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DEMOGRAPHIC AND GROWTH ANALYSIS OF BROAD SNOUTED CAIMAN (*CAIMAN LATIROSTRIS*) AT TRÊS MARIAS SÃO FRANCISCO RIVER DAM

Belo Horizonte

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Dissertação apresentada ao Programa de Pós-Graduação em Zoologia dos Vertebrados da Pontifícia Universidade Católica de Minas Gerais, como requisito parcial para obtenção do título de Mestre em zoologia

Orientador: Robert John Young

Co-Orientador: Marcos Eduardo Coutinho

Belo Horizonte

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RESUMO

Varias características da história de vida e comportamento dos crocodilianos tais como a taxa de sobrevivência, são dependentes da relação tamanho/idade a qual é determinada pela velocidade com que os indivíduos crescem. A dinâmica dos crocodilianos também possui uma relação de dependência com as condições climáticas e ambientais. Durante o período de Fevereiro de 2010 a Outubro de 2011, foram realizadas coletas mensais com o intuito de se estudar a população de jacaré do Reservatório de Três Marias. Os animais eram capturados, medidas, marcados e soltos para um monitoramento. Durante esse período foram coletados dados sobre o tamanho populacional e estrutura sexual, sobrevivência, distribuição e crescimento. Um total de 12 censos noturnos foi realizado, com comprimentos variando entre 17.3 a 48 km. O número de jacarés contados, incluídos os recém-nascidos, variou entre 6 e 78 indivíduos. Os animais marcados tiveram uma taxa de crescimento que variou entre 0.0 e 0.3 cm*dia^{-1} de SVL e -6.0 a 8.0 g*dia^{-1} de massa corporal. A natureza polifásica encontrada nas taxas de crescimento pode ser associada com diferentes fatores incluindo o nível d´água, tamanho, idade e mudanças alimentares. Crocodilianos são extremamente dependentes à condições climáticas, especialmente aos parâmetros térmicos e a hidrologia local. A estrutura de tamanho é característica de uma população em expansão devido ao grande número de jovens, isso demonstra que a espécie é resistente aos impactos do barramento e, que as modificações ambientais têm um efeito limitado na dinâmica populacional da espécie.

Palavras-chave: Jacaré do papo amarelo, *Caiman latirostris*, crescimento, sobrevivência, Bacia do Rio São Francisco.

ABSTRACT

Crocodilian life history traits and behavior such as rates of birth and death exhibit strong size/age dependence, which is determined ultimately by how fast individuals grow. Crocodilians dynamics also have a close dependence on ambient climatic conditions, especially thermal parameters and local hydrology. From February 2010 to October 2011 we conducted monthly spotlight surveys to study caiman´s populations at the Três Marias Hydro-electric Reservoir, southeast Brazil. Animals were captured, measured, marked and released for monitoring. During this period data were obtained on population size and sex structure, survivorship, distribution and growth. A total of 12 spotlight surveys were conducted, whose length ranged from 17.3 to 48.0 km. The number of caimans counted, including hatchlings, varied from 6 to 78 caimans. Marked individuals showed a growth rate that varied between 0.0 to 0.3 $cm*day^{-1}$ SVL and -6.0 to 8.0 $g*day^{-1}$ body mass. The growth polyphasic nature can be associated with different factors, including water level, size, age and dietary shifts. Crocodilians are a climate-sensitive group, highly dependent on natural climatic conditions, especially thermal parameters and local hydrology. The size structure was characterized as an increasing population due to larger number of juveniles, showing that the species was resistant to the impacts of damming impacts and that habitat modification has had limited effect on the species population dynamics.

Keywords: Broad-Snouted caiman, *C. latirostris*, growth, survivorship, São Francisco river basin

SUMÁRIO

Demographic and growth analysis of broad snouted caiman (*Caiman latirostris*) at Três Marias São Francisco River Dam

Luiza Figueiredo Passos[1]

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1. INTRODUCTION

The pattern of growth in vertebrates varies considerably. Mammals and other warm blood vertebrates present typical monophasic pattern, in which growth rate decrease constantly in relation to body size. Such pattern can be described using monotonic function such as the von Bertalanffy, Gompertz or Richard models. On the other hand, cold blood vertebrates may grow differently. For crocodilians has been reported a polyphasic growth for different species, salt and fresh water crocodile (Webb et al. 1978, Webb et al 1983), Nile Crocodile (Hutton 1987) and *Caiman crocodilus* (Magnusson and Sanaiotti 1995). For instance, *Caiman yacare* in the Pantanal shows a polyphasic growth pattern, which is correlated to biotic and abiotic environmental variables, such as type of prey consumed, temperature and water level (Coutinho 2000). Furthermore, crocodilian life history traits such as rates of birth and death exhibit strong size/age dependence (Gallegos et al. 2008), which is determined ultimately by how fast individuals grow (Charruau et al. 2010).

Crocodilians ecology has a close dependence on ambient climatic conditions, especially thermal parameters and local hydrology (Markwick 1998). Different human's activities have been altering habitat conditions and threatening crocodilians populations. The damming activity and its associated impacts such as the instability of the hydrological regime, is one of those activities that can have some serious

consequences for caimans populations. A dam can be defined as a hybrid system between a river and a lake, providing a habitat that is completely different from the original (Baxter 1977).

