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Reproduction of the Atlantic Bushmaster (*Lachesis muta rhombeata*) for the First Time in Captivity

Rodrigo C. G. de Souza
Serra Grande Grande Center for *Lachesis muta* Breeding
Itacaré/Bahia
BRAZIL
lachesisbrasil@hotmail.com

Introduction

Captive reproduction of *Lachesis muta muta* was achieved in the '80s at the Dallas Zoo (Boyer et al., 1989). Ripa (1994) published an account of the reproduction of the Central American species *Lachesis stenophrys* and *Lachesis melanocephala*. In this paper we present our experience in the reproduction of Atlantic bushmasters in captivity for the first time, involving parental (male and female) DNA from two (maybe three) different couples.

Materials and Methods

It took us five years of environmental education to avoid unnecessary killings and to form the groups (de Souza, 2006). As Ripa (2002) points out about our work: "de Souza's Project *Lachesis* in the Atlantic Forest of Brazil, is a real bushmaster 'farm' where nuisance bushmasters colliding with encroaching development are housed in outdoor enclosures separated only by screen barriers from natural rainforest surrounding them. . . . De Souza has constructed artificial burrows based on paca burrows and the snakes' inhabit these exactly as in nature. The snakes experience the normal rainfall, humidity and temperature gradients typical to the area."

Our first step was to select healthy adults weighing over 4 kg to ensure overall (not only sexual) maturity and good general condition, with some extra energy to spare. All of them were probed, dewormed and received a special diet in the "intensive" system, or individual boxes, prior to their introduction into one of four 2:2 groups, which occurred by the end of August 2006. To reduce and, maybe avoid altogether the possibility of loss of libido or sex drive, a problem already observed in colonies kept in small cages, the animals were communally kept for six months in large enclosures (up to 40 m^2 [430 sq ft]), built indoors in what we call "semi-intensive" system or outdoors in what we call the "extensive" system, both in prime *Lachesis muta rhombeata* territory, the Atlantic rainforest.

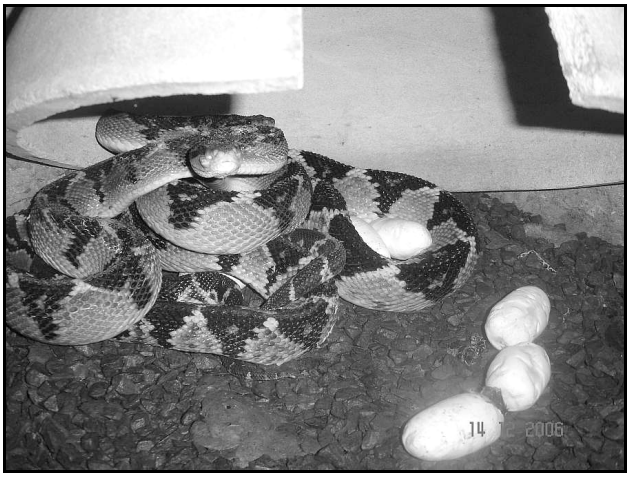
In late September 2006, during a series of cold fronts and thunderstorms, two of the four groups displayed indirect signs of sexual activity (male combat): destruction of plants, large water bowls flipped over, uncoiled animals seen "side by side" by one of the keepers. On 14 December, we performed an egg search in these two enclosures and found one clutch in each group, totaling 18 eggs. The fact that some of them could not be separated from their clusters suggests egg-laying a few days prior to the discovery.

In our region, cold fronts usually occur in September/October, bringing sudden temperature drops and rising humidity levels, a condition that Boyer et al. (1989) showed to trigger hormonal response in female bushmasters. If mating takes place during these months, egg-laying will happen in the "dry" season (January through March) when flooding is less likely to occur. In our experience, this apparently logical and evolution-oriented calendar seems to be fiction, and there's no such thing as a "breeding season" for bushmasters in the wild. We recorded actual mating again on 4 January 2007, during an unexpected cold front. Egg-laying should take place some 100 days on, coinciding with the beginning of the wet season.

Eggs found in an outdoor enclosure

The "no breeding season" idea is also supported by the fact that in any given 12-month period, we detect no pattern in the size, thus age, of the animals we encounter, which vary from a couple of months old, up to "teens" and young adults.

