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Female Participation in Courtship Behavior of the Turtle *Trachemys s. scripta*

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Detailed observations of courtship and copulation in *Trachemys scripta* have previously been reported by Cagle (1950), Jackson and Davis (1972a), and Davis and Jackson (1970, 1973). The various races of *T. scripta* are known to exhibit dramatic differences in stereotyped courtship behavior. For example, Davis and Jackson (1973) observed that courtship behavior of male *T. s. taylori* was relatively unspecialized and consisted of frequent biting. In contrast, courtship behavior in *T. s. elegans* was highly stereotyped and never included biting (Jackson and Davis, 1972a). Courtship in the neotropical races *T. s. grayi* and *T. s. ornata* reportedly includes the male behavior of spraying the female with water ejected through the nostrils (Regulo Rosado, 1967). Courtship behavior has not been reported for the subspecies *T. s. scripta*. During a study to determine the efficacy of various hormone treatments in eliciting courtship behavior by male *T. s. scripta* (Garstka et al., unpubl.), we observed female motor patterns not previously reported for this species. Most notable was the apparently active role females exhibited during courtship. The purpose of this note is to describe this behavior.

Turtles were collected in Aiken County, South Carolina, and marked for positive identification either by drilling coded holes in the shell margin (Cagle, 1939) or by attachment of numbered plastic tags (Plummer, 1979). Turtles were housed outdoors according to sex in 2.1 m diameter metal stock tanks with a sand bottom and 25 cm of water, and fed fish and dried dog food ad libitum.

Following random assignment to test group, 47 males were castrated or sham-operated under Brevital anesthesia (Wang et al., 1977; Camazine et al., 1981; Lawson and Garstka, 1985). Some of these were implanted with silastic capsules containing various hormones (2.0 cm lengths of 2.3 mm OD, 1.0 mm ID silastic tubing with 1.5 mm of packed hormone filling; Dziuk and Cook, 1965). Details of the operation and treatments are given elsewhere (Garstka et al., unpubl.). Results were pooled since female responses to the various male treatment groups were similar. Females were not treated or surgically altered. All turtles were sexually mature (Gibbons et al., 1981). Males ranged from 132-202 mm plastron length with a mean of 162 mm, and females ranged from 175-252 mm with a mean of 206 mm.

Courtship tests were conducted outdoors between 22 September and 6 October 1987. Evidence of fall courtship and mating has been observed in *T. scripta* under natural and laboratory conditions (Cagle, 1950; Jackson and Davis, 1972a; Moll and Legler, 1971; Lovich et al., 1990). Courtship tests were independent: each male was tested with one female. For each test, the test male and stimulus female were placed in a separate 2.1 m stock tank at approximately 0830 h. They were observed from an elevated blind from 0900-1000 h and 1600-1700 h. After the test, both were removed and the test tank was allowed to flush overnight with the flow-through water supply before adding the next pair.

Courtship behavior was subdivided a priori into the following (not necessarily sequential) fixed-motor patterns based on both literature (Cagle, 1950) and personal (Garstka et al., unpubl.) observations: (1) no courtship; (2) trailing and nosing—the male swims after the female with his nostrils directed toward her cloacal region; (3) orientation—the male moves in front of the female and faces her while swimming backwards; (4) titillation—the male rapidly vibrates his foreclaws in front of the female's head; (5) positioning—the male moves behind and dorsal to the female in preparation for coition; (6) mounting or attempting to mount—the male attempts to swing his tail under that of the female; and (7) intromission.

