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Short communication

Caiman latirostris growth: the effect of a management technique on the supplied temperature

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Abstract

Temperature and diet affect growth of crocodilians, and it has been suggested that growth depends on the interaction between temperature and food availability. High temperature during digestion increases appetite, gastric contraction frequency and amplitude, and peptic activity. In this paper, we present information about growth of *Caiman latirostris* in captivity under different thermal treatments. Our goal is to improve growing of caimans and thereby reduce production costs. We grew *C. latirostris* for 2 months under two different treatments (average temperatures TA=22.24 °C; TB=18.24 °C). Those kept at higher temperature grew faster, producing a 5.2 cm and 100.5 g difference after 60 days of experiment.

Keywords: Temperature; *Caiman latirostris*; Growth; Pen design

1. Introduction

Temperature and diet have influence over growth of crocodilians (Lang, 1987; Larriera and Aguinaga, 1990; Larriera et al., 1990; Coulson et al., 1996; Piña et al., 1996; Bucio, 1997; Pinheiro and Lavorenti, 1997). Temperature affects rates of digestion and it may affect its efficiency as well (Jackson and Cooper, 1981; Coulson et al., 1996). Coulson et al. (1996), reported that metabolic rate was highest at 31±1 °C in crocodilians (measured as oxygen consumption). *Alligator mississippiensis* hatchlings can eat as much as 10% of

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their body weight per day and they digest it quickly at 31 °C. Hatchlings can convert the equivalent of 50% of wet food intake into body mass (Coulson et al., 1996).

Lang (1987) suggested that growth depends on the interaction between temperature and food supply; he observed that animals grew faster when they selected higher body temperature during digestion. Digestion is directly affected by temperature, increasing temperature result in appetite increases, gastric contraction frequency and amplitude, and peptic activity. When alligators are fed, they seek higher temperatures for thermoregulation. When they have fasted, they move to the cooler end of the temperature gradient (20–40 °C). Lang (1987) reported that the major effect of thermophily following feeding appears to be a decrease in the time needed to process food, rather than an increase in the total amount of energy extracted from a meal. The primary benefit would be the time saved rather than the increased energy acquisition.

There is available information about growing rates of *Caiman latirostris* (Larriera, 1990; Larriera and Aguinaga, 1990; Larriera and Del Barco, 1992; Piña et al., 1996; Pinheiro and Lavorenti, 1997; Pinheiro and Santos, 1997), some of them referring to temperature treatments (Larriera et al., 1990). In this paper, we present information about growth of *C. latirostris* in captivity under different thermal treatments. Our goal is to improve the growing of caimans to reduce production costs of a ranching program in Argentina. This would result in a low cost technique to raise temperature during farming, instead of stopping growth during the cold season.

2. Materials and methods

A total of 74 *C. latirostris* (3–4 months old) from eight different nests, were randomly assigned to treatments (TA, N=38 and TB, N=36; Table 1). Clutches were evenly divided between the two treatments. All individuals were weighed and measured (precision 0.5 g and 0.5 cm; results are expressed as mean ± S.E.) at the beginning of the experiment. There was no significant difference between the animals assigned to treatments. All animals were marked individually with a Monel tag 1005-1 (Natl. Band and Tag, Newport, KY).

Table 1
Average (Mean), maximum (Max.) and minimum (Min.) temperatures for treatments A and B during the experiment

	TA	TB
Mean temperature (°C)	22.24	18.24
Max. temperature (°C)	37.55	37.05
Min. temperature (°C)	12.9	7
TL cm (beginning)	31.1 ± 0.4	31.2 ± 0.6
TL cm (end)	38.1 ± 1	32.9 ± 0.7
W g (beginning)	119.6 ± 5.1	120.4 ± 6.6
W g (end)	225.5 ± 25.5	125 ± 9.9

Average Total Length (TL cm) and Weight (W g) of both treatments ± S.E. at the beginning and at the end of the experiment.

