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Reproductive Characteristics of South Florida Sternotherus odoratus and Kinosternon baurii (Testudines: Kinosternidae)

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From 8 April to 7 August 1987, the study area was visited a total of 14 times for one hour each trip between 1040 - 1645 hrs. Collections were made by sweeping the plants with a sweep net. Specimens were transferred to a chloroform kill jar, then pinned, pointed, or preserved in 70% EtOH. Voucher specimens are located in the Arkansas State University Insect Collection, State University, AR 72467.

During this study, *T. calceata* was collected from and observed on a population of *T. virginiana* from 8 May - 7 August 1987 on Crowley's Ridge, in northeastern Arkansas. Adult and second through fifth nymphal instars were collected from this host plant throughout the study (Table 1). The absence of first nymphal instars in our collections was probably due to their small size and short stadial length.

No specimens of *T. calceata* were collected from this host plant during the prebloom stage (Table 1). Adults and second through fifth nymphal instars were collected throughout the flowering and postbloom stages of the host plant.

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REPRODUCTIVE CHARACTERISTICS OF SOUTH FLORIDA *STERNOTHERUS ODORATUS* AND *KINOSTERNON BAURII* (TESTUDINES: KINOSTERNIDAE)

The reproductive characteristics of south Florida kinosternids are poorly known; however, populations of the stinkpot, *Sternotherus odoratus,* in central (Gross, 1982) and north Florida (Iverson, 1977), and the striped mud turtle, *Kinosternon baurii,* in central (Einam, 1956; Lardie, 1975) and in north Florida (Iverson, 1977, 1979) have been studied. A comparative study of northern and southern United States populations of *S. odoratus* by Tinkle (1961) concluded that clutch size increases with increasing body size of the female. In addition, southern populations should produce multiple clutches and exhibit both early maturity and sexual dimorphism in size. These findings were later supported by Gibbons (1970) in central Florida. The objectives of this study are to provide information on the reproductive characteristics of *S. odoratus* and *Kinosternon baurii* from south Florida and to test Tinkle's (1961) summary of southern populations of *S. odoratus* from a region further south than his north Florida sample.

Fifty-four turtles were collected along 1 km of Snapper Creek canal between SW 87 Ave and US Hwy 1, and along 0.3 km of C-100A canal near 104th Str. and SW 82 Ave in Miami, Dade County, Florida, from June through August 1982. Specimens were captured by dipnet or wire mesh funnel traps (1.8 × 0.8 m and 0.8 × 0.5 m) baited with bread, fish and beef scraps. Carapace length (CL) and plastron length (PL) were measured to the nearest 0.1 mm. Females were considered mature if they possessed ovarian follicles exceeding 7 mm diameter or if oviductal eggs or corpora lutea were present (Iverson, 1979). Clutch size was estimated by counts of oviductal eggs, corpora lutea, or enlarged follicles over 11 mm for *S. odoratus* (Iverson, 1977) and 10 mm for *K. baurii* (Iverson, 1979). The presence of sperm in testes was used to determine maturity in males. All turtles were deposited in the National Museum of Natural History, Washington, DC. Means are followed by ± one standard deviation. All measurements are in mm.

