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PROGRESS REPORT TO THE NATIONAL ZOOLOGICAL PARK, SMITHSONIAN INSTITUTION

TITLE: Thermal Ecology and Social Behaviors of Caiman crocodilus
in the Llanos of Venezuela

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INTRODUCTION

During FY1976, studies were conducted by Dr. Dale Marcellini, Mr. Scott Maness, and Mr. Jeff Wyles on the distribution and daily activity patterns of caimans (Caiman crocodilus) and South American pond turtles (Podocnemis vogli) in ponds in the Llanos region of Venezuela where these species were locally abundant. During FY1977, I conducted research on the thermal ecology and social behaviors of caimans at one of these localities in collaboration with Mr. Scott Maness and Dr. Dale Marcellini. In addition, the thermal ecology of turtles living in the same pond was studied concurrently by Mr. Scott Maness and will be reported separately. In this report, I outline the research objectives, describe the methodology employed, some preliminary results, and discuss these results briefly. present

OBJECTIVES

Previous research conducted in FY1976 indicated that caimans and turtles were seasonally abundant in high densities, as many as several hundred or more individuals, in permanent ponds during the dry season. Both species exhibited well-defined, but different, daily activity patterns that appeared to be related to the daily thermal regime. The caimans tended to remain in the water during the day, whereas the turtles spent much of the day on land. However, without detailed environmental data and information on the thermal relations of each species, interpretation of their daily activity patterns and differences in these patterns were limited.

In addition to these studies, Mr. Scott Maness made preliminary observations of the social behaviors of caimans, and these observations indicated that social interaction was a prominent feature of the daily activity of caimans during this period. But, a detailed account of the various social signals and behaviors and an interpretation of their significance was not possible without studying marked individuals of known sex.

The objectives of the present study were:

- 1) to investigate the thermal ecology, and
- 2) to describe the social behaviors of caimans during the dry-wet season transition.

MATERIALS AND METHODS

The study was conducted at Hato el Frio, Apure State, Venezuela. This region, referred to as the "llanos," is a grassland savannah characterized by relatively constant and high temperature, but marked seasonality in precipitation. The study was initiated at the end of the dry season (early April) and continued until late May, about three weeks after the first rains of the wet season. The study site was a small permanent pond that measured 40 m in diameter and 2 m in depth at the end of the dry season. This pond, referred to as the Figure-8 Pond, was studied in 1976 when both caimans and turtles were present in high densities. In 1977, an estimated 230 caimans and 600 turtles inhabited this pond at the end of the dry season.

At the Figure-8 Pond, a total of 22 caimans (19 males and 3 females), ranging in size from 3-50 kg, were captured, measured, sexed, and tagged with colorful tags that permitted individuals to be identified. Small temperature-dependent radio transmitters were introduced into the stomachs of 14 of the marked caimans, and the body temperatures (T_b s) of these animals were monitored on portable walkie-talkie receivers. Several of these individuals were also equipped with probe transmitters that encoded brain or subdermal temperatures. Environmental variables that were monitored throughout the study included a continuous record of daily solar radiation and hourly measurements of water, air, and substrate temperatures as well as wind speed and direction, relative humidity, and light intensity during the periods of observation.

The thermal behaviors and T_b s of individual caimans were studied from 14 April until 20 May. Observations were made throughout the day on most days during this period and occasionally throughout the night as well. The social interactions of marked and unmarked caimans were observed and recorded on magnetic tape and later transcribed to provide a detailed account of specific social behaviors and the contexts in which these occurred. In addition, many of these behaviors were extensively documented on still and movie film for later analysis.

RESULTS

A. Thermal Ecology

Caimans assumed positions in and out of the water in a typical daily sequence that resulted in relatively constant T_b s throughout the day. The daily records of behaviors and T_b s of two caimans on a sunny day early in the study are shown in Figure 1. When water temperatures were seasonally high (29-30°C), caimans spent the daylight hours in the water in various positions. The head-emergent position (body below and head above the water surface) resulted in increasing T_b s in the morning (Figure 1a) or mid-afternoon (Figure 1b) when radiation levels were high. Later in the afternoon when radiation levels were reduced, this position resulted in relatively stable T_b s (Fig. 1a, b). During midday, a submerged position underwater resulted in a stabilization of T_b or only a gradual rise in T_b (Figure 1a, b).

