Notes of cases of aggression and ophiophagy by Bothrops jararacussu
(Lacerda 1884) in captivity

Nota de casos de agresión y ofiofagia por Bothrops jararacussu
(Lacerda 1884) en cautividad

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Abstract. Bothrops jararacussu is one of the most venomous snakes of medical importance in South America, mainly due to the toxicity of their venom and the large amount of that which can be injected in a single bite. The venom of this snake is required for the production, process and control of the therapeutic antivenoms used to treat Bothrops envenomation, so it is one of the Bothrops species common in Serpentariums located in Argentina and Brazil dedicated to the production of antivenoms. We reported two cases of ophiophagy due captive adult B. jararacussu females on Bothrops and Philodryas snakes and the aggression of specimens of this species is also described. Despite well known resistance to homologous venom of Bothrops species, the bite of this specie on other snakes of the same species and also other Bothrops snakes, produce serious injuries. These observations are important for professionals whom must maintain in captivity these species of snakes by educational or venom production purposes.

Key words: Ophiophagy; Natural resistance; Bite; Venom.

Resumen. Bothrops jararacussu es una de las serpientes venenosas de mayor importancia médica en Sudamérica, tanto por la toxicidad de su veneno como por la cantidad de veneno que puede inyectar. Su veneno es necesario para el proceso de producción y control del antiveneno terapéutico que se usa para tratar el envenenamiento por su mordedura, por eso es una de las especies de Bothrops comunes en los serpentarios de Argentina y Brasil dedicados a la producción de antivenenos. Por otro lado, dada la peligrosidad de su mordedura, estas serpientes suelen encontrarse en diferentes serpentarios educativos en los mismos países. En este trabajo describimos la ofiofagia de ejemplares hembras adultas de esta especie sobre ejemplares de Bothrops y Philodryas. También es descripta la agresión de ejemplares de esta especie a otros ejemplares conspecificos y de otras especies de Bothrops. A pesar de la conocida resistencia a los venenos homólogos que poseen los oídos, la inoculación del veneno de esta especie a otros ejemplares de la misma especie como a otras Bothrops produce lesiones de consideración. Estas observaciones son de importancia para quienes deban mantener ejemplares de esta especie en cautividad por motivos educativos o de producción de veneno.

Palabras clave: Ofiofagia; Resistencia natural; Mordedura; Veneno.

Introduction
Bothrops jararacussu (Lacerda 1884) (“yara-
racusú”: big yararaca in tupi language) is the
largest venomous snake in the South of South
America. This snake can be found in Misiones
province in Argentina, Paraguay and in South-
ern Brazil. Although there is a popular belief
that the size of this snake surpasses the 2 m
and it was described up to 2.2 m length (Milani
et al. 1997), the biggest specimen in the col-
lection of Butantan Institute of Sao Paulo had
1.77 m (Melgarejo 2003). Regardless the exact
maximum size of this species, it is clear that it
is one of the largest South American Bothrops.
Due to the females coloring, one of the names
that B. jararacussu receives is “tapete dourado”
(Freiberg 1968) or “urutú amarelo” (Belluomini
1971), which indicatein Portuguese its yellow or
golden colors (Figure 1).
**B. jararacussu venom is used for the production and/or quality control of some antibothropic antivenoms, so it is common to find specimens of this species in Argentina and Brazil Serpentariums for teaching and production purposes. The maintaining in captivity of these snakes for snake venom production is usually in individual cages. However, for teaching purposes the housing can be done in terrariums with individual snakes, or several snakes of the same species or occasionally of different species, (depending their behavior, the regular feeding and time of co-habitat of the co-habitant species) allocated in each box. Although they are not very common between *Bothrops* snakes, in our experience (mostly with *B. alternatus, B. diporus, B. moojeni and B. ammodytoides* specimens), accidents may only exceptionally occur. Nevertheless, in the case of *B. jararacussu* snakes, we observed a different behaviour regarding other *Bothrops*, like ophiophagy and aggression towards snakes, even towards conspecific specimens, causing important lesions, despite the well-known natural resistance to their own venom components that *Bothrops* species possess (Miranda *et al.* 1982; Tanizaki *et al.* 1991; de Oliveira and Tanizaki 1992; Lizoño *et al.* 1997; Oliveira *et al.* 2008, 2011; Thwin *et al.* 2010).

In this note, we present two observations on ophiophagy and two behavioural cases of aggression of *B. jararacussu*, in an exhibition terrarium of the Serpentarium of the National Institute for the Production of Biological (INPB) for the National Administration of Laboratory and Health Institutes “Dr. C.G. Malbrán”, of the Ministry of Health of Argentina, during 2006-2009 periods. Animals were under environmental controlled conditions, at 27 °C of temperature and humidity not under 30% with cycles of light / darkness of 12 h and were fed with mice or rats fortnightly.

