst (1976) found that the mean daily time of activity became progressively earlier as the season advanced and temperatures increased, and in laboratory experiments the mean preferred temperature exhibited by *C. guttata* increased with photoperiod (Graham and Hutchison, 1979). In addition, Nemuras (1966) found that even nearby populations display slightly modified activity cycles in response to different habitats.

Acknowledgments.—Earlier versions of this manuscript benefited greatly from comments given by J. Whitfield Gibbons, Carl H. Ernst, Jim Knight, and Justin D. Congdon. Special thanks are given to Julian R. Harrison for providing data from specimens in the Charleston Museum. Manuscript preparation was supported by Contract DE-AC09-76SROO-819 between the U.S. Department of Energy and the University of Georgia's Institute of Ecology.

LITERATURE CITED

- BRATTSTROM, B. H. 1965. Body temperatures of reptiles. *Am. Midl. Nat.* 73:376-422.
- CAHN, A. R. 1937. The turtles of Illinois. *Illinois Biol. Monogr.* 16:1-218.
- COCHRAN, W. G. 1954. Some methods for strengthening the common χ^2 tests. *Biometrics* 10:417-451.
- CONANT, R. 1951. The reptiles of Ohio. Univ. Notre Dame Press, Notre Dame, Indiana. 284 pp.
- ERNST, C. H. 1967. A mating aggregation of the turtle *Clemmys guttata*. *Copeia* 1967:473-474.
- . 1968. Evaporative water-loss relationships of turtles. *J. Herpetol.* 2:159-161.
- . 1972. *Clemmys guttata*. *Cat. Amer. Amphib. Rept.* 124.1-124.2.
- . 1976. Ecology of the spotted turtle, *Clemmys guttata* (Reptilia, Testudines, Testudinidae), in southeastern Pennsylvania. *J. Herpetol.* 10:25-33.
- . 1982. Environmental temperatures and activities in wild spotted turtles, *Clemmys guttata*. *J. Herpetol.* 16:112-120.
- , AND R. W. BARBOUR. 1972. Turtles of the United States. Univ. Press Kentucky, Lexington 347 pp.
- GABRIEL, K. R. 1966. Simultaneous test procedures for multiple comparisons on categorical data. *J. Amer. Stat. Assoc.* 61:1081-1096.
- GRAHAM, T. E., AND V. H. HUTCHISON. 1979. Effect of temperature and photoperiod acclimatization on thermal preferences of selected freshwater turtles. *Copeia* 1979:165-169.
- HUTCHISON, V. A., A. VINEGAR, AND R. J. KOSH. 1966. Critical thermal maxima in turtles. *Herpetologica* 22:32-41.
- NEMURAS, K. 1966. Spotted turtles in Maryland. *Bull. New York Herpetol. Soc.* 3:6-9.
- NETTING, M. G. 1936. Hibernation and migration of the spotted turtle, *Clemmys guttata*. *Copeia* 1936:112.
- SNEE, R. D. 1974. Graphical display of two-way contingency tables. *Amer. Stat.* 28:9-12.
- WARD, F. P., C. J. HOHMANN, J. F. ULRICH, AND S. E. HILL. 1976. Seasonal microhabitat selections of spotted turtles (*Clemmys guttata*) in Maryland elucidated by radioisotope tracking. *Herpetologica* 32:60-64.
- ZAR, J. H. 1984. *Biostatistical analysis*. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 718 pp.

Accepted: 29 April 1987.

Journal of Herpetology, Vol. 22, No. 4, pp. 485-488, 1988
Copyright 1988 Society for the Study of Amphibians and Reptiles

Feeding Responses of Skinks (*Eumeces laticeps*) to Velvet Ants (*Dasymutilla occidentalis*)

LAURIE J. VITT, *Department of Biology, University of California, Los Angeles, California 90024, USA*

WILLIAM E. COOPER, JR., *Department of Biology, Auburn University at Montgomery, Montgomery, Alabama 36193, USA*

A review of the literature on diets of insectivorous lizards revealed that they rarely feed on female velvet ants (Hymenoptera: Mutillidae) (Vitt and Ohmart, 1974, 1975, 1977a, b; Mitchell, 1979; Vitt et al., 1981; and many others). This observation was surprising for the following reasons: (1) in most areas where lizards are common, i.e., areas where daily temperatures are relatively high, velvet ants are also relatively common (see Krombein, 1951); (2) female velvet ants are terrestrially active at the same time as most diurnal terrestrial lizards (Manley and Spangler, 1983, for mutillids; Pianka, 1985, for lizards); and (3) velvet ants are highly visible due to their bright colors and continuous movement (Schmidt and Blum, 1977). From a human perspective, velvet ants appear to be among the most conspicuous invertebrates available and they are well within the size range of prey taken by most insectivorous lizards (see Pianka, 1985).

Eumeces laticeps is a large (85-143 mm SVL), sexually dimorphic skink widespread in the eastern United States (Vitt and Cooper, 1985). The diet includes a variety of invertebrates and small vertebrates (Hamilton and Pollack, 1961; Vitt and Cooper, 1986). Adults have powerful jaws and can crush and swallow large prey (Cooper, 1981a, b) including those with heavy exoskeletons (e.g., cerambycid and passalid beetles; Vitt and Cooper, 1986), and appear to have little difficulty eating stinging prey. For example, McIlhenny (1937) observed *E. laticeps* (referred to as *E. fasciatus*) repeatedly feeding on paper wasps (*Polistes*) with no apparent ill effects. In a study of the diet of *E. laticeps* in the southeastern United States (Vitt and Cooper, 1986) we found no mutillids in lizard stomachs even though *Dasymutilla occidentalis* was observed to be common in all habitats inhabited by *E. laticeps*.

Schmidt and Blum (1977) noted that females of the relatively large velvet ant *Dasymutilla occidentalis* are rendered undesirable prey because of their potent sting, strong and slippery cuticle, rapid, erratic locomotion, chemical secretions, and production of stridulatory sounds when attacked. In addition, their bright coloration (usually orange or red) is considered