

Observations on the thermal selection of the pantanal caiman (*Caiman crocodilus yacare*) hatchlings (Crocodylia: Alligatoridae)

Observações sobre a preferência térmica de filhotes recém-eclodidos do jacaré-do-Pantanal (*Caiman crocodilus yacare*; Crocodylia: Alligatoridae)

M. S. PINHEIRO

, Pelotas, , , Embrapa, CFACT , Brazil

R. ANDREOTTI E SILVA

, Campo Grande, , , Embrapa, CNPGC , Brazil

S. A. SANTOS

, Corumbá, , , Embrapa, CNPGC , CPAP, Brazil

[ABOUT THE AUTHORS](#)

Abstracts

Three options of water temperatures in a thermal gradient that changed from 22 to 35°C were offered to Pantanal caiman (*Caiman crocodilus yacare*) hatchlings. Animals from two nests were submitted to temperatures during 19 days (Nest 1 - 20 caimans caught in the nature hours after hatching), corresponding to 1 to 7 observations periods, and 13 days (Nest 2 - 20 animals obtained by artificial incubation) relative to observation period 8. Caimans remain fasting during experimental period. Hatchlings were allocated in a enclosure containing three styrofoam boxes (120 L) disposed side by side enclosed by wire netting and filled with water to the top. Thus, the animals were free to access the boxes, which temperatures were changed at the end of each observation period to avoid position effects. Air temperature was keep close to 22°C by air conditioning and water temperature was controlled by thermostats. The trial was divided in three phases determined by elimination of the less frequented temperature and its substitution by another temperature. In a first phase of the experiment that

contained 1, 2 and 3 observation periods, the thermostats were regulated to 22°C (BoxD), 26°C (BxC) and 32°C (BxA). In phase 2 to 26°C, 29.5°C (BxB) and 32°C, including 4, 5 and 6 periods. In the third phase that included 7 and 8 periods, the thermostats were adjusted to 29.5°C, 32°C and 35°C (BxE). The number of caimans in each box was recorded two to three times a day (8:00, 14:00 and 17:00h) before pointed water temperature. Mean water temperatures (+ standard deviation) and respective caiman frequency means by box/temperature were: Phase 1 (BoxD/22.3 ± 1.2°C - 10.3%; BxC/27.0 ± 2.4°C - 32.0% and BxA/31.2 ± 1.1°C - 57.6%); Phase 2 (BxC/26.6 ± 2.8°C - 13.3%; BxB/29.3 ± 2.2°C - 27.7% and BxA/31.3 ± 1.2°C - 59.0%) and Phase 3 (BxB/29.5 ± 3.6°C - 23.7%; BxA/31.0 ± 2.2°C - 31.9 and BxE/34.0 ± 2.2°C - 44.4%). Observing that in the phases 1 and 2 the box with hottest water (CxA) was more frequented. In the phase 3, the difference between higher and smaller frequency straiten to 20.7%, in relation to almost 46.5% in phases 1 and 2, indicating that water temperatures between 29.5 and 35°C resulted in body temperatures more next to the comfort zone, in the experimental conditions.

caiman; hatchlings; Pantanal; thermal selection; water temperature

Três opções de temperatura da água, em um gradiente térmico que variou de 22 a 35°C, foram oferecidas a filhotes recém-eclodidos do jacaré-do-Pantanal (*Caiman crocodilus yacare*). Os animais, provenientes de dois ninhos, foram submetidos às temperaturas durante 19 dias (Ninhada 1 - 20 jacarés capturados no campo, horas após a eclosão), correspondendo aos períodos de observação 1 a 7, e 13 dias (Ninhada 2 - 21 animais obtidos por incubação artificial) referentes ao oitavo período de observação. Os jacarés permaneceram em jejum durante o período experimental. Os filhotes foram alocados em um recinto contendo três caixas de isopor (120 L) dispostas lado a lado, cercadas com tela de viveiro e completadas com água até o topo. Desse modo, os animais tinham trânsito livre entre as caixas, cujas temperaturas foram trocadas ao término de cada período de observação para evitar efeito de posição. A temperatura do ar foi mantida em torno de 22°C por meio de um condicionador de ar e a da água foi controlada por termostatos. O ensaio foi dividido em três fases determinadas pela eliminação da temperatura menos freqüentada e sua substituição por uma outra temperatura. Em uma primeira fase do experimento, que compreendeu os períodos de observação 1, 2 e 3, os termostatos foram regulados para 22°C (CaixaD), 26°C (CxC) e 32°C (CxA). Na Fase 2, para 26°C, 29,5°C e 32°C (CxB), englobando os períodos 4, 5

