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PRELIMINARY ETHOGRAM AND *IN SITU* TIME-ACTIVITY BUDGET OF THE ENIGMATIC CANE TURTLE (*VIJAYACHELYS SILVATICA*) FROM THE WESTERN GHATS, SOUTH INDIA

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***Abstract.*—We documented *in situ* behavioral patterns of the endemic Cane Turtle (*Vijayachelys silvatica*) during the post-monsoon season, using direct observations on four individuals for a total of 53.9 h (males - 30.3 h, n = 2; females – 23.6 h, n = 2). We prepared an ethogram consisting of seven states and 10 events from these observations. This is the first ethogram made for an Indian turtle species. Preliminary time-budgets suggest females may be more active than males, and our observations suggest the possibility of other sex-specific behavioral traits, although our small sample sizes prohibit statistical validation at this time. We advocate long-term behavioral studies of the Cane Turtle in its natural habitat for conservation and management purposes.**

Key Words.—ethogram; focal animal sampling; in-situ conservation; sex-specific behavior; terrestrial emydid; Western Ghats

INTRODUCTION

An understanding of animal behavior is essential for developing tools required for the management of a species. Behavioral ecology provides basic data that can be used by conservationists to develop appropriate management strategies for populations (Singh and Kaumanns 2005). Environmental changes usually inflict costs upon animals, which are typically compensated for by changes in the physiology and/or behavior of the organism (Ruby and Niblick 1994). In terrestrial vertebrates, behavioral changes are frequently the most immediate or direct response to an environmental stress in order to avoid or reduce the impact of unfavorable conditions (Morse 1980).

Ectotherms are under a constant need to adapt to the changes in the environment (diurnal as well as seasonal) as environmental temperatures influence their metabolic rates. Most reptiles, for example, use diverse behaviors to maintain preferred temperatures (Pough et al. 2001). Thus, the inclusion of behavioral studies in conservation biology might offer a different perspective on the threats facing them. Despite that most ethological research initially focused on mammals, birds, and fish (Burghardt and Milostan 1995), a growing number of studies have evaluated activity and behavior patterns in chelonians (Rose and Judd 1975; Douglass and Layne 1978; McRae et al. 1981; Brown and Brooks 1993; Kazmaier et al. 2001). However, few of these turtle studies have constructed time budgets for the species they examined (Hailey and Coulson 1999). We are not aware of any time budgets for Indian chelonians in the literature.

One of the least known and most elusive Indian chelonians, the Cane Turtle (*Vijayachelys silvatica*), is a representative of the Asian family Geoemydidae and is endemic to the Western Ghats region of the Indian subcontinent (Das 1996). The Cane Turtle is a Schedule 1 species in the Wildlife Protection (Act) 1982 and the IUCN Red Data Book lists it as Endangered (Asian Turtle Trade Working Group 2000. *Vijayachelys silvatica*. *In* IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 27 March 2014.).

Several studies have been published regarding the natural history (Vijaya 1982, 1988; Whitaker and Vijaya 2009; Deepak and Vasudevan 2010, 2013), distribution (Sharath 1990, 1997; Daniels and Daniels 2001) and systematics (Praschag et al. 2006) of this Indian emydid. Reports of Cane Turtle behavior are mostly limited to captive accounts (Moll et al.1986), with preliminary behavioral observations related to defense and aggressive interactions between males in the wild made by Deepak and Vasudevan (2010, 2013). Given the uncertain status and limited understanding of natural behavior in the Cane Turtle, here we attempt a systematic cataloguing of the Cane Turtle's behavioral patterns in the Western Ghats. Specifically, the objectives of our study were to construct an ethogram for the Cane Turtle and describe the *in-situ* activity patterns during the post-monsoon season.