Studies on the impact of the construction of large hydroelectric stations on the density and reproduction of broad-snouted caiman populations are scarce, Mourão and Campos (1995) conducted aerial surveys to alert to a major impact caused by the damming activity, the destruction of natural floating vegetation used as a important reproduction site (Verdade et al. 2010).

The aim of this study was to obtain data on the population status, survivorship and growth rates of the broad-snouted caiman at the Pirapitinga Ecological station, located at the Três Marias Reservoir to increasing knowledge about this species, thereby facilitating the development of a management plan for the species in this reserve.

2. MATERIALS AND METHODS

2.1. Study Area

The Três Marias Hydroeletric reservoir is located at Minas Gerais state, at 538 meters above sea level in the high São Francisco river region (S 18° 12’ 51” W 45° 15’ 51”) (BRASIL 1987). The dam was built during the period from 1957 to 1960, with the aim of improving navigation and to generate hydroelectric power (Companhia Energética de Minas Gerais, 2006). Pirapitinga Ecological Station (ESEC Pirapitinga) is an artificial island, which was formed as a result of filling the reservoir.

The ecological station has an area of approximately 1.000 ha, which varies according to the reservoir water level. The vegetation of this artificial insular system comprises different Cerrado vegetation physiognomies (Sato and Sampaio 2006). The ESEC east face is characterized by strong winds, presence of stones on the edge, while the west face, closer to the reservoir margins, is protected from winds and is marked by flooded areas covered with mud, grass and shrubs (Brasil 1987).

2.2 Study Species

Caiman latirostris is a highly aquatic species found primarily in densely vegetated and quiet waters including marshes, swamps and mangroves along the Brazilian Atlantic coast (Medem 1983). This species is widely distributed in the central-eastern South America. Despite the fact that the largest part of *C. latirostris* range is located within Brazil,

information on the species population status in the country still scarce. Hydroelectric dams, wetlands drainage for agriculture, and pollution are affecting large portions of the species geographic distribution in the Brazil (Verdade et al. 2010).

The knowledge on *C. latirostris* biology in the wild comes mainly from the southern areas of its distribution range, (i.e. Argentina) and there are very few ecological studies conducted in Brazil (Moulton et al 1999, Filogonio et al. 2010). Filogonio (et al. 2010) found that, despite of the hunting pressure and the human impact on natural habitats, the populations of *C. latirostris* are widely distributed throughout the São Francisco basin (Southeast Brazil) and are not isolated.

On the other hand, a number of studies have been carried out in captivity (Larriera 1990, Larriera and Aguinaga, 1990; Larriera et al. 1990; Piña et al., 1996; Piña and Larriera 2001, Pinheiro and Lavorenti, 1997; Pinheiro and Santos, 1997; Pinheiro and Lavorenti 2001; Poletta et al. 2008), which have shown that the growth rates are affected by a diversity of factors. Among them, population density has a direct impact on growth rates; individuals kept at lower densities have a higher growth rate (Poletta et al. 2008). The effect of temperature on crocodilian growth has been the subject of different studies, for example Piña and Larriera (2001) demonstrated faster growth of *C. latirostris* when raised at higher temperatures. Incubation temperature can also affect hatchlings´ growth (Piña et al. 2003), temperatures too high can have a negative effect on hatchlings´ growth in the first year of development (Piña et al 2007).

2.3. Field methods

A total of 12 spotlight surveys were conducted from February 2010 to October 2011 with duration of 5 days each. Caimans surveys were conducted after dawn using a 4.8m long boat powered by a 15-hp outboard motor and a beam of a standard 12-V spotlight was used to locate the animals by “eyeshine”. Whenever possible individuals were captured, water and air temperature was measured with a fast reading calibrated digital thermometer. Individuals were weighted, sexed and measured to their snout-vent length (SVL) using a measuring tape with an 0.5mm of accuracy. Individuals were categorized based in the snout-vent length: Class I (<25cm), Class II (25-<50cm), Class III (50 - <80) and Class IV (>80). Sexing technique is only reliable for individuals >40 cm SVL, therefore, smaller individuals were assigned as juveniles of undetermined sex. All captured individuals were marked by removing tail scutes according to a prescribed

sequence. Information on growth, survivorship and movement patterns were obtained by mark-recapture study. Those individuals captured were released at their capture site on the same night they were marked, and all sites were marked using a GPS device (Garmin 60). The marking technique used has been widely used on crocodilian studies and having no effect on growth or survivor of marked individuals (Jennings et al 1991).

Somatic growth rates (SGR) were expressed by changes in snout-vent-length (ΔSVL) measured from the snout to the rear of the cloacal slit. For each recapture interval (ΔT), the specific growth rate at time given by SGR = (1/SVL)(ΔSVL/ΔT), and defined as the proportional increase in SVL (mm) per unit of time (days), was plotted against mean SVL for each respective individual´s recapture interval. Growth rates were calculated using SVL rather than total length (TL) to avoid errors resulting from tail tip loss.

Age specific survival rates were calculated by applying a stepwise approach of the catch curve method, as described by Krebs (1989). Accordingly, instantaneous annual mortality rates were calculated separately for individuals from age class one and two and two to four years of age. For age class one, survival was calculated using the ratio method, whereas for age classes two to four, the regression method (log of frequency regressed against age) was applied (Coutinho 2000). We cannot assign whether the animals actually die or move outside the studied area. Nevertheless, the estimates are meaningful to foster the understanding of the effect of a protected area on caiman population dynamics.