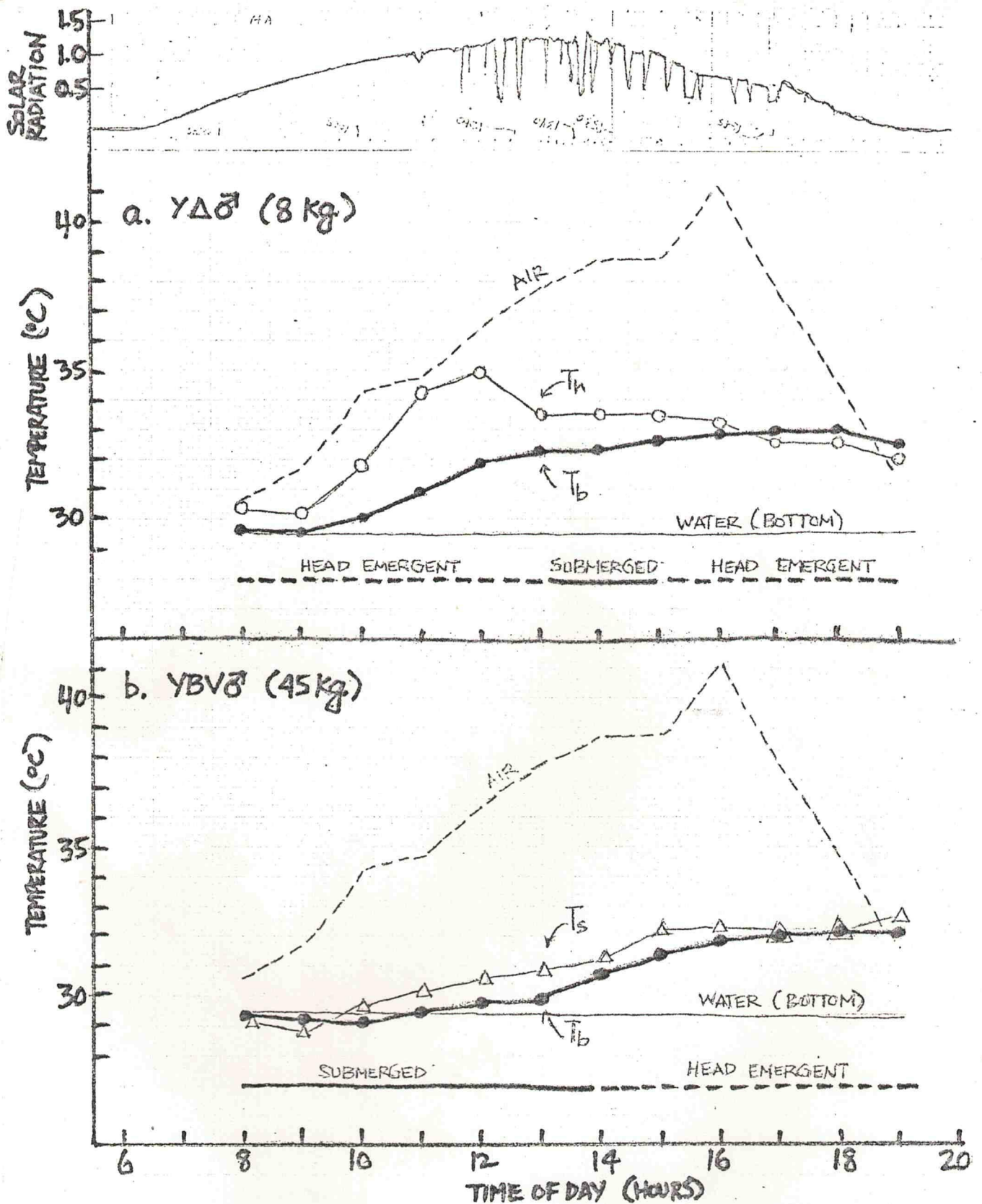


Figure 1: The thermal behaviors and body temperatures of two caimans (a,b) on a sunny day during the dry season in a permanent pond in the llanos of Venezuela. The caiman's positions relative to land and water are shown at the bottom of each record. Water and air temperatures are indicated in each record, and solar radiation (cal. cm^{-2}) throughout the day is shown at the top of the graph. T_b =stomach temperature; T_h =head temperature; T_s =subdermal temperature.

The daily positions that caimans assumed in and out of the water were dependent on the daily pattern of solar radiation. On cloudy days, such as shown in Figure 2 for the same two caimans, positions at the water surface were maintained when radiation levels were low, and exposure to available radiation resulted in gradual increases in T_b despite reduced radiation levels. In the evening, many caimans moved onto land and remained on land, either partially or entirely out of the water, for much of the night. These positions resulted in a gradual drop in T_b throughout the night.