**Cases presentation**

**Regarding the cases of ophiophagy**

1- An adult female of *B. jararacussu* (120 cm length approximately) and a specimen of *Philodryas olfersii* (60 cm length approximately) were housed together in a terrarium (1.80 x 1.20 m length approximately) with substrate of tree bark, sand, rocks, and soil, and with drinkable water (*Figure 2*). The terrarium was sealed to prevent snakes from escaping. After about 4 weeks of cohabitation, *Philodryas olfersii* specimen “disappeared” from the terrarium. The terrarium was vacuumed and the security measures were examined as well as adjacent sectors (which also had additional security measures) were meticulously registered, with negative results, showing that all the security measures were in order and the *Philodryas* could not be found. We therefore concluded that the only possibility was the ophiophagy of the *B. jararacussu* on *Philodryas olfersii*, considering the possible ophiophagy described for this snake (Martins *et al.*, 2002; Marques *et al.* 2004; Hartman *et al.* 2009). It is important to point out that despite the well-known ophiophagy in well-feed *B. jararacussu* specimens, in our experience, ophiophagy did not occur.

**Figure 1.** Adult female of *B. jararacussu*. See the black figures on golden background (sometimes the background is light grey).

**Figure 2.** *B. jararacussu* and *Philodryas olfersii* in the terrarium.
Unfortunately, inspection of the *B. jararacussu*’s feces, in order to find any undigested rests of the *Philodryas* specimen, could not be performed. The small body mass of this *Philodryas* snake (see Figure 2), turned impossible to infer if she was eaten by the *B. jararacussu* by observing the body (increased by the digestive content or not). However, the lack of chances to escape from the terrarium (sealed and locked) and the antecedents of ophiophagy described in *B. jararacussu*, strongly suggested that the *Philodryas* specimen was ingested by the *B. jararacussu*.

2- Another case of ophiophagy of *B. jararacussu* was observed on *Bothrops moojeni*. In a terrarium for exhibition, a little bigger than the one described above (around 2.0 x 1.5 m) which housed *B. jararacussu* and *B. moojeni* females, the ingestion of a female *B. moojeni* specimen (length around 70 cm) by a female *B. jararacussu* (length around 130 cm) was observed (Figure 3). We do not know if the *B. moojeni* was killed by the *B. jararacussu* or if she died of natural causes before ingestion. About an hour after ingestion, the *B. jararacussu* female regurgitated the *B. moojeni* snake (Figure 4). The external inspection, as well as the necropsy of death of the *B. moojeni*, showed no important lesions related to death from *Bothrops* envenoming, at least macroscopically.

Regarding the cases of aggression

1- Aggression towards *Bothrops moojeni*. In an exhibition terrarium like the one described previously, a female of *B. moojeni* was housed with a female of *B. jararacussu*, a deformation in the head of the *B. moojeni* was observed. The deformation, after inspection and palpation, proved to be an inflammation, which was associated with holes related with fangs. Given the possibility of envenoming by a *B. jararacussu* bite, a vial of Tetravalent Antibothropic antivenom (INPB-ANLIS “Dr. C. G. Malbrán”, immunogens *B. alternatus*, *B. diporus*, *B. jararaca* and *B. jararacussu*, prepared to be used in the Misiones Province, Argentina) was applied to *B. moojeni* specimen by intra-coelomic route. The animal treated stayed clinically normal, restoring the lesion to the normality with no external signs of lesions, or inflammation of head or venomous glands in a week. Unfortunately it died 3 months later of undetermined causes. It was nor possible to perform a necropsy.

2- Aggression towards *Bothrops jararacussu*. In a terrarium occupied by two specimens of
B. jararacussu only, an acute deformation in the head and in the face was observed in a 1.20 m length female B. jararacussu. In a few minutes, the lesion turned bigger and a hemorrhagic process could be observed in the eye of the affected region of the head, showing hipema (intraocular hemorrhage) (Figures 5a and b). The ocular structure, the periocular tissue and tissue from loreal zone were affected (Figures 6a and b). After 4 weeks, the inflammation reduced but the tissues of the region were seriously affected. Ocular structures with scares on the region of bite possibly with subcutaneous fibroses and loss of anatomical structure of the eye were observed (Figure 7). These lesions possibly affected the visual physiology of the eye and possibly the endings of Trigeminus nerve in the correspondent pit. None of these suppositions could be verified, although they seem to be very possible. Despite these important injuries, the snake spent several months until her death in the same terrarium. It was not possible to perform a necropsy.

Figure 5. (a) Inflammation of the left side of the face and the hipema (intraocular hemorrhage). In addition can be observed that the face and eye in the right side are not affected; (b) the same lesions taken over the snake’s head

Figure 6. (a) Details of ocular lesion showing the hipema and the lesion in the middle of the cornea. A slight edema in the pit can be observed. Alterations in the post and periocular scales can be observed; (b) the right side of the face without alterations.

Figure 7. Resolution of ocular lesion showing fibroses and loose of the intraocular structures by the clot in intraocular chameras, as well as the cicatrizaton around the zone injured.