The data were analyzed using Systat 11, with the significance level set at 5%. Mean values are presented followed by upper and lower interval using standard error of the mean.

3. RESULTS

3.1 Population surveys

Survey length ranged from 17.3 to 48.0 km and the number of caimans counted, including hatchlings, varied from 6 to 78 caiman. The rate of encounter ranged from 0.3 to 3.8 individual*km^{-1} (Table 1), with an average of 1.5 ± 0.38 individuals*km$^{-1.}$.

Table 1. Date of survey, length of survey, rate of encounter and number of broad-snout caiman observed for the Pirapitinga Ecological Station surveys, MG, Brazil.

Date of survey	Length of survey (km)	Number of caimans	Rate of encounter (ind/km)	Water Level S.L.	Air temperature range (°C)	Water Temperature range (°C)
Feb/2010	9.7	41	4.22	567.44	23.8 – 27.8	26.9 – 30.3
May/2010	20.2	42	2.07	568.1	16.4 – 22.4	22.6 – 26.9
Jul/2010	24.54	30	1.22	566.24	18.1 – 20.4	21.2 – 24.7
Oct/2010	17.25	41	2.37	562.98	23.1 – 27.4	25.1 – 28.0
Nov/2010	28.38	28	0.98	562.64	23.2 – 26.2	25.0 – 28.1
Dec/2010	28.02	12	0.42	564.11	22.7 – 25.6	29.4 – 31.3
Feb/2011	21.25	15	0.70	568.86	23.4 – 27.9	30.3 – 32.4
Mar/2011	48.14	23	0.47	571.01	21.4 – 24.6	26.7 – 27.4
May/2011	17.4	6	0.34	572.34	21.8 – 25.6	26.9 – 29.2
Jun/2011	20.75	13	0.62	571.88	17.8 – 22.2	23.6 – 24.6
Ago/2011	18.66	20	1.07	569.95	19.4 – 22.1	23.5 – 24.8
Oct/2011	20.55	78	3.79	567.35	21.6 – 24.3	24.5 – 27.3

Caiman population in Pirapitinga is composed mainly by juveniles. Three clutches of known age individuals ranging from one to four years of age were monitored during the capture-recapture procedures. Adult animals were in low numbers (n=4), wary and difficult to catch (Figure 1.).

The population sex ratio was estimated based on a sample of 22 individuals with svl>40 cm, in which sexes can be determine accurately. The overall sex ratio was 1.2:1 male/female. When considering juveniles and adults separately, the ratios are similar, 1.2:1 male/female for juveniles and 1:1 for adults.

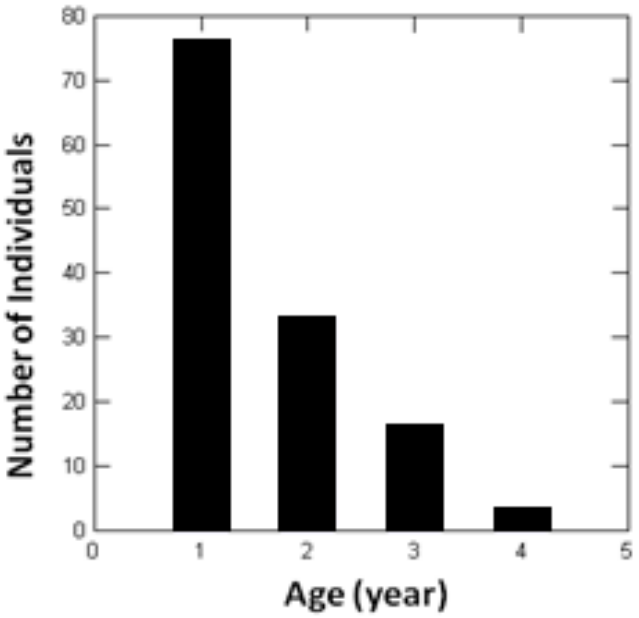


Figure 1. Age structure of *Caima latirostris* in Pirapitinga Ecological Station, MG Brazil, from February 2010 until October 2011.

The spotlight surveys covered the whole margins of Pirapitinga Island, however, we have observed that caimans were found only on the west side of the island, which was protected from winds and has muddy soil covered with aquatic grasses.

3.2. Estimates of survivorship

Based on the population age structure a first estimate of age classes one to four survivorships were calculated. The estimate survivorship for age class one, obtained by the ratio method, was 0.433, whereas the regression method used to estimate the survival of age classes two to four was 0.456. In other words, 43.3% of new born caimans persisted to the following age class (two years of age), and 45.6% of the two years old individuals reach four years of age (Figure 2).

