Abstract

The diel activity of Podocnemis vogli is characterized by a lack of visible activity after dark. Turtles are first seen in the water shortly before sunrise and begin basking shortly thereafter. The basking pattern is bimodal with a peak at 1300 hrs., a midday low, and an afternoon peak at about 1500 hrs. Caiman crocodilus are visible throughout the 24 hour period with higher in the water counts at night. Caiman basking activity is bimodal with a morning peak at 0900 hrs., a midday low, and a second higher afternoon peak at 1600 - 1800 hrs. Podocnemis diel activity appears to be governed by light but basking seems to be controlled in part by air temperature. Light appears to control the type of activity that caiman engage in, but air temperature may have some effect on basking patterns. The results of the present paper are compared to data from other studies and general agreement is found.

Activity Patterns of Venezuelan Caiman (Caiman crocodilus) and (Podocnemis vogli)

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Diel activity cycles have been described for a number of reptiles (Bustard, 1968, 1970; Cloudsley-Thompson, 1961; Marcellini, 1971). These studies have dealt largely with lizards, but some work has been done on diel activity cycles of aquatic turtles and crocodilians. Cott, (1961), Cloudsley-Thompson (1964) and Modha (1968) have reported on the 24 hour activity cycles of the Nile crocodile and Lang (1976) discussed the activity cycle of the American alligator. Turtle diel activity cycles have been mentioned in numerous papers but numerial data is rare. The activity cycle of the yellow-bellied turtle has been quantified by Auth (1975) and some work was done by Moll and Legler (1971) on the basking activity of Panamanian Chrysemys scripta. Other than the work of Moll and Legler, no quantitative investigations have been done on diel activity cycles of tropical new world chelonians or crocodilians.

This paper describes the daily activity cycle of the specticled caiman (Caiman crocodilus) and the pond turtle (Podocnemis vogli). Possible environmental determinants for these cycles are discussed and the present work is compared with the results of other studies on activity cycles of crocodilians and turtles.

Methods and Materials

Data were gathered during February, March and April of 1976 at two ranches in the inland plains (Llanos) of Venezuela; Rancho Pecuario Masagueral in the state of Guarico, and Rancho El Frio in the state of

Apure. Ponds on these ranches contain large populations of caimans and turtles. These populations are concentrated during the dry season (November thru April) making accurate censuses possible. Six census sites were used; two on Rancho Pecuario Masagueral, and four at Rancho El Frio. Three of the six sites were on ponds of a size that allowed the entire pond to be censused. Three sites were on large ponds and only animals in a specified area were counted. Hourly counts of turtles and caimans were made from predetermined census spots at each pond. A hand counter was used and binoculars aided the day counts. Night censuses were done with head lamps. Day and night caiman counts were relatively easy because the animals are large and their eyes shine when struck by the light of a head lamp. Turtle counts were more difficult because of their relatively small size and lack of eye shine. It was fortunate that night turtle counts proved to be of little importance because few turtles were abroad after dark. The number of animals in and out of the water was noted. Individuals with more than half their total length out of the water were counted as basking and visa versa. In this paper the term basking is synomous with out of the water. Censuses required about 15 min. to complete and were started on the hour.

Over 200 hourly counts covered a 24 hour census period but, more data were taken from 0600 to 2200 hrs. Basking and in water counts for each hour at each study site were expressed as a percentage of the highest number of caimans or turtles censused at that site. Basking and in water percentages, for each species, were averaged for each hour and are graphed in Figs 1 and 2. Averages of less than one per cent were not

included in the graphs.

Air and water temperatures were obtained with a Schulthesis thermometer. Air temperatures were taken one meter from the ground in the shade. Temperatures were not recorded for each census hour at each site but sufficient air temperatures were obtained (101) to construct a "typical" 24 hour temperature cycle. Water temperatures were taken approximately 30 cm. from shore and 5 cm. deep. These temperatures were also taken irregularly (97) but it is felt that they give a good indication of water temperature variation during the study period.

Results

Air temperatures ranged from 23 - 37 C with a mean of 30 C. A representative 24 hour air temperature cycle was obtained by averaging hourly temperatures taken at the six sites (Fig 1, 2). Water temperatures ranged from 21 - 31 C with a mean of 26 C. Daily water temperatures were lowest in the morning and highest in the afternoon, but the 24 hour variation never exceeded 6 C and was generally less than 3 C.