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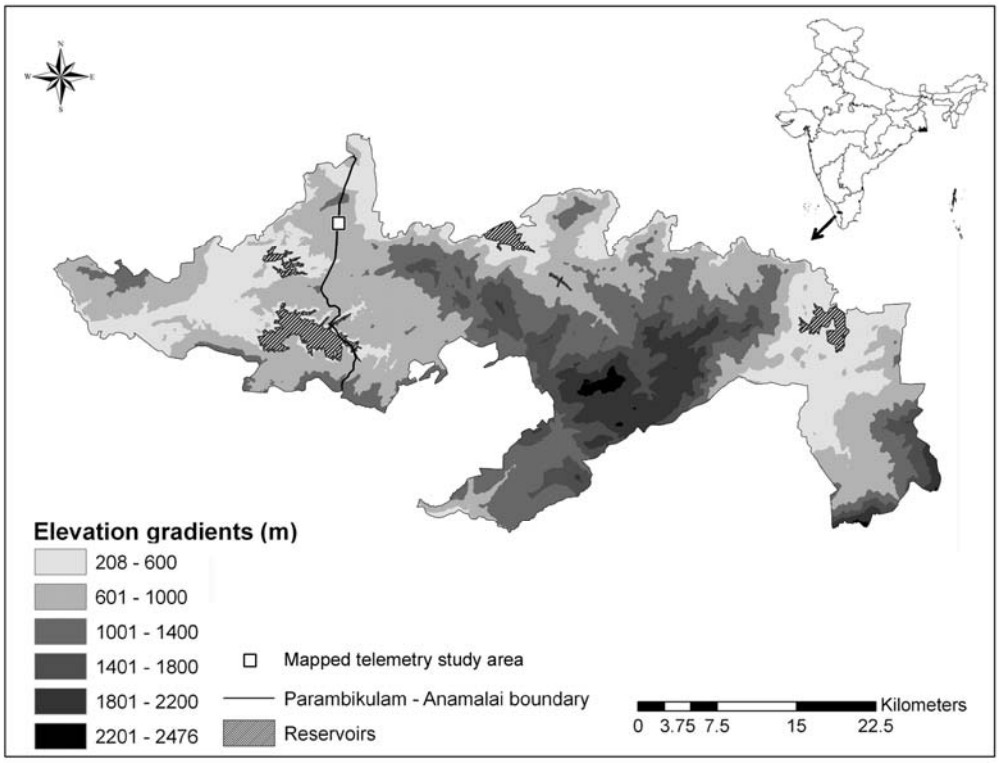

FIGURE 1. The study area located at the boundary of Anamalai and Parambikulam Tiger Reserves, where behavioral observations were made on radio-tagged Cane Turtles (*Vijayachelys sylvatica*) in southern Western Ghats.

MATERIALS AND METHODS

Study site.—This study was conducted from January to April 2008 in Anamalai Tiger Reserve, and Parambikulam Tiger Reserve situated in the southern Western Ghats, Tamil Nadu, India (N 10° 28' 18.5"; E 76° 50' 14.4"; Figure 1). The vegetation in the study area is classified as southern tropical wet evergreen forest comprised of *Dipterocarpus indicus, D. bourdilloni, Strombosia ceylanica* (Champion and Seth 1968). The mean annual rainfall, according to the nearest rain gauge at the meteorological station on Thunakadavu Dam, during 2006-2009 was 1711 mm. We investigated the behavior of four radio-tagged turtles as part of an ongoing project at the Wildlife Institute of India. They were given the following identifications: 10 (male), 9 (male), 5 (female) and 6 (female), hereafter referred to as ♂10, ♂9, ♀5 and ♀6 respectively.

Radiotelemetry.—We followed the protocol of Boarman et al. (1998) for attaching the transmitters on Cane Turtles with the following modification in the steps. In order to position the antenna, we cut short sections (10 mm) of flexible 3–4 mm diameter plastic tubing, and epoxied each section to the first four vertebral scutes. Each section was slightly shorter than the width of the associated scute. We used epoxy glue to hold each section of tubing in place and applied epoxy adhesive Hysol E-120 HP (Loctite Corp, Westlake, Ohio, U.S.A), and it was dried for an hour. On the sides, we used Abro tapes to avoid epoxy on the scute sutures or on the neighboring scutes.

Ethogram and time budget.—We used the focal animal sampling method (after Altmann 1974) to gather behavioral data. Altmann describes focal animal sampling as a method in which all occurrences of specified actions of an individual, or a specified group of individuals, are recorded during each sample period. Moreover a record of the length of each sample period and the amount of time during the sample that each focal individual is actually in view is made. Once chosen, a focal individual is followed to whatever extent possible during each of its sample periods. Our observations suggested that the animals were active early in the morning and late in the evening. During the rest of the time they retreated under leaf litter and remained motionless. Early attempts to make observations under artificial lighting, such as flashlights dampened by red cellophane wraps, frightened the turtles. Thus we

TABLE 1. Seven behavioral states observed in *Vijayachelys silvatica*.