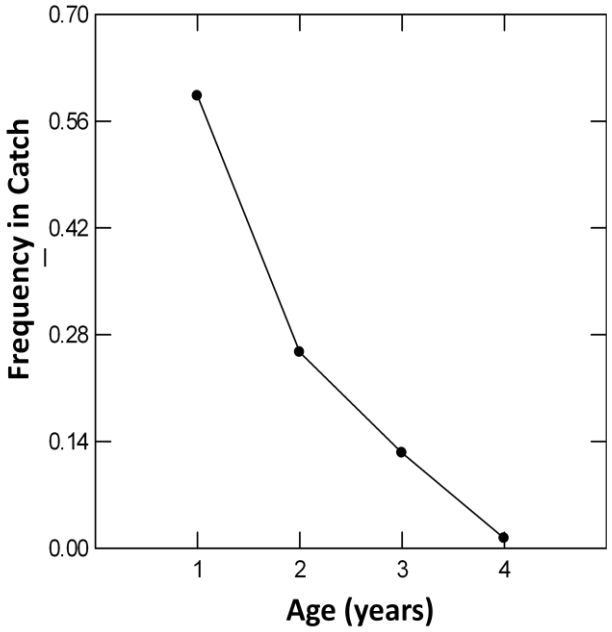


Figure 2. Catch frequency curve for *C. latirsotris* at Três Marias Reservoir during 2010 and 2011.

3.3. Growth analysis

Growth rate varied between 0.0 to 0.3 cm*day^{-1} SVL, with a mean of 0.035 ±0.004) cm*day^{-1}. The variation in body mass varied between -6.0 to 8.0 g*day^{-1}, with a mean rate of 2.0 (±2.7 S.D.) g*day^{-1}. Table 2 shows the number of caimans captured and the mean SVL and mass value for each sampling period. During the study period three clutches were monitored, the data were analyzed first separately and then together for evaluating of a possible clutch effect on growth rate.

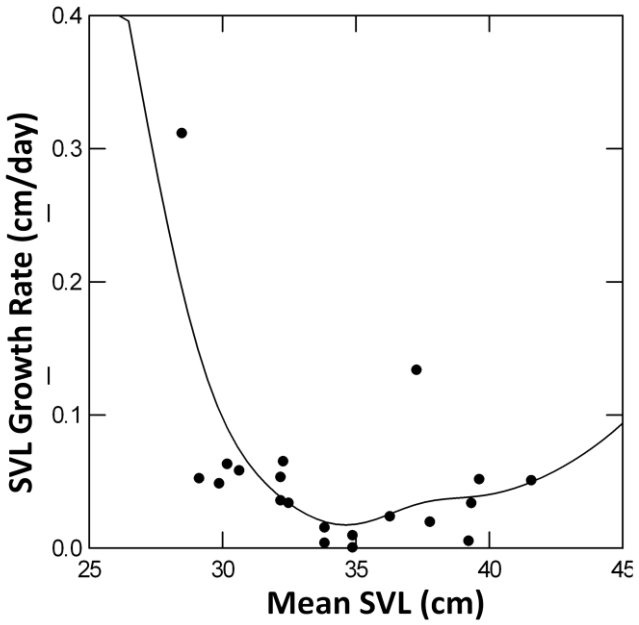
Table 2. Number of *Caiman latirostris* captured and recaptured, mean SVL and mass of captured animals for each month, in Pirapitinga Ecological Station, Três Marias dam, São Francisco river, MG Brazil.

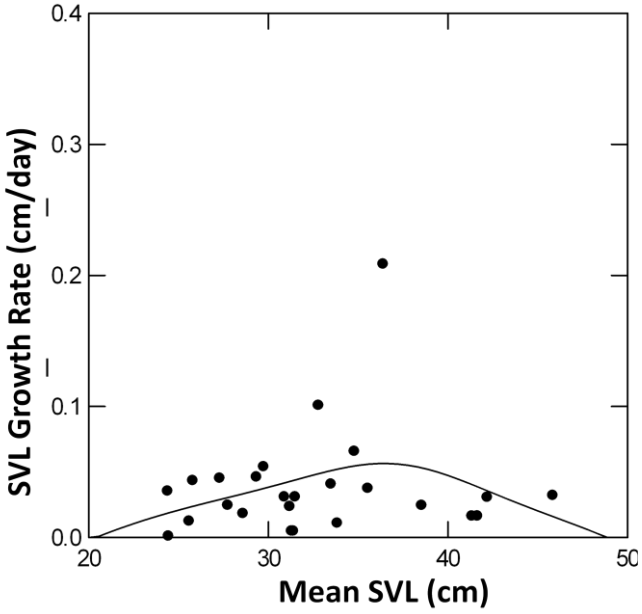
	Month/Year	Δt	N capture	N Recapture	Mean SVL (cm)	Mean Mass ±SD (kg)
1	Feb/2010	-	39	-	26.27 ±1.54	0.84 ±0.46
2	May/2010	102	32	29	31.37 ±1.76	1.18 ±0.51
3	Jul/2010	60	21	20	31.15 ±0.84	0.74 ±0.07
4	Oct/2010	83	21	20	35.15 ±3.83	2.13 ±1.77
5	Nov/2010	49	17	17	31.14 ±0.76	0.72 ±0.07
6	Dec/2010	27	7	7	32.20 ±1.21	0.78 ±0.12
7	Feb/2011	43	8	5	61.61 ±11.79	14.37 ±7.58
8	Mar/2011	47	7	3	32.10 ±3.95	1.01 ±0.36
9	May/2011	43	3	2	33.83 ±5.80	1.02 ±0.42
10	Jun/2011	42	2	1	40.10 ±2.00	1.48 ±0.24
11	Aug/2011	65	5	5	43.12 ±1.97	1.94 ±0.30
12	Oct/2011	45	67	7	20.18 ±1.04	0.40 ±0.09

Δt = days between captures

3.3.1. Size based model

The growth rate, expressed as centimeters of SVL per day, was plotted against mean SVL between captures; that is, $[(l_2 + l_1)/2]$, where l_1 and l_2 refer to lengths at capture and recapture, respectively (Fig 3, 4 and 5) for each monitored clutch. The relationship between growth rate and size was, firstly, examined fitting a distance weighted least square smoothing curve (DWLS) to the data set. From this analysis it was observed that no single growth model would fit the data set. In fact attempts to fit a linear regression equation to the entire data set revealed that it could not be used to generalize growth of these caimans (r^2=0.002; n=113; p=0.64).


