The diel activity of three captive adults and two juveniles were noted daily from July through October, 1985. The number of days (X lizards) for which activity occurred in the AM/PM respectively is as follows: July 5/43; August 7/23; September 13/32, and October 14/23. The data suggest that these lizards are more active during the afternoon hours than morning hours during these months. During the monsoon season in Sonora, which begins about mid-July (Walter et. al. 1975), overcast weather typically develops in the afternoon and provides suitable conditions for foraging (e.g. decreased temperature, increased humidity, increased insect activity; see Lowe and Howard 1975). During the preceding months, hot, dry conditions preclude or severely curtail afternoon foraging by these lizards.

It is surprising that my captive *Phrynosoma* displayed increased afternoon activity since the obvious natural cues were not available to them. An endogenous rhythm is one possible explanation, or the captive lizards could have been responding to changes in barometric pressure which accompany frequent summer afternoon storms in South Carolina. On some days the captive lizards did not emerge until after the lamps were switched off, despite the existence of a suitable thermal gradient in the cage. In fact, the lizards could be encouraged to leave their shelters by switching off the lights prematurely. This behavior suggests a crepuscular tendency in *P. ditmarsi,* as well as, perhaps, the habit of foraging during overcast conditions. Consistent with this idea is the presence of some crepuscular-nocturnal arthropods (e.g. scorpions, Vince Roth, pers. comm.) in the diet of this horned lizard. *Phrynosoma* species are generally active earlier, as well as later, in the day than most other sympatric lizards (Heath 1965; Norris 1949), and apparent nocturnal activity has been reported for some *Phrynosoma* (Harris 1958; Williams 1959; Mays and Nickerson 1968).

Conclusions drawn from the behavior of captive animals are often considered to lack validity when extended to natural populations. I hope, however, that the observations noted here will provide the impetus for field investigations of this interesting and little-known horned lizard.

ACKNOWLEDGMENTS

I thank Tom Mann, Wade C. Sherbrooke, and Vince Roth and his field party for assistance in procuring *Phrynosoma ditmarsi.* Live specimens were imported under Mexican permit no. 0404 to Steve Prchal of the Arizona-Sonora Desert Museum in Tucson. Howard E. Lawler kindly made arrangements for importation. Thanks are also extended to C.H. Lowe, University of Arizona, for help in planning the itinerary. I am indebted to Tom Mann for his tireless and conscientious care of the horned lizards during my periodic absences. James C. Munger and Wade C. Sherbrooke read an earlier version of the manuscript and offered helpful suggestions for its improvement. Finally, I am grateful to Sr. Mario Navarro, B., Baviacora, Sonora, for his logistical help and hospitality during our visit to Rancho la Palma.

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OBSERVATIONS ON THE NESTING ECOLOGY OF GREEN SNAKES (*Opheodrys aestivus*)

Because snakes are highly secretive, periodically dormant, and generally intractable, the use of radiotelemetry can provide ecological information that could not be gained otherwise. For example, discoveries of the nests of snakes occur rarely and are found fortuitously when investigators search for specimens. However, with radiotelemetry it is possible to directly observe an individual snake's nesting behavior and choice of nest sites. I used radiotelemetry to study nesting movements, nesting behavior, and nest sites of arboreal green snakes, *Opheodrys aestivus* (Plummer 1990). Because accounts of individual animals engaged in rarely observed events may contribute to a better understanding of a species' ecology (Fitch 1987), I here provide anecdotes concerning a little known aspect of the ecology of snakes, especially the heretofore unreported habit of nesting in tree cavities.

Miniature radiotransmitters (Model SOPI-1038-LD, Wildlife Materials, Inc.) were implanted into nine large (>500 mm snout-vent-length, SVL) gravid *Opheodrys.* On 19 June 1988, the telemetered snakes were released at their capture sites in the shoreline vegetation (primarily alder, *Alnus rugosa*) of a small lake 2 km west of Denmark, White County, Arkansas. Each snake was relocated several times each day until nesting occurred and once each day thereafter. Occasionally, I observed individual snakes through binoculars for periods of up to two hours.

The nesting ecology of *O. aestivus* at the Denmark locality may be summarized as follows (Plummer 1990): Prior to ovipositing, activities of female *Opheodrys* are restricted to small activity ranges averaging 15 m in length within the vegetation of a narrow band of alder at the shoreline. As the time of oviposition nears, snakes descend from their arboreal habitats and move terrestrially away from the shoreline and their activity ranges. Snakes nest in small chambers within the hollowed interiors of living oak and hickory trees averaging 56 m from their activity ranges. Snakes move back toward their activity ranges after nesting. Selected individual accounts follow.