Podocnemis vogli activity is largely restricted to the daylight hours with only a few irregular sightings occuring from 2000 to 0400 hrs. (Fig 1). Podocnemis are first seen in the water before sunrise, and they increase in numbers over a six hour period to a morning peak at 1000 hrs. At about 0700 hrs. some turtles begin to come out of the water to bask and at 0800 hrs. an explosive emergence occurs until a peak is reached at about 1300 hrs. There appears to be a drop in both in the water and basking counts at midday. This is followed by the

highest counts in both categories. Basking activity drops abruptly from this afternoon peak to a lack of basking by 1900 hrs. Turtles are still evident in the water after they have ceased basking but these counts also diminish to very low numbers (less than 1% of highest number censused) by 2000 hrs.

Caiman crocodilus are visible throughout the 24 hour period with higher counts from 1300 to 0700 hrs. (Fig 2). At 0600 hrs. very few caiman are basking but many are visible in the water. As the numbers in the water decrease to a low at about 1600 hrs. the number basking increase to a morning high at about 0900 hrs. From this high a decrease occurs until a basking low is reached at midday (1300 - 1400 hrs.). A second, and more pronounced afternoon basking period follows this low with a peak from 1600 to 1800 hrs. At about this time the number of caimans visible in the water begins to increase rapidly as the number basking drops. By 2100 hrs. basking is essentially over and the number in the water has peaked.

Turtles in the water didn't exceed 25% of the highest number censused while basking turtles approached 60% of the highest number censused. Basking caiman didn't exceed 36% of the highest number censused while percentages for caiman in the water were over 90% of the highest number censused.

Discussion

Podocnemis diel activity appears to be governed by light. Turtles are not often seen at night, and when they are seen they are only visible

for a moment. As sunrise approaches the numbers of turtles visible in the water increases greatly and these numbers remain high throughout the day. As sunset nears turtle sightings decrease and few are visible after sunset. Turtle basking, on the other hand, seems to be governed in part by air temperature. Podocnemis do not come out of the water in numbers until air temperatures have nearly reached their daytime highs (Fig 1). But, their retreat to the water begins while air temperatures are still high. The midday drop in basking turtles could be the result of overheating. This might also explain the sudden decrease in basking after 1500 hrs. while air temperatures are still high. Turtles may overheat in the afternoon and seek the water to cool off but the onset of darkness precludes a return to basking.

Caiman are visible throughout the 24 hour period, but light appears to govern if caiman are visible in the water or basking. Few caiman come out of the water before sunrise and few remain out after sunset. Air temperature seems to have little effect on basking emergence or retreat. Large numbers of caiman are out long before air temperatures have risen significantly from their night time lows and most caiman retur to the water while afternoon air temperatures are still high (Fig 2). But, high air temperatures and concurrent overheating may be responsible for the reduction in midday basking activities.

Water temperature variations are slight (6 C. maximum) and do not appear to effect the diel activity patterns of caiman or turtles.

Overcast skys and strong winds appeared to reduce basking activity

of both caimans and turtles, but sufficient data is not available to adequately support this statement. The effect of rain was not determined because of a lack of rain during the study period.

Interspecific interactions didn't appear to effect the activity patterns of the caimans and turtles. The animals seemed to ignore each other, even basking together. No instances of caiman predation on turtles were observed although animals were in close proximity at all hours.

The diel activity cycle determined for Nile crocodiles (Cloudsley-Thompson, 1964; Cott, 1961; Modha, 1968) are very similar to that of Caiman crocodilus. The crocodiles spend the night in the water and some begin basking before sunrise. Basking activity decreases before sunset and few animals are out after dark. Basking activity is bimodal with a peak from 0800 to 1000 hrs. a midday low and another peak from 1600 to 1800 hrs. In Modha's study no crocodiles were out basking at midday but this was thought to be a result of very high air temperatures.

Lang's work with captive juvenile American alligators presents a similar pattern to that described for crocodiles. The alligators began to move out of the water before sunrise and all were out by 0900 hrs. In the evening, they move back into the water (1700 to 1800 hrs.). The midday drop in basking activity was not quantified but it was mentioned.

The percentage of the population basking at peak hours in Nile crocodiles varies from 40% (Modha 1968) to 70% (Cott, 1961) while peak in the water percentages are all over 90%. The data for Caiman crocodilus in the present study agrees fairly well with these results.