SVL Growth Rate (cm/day)
0.4
0.3
0.2
0.1
0.0
25
30
35
40
45
Mean SVL (cm)


SVL Growth Rate (cm/day)
0.4
0.3
0.2
0.1
0.0
20
30
40
50
Mean SVL (cm)

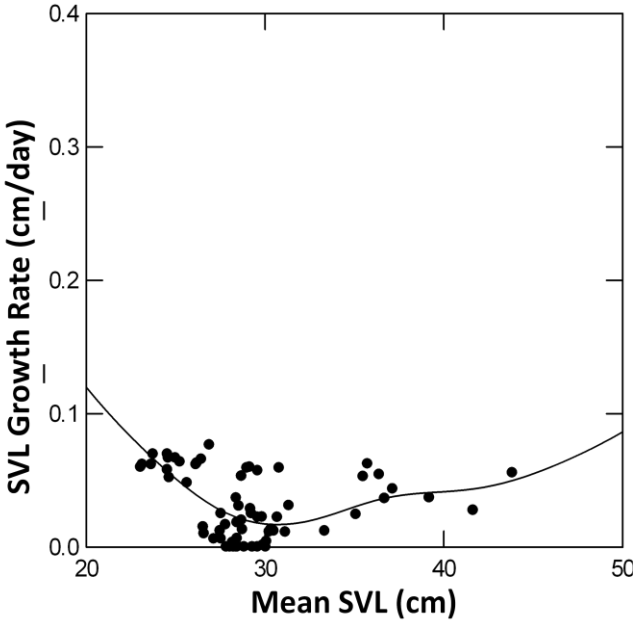
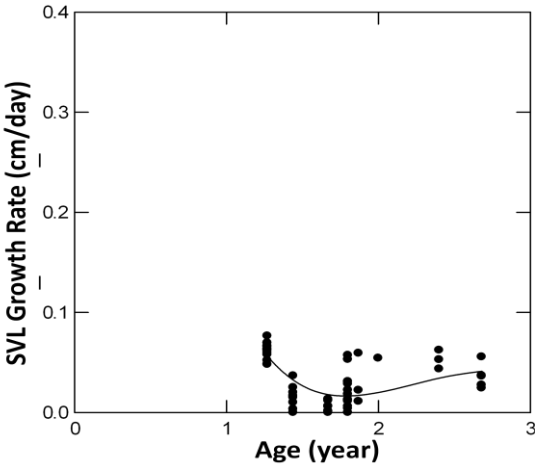

SVL Growth Rate (cm/day)
0.4
0.3
0.2
0.1
0.0
20
30
40
50
Mean SVL (cm)

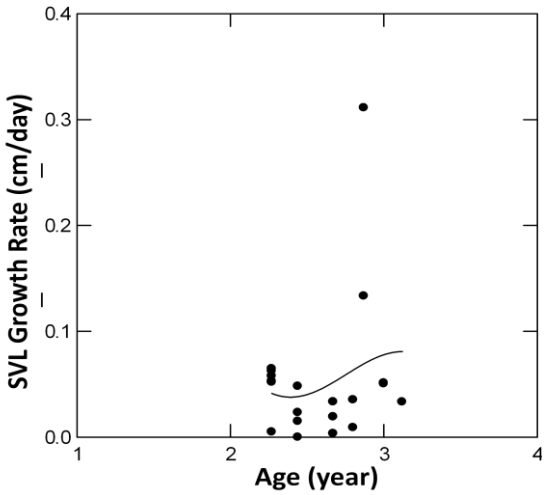
Fig 3, 4 and 5. Relationship between relative growth rate (cm/day) and Mean Snout-Vent Length (cm) of *Caiman latirostris* for the three monitored clutches at the Pirapitinga Ecological Station, MG, Brazil during the period of February 2010 until October 2011.

Analyzing the graph is possible to observe great variation between individuals, which cannot be explained by the size-growth relationship ($F_{1,71}$ =0.66; p=0.42). It is also possible to notice a tendency in the growth rate for larger individuals to decrease but, the lack of data does not permit the definition a better curve for larger individuals.

3.3.2. Age Based model

Data obtained from longitudinal sampling were available for 112 individuals, with ages ranging from newborns to four years of age. Most individuals were < 2 years of age and the lack of data on older individuals limited any attempt to define an age-specific growth rate function.