When water temperatures dropped to 26-27°C with the onset of the spring rains and rising water levels in early May, caimans moved onto land early in the morning on sunny days and after several hours returned to the water where they remained during midday. Thus, at the beginning of the wet season, caimans spent more time exposed to solar radiation when it was available and less time submerged compared to the daily sequence of positions assumed during the dry season.

Preliminary analyses of the daily thermal records of the monitored caimans indicate:

- 1) caimans controlled T_b s by assuming specific positions in and out of the water
- 2) daily positions in and out of the water were synchronized with the daily thermal regime
- 3) daily variations in solar radiation and seasonal changes in water temperature resulted in adjustments in the positions assumed relative to land and water and corresponding changes in T_b
- 4) caimans maintained relatively constant T_b s of 30-33°C during the day, and T_b s of 26-30°C at night during the transition between the dry and wet seasons.

B. Social Behaviors

The high density of caimans in the study pond provided an exceptional opportunity to observe and document social behaviors and the contexts in which these behaviors were performed. Preliminary analyses of the behavioral observations recorded during the study indicate:

- 1) The caiman signalling system consisted of a variety of vocal and non-vocal acoustical signals, as well as visual signals involving specific postures and movements. Vocalizations and sub-audible vibrations produced in the water played prominent roles in the communication of caimans.
- 2) Aggressive encounters were common throughout the study, particularly among large males. The outcome of these encounters suggested that dominance relationships were established and maintained by specific social behaviors performed by the larger males in the pond.

- 3) Courtship was not observed prior to dispersal from the pond, but pre-courtship activity intensified with the onset of the rains in early May.
- 4) Caimans dispersed from the study pond within several days after nearby areas filled with water; movements of 1-5 km were recorded during this period.

DISCUSSION

A. Thermal Ecology

Behavioral adjustments to the daily pattern of solar radiation played a major role in determining the daily activity of caimans. In particular, submergence underwater during the hottest time of day prevented overheating that would likely have occurred in other positions at the water surface or on land, especially at the end of the hot dry season. Caimans living in shallow ponds (less than 1 m in depth) at the end of the dry season buried themselves in the mud for much of the day. The mud was relatively cool (about 26-27°C) throughout the day, and served as an effective insulation from solar radiation in the absence of deep water in which caimans could submerge. During this period, caimans were also found buried in leaf litter in shaded areas of forest, away from any water. Apparently, there are a number of alternate strategies which allow caimans to endure the rigors of the dry season when available water is scarce. Further observations during the wet season are necessary to complete an outline of these thermal requirements of caimans during the year.

The different daily activity patterns of caimans and turtles living in the same pond are explicable on the basis of differences in their thermal ecologies. In contrast to caimans, turtles maintained higher daytime T_b s (35-44°C) by remaining on land throughout the hottest period of the day, when caimans were submerged underwater. Thus, the thermal requirements of these two species appear to differ considerably and these differences are reflected in the differing daily activities of the turtles and caimans. However, the functional significance of differences in the thermal requirements of these two species is not obvious and will require further study.

In many respects, the thermal ecology of caimans in the tropical llanos is similar to that of alligators inhabiting subtropical regions. In both species, movements between land and water are the major means of controlling T_b . Furthermore, the T_b levels maintained by the caimans I studied are nearly identical to those maintained by alligators at the end of the dry season in south Florida.

B. Social Behaviors

The social signals employed by caimans are generally similar to those utilized by alligators and crocodiles. However, some signals described for these species were not observed for caimans, while certain others appear to be unique to caimans. In particular, caimans performed repetitive sub-audible vibrations ending with vocalizations that resembled the

bellowing signal of alligators. This call was performed in chorus with other caimans. The extensive use of vocal as well as vibrational signals suggests that the caiman signal system more closely resembles that of alligators than that of crocodiles, but this supposition is contingent on further analyses of the behavior records.

Aggressive interactions were observed frequently between caimans, but rarely resulted in physical injuries. A variety of signals were employed by individuals engaged in these encounters that appeared to signal their changing intents, and prevented attack. In many instances, interactions between and among caimans were remarkably casual and did not result in aggressive behaviors. Caimans often tolerated others in close proximity, and in this respect, their social behavior resembles that of alligators.

Courtship was not observed during the study, although pre-courtship activity was apparent at the beginning of the wet season. Presumably, courtship occurs after the caimans disperse shortly after the spring rains. Caimans probably bred in small groups of 10-30 individuals that assemble after dispersal from the dry season ponds rather than in the large groups that form in ponds at the end of the dry season. If caimans do court and mate in small breeding units, this pattern would be more like the breeding system of alligators than that of crocodiles which are known to assemble in high density breeding groups.