e 6. Na terceira fase, que incluiu os períodos de observação 7 e 8, os termostatos foram ajustados para 29,5°C, 32°C e 35°C (CxE). O número de jacarés em cada caixa foi registrado duas a três vezes ao dia (8 h, 14 h e 17 h) antes de anotar a temperatura da água. As temperaturas médias da água (+ desvio-padrão) e as respectivas médias de frequência de jacarés por caixa/temperatura foram: Fase 1 (CxD/22,3 ± 1,2°C - 10,3%; CxC/27,0 ± 2,4°C - 32,0%; e CxA/31,2 ± 1,1°C - 57,6%); Fase 2 (CxC/26,6 ± 2,8°C - 13,3%; CxB/29,3 ± 2,2°C - 27,7%; e CxA/31,3 ± 1,2°C - 59,0%); e Fase 3 (CxB/29,5 ± 3,6°C - 23,7%; CxA/31,0 ± 2,2°C - 31,9%; e CxE/34,0 ± 2,2°C - 44,4%). Observa-se que, nas Fases 1 e 2, a caixa com água mais quente (CxA) foi a mais freqüentada. Na Fase 3, a diferença entre a maior e a menor freqüência se estreitou para 20,7%, em relação aos cerca de 46,5% nas Fases 1 e 2, indicando que as temperaturas de água entre 29,5 e 35°C resultaram em temperaturas corporais mais próximas da zona de conforto, nas condições do experimento.

filhotes recém-eclodidos; jacaré; Pantanal; preferência térmica; temperatura da água

OBSERVATIONS ON THE THERMAL SELECTION OF THE PANTANAL CAIMAN (*Caiman crocodilus yacare*) HATCHLINGS (*Crocodylia: Alligatoridae*)

PINHEIRO, M. S.,¹ ANDREOTTI E SILVA, R.² and SANTOS, S. A.³

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²Embrapa, Gado de Corte, CNPGC, C.P. 154, CEP 79080-900, Campo Grande, MS, Brazil

³Embrapa, Pantanal, CPAP, C.P. 109, CEP 79300-950, Corumbá, MS, Brazil

Correspondence to: Max Silva Pinheiro, Embrapa, Clima Temperado, Estação Experimental Terras Baixas, Capão do Leão s/nº, Campus UFPEL, C.P. 553, CEP 96001-970, Pelotas, RS, Brazil, e-mail: maxsp@cpact.embrapa.br

