Dry season diel activity patterns of spectacled caiman (*Caiman crocodilus*) in the Venezuelan llanos

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A considerable body of work has examined patterns of reptile behavior and activity in association with thermoregulation, including studies on crocodilians (Cott, 1961; Cloudsley-Thompson, 1964; Modha, 1968; Johnson et al., 1976; Smith, 1979). Due to the large size and resulting thermal inertia of most crocodilians (Spotila et al., 1972; Terpin et al., 1979), behavioral patterns of thermoregulation are assumed to be distinctive from those of other reptiles (Lang, 1987). Thermoregulatory strategies may also

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differ between temperate and subtropical heat seeking species (e.g., *Alligator mississippiensis*), and more tropical species (Lang, 1987). These differences may be reflected in patterns of land-water movements, with crocodilians under high ambient temperature conditions utilizing heat sinks to keep body temperatures from exceeding preferred levels. However, relatively little quantitative information exists regarding the pattern of land-water movements of wild crocodilians, particularly for tropical species.

The seasonal concentration of large numbers of spectacled caiman, *Caiman crocodilus*, into lagoons in the Venezuelan llanos habitat provides an ideal opportunity to examine diel variation in dry season activity (approximately December to April) and movement patterns. Previous examinations of caiman basking cycle have been conducted by Staton and Dixon (1975), Marcellini (1979) and Ayarzagüena (1983). Some evidence exists indicating that spectacled caiman do avoid high temperatures (Lang 1987), but these observations have not been put into the context of daily activity patterns. The objectives of this study were to quantify diurnal patterns of caiman land-water movement and estimate the proportion of the population engaged in principal activity categories throughout the day.

Diurnal behavior was studied at one lagoon (18 m × 71 m) on Fundo Pecuario Masaguaral, a cattle ranch located in the central Venezuelan llanos (8°33′ N, 67°37′ W). All observations were made during the annual dry season when reduced water availability concentrated large numbers of animals into a small number of lagoons (Staton and Dixon, 1975). Observations were made during continuous 12 hr periods (06.00-18.00 h) from a vehicle 30 m from the lagoon. The vehicle was parked adjacent to the lagoon approximately one-half hour prior to beginning observations, after an initial period caiman ignored the vehicle and would even haul out and bask next to it. At 15-min intervals all visible caiman were counted and classified in one of three categories: basking (on land), in the water (at the surface), or on the edge (caiman resting in shallow water adjacent to the shore or partially hauled out). The number of caiman underwater was calculated by subtracting the total number of caiman visible from the maximum total count made (usually during the 06.00 h count). Air temperature (Omega 871 hand-held digital thermometer) was recorded hourly. Air and water (5 cm below the surface) temperates were recorded randomly at a variety of water bodies throughout the ranch as part of a caiman radio-telemetry study (Thorbjarnarson, 1991).

Diurnal observations were made on six days (5 Jan, 16 Feb, 23 Mar, 2 May 1986, 18 Jan 1987, and 18 Dec 1988). The weather was sunny or partly cloudy on all days. Mean ambient temperature increased during the course of the dry season from January (29.3°C) through March (31.4°C), then dropped slightly in May (30.8°C; all temperatures for 1986). Overcast weather was only experienced from 12.00-14.00 h on 18 Jan 1987, and from 06.00-09.15 h on 2 May 1986. A brief drizzle fell at 08.32 h on this latter date. Daily air (Ta) and water (Tw) temperature variation followed a predictable pattern with Ta>Tw in the morning (08.00-12.00 h) and Tw>Ta in the afternoon (fig. 1).

The overall pattern of basking was bimodal, with peaks in the morning (10.00h) and

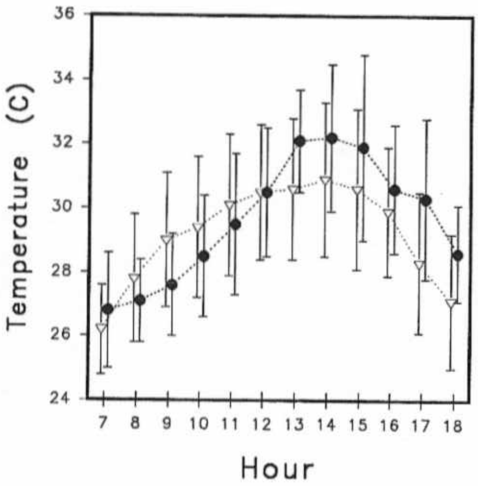

Figure 1. Mean air (open inverted triangles, n = 589) and water temperature at 5 cm depth (filled circles, n = 613) variation between 07.00 and 18.00 h in random water bodies on Fundo Pecuario Masaguaral.