1. Alert – Turtle flat on the ground; limbs may or may not be out; tail usually folded in; head out of the shell, resting on the floor with eyes open; this is a state of heightened alertness wherein the turtle will react to causes of disturbance (e.g., sound, movement, shining of torch, etc.).
2. Sleeping – Same postures as 'alert' but with the eyes closed, and does not react to disturbances unless they are severe.
3. Walking – Turtle moving, the shell/body lifted considerably high above the ground; tail out and held firmly parallel to the ground;
4. Feeding – Turtle biting, gnawing at, or chewing food item.
5. Scanning –
    a. neck retracted – Turtle resting on plastron with limbs withdrawn, tail may or may not be out; only head out (neck withdrawn), maintaining an angle of 40º–45° from the horizontal; the eyes are open; the head sweeps an 180° arc around the neck in one motion or with intermittent stops in between.
    b. neck out – Turtle may or may not be standing; if resting on plastron the limbs may or may not be out; tail may or may not be out; the neck is stretched out completely while the head maintains an angle of 40º–45º from the horizontal; the eyes are open; the head sweeps an 180º arc around the neck in one motion or with intermittent stops in between.
6. Staring – Turtle may or may not be standing, if resting on plastron the limbs may or may not be out; tail may or may not be out; the neck is stretched out to its fullest extent, and the eyes are wide open; the head is kept absolutely immobile anywhere between the 180º arc; this position is usually maintained for a long span of time.
7. Withdrawn – Head partially or completely retracted or head/complete body in leaf litter; limbs usually pulled in; tail pulled in.

restricted sampling to daylight hours only, carrying out observations from 0600 to 1300 and 1530 to 1900 depending on the visibility of the animals' environment, which was often covered in thick mist. We observed only one focal individual per sampling session and we randomized selection of individuals by drawing lots. Each session began roughly 5 minutes after locating an individual. We observed animals twice a day for 2 h (i.e., in 12 sessions of 10 min each) unless the focal individual went out of view in which case we discontinued sampling. There was an interval of 5 minutes in between two consecutive sampling sessions. We made observations from varying distances depending on the terrain and visibility. These distances varied from 2 to 8 m. The observer remained as still as possible, and was usually seated outside or hidden from the field of vision of the animal (e.g. behind a bush). After one week of observation, we categorized each distinguishable behavior type as either a 'state' (a long duration behavior type) or an 'event' (short duration behavior type) after Altmann (1974). We used the resultant list of behavior types to compose an ethogram of the species. When describing action patterns, we did not attempt to explain the proximate or ultimate cause of the behavior. We selected the name given to each action pattern to be descriptive and not to infer function (after Brockmann, H.J. 1994. Measuring behaviour: Ethograms, kinematic diagrams, and time budgets. http://college.holycross.edu/faculty/kprestwi/behavior/e&be_notes/E&BE_ethograms.pdf.). We also recorded intervals (time span from start to end) between states with the help of a standard stopwatch to the nearest second. To determine the percent of time spent in a particular state, we summed intervals of the state of interest and divided by the total sample time recorded. Using these percentages, we prepared an activity time budget for each individual. For a measure of total time spent being active proportions of states alert, walking, feeding, scanning, and staring were summed. We calculated time spent inactive by summing the cumulative total of the proportions of sleeping and withdrawn states.

RESULTS

We spent a total of 53.9 h (males = 30.3 h; females = 23.6 h) observing the turtles during the study period. Based on these observations we established an ethogram consisting of 7 states (Table 1) and 10 events (Table 2). We made observations on ♂10, ♂9, ♀5 and ♀6 for a total of 14, 16.3, 17.3 and 6.3 h respectively (Table 3).

DISCUSSION

Our Cane Turtle time budget shows trends for differences in time spent in various states for males and females and our ethogram revealed a large suite of previously unreported behavioral patterns. In particular, action patterns such as 'yawning' (Table 2) are interesting phenomena and merit further investigation since yawning behaviors are poorly understood in reptiles (Ramesh and Bhupathy 2009), but might have a thermoregulatory function (Gallup and Gallup 2007). Though ours is a smaller inventory of behaviors and does not include social interactions, some of the action patterns are analogous to behaviors described in ethograms for other turtle species, especially to that of the Desert Tortoise (*Gopherus agassizii*) by Ruby and Niblick (1994). Unfortunately, the lack of behavioral data for more closely related Indian species is lacking and does not allow for more appropriate comparisons. To the best of our knowledge, this is the first ethogram made for any Indian turtle.

When active, the Cane Turtles spent most of their time being alert and engaging in scanning behaviors. The individuals used in our study seemed to engage in

TABLE 2. Ten behavioral events observed in *Vijayachelys silvatica*.