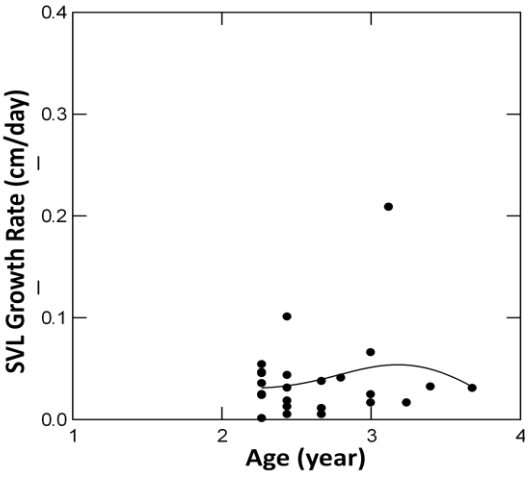


Fig 6, 7 and 8. Relationship between relative growth rate (cm/day) and Age(year) of *Caiman latirostris* for the three monitored clutches at the Pirapitinga Ecological Station, MG, Brazil, during the period of February 2010 to October 2011.

A DWLS smoothing curve highlighted the underlying SVL and Age relationship indicating clearly that caiman growth followed a polyphasic model, rather than a single growth model (Fig 9).

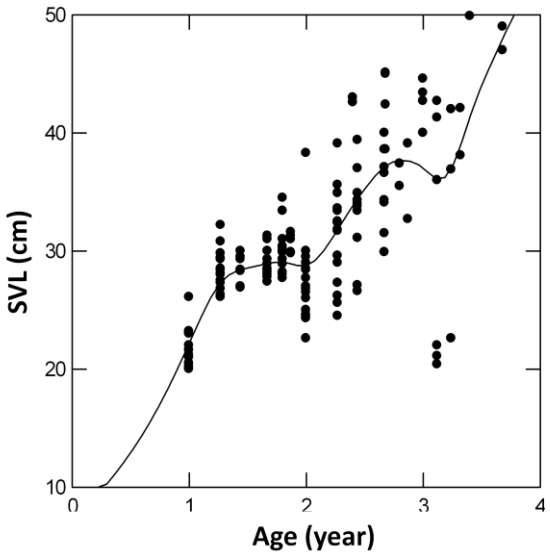


Fig 9. Size-at-age (Snout-Vent Length relationship, on a distance weighted mean least square (DWLS) to highlight the polyphasic nature of the relationship, of *Caiman latirostris at* the Três Marias Reservoir, southeast Brazil.

3.3.3. Effect of environmental variables on growth rates

The growth rate data set was also analyzed to verify the effect of environmental variables on individuals´ growth rate. The rainfall between recapture periods was analyzed to test its effects on caimans´ growth rate. Analyzes has showed that the relationship between rainfall and growth rate was positive and significant for both SVL (r^2=0.175; n=111; p<0.001; Fig. 10) and Body Mass (r^2=0.207; n=111; p<0.001; Fig. 11). Although the p values were significant the r^2 were low, which means that others important environmental factors that were not analyzed during this study may have a greater impact on growth rate.

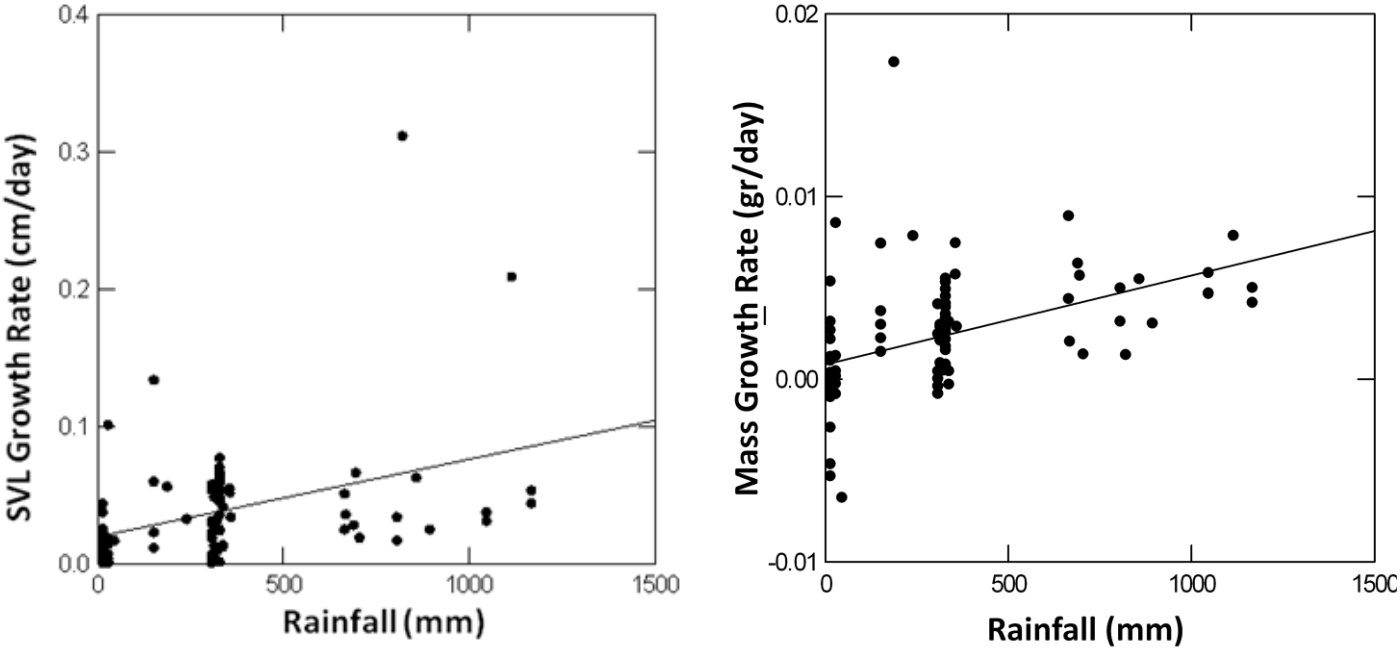


Fig 10 and 11.Relantioship between Pirapitinga Ecological Station rainfall between captures and *Caiman latirostris* snout-vent length(cm/day) and mass (gr/day) growth rates.