Opheodrys no. 5 exibited the most extensive nesting movements. After being monitored for 21 days in a typical pattern of restricted prenesting movements at the shoreline, she moved 55 m on 11 July and ascended an oak tree apparently in response to a severe thunderstorm. She remained coiled on a branch in the tree until fair weather returned on 13 July. She then descended and moved 45 m to a hollow hickory tree, spending at least two hours crawling on and in and out of the tree, but not ovipositing. Subsequent investigation of the tree hollow revealed four *Opheodrys* eggshells from a previous year. All eggshells contained longitudinal slits like those made by the egg tooth at pipping and were judged to have successfully hatched. After moving another 55 m on 13-14 July, *Opheodrys* no. 5 entered a second hollow hickory tree (Fig. 1A) and oviposited. On 15 July, she began moving toward her original activity range, eventually establishing a pattern of restricted movements in the vicinity of her original activity range similar to those of the prenesting period. On 15 July, I opened her nesting tree and found three freshly opened *Opheodrys* eggs with contents removed, apparently by a skink, *Eumeces laticeps*, which had been brooding a clutch of 11 eggs in the same hollow.

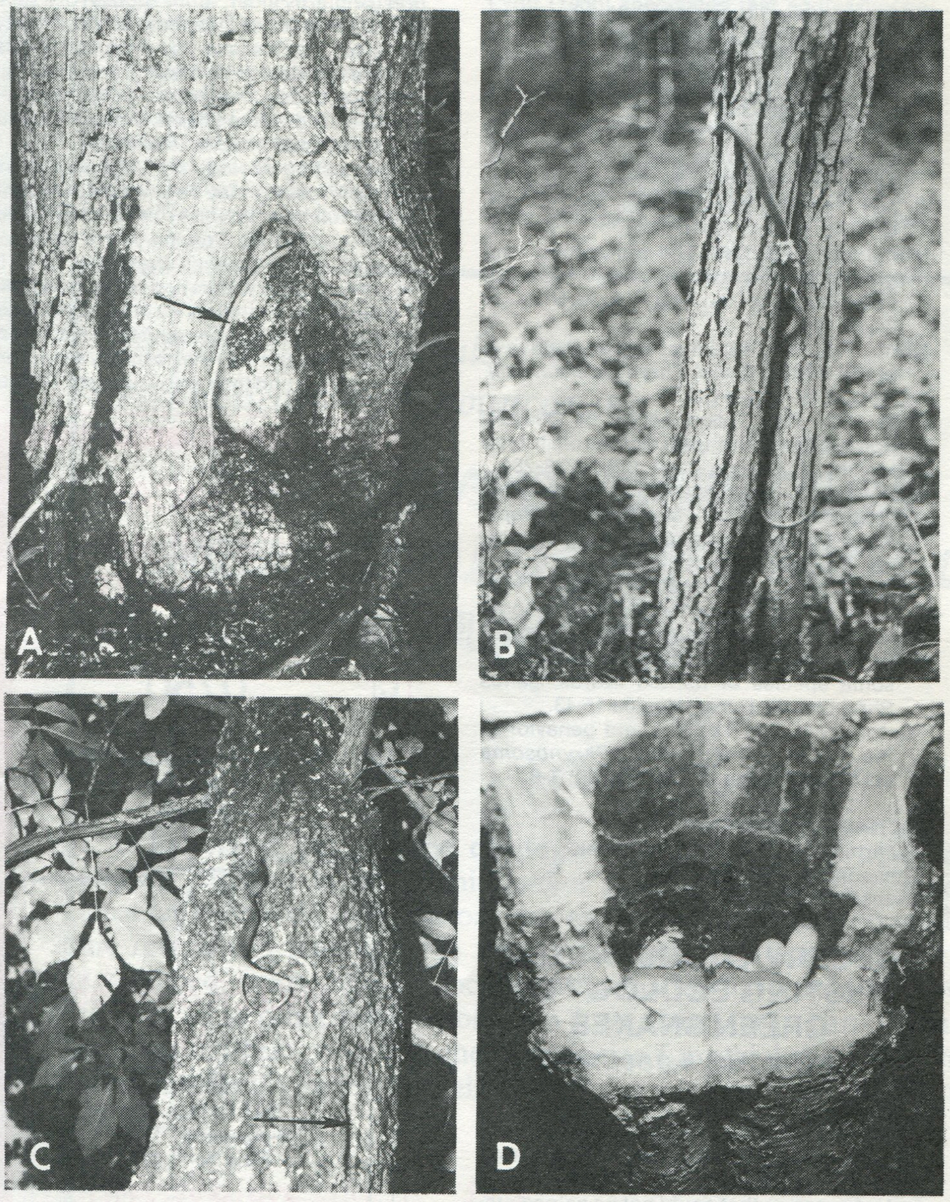

Figure 1. Nesting ecology of *Opheodrys aestivus*. (A) *Opheodrys* no. 5 entering nest tree at ground level (arrow). (B) *Opheodrys* no. 110 investigating tree where she later nested (see 1D). (C) *Opheodrys* no. 604 attempting to enter nest tree 3 m above ground level. Note slit where new tree growth has closed an old opening into the tree hollow (arrow). Sixteen *Opheodrys* eggshells from previous years were found within this tree. (D) Nest cavity and eggs of *Opheodrys* no. 110 exposed by opening tree with a chain saw.