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ABSTRACT

Three options of water temperatures in a thermal gradient that changed from 22 to 35°C were offered to Pantanal caiman (*Caiman crocodilus yacare*) hatchlings. Animals from two nests were submitted to temperatures during 19 days (Nest 1 – 20 caimans caught in the nature hours after hatching), corresponding to 1 to 7 observations periods, and 13 days (Nest 2 – 20 animals obtained by artificial incubation) relative to observation period 8. Caimans remain fasting during experimental period. Hatchlings were allocated in a enclosure containing three styrofoam boxes (120 L) disposed side by side enclosed by wire netting and filled with water to the top. Thus, the animals were free to access the boxes, which temperatures were changed at the end of each observation period to avoid position effects. Air temperature was keep close to 22°C by air conditioning and water temperature was controlled by thermostats. The trial was divided in three phases determined by elimination of the less frequented temperature and its substitution by another temperature. In a first phase of the experiment that contained 1, 2 and 3 observation periods, the thermostats were regulated to 22°C (BoxD), 26°C (BxC) and 32°C (BxA). In phase 2 to 26°C, 29.5°C (BxB) and 32°C, including 4, 5 and 6 periods. In the third phase that included 7 and 8 periods, the thermostats were adjusted to 29.5°C, 32°C and 35°C (BxE). The number of caimans in each box was recorded two to three times a day (8:00, 14:00 and 17:00h) before pointed water temperature. Mean water temperatures (+ standard deviation) and respective caiman frequency means by box/temperature were: Phase 1 (BxD/22.3 ± 1.2°C – 10.3%; BxC/27.0 ± 2.4°C – 32.0% and BxA/31.2 ± 1.1°C – 57.6%); Phase 2 (BxC/26.6 ± 2.8°C – 13.3%; BxB/29.3 ± 2.2°C – 27.7% and BxA/31.3 ± 1.2°C – 59.0%) and Phase 3 (BxB/29.5 ± 3.6°C – 23.7%; BxA/31.0 ± 2.2°C – 31.9 and BxE/34.0 ± 2.2°C – 44.4%). Observing that in the phases 1 and 2 the box with hottest water (CxA) was more frequented. In the phase 3, the difference between higher and smaller frequency straiten to 20.7%, in relation to almost 46.5% in phases 1 and 2, indicating that water temperatures between 29.5 and 35°C resulted in body temperatures more next to the comfort zone, in the experimental conditions.

Key words: caiman, hatchlings, Pantanal, thermal selection, water temperature.

RESUMO

Observações sobre a preferência térmica de filhotes recém-eclodidos do jacaré-do-Pantanal (*Caiman crocodilus yacare*; *Crocodylia: Alligatoridae*)

Três opções de temperatura da água, em um gradiente térmico que variou de 22 a 35°C, foram oferecidas a filhotes recém-eclodidos do jacaré-do-Pantanal (*Caiman crocodilus yacare*). Os animais, provenientes de dois ninhos, foram

submetidos às temperaturas durante 19 dias (Ninhada 1 – 20 jacarés capturados no campo, horas após a eclosão), correspondendo aos períodos de observação 1 a 7, e 13 dias (Ninhada 2 – 21 animais obtidos por incubação artificial) referentes ao oitavo período de observação. Os jacarés permaneceram em jejum durante o período experimental. Os filhotes foram alocados em um recinto contendo três caixas de isopor (120 L) dispostas lado a lado, cercadas com tela de viveiro e completadas com água até o topo. Desse modo, os animais tinham trânsito livre entre as caixas, cujas temperaturas foram trocadas ao término de cada período de observação para evitar efeito de posição. A temperatura do ar foi mantida em torno de 22°C por meio de um condicionador de ar e a da água foi controlada por termostatos. O ensaio foi dividido em três fases determinadas pela eliminação da temperatura menos freqüentada e sua substituição por uma outra temperatura. Em uma primeira fase do experimento, que compreendeu os períodos de observação 1, 2 e 3, os termostatos foram regulados para 22°C (CaixaD), 26°C (CxC) e 32°C (CxA). Na Fase 2, para 26°C, 29,5°C e 32°C (CxB), englobando os períodos 4, 5 e 6. Na terceira fase, que incluiu os períodos de observação 7 e 8, os termostatos foram ajustados para 29,5°C, 32°C e 35°C (CxE). O número de jacarés em cada caixa foi registrado duas a três vezes ao dia (8 h, 14 h e 17 h) antes de anotar a temperatura da água. As temperaturas médias da água (+ desvio-padrão) e as respectivas médias de freqüência de jacarés por caixa/temperatura foram: Fase 1 (CxD/22,3 ± 1,2°C – 10,3%; CxC/27,0 ± 2,4°C – 32,0%; e CxA/31,2 ± 1,1°C – 57,6%); Fase 2 (CxC/26,6 ± 2,8°C – 13,3%; CxB/29,3 ± 2,2°C – 27,7%; e CxA/31,3 ± 1,2°C – 59,0%); e Fase 3 (CxB/29,5 ± 3,6°C – 23,7%; CxA/31,0 ± 2,2°C – 31,9%; e CxE/34,0 ± 2,2°C – 44,4%). Observa-se que, nas Fases 1 e 2, a caixa com água mais quente (CxA) foi a mais freqüentada. Na Fase 3, a diferença entre a maior e a menor freqüência se estreitou para 20,7%, em relação aos cerca de 46,5% nas Fases 1 e 2, indicando que as temperaturas de água entre 29,5 e 35°C resultaram em temperaturas corporais mais próximas da zona de conforto, nas condições do experimento.