Diel activity patterns for turtles are infrequently reported in the literature and data is generally restricted to basking activity. Chrysemys scripta in Panama (Moll and Legler, 1971) exhibit two basking peaks; one at 1000 hrs. and a second higher peak at 1300 hrs. The peaks were separated by a low at 1100 hrs. Basking was virtually nonexistent before sunrise and after sunset, and few turtles were seen after dark. Cagle (1950) mentions that C. scripta are active throughout the day with basking peaks at midmorning and mid-afternoon. Above water activity after dark was much reduced, but Cagle did see some turtles basking late in the evening. Auth (1975) reported that Florida C. scripta exhibit seasonally different diel activity cycles. In all cases, turtles were infrequently seen before sunrise and after sunset. The time of morning emergence to bask varied with the season, but return to the water was consistently completed by 1800 hrs. In September, October and August, turtles emerged in numbers at about the same time (0900 hrs.) but in November morning emergence was delayed until 1000 hrs. Basking curves for September, October and November were essentially unimodal with peak numbers being reached later in the day as the season progressed. The August basking curve was bimodal with a higher morning peak at 1000 hrs., a depression at 1200 hrs. and a second much lower peak at 1400 hrs. Ernst (1976) found that spotted turtles (Clemmys guttata) in Pennsylvania demonstrated a single basking peak with no turtles visible before sunrise or after sunset.

The diel activity pattern of Podocnemis vogli is similar to those

reported above but differences in time of emergence and retreat and in midday basking pattern are found. These differences appear to be related to climatic and seasonal differences. Turtles emerge later and retreat earlier in colder climates and during the colder times of the year. Midday basking is unimodal when weather is cool and bimodal when the weather is warm.

Light and temperature have been mentioned as major factors controlling the diel cycle of Nile crocodiles (Cloudsley-Thompson, 1964; Cott, 1961; Modha, 1968) with light determining morning emergence and evening retreat while air temperature controls midday basking. Lang (1976) demonstrated that morning emergence to bask and evening retreat to the water by juvenile American alligators was cued by light.

The determinants for 24 hour activity cycles in turtles have been little studied but some work has been done with determinants for basking behavior. It is generally agreed that turtles don't bask and are generally less conspicuous after dark and that light controls visible activity (Auth, 1975; Ernst, 1976; Moll and Legler, 1971). Basking activity is apparently controlled by light intensity and air temperature (Auth, 1975; Boyer, 1965).

The data on determinants for diel activity cycles in crocodilians and chelonians in the literature agree well with the data in the present paper. It appears that light is important as a regulator of the type of activity that is engaged in. In turtles, light determines if they are visible in the water or basking or if they are under water. Crocodilians are generally visible throughout the 24 hour period but light regulates

basking emergence and retreat. Air temperature appears to be important in basking in both turtles and crocodilians. Air temperature seems to closely control basking in turtles. They don't emerge from the water until air temperatures are high and they appear to retreat to the water at midday to cool themselves reemerging for another basking period in the afternoon. Crocodilians seem less dependent on air temperature then turtles, but midday basking patterns appear to be affected by air temperatures.

This paper has outlined the dry season diel activity cycles for Venezuelan Caiman crocodilus and Podocnemis vogli. It should be pointed out that the Llanos environment changes abruptly in the wet season and that these changes greatly effect the turtle and caiman populations. More work is needed to determine if the diel activity cycles of these reptiles differ with the season.

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Literature Cited

Auth, D.L. 1975. Behavorial ecology of basking in the yellow-bellied turtle, Chrysemys scripta (Schoepff). Bull. Fla. St. Mus. 20: 1-45.

Boyer, D.R. 1965. Ecology of the basking habit in turtles. Ecology 46: 100-118.

Bustard, H.R. 1968. Temperature dependent activity in the Australian gecko Diplodactylus vittatus. Copeia 1968 (3): 606-612.

_____. 1970. Activity cycle of the tropical house gecko, Hemidactylus frenatus. Copeia 1970 (1): 173-176.

Cagle, F.R. 1950. The life history of the slider turtle, Pseudemys scripta troostii (Holbrook). Ecol. Monogr. 20: 31-54.

Cloudsley-Thompson, J.L. 1961. Rhythmic activity in animal physiology and behaviour. Academic Press, New York.

_____. 1964. Diurnal rhythum of activity in the Nile crocodile. Anim. Behav. 12: 98-100.

Cott, H.B. 1961. Scientific results of an inquiry into the ecology and economic status of the Nile crocodile (Crocodilus niloticus) in Uganda and Northern Rhodesia. Trans. Zool. Soc. Lond. 29:211-356.

Ernst, C.H. 1976. Ecology of the spotted turtle, Clemmys guttata (Reptilia, Testudines, Testudinidae), in Southeastern Pennsylvania. J. Herp. 10: 25-33.

Lang, J.W. 1976. Amphibious behavior of Alligator mississippiensis: roles of a circadian rhythm and light. Science 191: 575-577.

Marcellini, D.L. 1971. Activity patterns of the gecko Hemidactylus frenatus. Copeia 1971 (4): 631-635.