Photo: http://www.anlis.gov.ar/instituto-nacional-de-produccion-de-biologicos.
Comments

Oophagy in venomous snakes has been documented for many years (Abalos 1968, Astart et al. 1985; Manzato and Serapicos 2010; Martins et al. 2002; Mendoza and Fernández 2011; Sasa et al. 2009; Schonland 1895). This behaviour could be determined by genetics and environmental factors (Polis and Myers 1985). Regarding environmental factors, the diet of a B. jararacussu includes ectothermic and endothermic animals as its preys (Martins et al. 2002) and oophagy, which seems not to be common (Hartman et al. 2009), has been observed occasionally (Marques et al. 2004).

Although oophagy was described in several species of snakes, in our experience of more than 20 years working with Bothrops, the only cases of aggression towards other adult snakes between Bothrops or oophagy of adult snakes were related to B. jararacussu. These cases were related to adult females and were not connected with the feeding with mice or rats, which can be associated with bites or ingestion of a snake by another one bigger while eating a shared mouse or rat.

We have observed that oophagy in B. jararacussu has been restricted not only to prey colubrids, as has been reported previously (Marques et al. 2004; Ribeiro 2008), but also to other adult vipers. No relation with starvation was observed, since in the two cases described, snakes were regularly fed weekly or fortnightly with rodents (rats or mice) in a controlled way. No relation with environmental conditions could be determined due all the specimens of B. jararacussu were housed in the same conditions since its inclusion in the serpentarium several months (almost a year) before the cases described.

We could not find common factors that could have been related to these episodes, with the exception that there were female snakes. Although it is known that Bothrops snakes have plasmatic inhibitors of venom components (Neves-Ferreira et al. 2010), and consequently resistance to bothropic venoms (Miranda et al. 1982), we observed important lesions in Bothrops bitten by B. jararacussu, including on other B. jararacussu.

Possibly the large amount of venom injected surpasses the capacity of the neutralizing components of the plasma, specially considering the huge amount of venom that this snake can produce and inject (Freiberg 1968; Rosenfeld 1971; Kaiser & Michl 1971; Belluomini 1971; Sánchez et al. 1992; de Roodt et al. 1998; Melgarejo 2003). If the plasmatic toxin inhibitors have a determinate molar relation, it is obvious that a large dose of venom can surpass their neutralizing capacity. If the amount of toxins surpasses the number of molecules of inhibitors in the plasma, the remaining toxins will act, since all the inhibitors would be bound. If that was the case, it reinforces the basic concept of Toxicology enunciated by Paracelso (Phileppus Aureolus Teophrastus Bombastus von Hohenheim, Toxicology’s father): Dosis sola facit venenum, which means that the toxicity is directly related to the dose.

In this case, despite the presence of neutralizing components in the plasma, the large amount of venom concentrated in one point determined the lesions caused by the venom of a snake of the same species, which can be seen in Figures 5, 6 and 7.

Lesions observed in the Bothrops bitten were compatible with local lesions produced in mammals by bothropic venoms. These local lesions are caused by components like metalloproteinases which degrade the extracellular matrix (Bjarnasson and Fox 1994) and by cytotoxic components like some phospholipases (Mebs and Owny 1990). The presence of natural inhibitors in plasma of South American snakes was described (Fortes-Dias et al. 1991; Tanizaki et al. 1991; de Oliveira & Tanizaki 1992; Soares et al. 1997; Lizano et al. 1997; Oliveira et al. 2008, 2011; Thwiset et al. 2010). Although not all these inhibitors were described in the plasma of B. jararacussu, it would be possible that these snakes possess similar components in their plasma as observed in other bothrops species. The venom of B. jararacussu in yield, biochemical, immunological and toxicological characteristics shows some differences regarding other bothropic’s venoms. One of the factors which could be related to these characteristics may be the diet of these snakes. In fact, in the diet of the B. jararacussu, species which are “resistant” to bothropic venoms were found. This is the case of Didelphis sp. (Melgarejo 2003; Correa-Netto 2007; Correa-Netto et al. 2010). These mammals have neutralizing components of Bothrops venoms in their plasma (Soares et al. 1997; Neves Ferreira et al. 2002, 2010; Surza et al. 2002) but probably the large amount of venom delivered by the B. jararacussu surpasses this resistance allowing them to pray on Didelphis. Although the oophagy of B. jararacussu was described (Marques et al. 2004; Ribeiro 2008),
the purpose of transmitting the cases described is to alert on *B. jararacussu* ophiophagy even in adult specimens, including on *Bothrops* snakes and the aggressiveness of this species when sharing environments, even with conspecifics. These factors can be helpful in the planning of normatives to house different species of *Bothrops* snakes in terrariums or in other types of habitats. In addition, it shows that despite the neutralizing components of the venom found in snakes’ plasma, important lesions can occur, even between snakes of the same species.

**References**


Correa Netto C. Estudo imunocuímico do veneno de *B. jararacussu* (Lacerda, 1884) e identificação de moléculas biomarcadoras como ferramenta para o desenvolvimento de diagnóstico..Master in Science Thesis. 2007. Instituto Oswaldo Cruz, Rio de Janeiro, Brazil.


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