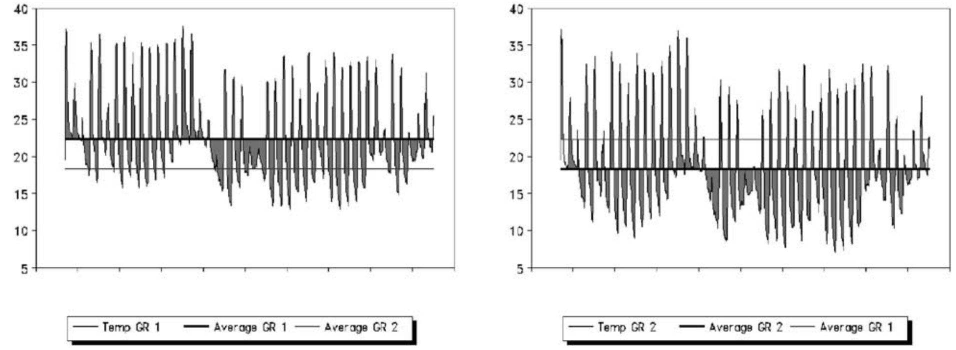

Fig. 1. Treatments temperature (TA and TB), through the experiment with their mean (TA=22.24 °C; TB=18.24 °C). Oscillations are cause by solar exposure (day–night). Temperature was recorded using HOBO TEMP Data Loggers on each treatment.

Ambient temperature of enclosures was recorded during the 60 days of the study with two Hobo Temp data loggers (Onset Computer, Pocasset, MA) for each treatment (Fig. 1). Data loggers were calibrated with a standardized mercury thermometer before implementation. The experimental enclosures consisted of concrete pools, 3×4 m, with 50% of the surface dry and the rest water. The pools were inside a greenhouse and were heated with electric resistances. Data loggers were located in the dry section of the pools, 20 cm high; resistances were located 20 cm high above the water at the opposite end. The only difference between treatments was that the enclosures in TA were completely covered with translucent plastic, keeping in the heat produced by the electric resistances, while in TB only half of the enclosures were covered. The plastic cover, in TA, increased mean ambient temperature by 4 °C, and avoided nighttime heat loss by 6 °C. The plastic cover did not influence the maximum temperatures between treatments (Table 1).

Animals were fed ad libitum, chicken supplemented with vitamins and minerals, three times a week. Food was dispensed into the water early in the morning in four small portions in different places. After 8 h, the remaining food was taken away and enclosures were cleaned.

We analyzed the data with a General Linear Model (GLM; Minitab 10.2) using total length (TL), and weight (W) as variables, nests and treatments (TA and TB) as grouping factors. Our alpha value for significance was 0.05.

Differences in how long temperatures were above 25 and 31 °C were calculated by counting the pixels above or below the curve of Fig. 1 in digital format, at the above-mentioned temperatures. The number of times temperature surpassed 25 and 31 °C was calculated by counting the peaks on the curve (Fig. 1).

3. Results

At the beginning of the experiment there was no significant difference between W or TL (Table 1; GLM; $P_{(W)}$=0.919, $P_{(TL)}$=0.908); after 60 days, animals from TA had

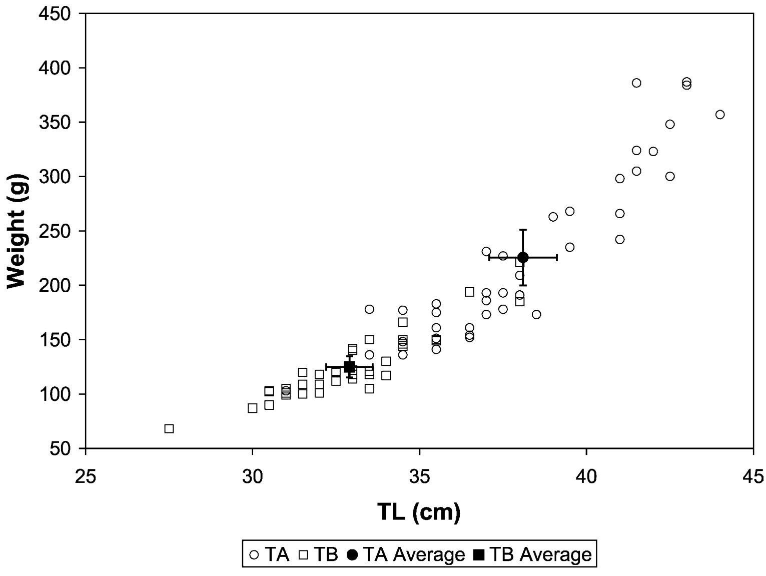

Fig. 2. Plot of the weight (g) of the animals in relation with their total length (cm) at the end of the experiment (after 60 days) for both treatments. Animals from TA averaged 225.5 g (W), and 38.1 cm (TL); TB animals averaged 125 g (W), 32.9 cm (TL). Solid circle is TA average ± S.E., solid square is TB average ± S.E.