Palavras-chave: filhotes recém-eclodidos, jacaré, Pantanal, preferência térmica, temperatura da água.

INTRODUCTION

The crocodilians depend on the external temperature to live, they are ectotherms but they don't live to regulate their temperature. Occasionally, these animals are exposed to high and low temperatures due to the presence of predators, illness, migratory movements etc. Normally the crocodilians spend most of their time in the water, being this the most important factor which determine its body temperature. Nevertheless, when the animals are exposed to the sun or are on the water surface, where is hotter, they can obtain higher temperatures, necessary to

its better digestion and growth. This way, the hatchlings can obtain heating faster than the adults because of its less mass/surface relation.

We know that the incubation temperature, the feed/fast, the infections, the sex and the social interactions, may affect the alligator hatchling selected temperature and probably of the other crocodylians too. The animals (*Crocodylus siamensis*) obtained in higher incubation temperatures (32.5-33°C; males) select higher temperatures in relation to the ones coming from lower incubation temperatures (27.5-28°C; females). The appetite is dependent of the temperature and consequently the growth. After a meal the alligators select higher temperatures and during the fast they choose lower temperatures to decrease the metabolism and save energy. Animals with infections present thermophily to increase the immune-defense efficiency. The alligator hatchlings present a slight thermophily (32.5°C, decreasing to 27-28°C in a month – in fast) when submitted to a thermal gradient, which is associated to the best absorption of the yolk, being that demonstrated to other crocodylian species (Lang, 1987).

The alligator metabolic rate (oxygen consumption) is increased in 30% when body temperature is elevated from 28 to 29°C (Coulson & Coulson, 1986), showing that differences of about 1°C may have a great importance in the valuation of suitable temperatures. Pinheiro *et al.* (1992) observed that the growth of Pantanal caiman hatchlings (*Caiman crocodilus yacare*) is greater between 29.5 and 32°C than at 26°C. At 22°C the food consumption and the growth were almost invalid, agreeing with the data of Coulson & Hernandez (1983). Brandt (1990) observations, carrying caimans (*Caiman crocodilus*) of about 37 to 80 cm, from Florida to South Caroline, showed that they can die if exposed to 10°C for six hours. Diefenbach (1988) observed that *Caiman latirostris*, a specie that lives on higher latitude, lives in water bodies which the lower temperatures can go to 9°C for several days during the winter. It was suggested that adult caimans of this specie don't eat for 5 to 6 months during the cold period.

According to Diefenbach (1975) the selected temperatures for *Caiman crocodilus* of 0.15 to 6 kg varying from 29.9 to 34.8°C in a ground-water gradient generated by infra-red lamps, but there wasn't any offers of intermediate and high water temperatures, and prevailed the exposed of animals on the dry area, as the lamps were located on this area. Alligators of 37.5 to 90 cm (TL) selected average body temperatures of 32°C, varying between 29.9 and 35.6°C, according Johnson *et al.* (1978). *Caiman latirostris* of 0.5 to 5.5 years old selected temperatures of 18.5 to 36°C in enclosures located inside a plastic greenhouse (Verdade *et al.*, 1994). Molina & Sajdak (1993) studied the thermal selection of *Caiman latirostris* of 1.1 to 26 kg with telethermometers, in enclosures of the

São Paulo Zoo, and suggested that the young select temperatures among 29 and 34.5°C.