Another relationship analyzed was water level effect on growth rate. From a linear regression it was possible to observe the positive and significant relationship (r^2=0.12; n=104; p=0.001) between the SVL growth rate and the water level dynamics (Fig. 12). A linear regression equation was also calculated for the relationship between mass growth rate and water level (Fig. 13). This relation was also positive and significant (r^2=0.17, n=104, p=0.000), but again r^2 values were low.

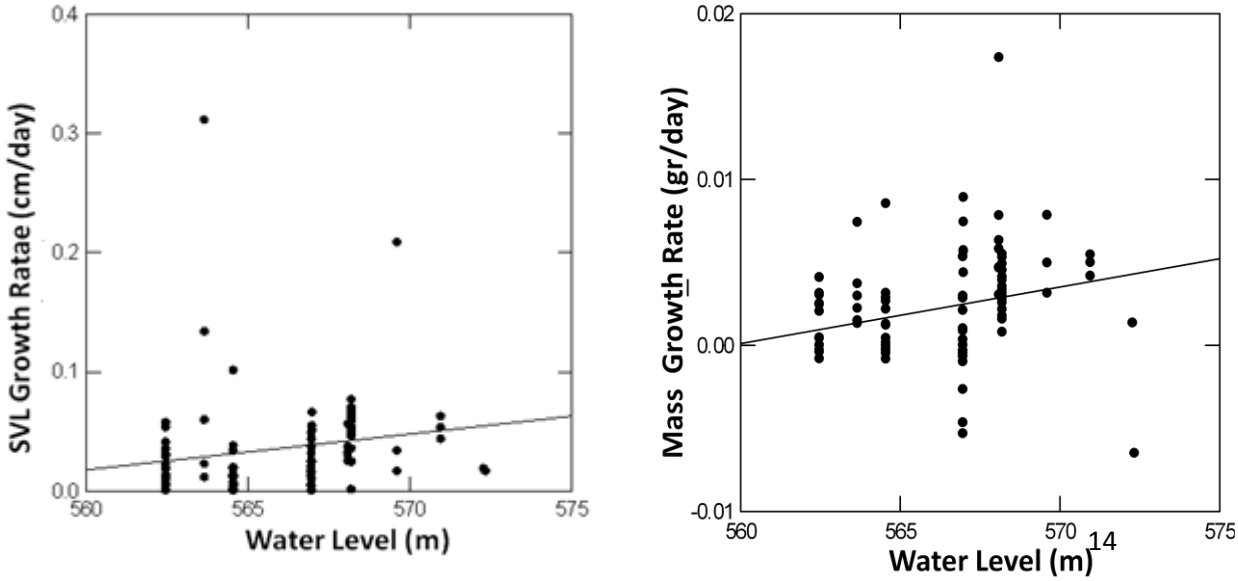


Fig 12 and 13. Relationship between Três Marias Reservoir´s water level and C*aiman. latirostris* snout-vent length (cm/day) and Mass (gr/day) growth rates.

4. DISCUSSION

4.1. Population Structure

Based on the data collected during this study it is possible to observe that the caiman population at Três Marias Reservoir has a size structure biased towards juveniles. Monitoring studies with others crocodilians species had showed that size structure biased towards juveniles can be associated with an increasing population (Brandt 1991). The low rate of encounter of sub adults and adults (Classes III and IV) may be related to wariness rather than to a lack of caimans representing these size classes. Although larger individuals generally occur in open water and should be easier to detect (Espinal and Escobedo-Galván 2011), adult individuals accounted for a small part of the ESEC Pirapitinga caiman population. The differences in wariness or activity level of these animals may have affected the count results during spotlight surveys.

Individuals might become wary of humans as a result of negative experiences associated with hunting, capture, surveys and habitat alteration (Espinal and Escobedo-Galván 2011, Webb and Messel 1979, Pacheco 1996). The presence of fishermen with boats and fishnets along the reservoir might be causing enough disturbances to increase the animals´ wariness and human avoidance.

The sex ratio found for the caiman population at Pirapitinga Ecological Station was similar to the one expected for a crocodilian population of 1:1 (Thorbjanarson 1997) without hunting pressure (Mourão and Campos 2004). The lack of difference on

sex ratios between juveniles and adults suggested that mortality rates are similar between sexes within size categories.

4.2. Caiman Distribution

The caimans´ distribution along the reserve margins could be associated with the presence of vegetation. The ecological station margins can be divided into the east margin, bathed by the São Francisco River´s original riverbed, with rocks and more susceptive to wind and waves, and the west margin, bathed by the flooded area, with mud, grasses and shrubs on the margin due to its wind protection. The animals' presence was recorded only on the grassy margin, which is expected to offer refuge and greater food availability.