afternoon (17.00h; fig. 2). However, a strong morning basking peak was only evident on one of the six days (5 Jan 1986). Afternoon basking peaks were variable, ranging from 10% to >40% of the population. The mean proportion of the population observed basking declined from the early dry season (December-January) to the late dry season (March-May; fig. 3). Typically, a small number of caiman emerged to bask during the morning: few would remain out of the water during the middle of the day (12.00-14.00 h). At this time there were a peak in "edge" animals, basking in shallow water, or partially hauled out on shore (fig. 4).

Most caiman spent a considerable amount of time submerged underwater (fig. 4), but during the early morning hours most were floating or swimming at the surface of the water. Caiman were more active during the early morning hours when the majority of bellows and agonistic encounters occurred; this was characteristic of caiman throughout the ranch (Staton and Dixon, 1975; Thorbjarnarson, 1991). During the mid-day hours, over half the caiman are submerged (fig. 4) and apparently inactive.

Among crocodilians, movements between the water and land have long been associated with thermoregulatory behavior (Cott, 1961; Modha, 1968), with emergence onto land during the day assumed to be a typical reptilian heat seeking behavior. However, Lang (1987) has noted that while this may be true of species that inhabit subtropical or temperature habitats (e.g., *Alligator mississippiensis*), and tropical species under some

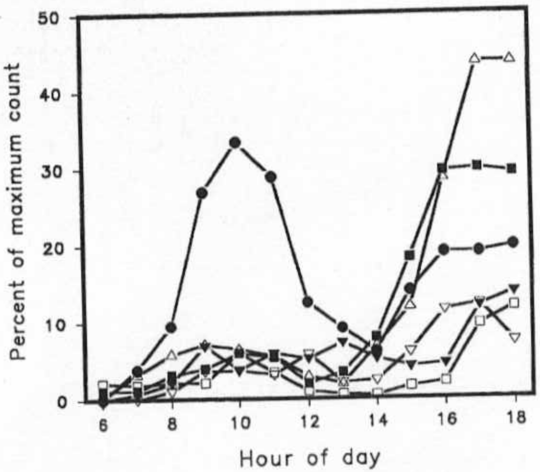

Figure 2. Percent of the caiman population on shore between 06.00 and 18.00 h for each of six days (filled circles-5 Jan 1986; open inverted triangles-16 Feb 1986; inverted filled triangles- 23 Mar 1987; open squares-2 May 1986; filled squares-18 Jan 1987; open triangles-18 Dec 1988).

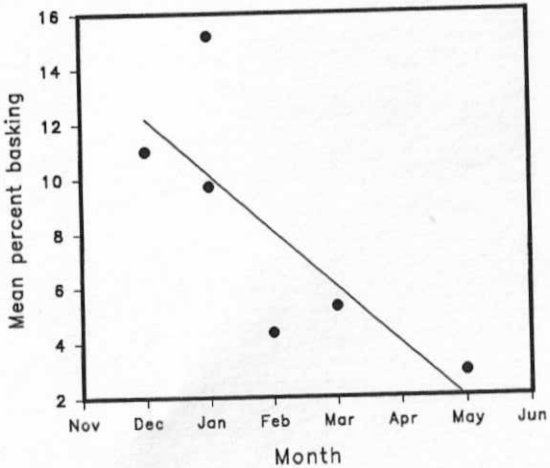

Figure 3. Mean percent of the population observed basking on land during the dry season for each of the six days, as a function of month (Dec-Jan: early dry season, May: late dry season).