Modha, M.L. 1968. Basking behaviour of the Nile crocodile on central island, Lake Rudolf. E. Afr. Wildl. J. 6: 81-88.

Moll, E.O. and J.M. Legler. 1971. The life history of a neotropical slider turtle, Pseudemys scripta (Schoepff) in Panama. Bull. L.A. Co. Mus. 11: 1-102.

Fig. 1. Twentyfour hour activity cycle for Podocnemis vogli based on average hourly counts from 6 ponds. The numbers of animals in and out of the water are expressed as a percentage of the highest number censused and are compared to average hourly air temperatures.

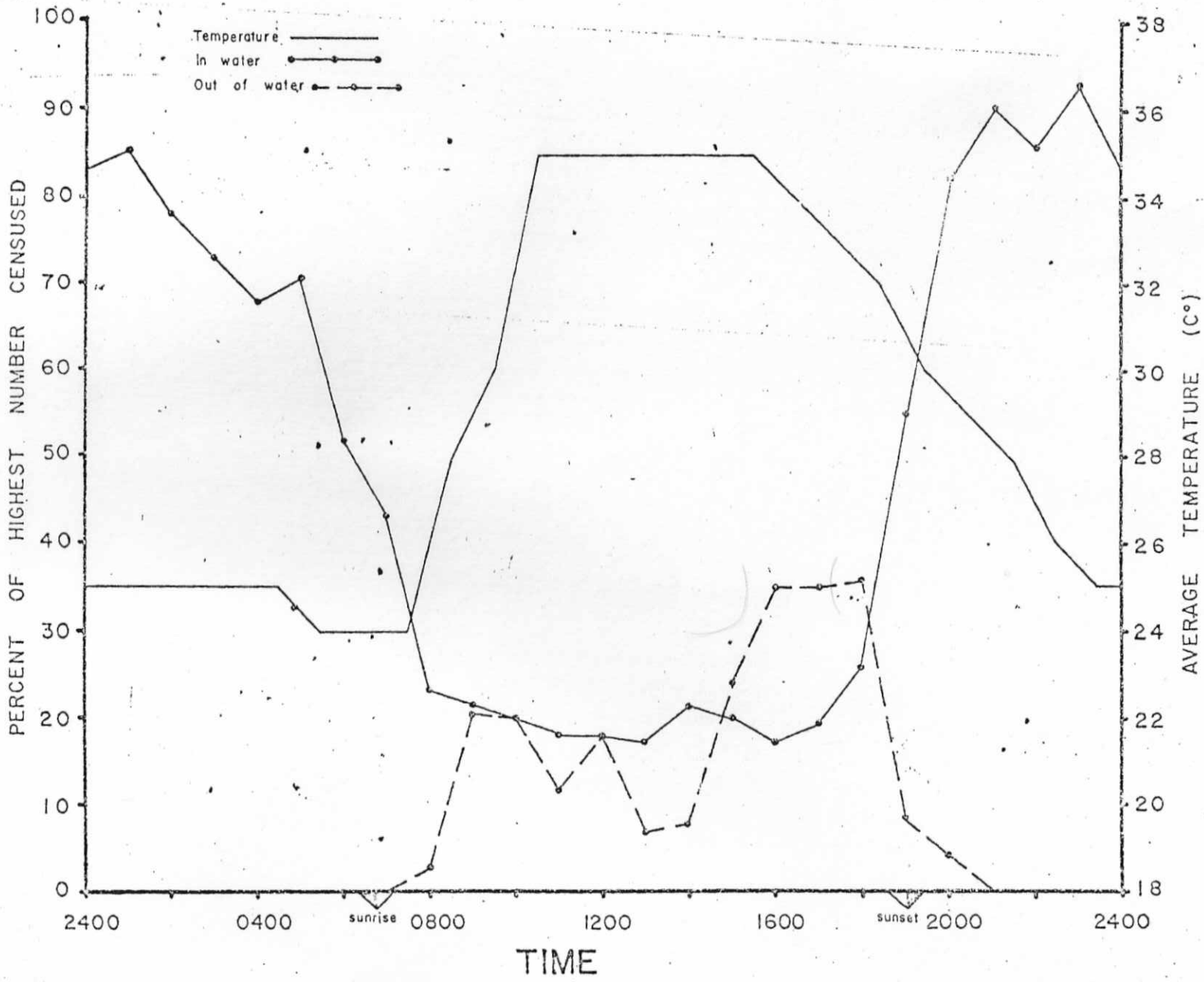
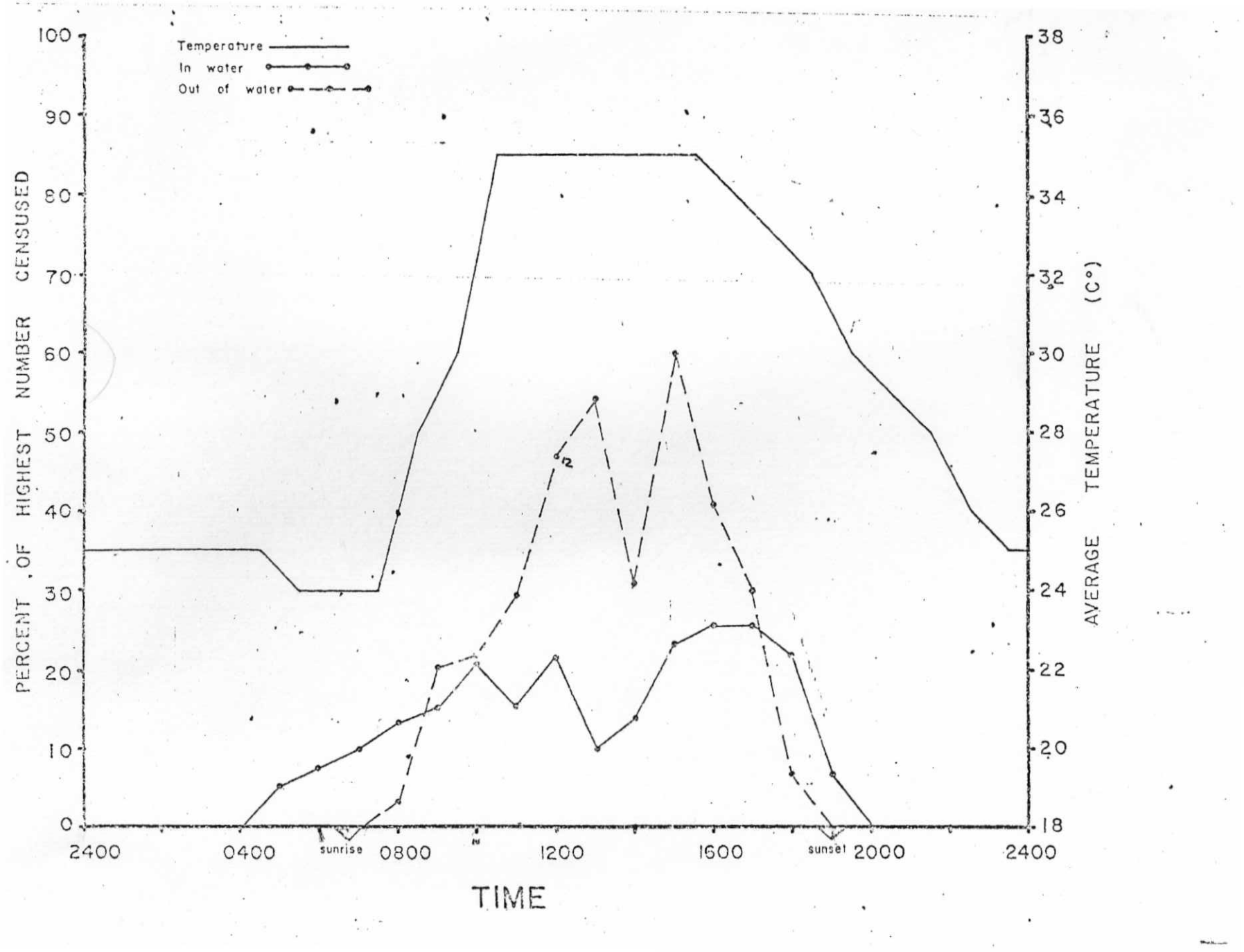

Temperature
In water
Out of water
PERCENT OF HIGHEST NUMBER CENSUSED
AVERAGE TEMPERATURE (C°)
100
90
80
70
60
50
40
30
20
10
0
38
36
34
32
30
28
26
24
22
20
18
2400
0400
sunrise
0800
1200
1600
sunset
2000
2400
TIME

Fig. 2. Twentyfour hour activity cycle for Caiman crocodilus based on average hourly counts from 6 ponds. The numbers of animals in and out of the water are expressed as a percentage of the highest number censused and are compared to average hourly air temperatures.


Temperature
In water
Out of water
PERCENT OF HIGHEST NUMBER CENSUSED
AVERAGE TEMPERATURE (C°)
TIME
sunrise
sunset
2400
0400
0800
1200
1600
2000
2400
100
90
80
70
60
50
40
30
20
10
0
38
36
34
32
30
28
26
24
22
20
18