Smith (1972) quoted by McNease & Joanen (1974), noted that the alligator (Texas) preferred temperature was between 32 and 35°C, but indicated that the optimum temperature to the young was 28.8 to 30°C (Louisiana). Colbert *et al.* (1946) indicated that the superior limit of the body temperatures, lethal to the alligator, is 38.5°C and that the ideal temperature during the basking is 32 to 35°C. To Lang (1987), experiments of Colbert *et al.* (1946), Johnson *et al.* (1978), and Diefenbach (1975) impute body temperatures selected on the superior limit of the body temperatures spontaneously selected and do not include lower values, because the animals were confined specially on ground or submitted to heating experiments.

Wilbur (1960) observed that temperatures of 34°C have a dangerous effect, due to a remarkable fluctuation on the cardiac rate and, at 40°C the damage to the heart of the alligator is irreversible. Coulson & Hernandez (1983) suggested that the optimum temperature to the growth of *Alligator mississippiensis* is maybe around 32 to 33°C, pointing out that these animals do not feed themselves during the cold period of approximately six months. The *Crocodylus porosus* preferred temperature was among 32 and 33°C (Johnson *et al.*, 1976). This study was part of a pilot research to determine the captivity handling to the Pantanal caiman and was carried out to evaluate the thermal selection of the hatchlings in thermal gradient with different sequences of water temperatures.

MATERIAL AND METHODS

This study was carried out at Centro de Pesquisa Agropecuária do Pantanal (CPAP/Embrapa) in Corumbá, State of Mato Grosso do Sul, Brazil. Three options of water temperature, in a thermal gradient which varied from 22 to 35°C, were provided to Pantanal caiman (*Caiman crocodilus yacare*) hatchlings. The animals, from two different nests were submitted to the gradient during 19 days (Nest 1 – 20 caimans caught in the nature hours after eclosion), corresponding to the 1, 2, 3, 4, 5, 6, and 7 observation periods, and 13 days (Nest 2 – 21 animals obtained by artificial incubation at the environment temperature) referring to the 8th observation period. The hatchlings were not fed during the study, counting on their yolk stock to survive.

The caimans were located in a enclosure containing three styrofoam box (120 L) (0.48 m²) disposed side by side and enclosed by wire netting (50 cm high to stop from escape), being filled with water to the top. This way, the caimans were free to access the boxes, which the water temperatures were randomizedly changed at the end of each observation period to avoid positions effects. The air temperature

inside the small room was kept around 22°C by air conditioning and the water temperature was controlled by thermostats with heaters of 100 W. At 50 cm from the water were located fluorescent lamps which were on for 9 hours during the day.

At the beginning of the study the caimans were distributed in equable lots in each box. The only dry area was the border of the styrofoam box (around 5 cm) and there was a repose wood platform (15 x 40 cm) located around 2 cm below the water. Doing only one water change as it wasn't provided any food.

The experiment was divided into three phases determined by elimination of the less frequented temperature and its substitution by a higher temperature. The number of caimans in each box was recorded twice or three times a day (8 am, 2 pm, and 5 pm) before pointing the water temperature. Counting fast, first the caimans in the boxes where there were a lower number of caimans and so obtaining the result of the last box, the most frequented, by difference.

In the first phase of the experiment, that contained 1 (n = 10 readings), 2 (n = 5) and 3 (n = 2) observation periods, the thermostats were regulated to 22°C (BxD), 26°C (BxC) and 32°C (BxA). In the second phase they were fit to 26°C, 29.5°C (BxB) and 32°C, including 4 (n = 21), 5 (n = 6) and 6 (n = 10) observation periods. In the third phase, that included the observations periods 7 (n = 3) and 8 (n = 34), the thermostats were set to 29.5°C, 32°C and 35°C (BxE).