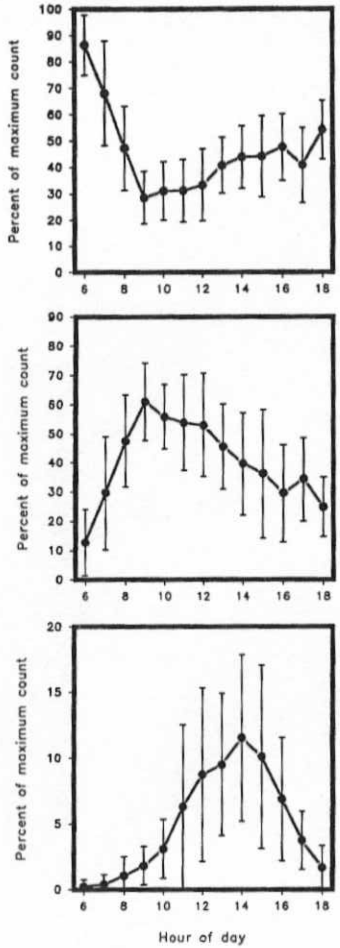

Figure 4. Mean percent of the population swimming or floating at the surface of the lagoon (upper), submerged (middle), or partially in the water along the edge of the lagoon (bottom) (±1SD).

circumstances, heat avoidance behavior may be characteristic of tropical species where ambient air and water temperatures are normally within or exceed the preferred body temperature range. Lang (1987) pointed out that in certain areas, *C. porosus* will remain in the water most of the day and emerge onto land in the evening. Similar nocturnal emergences were reported by Lang (1987) for several other species, including *Caiman crocodilus*. In this study, morning basking was typical of only about 5% of the population on five of the six days. A peak of approximately 10% of the population was observed basking in shallow water in the early afternoon. Combining edge and on land basking individuals, only approximately 15% of the population exhibited thermophilic behavior prior to 14.00 h. Lang (1979) noted a thermophilic response among recently fed alligators. The one morning with a large basking peak (> 30%) was in January, when feeding activity is greatest for this population (Thorbjarnarson, 1993); however during the other January observation small numbers of caiman were basking in the morning. The number of caiman basking during the morning hours declined during the course of the dry season and may reflect a decline in preferred body temperatures (due to decreased feeding), or higher ambient temperatures.

In nearby shallow lagoons caiman were frequently observed during the day resting on the bottom, occasionally lifting their heads to breath. This was also seen in the study lagoon, but due to its depth (1.5-1.8 m), required that the caiman swim to the surface to breath. The large percentage of animals submerged during the day may reflect avoidance of high ambient temperatures (Smith, 1979), or avoidance of agonistic social interactions caused by the high density conditions in the dry season lagoons. Other plausible reasons for submergence are subsurface foraging, and avoidance of wave action which interferes with breathing and vision. In very shallow lagoons, submergence by itself may not be an effective heat avoidance behavior, but may be accompanied by burial in bottom sediments (Thorbjarnarson, personal observation).

During the afternoon, use of shallow, unvegetated water around the edge of the lagoon as a heat sink may not be feasible because water temperatures may exceed preferred levels. Diefenbach (1975) reported the preferred temperatures of juvenile caiman ranged from 29.9°C to 34.8°C, but Lang (1987) indicated that because these were heating trial, the values represent upper limits to voluntarily selected body temperatures. Afternoon surface water temperatures would frequently exceed 32°C. Afternoon emergence onto land took place after shallow water temperatures exceed air temperature, suggesting that caiman may be trying to lower body temperatures. This interpretation is supported by the fact that caiman would remain on shore into the evening and well into the night when clear skies and low relative humidity would facilitate radiative heat loss. During nocturnal counts of caiman on the same ranch in the dry season, over one-third of the caiman were seen on shore at some bodies of water (Thorbjarnarson, unpublished data). Nocturnal counts (conducted prior to 23.00 h) on the Capanaparo River in southern Apure state found 22.6% of observed caiman were on shore (Thorbjarnarson and G. Hernández, unpubl. data). Similar patterns of temperature regulation have been reported for *C. porosus* (Lang, 1987) and *C. niloticus*

(Loveridge, 1984). A similar late afternoon and evening peak in numbers of caiman on shore was noted by Staton and Dixon (1975). Marcellini (1979) and Ayarzagüena (1983), although the latter two authors observed few animals out of the water after 20.00 h.

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