Sternotherus odoratus — Average carapace lengths for eighteen sexually mature females (77 ± 5.69; range = 52-80) and ten sexually mature males (68 ± 8.79; range = 62-86) support Tinkle's (1961) findings of sexual dimorphism in southern populations. This, however, was not observed by Tinkle (1961) in northern specimens. The small size at maturity in both males and females from south Florida is similar to those findings reported Tinkle (1961) and Gibbons (1970) of 54, 61 and 52, 65, respectively. These data reveal an almost continuous north to south decrease in minimum size at maturity in Florida stinkpots. Mean clutch size was not significantly different ($p>0.05$) whether by counts of enlarged follicles (2.22 ± 0.441 N = 9), oviductal eggs (2.38 ± 0.51; N = 8), or corpora lutea (2.34 ± 0.76; N = 18). Based on oviductal eggs, clutch size was significantly larger ($t = 2.13$; $p < 0.05$) than the mean (1.74) reported by Gross (1982) in central Florida and significantly smaller ($t = 2.87$; $p < 0.05$) than the mean (3.2) in north Florida (Iverson, 1977). Clutch size, based on either corpora lutea ($r = 0.198$) or oviductal eggs ($r = 0.178$ showed no significant positive correlation with female plastron size at 0.05 level. Multiple sets of corpora lutea (largest first) followed by oviductal eggs found in nine female *S. odoratus* were 2,2 and 2 eggs (71 mmPL), 2,2,2 and 2 eggs (76 mmPL), 2,2,2 and 2 eggs (75 mmPL), 2,2 and 2 eggs (80 mmPL), 3,1 and 0 eggs (76 mmPL), 3,2 and 0 eggs (71 mmPL), 3,2 and 0 eggs (80 mmPL), 2,3 and 2 eggs (81 mmPL), and 2,3 and 2 eggs (85 mmPL). Pre-ovulatory follicles greater than 10 mm were found in all but the last three turtles. Three clutches are clearly produced by some turtles, however, production of four clutches by one female indicates that at least nine eggs are produced annually by south Florida stinkpots. Mean egg size for 19 oviductal eggs from eight females examined was 22.59 ± 2.10 (longest diameter; range = 20.0-29.0) by 13.63 ± 0.8 (shortest diameter; range = 12.2-15.0) and was not significantly correlated with female plastron size ($r = 0.142$; $p > 0.05$). It is unclear whether the absence of any significant positive correlation between clutch size and female plastron size of south Florida sinkpots reflects an artifact of a small sample, a geographic trend, or even local habitat differences. Although this sample was collected from a region further south than Tinkle's (1961), the presence of sexual dimorphism, early maturity, and multiple clutches from south Florida specimens corroborates Tinkle's (1961) summary of southern populations.

Kinosternon baurii — Average carapace lengths of fourteen sexually mature females (105 ± 10.0; range = 85-125) and twelve sexually mature males (91 ± 4.97; range = 90-98) indicates sexual dimorphism in size. Difference in mean clutch size for this sample was not significant whether estimated by counts of enlarged follicles (2.91 ± 1.75; N = 12), oviductal eggs (3.14 ± 1.67; N = 7), or corpora lutea (2.70 ± 1.43; N = 13). No significant difference in clutch size was found when compared to the 2.6 average in north Florida (Iverson, 1979). Multiple sets of corpora lutea (largest first) and oviductal eggs found in three turtles were 5,3 and 5 eggs (102 mmPL), 3,5 and 3 eggs (104 mmPL), and 3,2 and 3 eggs (95 mmPL). Pre-ovulatory follicles greater than 10 mm were found in all three specimens. Egg retention is suspected in one turtle (109 mmPL) that contained two corpora lutea (5.7 and 5.3 mm) and one oviductal egg. Clutch size, based either on corpora lutea ($r = 0.253$; $p > 0.05$) or oviductal eggs ($r = -0.321$; $p > 0.05$) was not significantly correlated with plastron size. These data suggest that at least nine eggs are produced from at least three clutches. Mean egg size for 22 oviductal eggs from seven females examined was 27.57 ± 1.63 (longest diameter; range = 25.0-31.0) by 15.30 ± 1.40 (shortest diameter; range = 11.7-17.3) and egg length was significantly correlated with female plastron size ($r = 0.816$; $p < 0.05$). No such correlation was found in north Florida (Iverson, 1979) using a larger sample.

The influence of tropical conditions is known to play a role in multiple clutching and aseasonal reproduction in turtles (Moll and Legler, 1971); however, the scarcity of available information concerning south Florida populations as well as the diversity of suitable habitats stresses the need of further studies before possible trends in the reproductive biology of south Florida kinosternids can be established.