4.3. Effect of environmental conditions on night counts

During the wet season, grasses and shrubs grow along the shoreline of the reservoir providing refuge for caimans (Silveira et al. 1997), especially hatchlings and yearlings, which decreased the visibility of individuals at the reserve´s margins. On the other hand, with the high water level the main lake is connected with smaller lagoons and creeks around it making it possible to reach those other habitats, which were unreachable during the dry season. The lack of significance for water level and night counts might be related this methodological constrain.

4.4 Survivorship Estimates

High mortality of caiman hatchlings during their first year of life was expected, theirs small size and the fact that they aggregate in crèches in the shallow waters make them an easy target for different predators (Coutinho 2000). In a predator free environment the survivorship rates for the first year tend to be higher. Piña et al,

(2003) found that in captivity, depending on the incubation temperature, the *C.* latirostris survivorship rate in the first year can vary between 50 to 80 per cent.

The survivorship rate of the age class 2 to 4 years can be explained by different reason. Individuals are still small to have many predators species (Coutinho 2000). Survivorship rates can also be related to movement patterns and not only mortality. Webb and Messel (1978a) found that for *C. porosus* after 13 months only 42% of hatchlings were found near the nesting sites. Hatchlings could be found in large groups, but as the individuals grew they tended to dispersal from their original sites, although the reasons for this and observed patterns are not clear (Magnusson 1987).

As individuals grow they become more wary and difficult to catch, consequently affecting their frequency of catch (Pacheco 1996). Individuals may become wary of humans as a result of negative experiences associated with hunting, capture, surveys or habitat alteration (Espinal and Escobedo-Galván 2011, Webb and Messel 1979). Thus there was, probably, a problem with the sub-estimation of older individuals so, the data might be sub estimated for larger individuals and in reality, the survivorship rate could be higher.

4.5. Characteristics of Growth

Caimans in the Pirapitinga Ecological Station showed a polyphasic growth. Caimans´ polyphasic growth can be associated with different factors, including water level, size, age and dietary shifts (Coutinho 2000). At least three growth phases could be recognized. The first phase is characterized by high growth rate immediately after hatchling. Growth decreased in the second year of life, and then increased again

during the third year of life, and by the end of the third year growth rate decreased again, when individuals reached about 40 cm SVL.

The relationship between age and size is perhaps the most fundamental of all crocodilian life-history traits (Webb and Smith 1987) because it allows maturity and senescence to be estimated and can then be related to the population age structure (Wilkinson and Rhodes 1997). The data showed some differences in growth rate associated with age, this fact could be associated with the dietary shift that is expected to happen (Coutinho 2000). Caimans, when hatchlings, will prey mostly on invertebrates, but a diet composed of invertebrate prey is not energetically compatible with accelerated growth as individuals increase in size (Coutinho 2000). When they change their feeding habitat, the gains in energy from preying upon other (vertebrate) sources of food could then explain the changes in growth rates (Coutinho 2000). A number of studies have showed an increase in body size related to larger prey size for different species of crocodilians, such as *Crocodylus porosus, Alligator mississippiensis, Crocodylus. niloticus, Crocodylus acutus* and *Caiman crocodiles* (Webb et al. 1978b).

Growth rates can be affected by the different challenges faced by animals in the wild such as low temperatures (Lang 1987) and shortage of food (Rice 2004). In captivity, those stressful variables are controlled leading animals to an optimal growth. Piña and Larriera (2001) in a captive experiment found growth rates ranging from 0.18 and 0.03 cm/day for SVL and 1.77 and 0.08 g/day for body mass using different temperature treatments. The caimans growth rates found at Três Marias reservoir (SVL 0.03cm/day; BM 2.00g/day) are similar to those found by Piña and Larriera (2001) even with the challenges faced on their environment. With this is possible to infer about the habitat quality provided by the reservoir.

4.6. Effect of environmental variables on caiman growth rates

Crocodilians are a climate-sensitive group, highly dependent on natural climatic conditions, especially thermal parameters and local hydrology (Markwick 1998), variations in water level and temperatures can affect their ability to find and digest food and consequently their growth (Webb et al. 1978, Piña and Larriera 2001).

Caimans have an opportunistic feeding habit which can be favored by the increase of plants along the margins associated with the rainy season (Fonseca, 2005), the vegetation growth can provide hiding places for individuals while they ambush theirs prey. The rainy season can also be associated with abundance of animal life (Fonseca, 2005), the increase of food available can encourage caimans ´growth.

The relationship between caiman growth rates and water level was significant and positive. The high water levels allowed caimans to exploit new feeding areas and to remain for long periods on the edge of or amongst the vegetation, in which insects, crustaceans and mollusks may have been abundant (Webb et al. 1978). The period of high water level is, normally, associated with the rainy season, which has higher temperatures, favoring caimans´ activity, digestion and, thus growth.

4.7 Conservation Implications

The broad-snouted caiman is a keystone species of great conservation concern due to its important role in the ecology of the watershed. With the data collected after almost two years of field work is possible to infer that the ecological station´s has a conservation importance for the broad-snouted caiman, the large number of juveniles found seems that the area is a breeding site and that the population might be increasing .

Despite all the impacts of damming, like the habitat modification, the caimans seems to be resting showing that the reservoir has had limited effect on the species population dynamics.

The ecological station and the reservoir both have a great potential for caiman conservation and management. However, more surveys in the area are necessary and will provide an even better understanding of the current status, allowing the development and implementation of strategic conservation and management plans.

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