Females directed titillation behavior toward males in five trials (Table 1). This behavior was observed across several treatment regimes applied to males. In all cases, males remained passive, a role normally reported for females (Jackson and Davis, 1972a). Males were observed titillating females in only three trials. The duration and repetition of titillation was not noticeably different from that reported for male *T. s. elegans* (Jackson and Davis, 1972a). Females were also observed nosing the cloacal region of males, and actively trailing and orienting toward males in five trials, again in sharp contrast to the passivity previously reported for females. An unexpected observation was "blinking behavior" by females. In this behavior the nictitating membrane is closed, producing a dramatic white flash. As many as six blinks were observed in a 1 min interval. This behavior was only observed when males were orienting near a female. The number of trials in which reproductive behaviors were directed by females toward males ($N = 17$) did not differ significantly from the number of trials in which males directed reproductive behavior toward females ($N = 10$), ($\chi^2 = 1.81$, $df = 1$, $P > 0.10$). Courtship stages 5-7 were not observed.

Given the diversity of reproductive behaviors exhibited by this wide-ranging species, we were not surprised to see additional unreported motor patterns, including female titillation and blinking. These behaviors suggest a much more active role of females during mating. In fact, males did not direct noticeable reproductive behavior toward females in significantly more trials than females directed reproductive behavior toward males. Previous observations of female participation have been reported in several closely related species. Female titillation was reported by Ernst (1971), Zappalorti (1976), and Rives (1978) for *Chrysemys picta*, Wahlquist (1970) for immature female *Graptemys flavimaculata*, and Jackson (1977) for *Pseu-*

TABLE 1. Number of trials (of 47 total) during which various courtship behaviors were exhibited by *Trachemys s. scripta*. Behaviors (defined in the text) are not arranged sequentially.

Behavior	Sex	
	Males	Females
Trailing and nosing	2	2
Orientation	5	5
Titillation	3	5
Positioning	0	0
Mounting or attempt	0	0
Blinking	0	5

demys nelsoni. However, Kramer and Fritz (1989) reported that female *P. nelsoni* appear to pay no attention to titillation by males. According to Wahlquist, female *G. flavimaculata* titillate simultaneously with males. Female participation was also suggested by Jackson and Davis (1972b) for *Pseudemys concinna suwanniensis*.

The function of these behaviors by females in the presence of conspecific males is unknown. Nevertheless, our results demonstrate that sexual behavior in this species is more complex than previously assumed. Beach (1976) characterized female sexual behavior in mammals as: (1) proceptive—those behaviors that the female does to actively solicit male attention; (2) attractive—those passive attributes, such as pheromones, that increase male attention; and (3) receptive—those actions that indicate willingness to copulate (like lordosis in mammals). Numerous authors (Cagle, 1950; Davis and Jackson, 1970; Ernst, 1971; Jackson and Davis, 1972a; Plummer, 1977; Baker and Gillingham, 1983) have commented on receptivity of female aquatic turtles, indicating that the female must maintain a passive position in the water for the male to achieve intromission. Other authors have dealt with female attractivity in turtles (Madison, 1977; also see review in Manton, 1979) and concluded that the main means of sexual discrimination is olfactory.

Our data indicate an active role for female *T. scripta* during courtship and provide evidence of proceptive behavior in the form of blinking and titillation. It is possible that female *T. scripta* are capable of communicating receptivity with tactile or visual signals. The fact that titillation and blinking occur only after trailing and its associated nosing suggests that tactile and visual signals from the female may be required to stimulate courtship following discrimination of olfactory cues by the male of some species of aquatic turtles. We suggest that the interaction of male and female sexual behavior in *T. scripta* is important, and that the behaviors reported in this study may serve to reinforce male courtship and facilitate female receptivity.

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Sex Identification through Cloacal Probing in Juvenile Marine Iguanas (*Amblyrhynchus cristatus*)

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Sex identification in lizards is in most cases simple because of the existence of external sexual dimorphism, e.g., the presence or absence of femoral pores, coloration dimorphism, differences in scale counts, etc. (Conant, 1975; Laszlo, 1975; Arnold and Burton, 1978). However, in juvenile or hatchling lizards, sexual dimorphism is often lacking. Long-term field studies and behavioral studies need accurate information about the sex of individuals and the sex ratio in the population. The sex of lizards can be obtained by individually marking young animals and identifying the sex when they reach sexual maturity. This method is useful for short-lived species, but impractical for studies of long-lived species.