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MEASUREMENTS OF THE DRAG ON SPHERES FALLING THROUGH THE AIR

A problem often investigated in undergraduate labs on classical mechanics is the effect of air resistance on falling objects. One of the most interesting of these involves the drag force on spheres falling through the air. Frequently in these experiments the time of fall of the sphere is measured; this time is then used in a drag equation to calculate the distance fallen, for comparison with the measured distance. This distance measurement is a critical one and, for distances on the order of a few meters or less, must be accurate to within 0.5 mm. Measurements to this precision are difficult with the equipment and techniques available to the average undergraduate laboratory and, when several distances are involved, can present a large source of error. The experiment to be described eliminates the need for this distance measurement by using a phototransistor timing circuit to obtain the velocities at various times of flight. These measured velocities are then compared to the velocities calculated from a drag equation.

For many problems in fluid mechanics it is useful to define the dimensionless drag coefficient C_d in terms of the drag force F_d by the equation $C_d = (F_d/A)/(\frac{1}{2}\varrho V^2)$, where A is the cross sectional area of the body normal to the direction of motion, ϱ is the density of the medium, and V is the speed of the body. Thus, for a sphere falling through the air, $F_d = \frac{1}{2}C_d\pi r^2\varrho_a V^2$, where ϱ_a is the density of air and r is the radius of the sphere. Another dimensionless quantity which relates the inertial forces on a body to the viscous forces is the Reynolds number R which is defined by $R = 2rV/\nu$, where ν is the kinematic viscosity of the medium. For spheres, the relationship between C_d and R is well known from experiment; a value of $C_d \approx \frac{1}{2}$ for R between 10^3 and 10^5 is commonly accepted (H. Rouse, *Elementary Mechanics of Fluids,* Dover Publishing, 1978, p. 249). For air at room temperature, $\nu = 0.15$ cm/s^2, and for a sphere of radius r = 2 cm, this range corresponds to velocities between 38 cm/s and 3800 cm/s. Since all velocity measurements in this experiment are made in this range, the drag force may be approximated by:

$$F_d = \frac{1}{4}\pi r^2 \varrho_a V^2 \quad . \qquad [1]$$

From Newton's 2nd Law,

$$M\frac{dV}{dt} = Mg - F_d = Mg - \frac{1}{4}\pi r^2 \varrho_a V^2 \quad , \qquad [2]$$

and

$$\frac{dV}{dt} = g - (\frac{1}{4}\pi r^2 \varrho_a V^2)/(\frac{4}{3}\pi r^3 \varrho_s) \quad , \qquad [3]$$

with ϱ_s = the density of the sphere, so that

$$\frac{dV}{dt} = g(1 - (3\varrho_a V^2)/(16\varrho_s g r)) = g(1 - V^2/V_0^2) \qquad [4]$$

where $V_o^2 = (16\varrho_s g r)/(3\varrho_a)$. From this we find

$$\frac{dV}{V_0^2 - V^2} = g\frac{dt}{V_0^2} \quad . \qquad [5]$$

Integrating both sides and setting V = 0 at t = 0, we have

$$(1/V_0)\tanh^{-1}(V/V_0) = gt/V_0^2 \quad , \qquad [6]$$

and

$$\tanh^{-1}(V/V_0) = gt/V_0 \quad . \qquad [7]$$

With this approximation the velocity of a sphere falling through air is given by

$$V = V_0\{\tanh(gt/V_0)\} \quad . \qquad [8]$$

The device used for dropping the spheres was constructed by modifying the apparatus used in a typical undergraduate falling body lab. An electromagnet is mounted on a stand approximately 1.7 meters tall. Positioned in front of the magnet is a bracket designed to hold the ball before it drops without influencing its motion when it is released. The ball is held against the bracket by a metal bar which is hinged to the stand under tension by a spring, and held in place by the electromagnet. Timing was done with a Merlan Micro Series Computimer #30M100 controlled by a Commodore CBM Model 8032 Computer. A double pole-single throw switch is used to control the electromagnet as well as the timer. When