Based on previous experience, our main concern was to keep insects in general and, particularly, a very small fly (about one-quarter the size of a typical *Drosophila*), endemic in our region, from getting to the eggs. The problem was that,



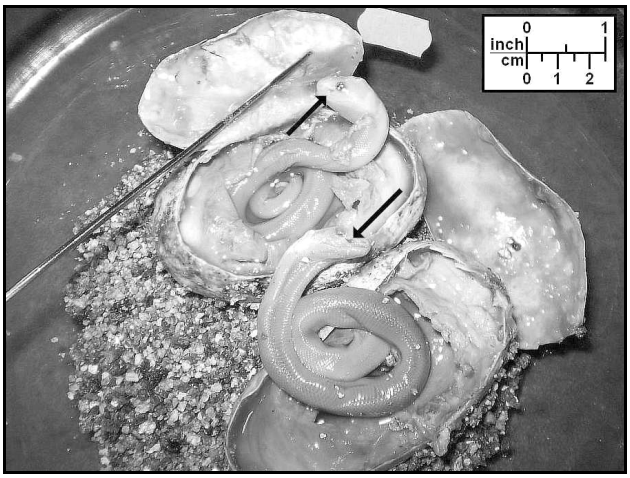
Eggs found in the indoor enclosure

while we had to guarantee that the protection would be tight enough to keep these flies away, normal egg metabolism had to be preserved. Since we had no information regarding gas exchange of the eggs, we decided to conduct a simple experiment to test if our protection scheme (more below) would allow normal metabolism of the eggs. The experiment was based on the reasonable assumption that the metabolic requirement of an egg is less than that of a small gecko (*Hemidactylus mabouia*). We placed a 4" specimen of this gecko under the same conditions as the eggs and were able to keep it alive and well for two weeks without any air renewal. Just to be safe, we decided to ventilate each bowl every third day and inserted insulin needles through the plastic film covering the glass bowls to serve as vents, assuring free gas exchange without compromising the protection against the tiny flies (circle in the picture below).

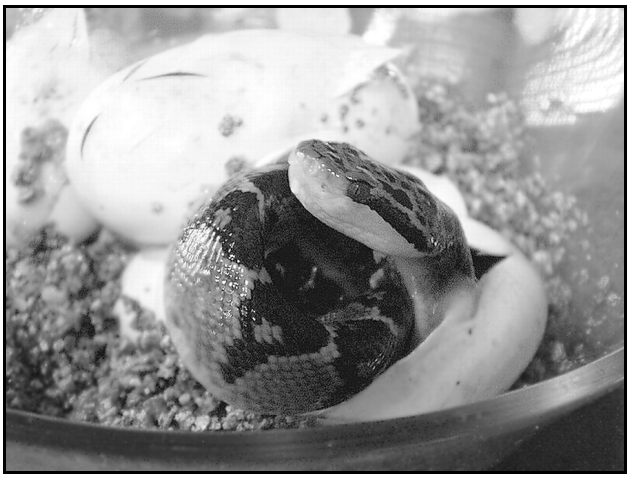
The chosen substrate was vermiculite, mixed 1:1 by weight with sterilized water. This vermiculite was kept in an oven at 300°C (572°F) for 3 hours and vacuum packed until needed, a month later. Fungi were not a problem. Since we are experiencing one of the hottest summers in recorded history, every 10 to 15 days each medium received 10 ml of sterile water (the same normally used in hospitals). The temperature in the Atlantic rainforest, where the vivaria and the eggs were kept, was naturally always between 25 and 28°C (77–82°F) and the humidity levels were always between 80 and 95%.

We decided to add some extra protection, an adapted 200-l (53-gallon) aquarium in which we placed the sealed glass bowls with the eggs when we found a rice rat (*Oryzomys* sp, a bushmaster's favorite) in the incubating room. These little guys are known to eat anything, eggs included.

The decision to follow common sense and avoid "placing all eggs in the same basket," dividing them in several bowls, turned out to be very important, because on the 50th day of incubation, one of the handlers in charge of the ventilation of the bowls, left one of them uncovered for 24 hours and, within a few days, the eggs shriveled up. Their shells became leathery and changed color, from white to a greenish yellow. The picture below shows these eggs with a window cut off, allowing us to clearly see the fetuses, with their loreal pits clearly formed already (arrows).



Out of 18 eggs (78–82 g each, 4 samples) from two different groups, one atresic egg was lost in the fourth day, two lost to flies in the 50th day and 15 babies (39–61 g, total length 43–49 cm) are doing fine. Hatching between 74–79 days at 75°F (25.4°C) average under 80–99% humidity levels. We credit the good success ratio to the cool conditions. The Atlantic rainforest, natural *Lachesis* territory, determined these atmospheric parameters; no electricity or technology was involved.



Manipulation of the eggs when they start "pipping" or when the snout starts to protude may lead to a twisting of the umbilical cord and nutritional deficit. Sometimes the neonate will take as long as 5 days to leave the egg and attempts to "help" or even to take good photographs may lead to harmful motion.

Conclusions

Following in the footsteps of Boyer and Ripa, we have achieved an important step towards the preservation of the highly endangered Atlantic bushmaster. Our observations lead us to conclude that there is no such thing as a "breeding season" for bushmasters in the wild. Every cold front is a potential breeding season for these rare, reclusive, demanding and highly specialized snakes, already faced with the destruction of 93% of their Atlantic rainforest habitat. For the second time, we observed apparent male/female guarding of eggs, behavior yet to be confirmed by further observation.

Acknowledgements

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