1. Yawning – Turtle might be either resting on plastron or standing, the neck stretches out vertically and almost simultaneously the jaws are opened wide while the eyes are closed.
2. Wiping face – Turtle moves either of the forelimbs to the face and rubs it, usually in a circular movement and in abrupt bouts.
3. Blinking – Turtle moves lower eyelid firmly and quickly over the eyeball, then retracts eyelid back to original position.
4. Nosing – Turtle stretches the neck out completely towards leaf or leaves on the floor then rests its nose on the litter for some time (few seconds to several minutes); it then either penetrates the litter with its snout or rubs its head (side or snout or both) against a leaf or leaves.
5. Stretching limbs – This event observed only when turtle in states - 'alert' and 'sleeping'. Turtle stretches out one/both of its front limbs in front and rests it/them beside its face, often maintaining this posture for several minutes to an hour; this is often followed by nestling the head against the outstretched limb.
6. Penetrating litter – Turtle shuffles forward stretching out its neck and ducking its head under litter while the forelimbs perform a forward and outward sweep, clearing the litter in the process.
7. Biting – Turtle begins by slowly stretching out its neck towards the object while opening its mouth; this is followed by striking at the object by quickly extending the head forward, and quickly closing the jaws.
8. Head jerking – This event observed only when turtle in states - 'alert' and 'sleeping'. Turtle suddenly and violently jerks head right/left while simultaneously withdrawing it slightly into the shell.
9. Climbing – Turtle begins by putting its forelimbs onto the object, after which the neck is stretched out completely while the limbs push down on the object to hoist the body up. Often when the object is too high (beyond the reach of the forelimbs) the turtle begins by placing its chin on the object and pushing down with it, to lift itself sufficiently off the ground for its forelimbs to reach the object.
10. Head shifting – This event observed mostly when turtle is in the 'sleeping' state. Turtle shifts head to right/left/center periodically, often stretching the neck out and bending it to form an "L" shape.

normal behavioral activities in the presence of an observer. However, they would often respond to loud noises or sudden movements by withdrawing their heads. The neck retracted scans almost always preceded the neck out scans. The major locomotion category was walking with the pace varying from slow and ambling to brisk hop-like steps. During their locomotion they often probed the litter. Climbing over obstacles such as buttresses, fallen logs, or roots was regularly observed as the turtles moved on the forest floor**.**

Other activities included wiping face, head shifting, stretching limbs, head jerking, biting and nosing**.** On 9 February 2008 between 0710–1005 we observed ♀5 "nosing" the leaf litter while walking on a rainy day. We infer that the animal was probably hunting for food based on a report by Ruby and Niblick (1994) of a structurally comparable behavior by the Desert Tortoise described as "substrate sniff" which was said to be part of its foraging behavior.

The time that the turtles spent inactive was mostly spent in the state of sleeping**.** During dry spells, the turtles remained inactive for as long as a month. This inactivity mostly occurred while the individuals were buried under dense leaf litter; however, in some instances an individual would briefly become active (alert) and remain in a stationary position just above the leaf litter for hours.

Our observations suggest a drop in Cane Turtle activity levels on days without any rainfall. Walking and scanning were only observed during or after rains. These behaviors were often part of a sudden burst in the levels of activities that were associated with rain. During these periods, turtles were active longer and displayed a larger range of activity types. Rainfall is known to influence activity of chelonians from diverse habitats such as *Gopherus agassizii* (Peterson 1996), and *Terrapene carolina* (Stickel 1950; Strang 1983). This could be an adaptation for avoiding evaporative water loss in terrestrial turtles (Peterson 1996).

We observed a single instance of feeding behavior during our study. On 12 February 2008 at 0940 hrs we observed ♀6 biting an *Indrella ampulla* which was clinging on to the base of a tree trunk. A large terrestrial snail of the family Zonotidae, *I. ampulla* is endemic to the Western Ghats (Blandford and Godwin-Austen 1908). This observation coupled with a previous observation made by one of us (VD) suggests that snails are possibly a regular component of the Cane Turtle's diet (Deepak et al. 2009; Vasudevan et al. 2010).

Despite the logistic hurdles inherent with *in-situ* research of a secretive turtle and the fact that our study was conducted on only a small number of individuals,

TABLE 3. Individual, *in situ* behavioral time budgets for each of the 2 male and 2 female Cane Turtles (*Vijayachelys sylvatica*) from January through April 2008. Budgets are expressed as percentage of time spent in each state.

Individual	Alert	Sleeping	Walking	Feeding	Scanning	Staring	Withdrawn
♂**9**	22	26.7	3	0	4.9	0.5	42.9
♂**10**	23.9	16.7	1.8	0	12.4	4.1	41
♀**5**	30.7	34.9	1	0	5.5	0.8	27
♀**6**	42.6	2.1	0.8	2.6	12.4	2.6	36.8

these initial descriptions of behavioral traits do contribute to our knowledge of the natural history of this endangered and endemic species. An understanding of the behaviors of endangered and threatened species has great preservation and protection value; for example, responses of the Desert Tortoise to relocation (Berry 1986), to barriers (Boarman et al.1993), and to captive breeding help in the management of this species (Ruby and Niblick 1994.). Based on the results of our preliminary study and the resultant ethogram, we recommend long-term *in-situ* studies, using a larger number of individuals, on Cane Turtle behavior and thermal ecology. This would also help gather valuable data on the biology of the species that would validate the existence of sex-specific behaviors that inform conservation breeding programs.

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