Opheodrys no. 104 moved from her activity range to a nesting site 30 m distant on 26 June and oviposited the same day. She then moved back to her activity range on 27 June where she was monitored until 15 July. The hollow oak tree where she oviposited contained four *Opheodrys* eggshells from a previous year, all appearing to have successfully hatched.

Opheodrys no. 604 moved from her activity range on 24 June directly to a tree where she was observed trying unsuccessfully to enter a small opening (Fig. 1C). After she abandoned her efforts, I opened the cavity and found 16 *Opheodrys* eggshells from previous years. Based on appearance, the eggshells could be segregated into a younger group of five and an older group of 11 eggs, all appearing to have successfully hatched. Apparently, growth of the tree had decreased the diameter of the opening and prevented her entrance.

Prenesting and nesting behavior of other *Opheodrys* were similar to those above. Of special note is the persistence shown by no. 110 attempting to enter a tree on 6 July. She was observed for over an hour attempting entrance into the rotted interior of an oak tree (Fig. 1B), eventually abandoning her efforts and retreating to a small nearby bush where she coiled and became inactive. Three hours later, she continued her efforts and eventually gained entrance into the tree where she oviposited (Fig. 1D).

Although nesting in tree holes containing eggshells from previous years could result from communal nesting of several individuals, the behavior of no. 604 suggested that she returned to a site previously used. She moved 55 m directly away from the shoreline to a tree, climbed 3 m up the trunk to a small opening difficult to detect by two humans from the ground, and for 30 minutes attempted to enter a cavity containing old eggshells. Along her path she passed within 5 m of 52 trees, 22 of which were hollow (Plummer 1990).

At least five authors have reported finding eggs of *O. aestivus* under surface cover (summarized in Plummer 1990), observations which question the prevalence of tree cavity nesting by this species. The discovery of an *O. aestivus* nest containing seven fresh eggs 10 July 1989 in a tree cavity on the Savannah River Site near Aiken, SC (M. Gibbons and T. Mills, unpublished data) suggests that the behavior is geographically widespread. Also suggestive of tree cavity nesting is the record of a large communal *O. aestivus* nest found in the insulation of a metal refrigeration panel which was standing upright against an oak tree in North Carolina (Palmer and Braswell 1976). The greater number of references to nesting under surface cover probably reflects more where field workers search than an actual nesting affinity of *Opheodrys*. Because nests in tree cavities are difficult to detect without adversely affecting the trees and since routine field use of chain saws is neither desirable nor recommended, this bias will not likely change. Despite these difficulties, I encourage field workers to nondestructively investigate tree cavities when possible (McComb and Noble 1981).

ACKNOWLEDGMENTS

I thank C. Ransom for permitting me the use of his property to study *Opheodrys*, B. Forsythe for assistance in the field, and J. Congdon and W. Gibbons for comments on the manuscript. This study was supported in part by a Faculty Research Grant from Harding University. Manuscript preparation was supported by contract DE-AC09-76SROO-819 between the Department of Energy and the University of Georgia's Savannah River Ecology Laboratory.

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TECHNIQUES

A NEW THERAPY FOR MARINE TURTLES PARASITIZED BY THE PISCICOLID LEECH, *Ozobranchus branchiatus*

Marine leeches, *Ozobranchus* spp., are prominent ectoparasites on the green turtle, *Chelonia mydas,* in the Hawaiian Islands and on certain other sea turtle populations worldwide (Hirth 1971; Balazs 1980). Both *O. branchiatus* and *O. margoi* have been documented on green turtles in Hawaii, but the former species is believed to be more prevalent (Balazs 1980). A quantitative survey on this subject is currently in progress by the authors.

The two species of leeches are easily distinguished in that *O. branchiatus* has seven pairs of branchiae and *O. margoi* has only five. The former species ranges in length from 3.5 to 11 mm, and the latter is 4 to 30 mm (Sawyer et al. 1975; Davies 1978; Lauckner 1985). Both species attach to soft skin surfaces of the axial and inguinal regions, as well as the neck, eyes and cloaca. In heavily parasitized turtles, yellowish mats of leech egg cases are commonly found cemented to the plastron and ventral surfaces of the neck and flippers.