grown faster than those of TB (Fig. 2), achieving 225.5 ± 25.5 (S.E.) g (W) and 38.1 ± 1 cm (TL) vs. 125 ± 9.9 g (W) and 32.9 ± 0.7 cm (TL).

Growing rates (ΔTL/day and ΔW/day) were 0.18 cm and 1.77 g for TA; and 0.03 cm and 0.08 g for TB. Treatment A animals were significantly longer and heavier ($P_{(TL,\ W)}$<0.001). There was a significant 'clutch effect' on the two variables we measured ($P_{(TL)}$=0.041 and $P_{(W)}$=0.022), and we detected a 'nest *X* treatment' interaction in W (P=0.031). All nests (eight) grew better in TL and W in TA than in TB. Survival during the experiment was 100% in both treatments.

The amount of time temperature spent over 25 and 31 °C was greater for TA than for TB (X^2=9.989; P=0.002 and X^2=12.407; P<0.001, respectively; Fig. 1). The number of times temperature was greater than 25 and 31 °C was not significant between treatments, at 25 °C (X^2=0.895; P=0.344), but showed some evidence of an effect at 31 °C (X^2=3.472; P=0.063).

4. Discussion

We present a simple solution for caiman farming to avoid cold periods. This minor change in pen design produced a growing increase of 400%, compared to the other treatment, in 60 days period during winter, reducing time to reach culling size.

Larriera et al. (1990) conducted a similar experiment using four month old hatchlings during a period of three months. Hatchlings were, at the beginning of the experiment, 55 g; at the end, the warmest treatment (27.8 °C) was 222.2 g. We grew the animals for 2 months, and started with 119.6 g animals and finishing with a mean in TA of 225.5 g. We suspect that differences are due to temperature regime, the fact that the two experiments measured temperatures in different ways, and that Larriera et al. (1990) fed animals with red meat which may have caused an increased growth rate (Larriera and Aguinaga, 1990). However, temperature had similar effects on growth rates in both experiments.

All the nests grew better in TA than TB, but the 'nest *X* treatment' interaction detected was due to a single nest. This nest was the biggest nest in TA and the smallest in TB. If we remove this nest from analysis there is no 'nest *X* treatment' interaction (P=0.835). We interpreted this interaction as the effect of ambient to nest's growing potential, since only under certain circumstances animals could 'exploit' all their growing capability. In this experiment, TA improved the growth of the nest above the average of other nests and TB reducing it to below the average.

Coulson et al. (1996) reported that caimans maintained at temperatures lower than 25 °C refuse to eat. Since growth rates of crocodilians are influenced by ambient temperatures, growth may be suspended during colder periods of the year. The decrease of growth is likely due to inability to process food at cold temperatures. The 4 °C difference between treatments (22–18 °C) is sufficient to explain differences in growth rates (Larriera et al., 1990). The increased time spent above 25 °C between treatments allowed TA animals to eat more and use that additional input to increase body mass. By spending more time above 31 °C, caimans in TA were able to increase the rate of digestion which allowed them to process more food than caimans in TB (Lang, 1987; Coulson et al., 1996). While average temperature is important in the growth of caimans, the time spent above 25–31 °C may be more significant in determining food consumption and the rate at which it is processed.

If caimans are fed once a week, temperature should be higher when animals are feeding and then it should be decreased to conserve energy. If they are fed every day or every 2 days, the average temperature should be higher to increase growth. Caiman can then process food faster, reducing the time needed for digestion, so the animal can be feed again sooner, if food is available (Lang, 1987).

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