RESULTS AND DISCUSSION

The average of the water temperatures (+ standard deviation) and the respective average of the caiman frequency percentage by box/temperature were:

Phase 1 (BxD/22.3 ± 1.2°C – 10.3%)

(BxC/27.0 ± 2.4°C – 32.0%)

(BxA/31.2 ± 1,1°C – 57.6%)

Phase 2 (BxC/26.6 + 2.8°C – 13.3%)

(BxB/29.3 + 2.2°C – 27.7%)

(BxA/31.3 + 1.2°C – 59.0%)

Phase 3 (BxB/29.5 + 3.6°C – 23.7%)

(BxA/31.0 + 2.2°C – 31.9%)

(BxE/34.0 + 2.2°C – 44.4%)

The Chi-square test applied in Phases 1 ($c^2 = 92.5$), 2 ($c^2 = 100.8$) and 3 ($c^2 = 76.0$) indicated that there were significant differences ($p < 0.05$) in the caimans frequency among the different temperatures. Noting that in Phases 1 and 2 the difference between the higher and lower frequency was around 46.5% and in Phase 3, where the temperatures offered were higher, this difference was close to 20.7%, indicating that the temperatures between 29.5 and 35°C were the temperature closest to the comfort zone, in the experiment conditions. The highest frequencies of caimans in the eight periods were verified in medium water temperatures between 27.45°C and 33.89°C, with a general average of 31.39 + 1.97°C ($n = 8$).

The *Caiman crocodilus yacare* hatchlings selected temperatures as high as 34°C. Nevertheless, the existence of air temperature of 22°C, in this study, allowed that the animals can expose parts of the body (specially the head) out of the water, indicating that the body temperature should be a little bit lower than the temperature verified in the water. This suggest that we could use water temperatures as high as 38-40°C, so to obtain all the answer curve. Besides, the use of temperature electronic sensors located in the animals stomach (Lang, 1987) would allow a better approximation to the body temperatures selected in the several hours during the day and a higher number of observations in a small time.

The caimans did not present thermal chock problems caused by the contrast between the air-water temperature, verified by Pinheiro *et al.* (1992), probably because there was an opportunity to choose the different body temperatures by the animals and the water wasn't frequently changed exposing the animals to the contrast. The crocodilian hatchlings tend to present thermophily in the yolk absorption period which can last for more than two months (personal observation), according to the body temperature. On the other hand, alligators in fast tend to choose lower temperatures (Lang, 1987). Due to the chosen high temperatures, it is probable that the caimans of this experiment presented thermophily even when in fast. However, it was postulated that more tropical species, as the crocodilians from Brazil, tend to adopt a strategy of thermoconformity and not to search for higher body temperatures as it is the case of the American Alligator, which is the crocodilian able to live in the highest latitude and in lower temperatures (Lang, 1987).

Joanen & McNease (1977) kept higher temperatures (32.2 to 33.3°C) in the environmental chambers during the first ten days of the alligator life to increase the yolk absorption rate and anticipate the beginning of the food supplying.

Pinheiro *et al.* (1997), incubated eggs of *Caiman crocodilus yacare* in temperatures of 28 to 34°C, and the animals obtained in this last temperature (93% male) showed an excellent health condition. Vianna (1995) tested the temperatures of 30, 32, and 34°C for *Caiman latirostris* hatchlings in growth experiment and the animals in the higher temperature do not present any problems unless higher consumption and worse food conversion, and not obtaining, this way, better growth. These studies and the data of this experiment indicate that caimans hatchlings can be submitted to temperatures of $34 \pm 2^\circ\text{C}$ to faster yolk absorption during the first weeks of life.

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