Increasing numbers of green turtles afflicted with debilitating fibropapillomas (fibrous epithelial growths) have been recorded during recent years in the Hawaiian Islands (Balazs 1986; Dailey and Balazs 1987). A concomitant increase in parasitization by *Ozobranchus* has also been seen, especially on the turtles diseased with tumors. Fibropapillomas are highly vascularized, thereby affording ideal sites for leeches to attach. The relationship between *Ozobranchus* and fibropapillomas was first described by Nigrelli and Smith (1943).

Experimental prophylaxes on captive sea turtles parasitized by *Ozobranchus* have included the use of various toxic agents. Schwartz (1974) immersed captive loggerheads, *Caretta caretta,* and green turtles in copper sulfate solution; this treatment proved effective in eliminating *O. margoi* adults and their egg cases but induced increased swimming activity in the turtles. Concentrated topical iodine used by Schwartz (1974) was only temporarily effective. Davies and Chapman (1974) reported that 3 of 85 captive sea turtles heavily parasitized by *O. branchiatus* and *O. margoi* died several months after treatment with copper sulfate, but cause of death was not determined. They also applied 10% formalin directly to the leeches and their eggs, after which the turtles were left out of the water for 3 hours. This treatment, however, was not highly effective (Davies and Chapman 1974). At Sea Life Park in Hawaii, several topical treatments with isopropyl alcohol successfully eradicated *O. margoi* in a massive outbreak on captive green turtles, loggerheads and hawksbills, *Eretmochelys imbricata* (Sea Life Park unpublished data, 1978).

As with any toxic chemical treatment for parasites, there is the possibility of undesirable, acute or chronic side effects to the host. Consequently, the use of a benign therapy would be preferable, if such a treatment were available. On 9 August 1987, a lethargic juvenile green turtle, afflicted with tumors and measuring 55 cm in carapace length, was found stranded at Kailua Beach on the Island of Oahu, Hawaii. Numerous *O. branchiatus* were present on the turtle, especially on the ulcerated tumors protruding from the neck and eyes. Egg cases also were present in abundance. The turtle was subsequently held in a shaded seawater tank measuring 2.4 m in diameter and filled to a depth of 0.5 m. The turtle continued to survive in this holding facility, where it was fed chopped fish and squid on a daily basis. Incidental observations made during routine tank cleaning over the following weeks revealed that the leeches seemed to be negatively affected by rinsing with fresh water from a hose. As a result, systematic treatment and observations were conducted. Treatment consisted of draining the turtle's tank completely and filling it with fresh water. When treatment began on 23 September 1987, 120 leeches were attached to the turtle. The leeches reacted immediately to immersion in fresh water by rapidly crawling over the surface of the turtle. Within 30 minutes of soaking in fresh water, leeches began to fall off and were found dead on the tank bottom. After 90 minutes, 80 leeches remained on the turtle. The tank was then drained and refilled with seawater. The number of leeches on the turtle decreased progressively after the freshwater immersion. On the following day, only 35 of the initial 120 leeches remained. Only four leeches remained after 4 days; no leeches were present on Day 6.

Two weeks after treatment, leeches began to reappear, and the egg cases had changed from a dark to a light color. Close examination revealed that the lighter color represented newly hatched eggs. Consequently, it was concluded that the freshwater treatment had little or no effect on the egg cases and that additional treatments would be needed to completely rid the turtle of leeches as new ones hatched. Subsequent immersions were conducted on this turtle and on a second one also found stranded with a heavy infestation of *O. branchiatus.* Eventually, both turtles were completely freed of leeches, and no negative effects were seen.

The relative scarcity of *Ozobranchus* on healthy green turtles in Hawaii suggests that some natural mechanism exists to deter or eliminate these parasites. Hawaiian green turtles commonly use algal and sea grass foraging habitats, where freshwater discharges into the sea. Reduced salinities at these locations may aid in the control of *Ozobranchus* through hypotonic shock. According to Sawyer et al. (1975), both *O. branchiatus* and *O. margoi* occur exclusively in salinities over 30%. Another possibility in controlling leeches is that healthy turtles subject themselves to more frequent grooming by certain fishes at discrete underwater cleaning stations known to exist in Hawaii (Balazs 1980; Balazs et al. 1987). The special circumstance of adult green turtles sometimes basking ashore in Hawaii may also facilitate leech control through heating and desiccation (Whittow and Balazs 1982).

Future research should examine different levels of salinity and duration of immersion needed to effect mortality in leeches on captive turtles. These data may then be used to help explain, or predict, the natural means of parasite control by sea turtles in the wild and to refine a practical nonchemical treatment against leeches in captive turtles.

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