The problem of reliably identifying the sex of juveniles has arisen during a long-term study of marine iguanas (*Amblyrhynchus cristatus*), which are endemic to the Galápagos Archipelago. Females reach sexual maturity when 3–5 yr old, males when approximately 6–8 yr old (Laurie, in press). Adults can be reliably sexed above a size of 224 mm snout-vent length (SVL); males are bigger and heavier than females, have a relatively taller nuchal crest, wider heads, and a thicker tail base, and show characteristic territorial and courtship behaviors during the reproductive period. However, there are no external morphological differences in hatchling and juvenile marine iguanas,

and sex identification has proven elusive for these animals.

We report here on sexing of marine iguanas by measuring cloacal depth with a probe, a technique widely used in zoos and laboratories (Schaefer, 1934; Szidat, 1968; Honegger, 1978; Hitz, 1984).

Our study site is located on the southeast coast of Santa Fé Island, Galápagos. It holds a population of about 8000 marine iguanas, of which about 50% have been individually marked since 1981 by branding.

The probe was a long, thin (1 mm diameter for hatchlings, 2–3 mm diameter for adults and juveniles), blunt, lubricated metal rod. It was inserted gently into the cloaca towards the tail (Laszlo, 1975), and slipped into one of the lateral posterior pouches. The length of the inserted part of the probe was measured with vernier calipers to the nearest mm and was called posterior cloacal pouch depth (CPD). Together with CPD we recorded SVL for every animal.

A total of 2264 individual marine iguanas was measured from 1987 to 1989; 790 adults were sexed based on external sexual dimorphism (330 females, 460 males), and 1474 were juveniles of unknown sex of which 1042 were hatchlings that were caught directly upon emergence from the nest burrow in April or May 1988. Nine months after the first measurement, 622 individual iguanas were probed again. Twenty previously probed marine iguanas were examined by cloacascopy. Females were recognized by the paired papillae urogenitales. We used the SPSS statistical package (SPSS, Inc., 1986) for data analysis.

Apparently no damage was caused by probing. The behavior of probed animals was not different from that of handled but not probed animals. Of 88 previously probed animals, 12 males were seen copulating, and 76 gravid females were seen nesting. Successful reproduction of probed animals was also found in other studies (Szidat, 1968; Hitz, 1984).

In adult females the probe did not penetrate more than 19 mm into the posterior cloaca. In adult males it slipped into one of the paired lateral posterior diverticula formed by the retracted hemipenis (Arnold, 1984), reaching a depth of up to 58 mm. No difference was detected whether the right or the left side of the cloaca was probed (Wilcoxon matched-pairs signed rank test: $Z = -0.607$, $N = 49$, $P = 0.544$). When CPD is plotted against SVL, males and females separate into two non-overlapping groups (Fig. 1).

CPD of juveniles whose sex could not be ascertained by external morphology fell into one of two separate groups with hardly any overlap (Fig. 1); hatchlings separated perfectly, with 508 animals having more than 7 mm CPD and 534 less (Fig. 2). Body size (SVL) for presumed male hatchlings was slightly greater than for presumed female hatchlings (Mann-Whitney U -test: $U = 119,907$, $N = 1042$, $P = 0.001$).

The relationships between CPD and SVL are best described by polynomial regressions: $[CPD_m = 7.92 - 0.003SVL + 0.00028SVL^2]$ ($r^2 = 0.94$, $N = 835$) for males and $[CPD_f = 4.94 - 0.032SVL + 0.00022SVL^2]$ ($r^2 = 0.95$, $N = 1114$) for females. Linear regressions showed skewed residuals and had lower coefficients of determination. Males larger than the largest female (i.e., above 318 mm SVL) were excluded from the regressions. The variance in CPD for these males was much greater than for males of lesser size. Regressions are based on one measurement per individual. Re-